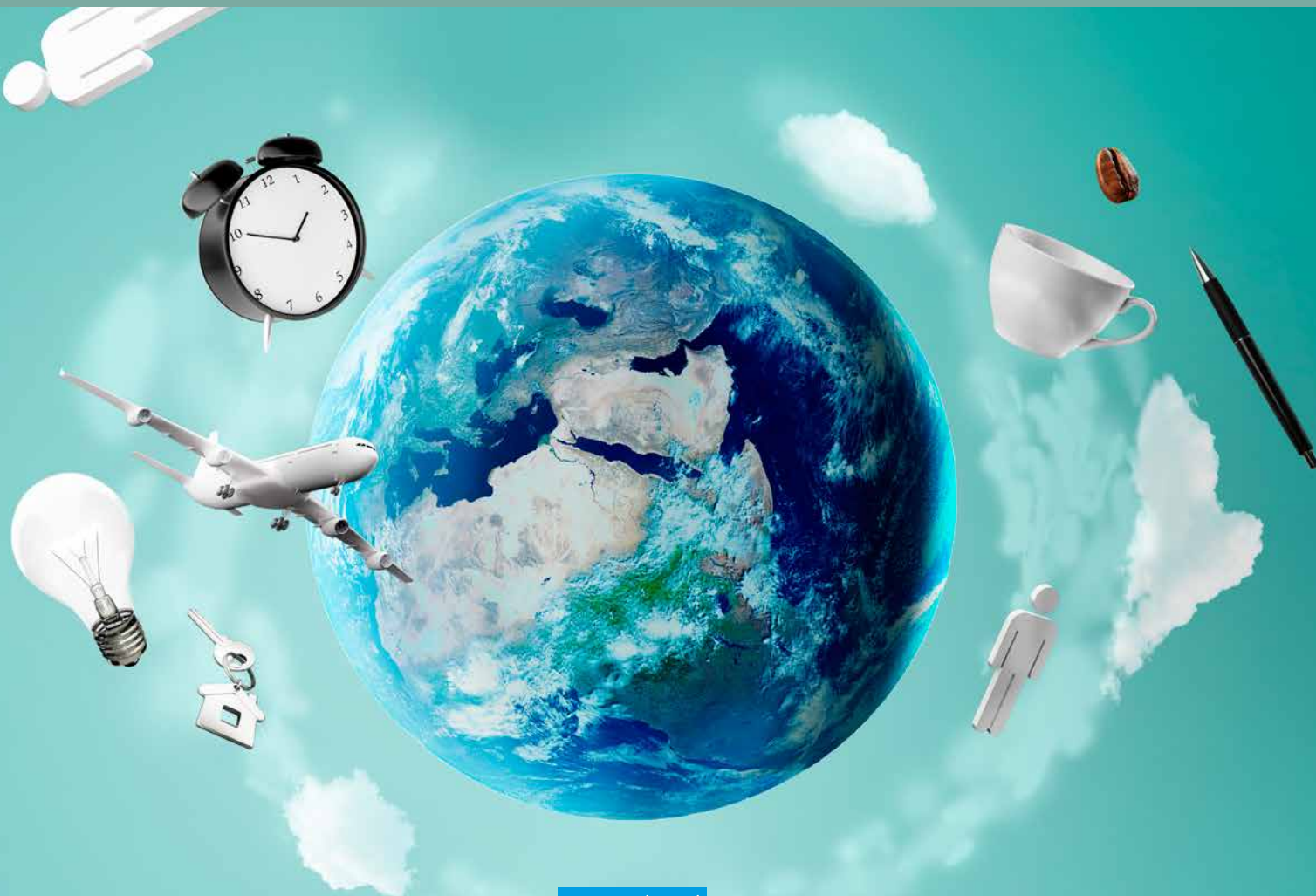





# Screening

## of Regulatory Framework

*Final Report*



*Research and  
Innovation*



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# Screening of Regulatory Framework

*Final Report*

13th November 2013

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Cataloguing data can be found at the end of this publication.

Luxembourg: Publications Office of the European Union, 2014

ISBN 978-92-79-34792-4

doi:10.2777/53146

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# Executive Summary

Combining regulation and innovation

To develop a screening methodology for regulation, two bodies of thought, namely innovation theory and practice on the one hand, and regulation theory and practice on the other hand were combined. Since innovation and regulation are in general treated separately, the methodology used here tries to overcome the shortcomings this creates by including three perspectives i.e., **an innovation, a regulatory and a stakeholder perspective.**

The screening methodology that has been developed here is built on individual steps which divide the screening process into manageable blocks. For each step the methodology suggests tools which help structure the step and to obtain insights that, at the end of the process, will enable those conducting the screening exercise to draw conclusions and consider regulatory changes.

From the **innovation perspective** the methodology uses an innovation systems approach, enabling users to identify and analyse barriers and drivers for innovation in a systematic way.

A clear taxonomy determining the direct and indirect innovation effects of a given regulation does not exist. Similarly, how regulations affect innovation processes is, to a large extent, unknown and the process remains a 'black box'. Depending on the choice of policy domain, many regulatory instruments and types of regulations may have direct or indirect, intended or unintended innovation effects in the shorter or longer run.

Thus, from the **regulatory perspective**, the methodology developed here allows the user to systematically screen a larger body of related regulation, not only the regulation that is directly focused on the sector/issue in scope. This could be a very extensive exercise indeed and thus, to put a boundary around the screening, stakeholders come into play:

**Stakeholders** have the best view on how regulation affects them. However, their views may be biased towards their own interests or be based on a limited overview. In order to obtain ideas on negative and positive effects on various groups in the innovation system a broad stakeholder involvement in identifying regulation that affects innovation is recommended. Careful planning is needed to ensure that all relevant aspects are discovered. How and if contrasting opinions are taken into account for any amendment remains a political decision. The approach described in this report sets out methods for undertaking stakeholder assessments including a checklist that can be used by stakeholders in order to help with identifying the more remote drivers and barriers.

This generic methodology was adapted and tested in the fields of water and raw materials, and since the EIP's priorities are rather broad they were then broken down and further analysed in case studies, focusing on the transposition of EU law in a specific, geographically bounded case.

Qualitative methods such as expert interviews, workshops and an online survey were tested and used to obtain useful inputs to the cases and feedback on the methodology design.

No straight cause-effect relationship.

Offering a broad set of methods and structuring approaches is the basis for a widespread use of the screening methodology. It **can easily be adapted** to individual cases by choosing and mixing methods according to available resources such as time, money, in-house knowledge or access to external knowledge by the screening authority.

However, the screening of existing legislation is a process which must keep in mind the fact that there are **structural characteristics** of the bodies of knowledge it will deal with which severely limit the value of searching for a single direct causal relationship:

- There is **rarely one isolated regulation** for any well-defined subject; in general, aspects from various laws, by-laws and other implementation rules can impact particular aspects and have innovation effects as well. Ideally, the various legal provisions are complementary but often they are overlapping and in the worst case they are conflicting. The exact measuring of an individual regulation's effects on innovation is, therefore, impossible and indirect indicators need to be used for estimating effects.

- **Regulation** as such is rarely an isolated driver, in general it **functions within a set of other drivers and barriers**. Identifying direct effects of regulation is possible but limited to isolated cases. The same regulation in another context can function with a different set of drivers and barriers to create different effects.
- Innovation effects of regulation happen often with a **considerable delay** and it is likely, between implementing regulation and the time it would take for its expected effects to be seen, that other factors may have increased in importance for innovation decisions or parallel existing regulation may have cumulatively caused the effects.
- Several case studies indicated that **innovation is not hampered per se by regulation** but rather through its implementation or enforcement in a specific environment. In general, it is instructive to compare the different implementation modes of laws in different settings and analyse differing innovation effects. In this respect, stakeholder meetings with experts from different countries can be a rich source of hands-on experiences in implementation practices. The involvement of stakeholders and experts may also prove to be a benefit when adopting new regulation as they encourage the taking into account of good practices from other countries or regions. Clearly, it is unlikely that a one-to-one transfer is possible given the varying local, regional or national circumstances, nevertheless comparisons can identify enabling conditions in which regulation promotes emergence and diffusion of innovative solutions.

### **Hampering and fostering regulation**

In terms of an assessment of specific regulation, the **water framework directive** (WFD, 2000) for example was found to have **stimulated innovation directly and indirectly** through quality requirements for water and stipulations on the use of best available technology. Infrastructure investments were necessary to varying degrees in the EU-15 and the, then, accession countries. Through the framework directive, the demand for water-related goods and services was induced. Being a stringent and reliable regulation, it signalled to European companies in the water sector a growing demand that was met through the diffusion of innovative goods and spurred the demand for innovative goods and services. The EU-internal demand for water goods was and still is mainly supplied by a growing European industry. Existing EU legislation, including several EU Directives are seen as important drivers as they provide 'room' for innovation by imposing stricter standards which require new technologies to meet them. Environmental regulations are more influential in promoting technological innovation in the water sector than economic regulation. However, regulation needs to be adaptable in order to address further challenges and remain a driver for innovation.

For the water (as well as the waste collection) segments addressed by the EIPs, governance is a key driver or barrier. Effective enforcement of legal requirements but also economic regulation, in particular pricing, play decisive roles for the behaviour of firms and end-users alike.

In terms of **recycling and the aim of fostering the use of secondary raw materials, current legislation is an innovation barrier**. Waste legislation basically aims to divert waste disposal away from landfill – with the effect that many countries have invested in incinerating technologies and infrastructures creating large capacities at relatively low cost for disposing of waste. This form is by far cheaper than recycling, which needs a thorough sorting and dismantling of complex goods prior to recovering useful materials. Recycling is also still too costly compared to buying new raw material. Since the price of the competing technology and raw material respectively are too cheap to pose a real driver towards recycling and the use of secondary raw materials, much **more demanding regulation, possibly in a package with fiscal measures is needed** to incentivise recycling, and to create demand and a new market for secondary raw material.

With water and waste, the study focused on two public sector regulated fields. For several innovation leaders, the sales of environmental goods in these fields are slowly decreasing. Other empirical studies suggest that a structural shift on the level of environmental goods for climate protection and air pollution can be seen. The regulatory instruments of the public sector-regulated fields differ from upcoming private sector innovation methods. For the water and waste fields command and control regulation were typically used, fostering the development of environmental goods. More holistic approaches within the private sector use integrated environmental protection measures. Integrated environmental protection methods are less tied to regulations imposing targets rather than to softer forms such as voluntary instruments (e.g., environmental management systems (EMAS), voluntary standards).

# 1 Introduction

Based on Commitment #15 for the EU and Member States of the Innovation Union flagship to “... undertake a screening of the regulatory framework in key areas, [...] with a view to identifying the rules that need to be improved or updated and/or new rules that need to be implemented in order to provide sufficient and continuous incentives to drive innovation”, Technopolis Consulting Group has been asked to develop a methodology for screening regulatory frameworks and to enable an assessment of their impact on innovation.

The assignment would:

- develop a methodology for the screening of regulatory frameworks, and
- apply the methodology on regulations defined through the two European Innovation Partnerships (EIP) *Water* and *Raw Materials*, specifically focussing on innovation effects.

This final deliverable includes the results obtained for the project on “Screening Regulatory Frameworks”, under Framework Service Contract Number B5/ENTR/2008/006-FC-Lot5.

The report contains the extended methodology for regulatory screening and draws lessons from interviews and workshops. Annexed is data as well as the case studies.

## 2 The relationship of innovation and regulation: conceptual background

Innovation is central in the EU policies for smart, sustainable and inclusive growth and plays an important role in tackling major societal challenges like climate change, ageing, energy and resources scarcities. The role of innovation for economic growth has been acknowledged widely in academic and policy circles. How to best foster innovation, therefore, has been a critical question over recent decades. A wide range of routes to innovation have been identified but truly ubiquitous patterns and, thus, one best way has not emerged. Many aspects of innovation are addressed in the theoretical and empirical work at different scales; how regulation influences innovation, however, is not a question at the centre of academic debate.

Empirical evidence (following in particular the Porter hypothesis (1995)) suggests that investments in environmental innovations have positive effects on firms. Since then, a number of studies have provided greater insights into the interplay of regulation and innovation. The main focus of this strand of analysis is on environmental regulation. The literature and empirical evidence suggests that innovation effects of regulation vary by different areas (Frondel et al 2007; Kammerer 2009) and are stronger due to national than non-national regulation (Popp 2006). Regulation plays a more important role for fostering traditional end-of-the pipe technologies whereas other measures such as environmental management schemes and cost saving attempts seem to be more important when it comes to the introduction of clean technologies or resource efficiency measures (Frondel 2007, Fleiter 2013). Positive innovation effects can thus be derived from regulation but regulation is not the sole or the best means to trigger innovation. Regulation (possibly in combination with framework conditions) can also produce losers – those negatively affected such as (innovative) companies that cannot or are not willing to afford the required costs or investments (e.g., investments needed for new environmentally sound technologies, costly certificates etc.). Their exit from the market may or may not be counteracted by new establishments benefitting from the regulation and favourable framework conditions.

The academic work focussing on the interface of regulation and innovation is largely descriptive since the relation between regulation and innovation is complex, most often indirect and often evolving over long time periods and, thus, bearing effects only after long time lags. There may also be intended and unintended, direct and indirect effects. Between the implementation and effects of a regulation, several other measures may have been introduced which may have triggered changes and, thus, factors other than the regulation may have influenced innovation.

In the absence of direct causality, researchers have used analogies. Grupp (1999) demonstrated in an econometric analysis the effects of crude oil prices on ‘environmental’ patents. The study showed that the innovation rate for resource and energy saving followed the oil price. Popp (2002) came to similar results and reasoned that if price has such a strong effect on innovative behaviour then “environmental taxes and regulations not only reduce pollution (...) but also encourage the development of new technologies that make pollution control less costly in the long run.”

The attribution of innovation effects to a specific regulation is methodologically challenging as well as strongly context dependent. So far, academic research has used either surveys such as the Community Innovation Survey (and their specific national surveys) or interviews in order to obtain better insights about the role of regulation in general (e.g., whether it is a driver or barrier to innovation). A straightforward indicator-based input-output scheme has for the reasons stated above, not been developed.

**Innovation effects of regulation**

In a study of the German Environmental Agency (UBA 2008), various environmental instruments were analysed for their innovation impacts. The analysis of individual regulations by type of instrument revealed varying innovation effects. Selected ones are summarised in the table below.

Type of instrument	Innovation effect	Comments
<b>Levy (fee, tax, charge,)</b>	+/- Predominantly fosters the diffusion of already existing technologies;  Levy needs to be high and credible to realise long-term innovation effects;	Works well in combination with command-and-control instruments but does not deliver beyond diffusion of existing technologies;  High environmental taxes provide a high incentive to innovate (Kemp 1997);
<b>Absolute liability (e.g. the German UmweltHG)</b>	+ Incentive to prevent potential harm.	Empirically no proven innovation impacts. Private sector seeks risk assurance models to prevent possible liability claims
<b>Command-and-control (ban, standards, ....)</b>	+ Primarily fosters diffusion of environmental technologies but not necessarily new technologies;  - Delayed innovation effects;  ++ Creation of new markets (incl. lead markets)	Important that flexibility and dynamics are built in (best available technology instead of threshold);  More effective if there are no exceptions;  Needs communication of long-term goals instead of frequent adaptation to provide better innovation incentives;  Linking to levy (e.g., a higher price for the use of the old technology) increases innovation effects.  Not the most cost-efficient instrument

The strict and early environmental regulation in Germany that is historically basically built on command-and-control regulation is often mentioned as a reason for the German dominant position on world markets for environmental goods and the German competitiveness (measured in terms of sales) in this field.

In Germany, there is a structural shift on the level of environmental goods: while public sector regulated fields such as water and sewage are decreasing in terms of sales, goods for climate protection and air pollution are on the rise. These are typical fields, where private sector environmental protection is required, fostering air pollution prevention and integrated environmental protection measures. The latter is tied to other regulative – often voluntary – instruments, such as environmental management systems (EMAS, voluntary standards).

The most often mentioned regulation fostering renewable energies (and thus, an important share of environmental goods and services) in Germany is the EEG, which guarantees renewable energy producers a degressive price for the supplied energy fed into the grid. The fixed price is paid by the grid owners – private electricity companies in general- but their

higher charges are shifted to the consumer.

According to the Mannheimer Innovation panel (ZEW 2003) which asked companies if and, if yes, which regulation had affected their innovation behaviour, one quarter of the surveyed companies reported an innovation effect. The most frequently mentioned fields with innovation effects were energy production (EEG, KWK, EnWG), material efficiency and avoiding dangerous materials (bans and regulations to reduce materials such as lead, quicksilver, solvents etc.), circular economy and recycling (end-of-vehicle regulation, waste regulation, packaging regulation). About 80% of the firms reported induced product innovations, 30% process innovations and 15% both types of innovations.

According to an R. Berger study (2006) companies in the 'sustainable water' area see a further need for command-and-control regulation as this is the most effective form of regulation in this field. In order to foster energy efficiency goals, stricter regulation (binding efficiency specifications) are seen as important regulations.

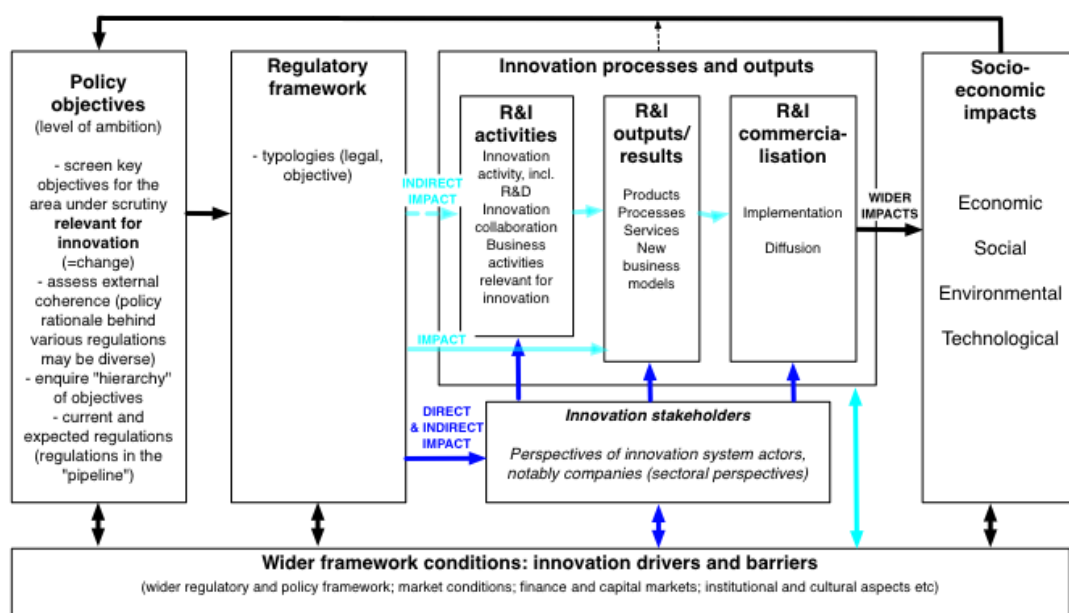
A competitive advantage of innovations induced through regulation is tied to the degree of internationalisation of the regulation. First-mover advantages due to early regulation implementation in the home market can be a strategic advantage for penetrating foreign markets. EU regulation in the field of emission standards helped German companies that had innovated in the field and had a lead position to widen their product markets.

International, consistent standards are equally important for a wider diffusion of goods. They decrease costs otherwise necessary for adapting products to regional markets as well as for regionally differing quality and security testing requirements. Again, a first-mover advantage can be obtained by the standard setting firm or group of firms.

The task of developing a screening methodology differs from previous academic work: its aim is not primarily to measure positive or negative effects of a given regulation but to provide policy makers with a sound approach to not only identifying a hampering/fostering regulation as such, but also to addressing the issue in a wider context; possibly enabling them to compare implementation modes and, thus, identify why and how a regulation is influencing innovation.

The study framework as depicted in Figure 1 captures the complex linkages between various conceptually different aspects of regulation that were taken into account during the development of the screening methodology.

Figure 1 Study framework



Source: Technopolis Group



Which regulation fosters or hampers innovation? The answer should be provided via the screening methodology. A systematic screening of all types of regulation however will be a quite laborious task, especially when regulation at various levels (EC, MS, and lower) is considered.

The complexity - or interrelatedness - of regulation, innovation, and framework conditions which shifts over time makes it difficult to identify and measure direct regulation effects.

This complexity requires the methodology to be adaptable for screening regulations in different fields and sectors, enabling users to identify and quantify the innovation effects in a robust and simple way. Since a purely quantitative approach is not feasible, the screening methodology takes into account three perspectives, trying to combine quantitative and qualitative information from the following pillars:

- Regulation (what are the effects of regulation on innovation),
- Innovation (what are the functions of a regulation for innovation),
- Stakeholders (qualitative assessment of the effects of a regulation on innovation)

These perspectives are combined with wider framework conditions, which look at (other) drivers and barriers for innovation.

The methodology thus provides a framework for a procedure intended for policy makers to analyse regulation effects on innovation in a given geographical and sector/technological domain.

The framework is called “a six step approach”, explained in the following section in greater detail. Whenever it is relevant the description will include examples from the two thematic studies that were conducted in parallel.

### **3 Six step approach for regulatory screening**

#### **3.1 The methodology: overview**

The methodology is designed predominantly for assessing existing regulation by policy making authorities. It can be adapted in order to be used in an area where new regulation is being prepared – it would then be a tool to identify possible innovation impacts which are not necessarily taken into account in impact assessment of new regulation by default with its focus on economic, social and environmental impacts.

The methodology can be used for analysing innovation effects for any level of regulation (EU, national, regional). EU regulation is in general intertwined with national level implementation and geographically determined differences in context and actors. Thus, if a national policy maker aims to analyse the regulation for a given sector or technology in his or her country, it is often indispensable to check on EU law.

#### **What do we mean by regulation?**

From an economic perspective, the term regulation is used to describe market entry mechanisms such as prices, quality or conditional entry. Means to regulate are bans, commands, obligations, prescriptions etc. While many regulations are sector/ or industry-specific, quality and security regulations tend to be found in all sectors of every industry.

Instruments of public regulations with a much broader aim than regulating markets are EU-directives, laws, decrees, but also technical norms and standards.

Regulation is defined by the OECD as “the diverse set of instruments by which governments set requirements on enterprises and citizens. Regulations include laws, formal and informal orders and subordinate rules issued by all levels of government, and rules issued by non-governmental or self-regulatory bodies to whom governments have delegated regulatory powers.” (OECD, 1997)

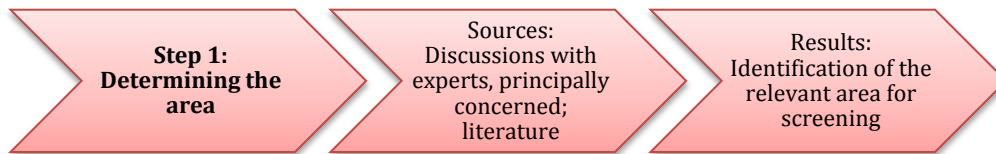
Figure 2 provides a graphic overview of the step-wise approach proposed for the assessment of regulatory impacts on innovation.

Figure 2 Six-step approach for regulatory screening

Steps	Result	Source
Step 1. Determine the area for the assessment	Identification of the relevant area for screening	Discussion with principal, (business) literature, policy documents
Step 2. Scope the area in focus	Evidence on innovation needs and identification of innovation stakeholders in the area	Policy documents, (business) literature, databases, expert interviews
Step 3. Identify innovation and drivers and barriers for innovation	Evidence on innovation activities in the area, drivers and barriers for innovation	Innovation literature (business) literature, expert interviews
Step 4. Screen regulatory landscape relevant for the area in focus	Overview of regulatory landscape possibly relevant for the area in focus	Regulatory literature, expert interviews
Step 5. Analyse links of regulation and innovation	Evidence on links between regulation (and wider policy framework) and innovation	Stakeholder views (workshop, interviews, survey), case studies, benchmarking
Step 6. Recommendations	Recommendations on regulation and/or wider policy framework	Earlier analysis

Source: Technopolis Group

## 3.2 Step 1: Determine the area for assessment



The first step of the methodology is **defining the area** for which the regulatory screening will be done. A screening may follow when stakeholders such as companies or consumer rights groups have voiced concerns or complained about a particular regulation or about existing regulations in a particular field which they think might be hampering innovation or affecting society negatively. A screening may also be carried out by policy makers in order to review existing regulation in light of current plans and likely future developments.

There may be two scenarios for policy makers: first, they already have a particular regulation in mind for which they want to analyse the impacts on innovation or second, they aim to identify the innovation-relevant regulation within a given technological field or an industry sector. The screening methodology is meant for existing regulation and it is rarely, if ever, the case that a specific law on its own is known as having the determining negative or positive innovation effects. Therefore, it seems more likely that a screening will occur within a given field taking into account the more complex innovation system and interplay of various actors, regulations, and framework conditions. The first scenario does not always need to use the full screening methodology since a particular regulation is already identified by policy makers and the focus of the study is clear. They will possibly use some core elements of the screening process only.

What can policy makers or public administrations do to identify the relevant regulations and framework conditions? In most instances, a discussion with the immediately concerned industrial stakeholders will be the first step. Ideally, consultation with stakeholders such as consumer groups, and other related industries will follow since they may also be affected directly or indirectly.

What is perceived as hampering for one industry can be seen as fostering by another, and views may change altogether over time. Strong environmental obligations may use resources (and thus profits) for some, and open new market opportunities for others. First movers and adapters to environmental obligations may at first complain about the obligation and added time and expense but, in the longer run, it can give them a competitive edge by allowing them to enter wider international markets.

Thus, a balanced analysis is necessary. This analysis needs to decide on its starting point, including:

- boundaries (e.g., by sector(s) or industries affected),
- type of regulation (e.g., EC directive or EC regulation; national law),
- by regulatory agent and level (e.g., looking at regional, national or supra-national level).

It is important but difficult to set the right level of focus which must neither be too narrow nor too broad. The risk of choosing too narrow a focus is that only a very partial part of the innovation system is studied - drivers and barriers for innovation may then not be identified correctly and available data may not correspond to the level at which the system is to be analysed. On the other hand, when the focus is too broad, the subject may be too diverse and coverage of too many factors necessary which will render it very difficult to identify the relevant drivers and barriers. Since the innovation effects seem to be determined by details in the implementation of regulation, a broad scope may also lead to too complex a system for the analysis.

In many cases, different political units, such as ministries designing regulations, may have different 'customers' and in the past may have issued regulations benefitting a particular stakeholder group which after some time begin to hamper the innovation activities of other groups. A lack of coordination among policy-making units and/or conflicting policy-goals may thus be the reason for a perceived sub-optimal regulation.

Once the area of assessment is determined, it is highly recommended that policy teams check with other political units (ministries, agencies) possibly forming an ad-hoc working group, which can serve as a first filter and information provider concerning “other” stakeholders as well as possibly conflicting goals in previous legislation.

### **The right choice**

**The two areas analysed within the assignment were politically (top-down) assigned. The two European Innovation Partnerships (EIP) on water and on raw materials were the two test beds. Within each EIP, consensus-driven priority setting was already achieved (in the case of water), or underway as in the case of the raw material EIP.**

**The priorities in the case of water are all very broad, partly overlapping in terms of industries concerned and in terms of innovations (e.g., the priorities of water re-use/recycling and water and wastewater treatment), leading to duplication in the quantitative analysis. The priorities are not backed-up by common statistical information and there are gaps in the data. Since the mid 1970s for health and since 1987 for environmental concerns, EU water regulation comes in the form of directives, transposed into national law and implemented locally. A plethora of regional or even local governance schemes forms the level at which policy is implemented creating a very wide variety of local innovation ecosystems.**

**Given that statistical information such as R&D investments, number of companies, employment and R&D personnel in companies or the public research sector, patents, or trade data for the various water priorities are not available for all member states either at state or regional level the researcher needs to work with available data, proxies or indirect indicators. For example, business R&D investment for 'Water collection, treatment and supply' is only available aggregated with 'Electricity, gas, steam and air conditioning supply'. Output indicators such as traded goods or patents can, however, be calculated although this needs extra effort and expertise with trade and/or patent data (see Section 4.3).**

**In the case of raw materials, there are two broad areas in the EIP i.e., recovery/recycling of waste and enhancing the raw materials/mining regulatory framework. Concerning the latter, there are framing regulations (i.e., Natura 2000 and the environmental impact assessments (EIA)) which are interpreted in different ways in their implementation at national level. The complex, often contradictory procedures at national or regional level taking up to several years, are identified as main obstacles.**

**When it comes to waste, the situation is very similar to the water case with EU-level directives, national and regional/local level implementation with a wide range of governance, pricing, and incentive schemes. Analysis at the priority level of the EIPs and the selected priority action lines for case studies showed a high level of interdependencies.**

**The EIP priorities for water and selected priority action lines where taken up in a number of case studies (see Annex). In the case studies, a focus on the local level (water collection in the greater Barcelona area) or national level (e.g., the strategic flood map in Northern Ireland, the introduction of WEEE in the UK) proved to be a much better level of analysis than the more generic priority. This is basically due to data and information inputs which are more likely to be obtained at national level than at EU-level.**

**However, in order to understand regulation effects and to obtain some idea of a benchmark (does it foster or hamper innovation effects?) a comparative view on implementation modes is helpful.**

**Thus, the definition of the area should be sufficiently narrow but in step 2, data and information beyond the national boundary should be collected and taken into account.**

### 3.3 Step 2: Scoping the area in focus



Once the area is defined, the next and decisive step is the scoping phase. In the scoping phase, the innovation needs in the area and the importance of innovation needs in the area for society should be integrated. Without real innovation needs, a regulatory screening for innovation serves little purpose. The scoping exercise is similar to step four of the impact assessment guideline of the EC, where interested parties need to be consulted, expertise collected and the results analysed. A further tool for analysing innovation effects of regulations is included in step 3. In the screening methodology, the analysis part thus does not only rely on step 2, but also on step three and step four which will provide insights that will be analysed together with the material collected here.

#### **What do we mean by scoping?**

**Scoping is a systematic exercise trying to identify and collect information which is then used for further analysis such as:**

- **What are the main innovation needs?**
- **Who are the main actors involved?**
- **Is there available data supporting the analysis?**

**The level of detailed information that can be collected will vary. For an analysis that starts with a particular regulation, a narrower focus may be sufficient in order to identify the range of affected actors. The more complex the subject matter is, e.g., starting with a broader set of regulations in a given industry, the broader the scoping exercise.**

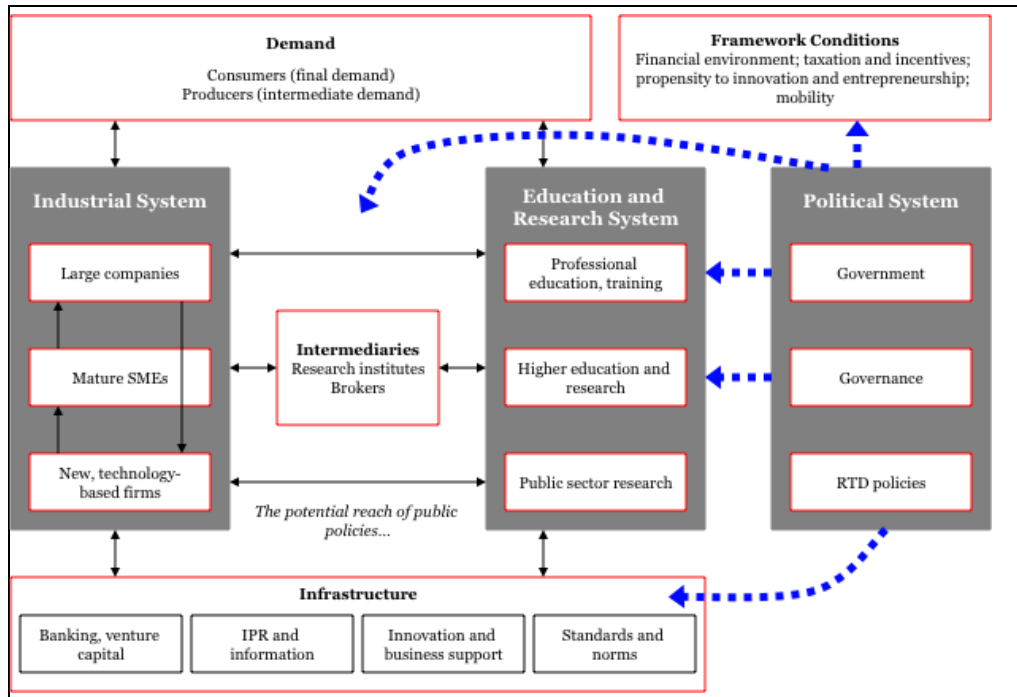
The main goal of this exercise is to systematically identify directly affected actors but also to extend the map outwards to those well beyond the immediate focus to try to get a well/rounded picture of the regulation and its impacts. To do this will sharpen the understanding about important framework conditions, drivers and barriers not only by collecting data, but also by obtaining expert and stakeholder views.

In order to catch the essence of the relation between regulation and innovation, one needs to take the complexity of innovation processes into account. For many years, a linear model of scientific finding, technological applications leading to innovations dominated the innovation research field and S&T policy making. This has changed over the last four decades with the approach of national innovation systems, which envisaged technological innovation as the result of social and economic processes, with numerous and frequent interactions and feedback loops between users and producers. This systemic perspective starts with two related basic assumptions:

- innovation is a multi-actor based process that depends on the interaction between different actors,
- innovation has a systemic character, and is a result of complex interaction between various actors and institutions.

The approach is used in a slightly adapted form on regional innovation systems and sectoral innovation systems. Whatever the focus of analysis, the framework presented in Figure 3 can guide the analysis and mapping of the actors and/or stakeholders that play a role in innovation processes. It differentiates three main sub-systems with each including different actors: the industry system, the education and research system, and the political system. These sub-systems are regulated by institutions. Institutions create ‘the rules of the game’ and provide instructions on how things are done. Demand-factors and framework conditions are factors that shape the institutions as well as the actors. Analysing an innovation system using this framework should lead to the identification of the main actors and main interrelations.

Figure 3 The innovation system concept framework



Source: Arnold & Kuhlmann 2001

We suggest focusing on the following aspects to be scoped:

- Social importance of the area: a short description of the role in society for the sector. This should include policy objectives for the area. Policy objectives can cover broad areas, including social (e.g., access to clean water for everyone; safe working environments), environmental (e.g., prevention of algal blooming) and business goals (e.g., become world market leader in water cleaning technology). Social importance can be backed by quantitative data, for example, reduced mortality rates due to voluntary or compulsory quality standards have an undeniable and beneficial social impact.
- Economic importance of the area: this is largely based on available quantitative data. The focus should include an overview of business turnover in sector and subsectors; employment figures, etc. It is also good to reflect on the global competition in the area.



- Table 1, below, describes some indicators that are available for most EU countries as well as the main competitors. National and regional statistical offices may have more detailed data not available from Eurostat. If economic data is used, it is useful to compare the home country position with other countries or the EU-28 average over a longer time period.
- Are there fluctuations in growth or is the rate constant? Maybe some data can tentatively be linked to regulation: the phasing out regulation on incandescent light bulbs (which is being implemented throughout many regions of the world with differing phasing-out starting years) will most likely show in R&D expenditure, patent and trade data. While bans are likely to have the most obvious direct and measurable effects, other types of regulation are less likely to produce clear effects.

Table 1 Indicators for scoping the economic importance

Theme	Indicator	Suggested source
Productivity	Production index, % change from previous year	Eurostat
Turnover	Turnover index, % change from previous year	Eurostat
R&D	Business R&D expenditure	<u>Eurostat</u> : BERD by economic activity and type of costs; industry data from associations
	Public R&D expenditure	<u>Eurostat</u> : GOVERD and HERD
	Patent applications per capita	<u>Eurostat</u> (NACE sectors); or <u>espacenet</u> : specific studies (e.g., for key technologies)
Employment	Gross employment, % change from previous year	Eurostat
	Absolute employment	Eurostat
Trade	Trade balance EU27 vs main competitors (volume/price)	<u>Eurostat</u> or OECD
Global Trade		<u>Eurostat</u> , <u>COMTRADE</u> , industry associations' data
Internal Demand	Final consumption expenditure (absolute or % change)	Eurostat

For the identification of innovation, various sources are available, however, **availability may vary between indicators and the selected level of analysis**. Indicators for environment, economy and innovation are often not available at the required level of detail (such as industry sector or regional geographic breakdown) for analysing impacts. Thus, choices need to be made for example by identifying proxy indicators. Ideally, the choice for selecting data and indicators will be informed by contributions from sector experts.

Data can be obtained without additional costs from: Eurostat using innovation expenditures or results from the Community Innovation Survey (CIS); specific data on country level or regional level (from public websites using Innovation Union Scoreboard or Regional Innovation Monitor); patent data can be downloaded from Eurostat as well as directly from the European Patent Office (EPO) servers. Information on the research sub-system can be obtained via an analysis of the participation patterns in EU research programmes (including FPs by way of CORDIS), or scientific publications. No cost alternatives like Google Scholar will often result in useful full texts, otherwise only available via a costly database access.

### Time aspects of regulation

An aspect not covered in the graphic but, nonetheless important for analysis, is time. This relates to at least two aspects: a regulation may have been introduced 15 years ago and remained basically unaltered ever since. An important aspect concerns the implementation time: if the period for transposition is longer, (say five to seven years), the chances are higher that radical innovations can occur. Short implementation periods (e.g., one to two years) favour incremental innovation since the available time for developing something more than incremental, requires more time.

Time lags are another factor to consider, in particular in command-and-control regulations which often refer to best available technology. However before best available technology is implemented via standards there are considerable time lags. Double-glazing with  $k=2.5$  was developed 1960. In Germany, it became an industrial norm in 1969. 1970 new insulation glass was developed the relevant industry norm was adapted in 1974. This was then the basis for the first insulation regulation (WschV) in 1977. From 1978 onwards, single glazed windows were prohibited for the construction of new buildings. A further development of heat-absorbing glass ( $k=1.5$ ) by 1980 was taken into account for the review of the regulation in 1984, superglazing ( $k=1$ ) developed by 1990, followed in the second revision in 1995. The long sequence between technical state of the art and its adoption in regulation needs to be taken into account because once a regulation is issued the best available technology as codified in the technical norms may already not be the latest state of the art. By imposing thresholds based on codified best available technology, a typical command-and-control regulation may thus be not sufficiently demanding to foster innovation effects.

Where possible, **time series should be used**, this could give indications on whether there are changes in innovation activity at certain points in time (that may coincide with changes in regulation).

### What do we mean by proxy indicator?

It would be ideal to be able and measure the impact of a policy measure such as a tax break, a research programme, or a law on the innovation outcome of a given industry. Since the innovation process is complex, cumulative and very much interlinked, we generally lack a clear direct measurement of impacts such as 'tax break x led to y new innovations in year 1, year 2, year 3', etc. While a causal relationship can be made only in exceptional cases, the main tool is to use indirect measures that seem to represent the phenomenon in the absence of a direct measure.

Patents for example are often used as an indirect or proxy indicator for innovation although in fact they are first and foremost signs of inventions

The interpretation of comparable economic data often needs further insights. Why is country 'A' performing differently to country 'B' for example in the growth rate of innovative firms in sector 'C'? In particular in the case of an EU regulation that has been transposed into national law it is useful to obtain information about different institutional settings i.e., when and how the law has been transposed. To some extent, this may explain seemingly varying economic and innovation performances. Thus, in order to obtain benchmarks, it is useful to look at how something is done in other countries. This is often a more **qualitative analysis**, trying to explain how things are done elsewhere.

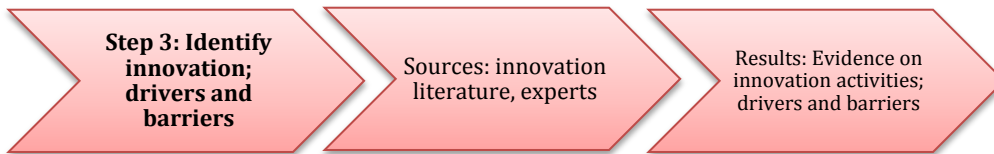
Identification and description of the **stakeholder groups** (public, private, NGO's), their role and their importance: innovators and other stakeholders inside the sector ecosystem (e.g., environment groups) are most likely to be aware of the effects of regulation on innovation. Therefore they will be the prime target group for obtaining feedback. A regulation can produce winners and losers, thus it is useful to identify not only the industries directly affected by a regulation, but also other indirectly affected ones. This can include producers of alternative products or different actors from a given value chain.

**Sources** for identifying these innovators and innovation stakeholders are varied, ranging from simple desk research for the identification of databases, experts, or industry associations. Policy documents, (business) literature, statistics (e.g., Eurostat), and market reports can be used as sources, leading to the identification of innovation stakeholders as well as individual product or process innovations. Interviews with identified experts in the area can be a quick way to get a good overview of the area in question.

- **If possible, quantitative information should be used in order to get a clear picture of importance of the area and the relation between ambitions in terms of expected outcomes and real achievements. Qualitative feedback from various stakeholders is vital for a better assessment of the regulation effects on innovation.**

The results of the research leading to the scoping of the area should be laid down in a short paper. It will serve as a reference and background material for further analysis, as well as discussion with experts. It can be thought of as a work in progress – new insights from stakeholder meetings or interviews can be incorporated throughout the screening process.

### 3.4 Step 3: Identifying innovation; drivers and barriers for innovation



Regulation has intended and unintended, direct and indirect effects on innovation. This step is providing two analytical tools which can help to structure the basic reasoning for the scoping exercise and help with identifying framework conditions that influence innovation either directly or indirectly via regulation.

Step 3 offers some classifications that can be used in order to analyse the innovation process in light of regulation in a systematic manner. Regulations are designed in order to achieve specific aims (in most cases innovation will not be among the core aims) and indirect or unintended effects may occur. Direct regulations such as command-and-control types that have been common in environmental regulation, can relatively easily be associated with direct and intended innovation effects. However, given the complexity that comes with varying procedural requirements stemming for example from an EIA type of regulation, there may be a number of indirect and unintended effects which are more likely to be grasped by using the right analytical scheme.

The following section 3.4.1 includes very basic classifications with the advantage that they are equally the basis for available data (e.g., in the Community Innovation Survey). Others are more complex and would possibly pose a heavy burden were an attempt made to use them rigorously. From experience with the methodology, choosing the classification according to the circumstances of the case seems to be a practical and effective approach.

The section also includes a section on wider drivers and barriers that can be used in order to identify aspects that shape regulation which then influence innovation.

#### 3.4.1 Identification and description of innovation

Three different conceptual approaches related to innovation should be kept in mind when describing/analysing the innovation:

- Innovation types (such as product, process, organisational innovation);
- Radical (disruptive) or incremental innovation.
- Innovation phases (from non-oriented research, through applied research, prototyping, commercial applications, etc. to market diffusion);

These classifications are helpful since specific types of regulations may not influence the full innovation process but for example exert more power in one phase compared to the other.

In the analysis and the case studies for this report radical innovations were not identified. Several regulatory instruments foster incremental innovation or are simply helping to diffuse existing products. More difficult to identify and in particular to quantify are process and organisational innovations. They can be captured only through surveys or interviews with relevant stakeholders.

### 3.4.1.1 Innovation types

The OECD presents a classification in four types of innovation in its 2005 update of the Oslo Manual on Innovation.

Table 2 OECD innovation classification

Type of innovation	Description
<b>Product Innovation</b>	The introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics
<b>Process Innovation</b>	The implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software
<b>Marketing Innovation</b>	The implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing
<b>Organisational Innovation</b>	The implementation of a new organisation method in the firm's business practices, workplace organisation or external relations

Source: OECD 2005

This classification is widely accepted and provides a useful framework for analysing the expected effects of regulation on innovation. For instance, a 'moving emission target' for companies may steer them in the direction of process innovation while limiting product innovations due to opportunity costs.

### 3.4.1.2 Disruptive vs. Incremental Innovation

'The Innovator's Dilemma' (Christensen 1997) presented a distinction between incremental and disruptive innovations and their effects on businesses. In general, disruptive innovations have larger social and economic consequences, however they are relatively rare. Disruptive innovations have three main characteristics:

- Initially provides inferior performance,
- Adopted by a market which is currently underserved,
- Have a steep improvement trajectory.
- Table 3 describes the key differences between disruptive and incremental innovation.

Table 3 Disruptive and Incremental Innovation

Incremental Innovation	Disruptive Innovation
Built on existing knowledge and resources	Requires new knowledge & resources
Competence enhancing	Existing competences lose value
Relatively small changes in performances/utility	Step changes in performance
Omnipresent	Relatively rare

Source: Based on Christensen (1997) and Davila, Epstein and Shelton (2006)

Whether disruptive or incremental innovation occurs is also to some extent determined by the regulatory regime.

### **Identifying possible innovation effects**

#### **Example: Ecosystem Services Approach to Water Management in Bulgaria and Romania**

In the EU, water management innovations based on the ecosystem services approach are rare. The Water Framework Directive (WFD) (2000), the key regulation behind the approach, takes a holistic approach to protecting water ecosystems. The legislation, however, only hints at the concept of ecosystem services and does not promote it explicitly. The provisions of Articles 5 and 9 of the Water Framework Directive have been considered a starting point for the development of payments for water ecosystem services and as a driver for the national authorities to start working towards assessing ecosystems, including aspects related to the cost of different externalities or adding the anthropogenic impact to the price of water.

Romania supported some pilot demonstration projects from 2011-2013 in this area promoting:

- **Governance innovation by introducing a new concept for governing and using water resources in ecosystem services schemes by the public sector**
- **Eco-innovation and social innovations, as it facilitates and trains private partners on how to develop ecosystem services schemes to achieve nature conservation objectives and develop the local communities at the same time**
- **The WFD mainly promotes the “polluter pays” principle and not the “beneficiary/user pays” principle inherent to the ecosystem services approach. The WFD does not, therefore, explicitly foster the function of the innovation system in terms of providing guidance and policy direction for the stakeholders towards a more widespread take-up of ecosystem services innovations. The flexibility of the regulatory environment means that the innovations are implemented slowly. Nevertheless, WFD leaves room for innovations by creating room for different compliance paths, which allows the stakeholders to experiment with the implementation of ecosystem services schemes.**

If water management innovations are implemented more broadly the innovation can be disruptive: it requires new knowledge and resources such as the development of methodologies for assessing the benefits brought by ecosystem services and their integration into policies and business models. Some existing technologies currently used for improving the water quality may become obsolete as the new measures taken to preserve the local water ecosystem may prove to be more cost-effective and sustainable. The pilots have the potential to drive governance innovation, eco-innovation business model innovation, as well as social innovation. The main industry sectors that are prone to changes stemming from the ecosystem service innovations vary; the sectors potentially influenced are the water utilities sector, the agro-industrial sector and the aquaculture sector.

### 3.4.1.3 Innovation Phases

Another means to classify the innovation process is by innovation phases. The classical linear innovation model as well as intertwined models (Grupp 1997) differentiate between various innovation phases, typically starting with a research phase, through the development phase to the invention and diffusion.

From a regulation perspective, these innovation-phases provide a useful grid to analyse regulations and to understand their effects in the different phases:

In the early invention phase new processes and products are developed. In this phase technical standards can be a barrier or a driver. If the new product or processes are 'out of the technical norm' they may face regulatory barriers since e.g., health or environmental effects need to be tested and existing regulation adapted in order to not restrict market entry.

In general, the scale of operations and the interaction with the wider sector environment become more important in the implementation phase. The products and processes are still new (sometimes not adequately regulated) and unexpected incidents may occur. Efforts to organise adequate regulation may be a major burden for the innovator in this phase (e.g., approval procedures for new medicines).

In the diffusion phase, major regulatory barriers related to the newness of the innovation have often already been overcome, however for new geographical areas, additional procedures may be necessary. Furthermore, an increased scale may require new regulatory efforts (e.g., Environmental Impact Assessments).

#### Box 5 Structuring by innovation phases

- **When and where to use the innovation phase structure?**

This approach is useful when the focus is on a technology or industry. Developing technologies can benefit from different types of regulation in the different development phases. It thus allows regulators and researchers to assess if they are planning to implement the appropriate type of regulation for innovation phase they are dealing with.

The innovation phase model was combined with the OECD classification in the case study on the WEEE Directive in the UK to structure innovation effects in the following way:

- **Product innovation by producers in the product design phase aimed at improved material efficiency,**
- **Process/organisational innovation by producers and distributors in collection mechanisms,**
- **Process/organisational innovation by waste treatment facilities and recycling companies aimed at improved recovery, recycling and re-use.**

### 3.4.2 Functions of innovation approach

A more holistic, but also a more laborious approach is to analyse the functions of innovations (Hekkert et al 2007). This approach takes into account system dynamics as well as system level activities and may, therefore, provide better insights into how regulation affects innovation than a static systems approach. The process of change (i.e., innovation) at system level is the result of many interrelated activities. The activities that (may) contribute to the diffusion and utilisation of new science and technology (both positive and negative) are called 'functions' of innovation systems. Over the course of time various crucial functions have been identified and tested. Annex Table 1 presents the set of functions.

The functions approach gives new insights into possible drivers and barriers, and to how innovation systems work. Robust indicators for the functions are however still under development and data on indicators are not always readily available.



### 3.4.3 *Drivers and barriers for innovation*

While one can conceptually focus on a given regulation, regulation is also a part of the wider sector framework conditions (such as tax rules, IPR laws, financial market regulations etc.). Regulation as ‘the rules of the game’ and the functioning of framework conditions may have a driving, hampering, or neutral function for innovation. Trying to identify the relevant framework conditions for a given problem analysis (i.e., the context of either a specific regulation in relation to its objective or the context of a given problematique), enables the policy maker to broaden their view and may be helpful for setting priorities in terms of trying to redesign regulations that are hampering innovation.

Analysing drivers and barriers for the creation of new markets, products and services, Annex Table 8 includes a longer list of factors that can influence innovation. The factors are classified under four main headings:

- Policy, regulation, governance;
- Economic and market
- R&D capabilities
- Socio-cultural

The list is certainly not all-encompassing but it includes fields which may not be on the immediate list of factors that a screening body would have in mind. Thus, the list can serve a purpose similar to the list of innovation functions above i.e., as an input to a creative brainstorming about factors that may be on the margins of the immediate realm of effect of a given regulation.

If one wants to identify relevant drivers and barriers from scratch one may depart from existing business models in the area to be analysed. Trying to explain why they work or why they don't can be a good starting point to identify the relevant factors.

## Drivers and barriers

### Analysis of barriers and drivers through stakeholders consultation

Expert panel workshops organised in both thematic studies (Water and Raw Materials) have been instrumental in analysing and prioritising the barriers and drivers.

Firstly, a preliminary literature review helped the research team to list and structure the important factors influencing innovation. This list was further used as a basis for discussion during the expert panel workshop. The experts provided their views on the relevance of each factor, provided additional explanation and suggested new barriers and drivers to be added.

The idea was to analyse the link of each barrier and driver with regulations (i.e., to assess whether it is caused by regulation). This required limiting the list of barriers and drivers and focusing on a few highest priority ones. An example of the list of barriers and drivers in Water area can be seen in Section 4.

### Use in the case studies

In the WEEE case study the dominant barriers are economic and market factors which would need to be reversed in order to turn them into drivers. A stringent implementation of extended individual producer responsibility or the introduction of material-specific targets could greatly increase the incentives for innovation but also have much larger (negative) side-effects such as a potential loss of competitiveness for the UK industry. The table below is an excerpt from the full analysis.

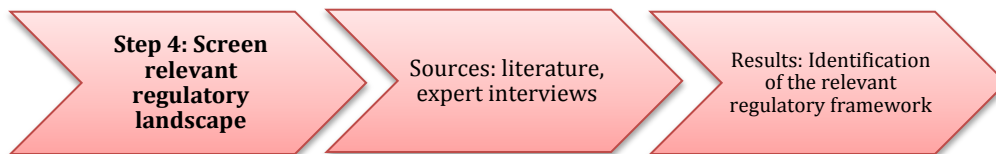
In the case study, the list of drivers and barriers was used as a starting point for the research. Identification of relevant drivers and barriers was done by literature review and expert interviews.

Factor	Driver	Barrier
<b>Economic and market factors</b>		
• <i>Current industry structure</i>	+ competition stimulates innovation and cost reduction.	--- most product design is globally oriented, while recycling (WEEE) regulation is national
• <i>Pricing</i>	+ markets for most of the recovered materials	--- prices are often too low and volatile, do not provide incentive to collect material other than ferrous metals
• <i>Market demand</i>	+ market demand for most raw materials + increasing attention/value given to rare earth metals/minerals	--- most of the supply chains are not oriented towards recovered materials such as plastics
• <i>Consumer market demand</i>	+ growing awareness of energy use of appliances	-- no real consumer 'pull' for resource efficient products or 'product-as-a-service' concepts'.
• <i>International competitiveness</i>		--- Recovery market is competing with low-labour disassembly in non-EU countries
<b>R&amp;D capabilities</b>		

<b>Research organisation structure</b>	+ waste research in the UK is increasing	-- there is no large technology institute 'pushing' new technologies
<b>Socio-cultural</b>		
<b>Environmental awareness</b>	+ WEEE fits into and supports a growing environmental awareness among consumers, although there is a threat of 'environment fatigue'.	- there is no tradition of consumers being responsible for waste collection beyond separation at home
<b>Policy</b>		
<b>Governance structures</b>	+ existing WEEE regulations offers flexibility to producers	--- lack of individual producer responsibility leads to a lack of individual incentives
<b>Demand-side innovation policy</b>	+ Existence of the SBRI innovation funding	-- No use of the municipal authorities often responsible for these waste collection facilities of the SBRI.

**This exercise helps identifying other relevant factors that impact innovation – within the specific regulation realm. In this case, the WEEE Directive functions in a complex set of actors (producers of EEE products, distributors, consumers, local recycling centres, and treatment facilities). The Directive's innovation impacts on these groups differs; yet, in order to obtain the expected innovation results of the Directive, it is essential to identify interdependencies. This may help to design better policies - including regulation – that can help to trigger innovation more effectively.**

### 3.5 Step 4: Screening of regulatory landscape relevant for the area in focus



While step 3 uses classifications and suggests a structural model to analyse innovation, step 4 can be done in parallel or sequential to step 3. It aims to identify the relevant regulatory regimes.

Good starting points are the OECD classification of regulation and the possible innovation effects as identified by Blind (Annex Table 2).

Blind (2012) used the OECD classification to survey literature on theoretical and empirical evidence on innovation effects of these different regulations' objectives, distinguishing between positive effects (innovation incentives) and negative effects (compliance costs).

Regulations are broadly categorised in economic, social, and institutional objectives. Environmental protection for example is classified under social objectives. They can stimulate new products and processes for example by requiring very high technical standards not met by currently existing products. They can however limit R&D budgets since compliance costs with the regulation may be very high.

The table leaves open the question of which effect dominates when and where. The Blind classification is useful to classify regulations by type and objective. It increases the understanding of expected positive and negative effects. Its use in empirical cases illustrated the highly contextual nature of both regulatory and innovation domains.

The result is an overview of possible relevant categories of regulation that can be used as a basis for the targeted approach of stakeholders in step 5.

### **Using the Blind classification in the case studies**

#### **The case of WEEE in the UK:**

**The WEEE regulations form a complex 'regulatory system' with institutional, economic and environmental aspects across multiple parts of the life-cycle of a product through the extended producer responsibility principle. Classifying the WEEE Directive and the UK implementing regulation using the Blind/OECD methodology, multiple aspects can be distinguished:**

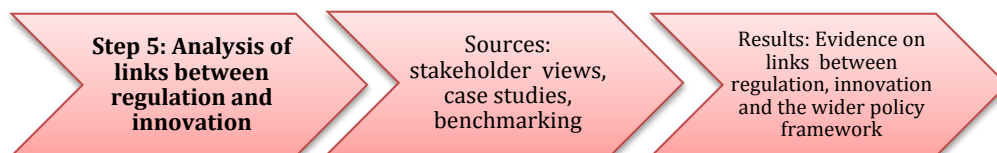
- **Social**
  - Environmental protection
  - Product and consumer safety
- **Economic**
  - Market entry regulation for compliance schemes, approved waste treatment facilities and exporters
- **Institutional**
  - Extended producer responsibility changes the institutional arrangements on product liability/environmental impact.

#### **The case of the landfill ban in the Netherlands:**

**Classifying the Dutch ban on landfilling and the waste policy since the early 1990's, one can distinguish the following aspects:**

- **Social**
  - Environmental protection by creating a disincentive for employing the least favoured options in the waste hierarchy that have the highest negative environmental impact
- **Economic**
  - Price regulation in the form of steeply rising tax rates for landfilling remove the economic disincentive for incineration or recycling
- **Institutional**
  - Producer responsibility introduced since early 1990's places liability for waste production on producers of goods and materials. Preferred options of waste prevention and minimisation become more feasible and paid for by the industry.

## 3.6 Step 5: Analyse the links of regulation and innovation



A definitive taxonomy determining the direct and indirect innovation effects of a given regulation does not exist. Similarly, we have no clear or complete view of how regulations affect innovation processes. Numerous case studies suggest some effects but currently we are far from the codification of agreed facts and characteristics that can serve as a basis for a robust analysis. Furthermore, depending on the choice of policy domain, many regulation instruments and types of regulations may have intended or unintended innovation effects as well as direct or indirect ones.

The analysis of the links between regulation and innovation should therefore be approached in a pragmatic way. Two frameworks that were developed from practical experience (Stewart, 2010 and BERR, 2008) are both a good starting point. Interaction with stakeholders (who are affected by regulation) can then help in more detailed identification of regulatory impacts.

In this step, it is again important to take time factors into account. Life cycle aspects should be taken into account, e.g., by comparing regulation that promotes large-scale implementation of present technology with regulation that promotes the development of options for new (more uncertain) technologies that may have larger societal effects in the future.

Since only parts are likely to be covered by available quantitative evidence, qualitative evidence ('story telling') is an important factor.

### 3.6.1 Stewart framework for relation between regulation and innovation

Stewart (2010) argues that a new regulation can change the regulatory regime (i.e., the total body of relevant regulation). This can be analysed by looking at three dimensions:

Flexibility - representing the number of implementation paths available for compliance.

Information - representing the degree to which a regulation promotes complete information in the market.

Stringency - measuring the degree to which a regulation requires compliance innovation and imposes compliance costs (also see Ashford, 1985).

Stewart measures the effects, like Blind, in terms of negative effects (compliance costs) and positive effects (compliance innovation). His approach, however, distinguishes between successful and unsuccessful or 'dud' innovations. By means of a broad literature survey across many sectors, Stewart identifies the effect on innovation based on these general properties (Annex Table 3).

Like the classifications described earlier, this approach provides added methodological insights to screen regulations as all the properties above can be attributed relatively independently by assessing the terms of the specific regulations. Unfortunately, just like the OECD/Blind classification, detailed knowledge on effects based on these properties is often missing or ambiguous.

**Testing regulations according to the Stewart framework**

**The WEEE Directive in the UK used the Stewart framework since the UK is just carrying out a revision of the regulation. The framework was used to structure positive and negative specificities according to the three dimensions.**

<b>Dimension</b>	<b>Positive</b>	<b>Negative</b>
<b>Flexibility</b>	+++ outcome-oriented requirements	- need to update when new product classes appear
<b>Information</b>		- compulsory collected data is not publicly available; producers cannot trace their individual products, they receive only average cross-brand recycling figures
<b>Stringency</b>	++ designed to work together with RoHS Directive	

**The *Building code* mandating the installation of rainwater and grey water harvesting in the new buildings in the Netherlands used the Stewart framework as well:**

- Command-control type of regulation which resulted in compliance innovation
- Flexibility is limited in case of new buildings (mandatory installations); for old buildings, it does not apply
- Allows flexibility in terms of choice of technology, which was helpful in switching to newer, more efficient technologies over time
- In terms of information provision, no specific standards have been communicated, however it also does not prevent information about the market for specific technologies
- Can be seen as disruptive regulation, as it pushes for a shift from traditional centralised water supply, to alternative decentralised systems and is also novel due to its recycling components

### 3.6.2 BERR framework

The study on regulation and innovation carried out by BERR (2008) finds six drivers, which determine the impact of regulation on innovation (Table 4).

The BERR framework is closely aligned to the Stewart framework and finds similar effects. The BERR approach adds a perspective on the importance on timing and differentiated compliance costs which may exacerbate effects for certain business types (e.g. SMEs).

Table 4 BERR framework

	<b>Effects on innovation</b>
<b>Prescriptive vs. outcome-based regulation</b>	Outcome-based regulation increases flexibility and offers more incentives for innovation. However, a greater level of uncertainty about whether individual solutions are accepted under the regulation may discourage innovation
<b>Stringency</b>	The most important factor: stringent regulation triggers radical innovation (from Ashford, 1985)
<b>Timing</b>	Evidence for an optimal timeframe for the regulation suggests that too short a time horizon results in less than optimal solutions (incremental innovation) while if it is too far out the effect is to delay investment
<b>Compliance costs</b>	Compliance costs are relatively larger for SMEs and may hamper innovation for this category of firms
<b>Regulatory uncertainty</b>	Mixed evidence
<b>Interactions with other government policies</b>	Regulations can have (positive or negative) synergy with the existing stock of regulation.

Source: Adaptation of BERR (2008)

An important contrast between the OECD approach on the one hand and the Stewart and BERR frameworks on the other is the former's understanding of regulation as the sum of individual legal provisions and a more holistic 'regulation stock' approach in the latter. The regulation stock can be seen as the sum of individual legal provisions but discounted for positive and negative synergies. As such it is more than the sum of its parts. While presenting a much more realistic perspective, the 'regulation stock' approach has significant drawbacks in terms of providing us with feasible methods of screening regulation.



**Example I: The use of the BERR framework in case of waste and secondary raw materials**

**Waste and secondary raw materials are now affected by several sets of regulations that on the whole hinder than drive innovation. The regulations are effecting the quality and use of secondary raw materials.**

**The six main drivers identified in the BERR Study determine the impact of regulation on innovation. To secure the quality of recyclate envisaged in the EU's resource efficiency road map and to drive up the quality of recovered raw materials and put it back into productive use these six drivers will need to be in practice – but they are not.**

**Historical waste regulation has been largely prescriptive. From being originally designed to ensure the safe disposal of waste, regulation has moved away from disposal to resource management and a more outcome-based focus. However, the historically fractured methods of implementation now create barriers in what is now a global industry.**

**Decisions that affect recyclate quality have implications for the EU and world trade, impact primary raw material resource flows and change the dynamics of markets. The recovery and re-use of secondary raw materials are also affected by decisions covering product regulations and economic regulations. In effect, we currently have a poor regulatory framework to support the recovery of secondary raw materials and one that hampers innovation in this area.**

**So far, stringent, internationally applied regulation that fosters the use of secondary raw materials does not exist.**

**Example (b): Pollution of Surface Waters Act in the Netherlands – role of compliance cost**

**The Dutch "Pollution of Surface Waters Act" (1970) stimulated widespread diffusion of water treatment technology, using market-based instruments following the Polluter-Pays principle.**

**The significant regulatory impact of the Law was, to a large extent, the result of the effluent charges it introduced (rather than the standards and permit system). Effluent charges were earmarked to finance public water treatment systems, but also succeeded in changing the behaviour of industries (on the basis of a market-based, polluter-pays principle). The result was a widespread diffusion and significant incremental improvement of water treatment technologies.**

**The compliance cost appears to have been a significant factor for innovations in companies. Companies paid for the amount of waste they discharged. This levy, that was originally intended to finance the public treatment of wastewater, eventually had a regulatory effect as it changed the behaviour of firms. The levy functioned as a financial incentive for firms to take measures themselves to reduce pollution. Because the charges to a company could easily be a million Euros, it was often cheaper for a company to treat the wastewater themselves. In 60% of the companies, the effluent charge was the crucial factor in the decision to adopt these measures (Schuurmans and Tegelaar, 1983). Of the total reduction in pollution between 1975 and 1980, 80% can be explained by the levy and only 20% by the role of non-levy factors.**

### 3.6.3 Stakeholder involvement

Stakeholders have the best view on how regulation affects them. However their view may be biased by their own interest or limited viewpoint. Individual stakeholders may also not have a view of the whole system where negative effects in one area are often traded against positive effects elsewhere. Finally stakeholders tend to pay more attention to barriers and take positive effects (of regulation) as the natural state of affairs.

Involving stakeholders in identifying regulation that affects innovation therefore needs careful planning, including determining which stakeholders will be involved and how and how to evaluate possible contrasting opinions.

Various methods can be used to involve stakeholders, e.g.:

- Open stakeholder consultation by means of the internet;
- Stakeholder workshops;
- Stakeholder surveys;
- Stakeholder interviews.

An open stakeholder consultation provides the opportunity to all stakeholders to provide input. It works well in organised areas with professional management, however, it is difficult to reach all stakeholder groups and obtain views from all of them. Very often, the quality of inputs is rather varied.

Stakeholder workshops are an efficient way of identifying relations between regulation and innovation, and - since there is direct contact and interaction between different groups of stakeholders - also provides a way to identify the importance of these impacts and different options for reducing negative effects. Representatives of various stakeholder groups should thus ideally be present in workshops. Workshop participation requires a significant effort from participants but the benefits of attending are not always obvious to them. Thus, participation of certain groups of stakeholders (e.g. companies, especially SMEs) may always be possible.

With a stakeholder survey (e.g., an internet questionnaire sent to selected stakeholders) offers the opportunity to directly approach the most important stakeholders and ask for comments about issues at a more detailed level. A low response rate might be an issue, as well as the representativeness of the sample - but these are problems that are faced in all kinds of qualitative methods. Therefore a good overview of relevant stakeholders and clear expectations about the survey outcomes are prerequisites for this approach.

Interviews are the third form of interaction with stakeholders. They offer opportunities for intensive discussion, based on pre-developed interview scripts that can include questions which are not covered by data or other available information or are simply trying to obtain opinions of specific groups. This approach is however time-consuming (including identification of the right interview partner, arranging for the interview (direct or via telephone), the time for the interview and wrap-up) so that in general, only a limited number of stakeholders can be interviewed. The issue of a non-representative interviewee sample should also be kept in mind when using this method.

A combination of methods is also feasible, e.g., starting with selected stakeholder interviews to explore the area, continuing with a targeted survey to assess which regulation matters, is hampering for what reason or which is of lesser importance, etc. Workshops can be useful to discuss the matter at a more overarching level - since interviews tend to be one-to-one, many stakeholders will change their opinions when confronted with other views and supporting evidence.

### 3.6.4 Analysis and reporting

International comparison of regulation and innovation on specific issues (benchmarking and international case studies) are good tools to analyse the innovation effects of regulations. In many cases, where EU law for example leaves the implementation up to the EU-MS, their varying implementation modes lead to various innovation paths. For example, in recycling those countries having implemented regulation early on have not only higher recycling shares but tend to be leading technologically. Differences in implementation modes (collection schemes, incentives – comparing different paths) can help identifying other implementation practices that have led to more innovation.

Since our testing looked at the level of EU regulation and innovation effects, a comparative view was taken which was limited to available innovation-related data such as R&D investments, patents and trade.

On a more focussed level – mainly at the level of the case studies – the use of data is instructive but a better understanding and interpretation of the data is achieved with the inclusion of stakeholders. The analysis of macro-level data as presented in the box below, quickly demands further explanation, such as which other factors may have been influential for particular developments? These questions can only be addressed by experts who may be able to point out to context-specific elements.

Box 10      Linking innovation and regulation

#### **Linking innovation effects to regulation: The water framework directive and the trade of water technologies**

**On rare occasions, EU regulation comes first. In general EU regulation is implemented following a longer consultation process with the EU-MS. EU directives aim to harmonize existing regulation and by doing so, require adjustments in national regulation. In the case of the Water Framework Directive (2000) for example, the consultation process started in 1996. In the end, the directive included several requirements including water quality, cost-effectiveness and use of best-available technology. For most EU countries this implied large infrastructure investments to replace or build (waste) water systems, affecting wastewater treatment and water prices.**

**Since not all EU-countries may have been in the position to supply the necessary technologies and products (and services), it is instructive to analyse trade data in greater detail. In terms of trade volumes (in US\$), the USA was the leading exporting country for water technologies in the 1990s, followed by some distance by Germany, UK, Japan, Italy and France.**

**By comparing growth rates before and after the implementation of the WFD in 2000, one can see interesting developments. In terms of exports of water technologies and products, the USA saw an average increase of 6.2% in 1996-1999 while in the EU, the four main exporting countries saw decreases in the same period; overall the EU-15 obtained only a small growth of 1.3% during this period. But exports levelled off in 2001 for Germany, followed by France and Italy in 2002/2003, surpassing the volumes seen in 1996-1999 dramatically. In the period 2000-2003, when the WFD started to be implemented in the EU-MS as well as in the then accession countries, export growth was 10.5% for the EU-15, but only 0.2% for the USA. During the WFD implementation from 2000 to 2011, the EU-15 realised a growth of trade in water goods of 8.9% on annual average compared to 3.4% for the USA. An interesting exception occurred for the UK: from being the second largest European exporting country, UK exports dropped sharply in 2000 to 50% of the volume of 1999. This severe drop was only gradually recovered by 2007, when the level of 1996 was matched again. By then, Italy and France had by far increased their volumes, continuing the path since the early 2000s.**

**The influence can also be seen in terms of water technology and products' imports. In 1996, the largest importing country was the USA, followed by France, the UK, and Germany. Growth rates were higher for the US with 14.4% for 1996-1999, compared to an average of 3.3% in the EU-15. The 12 accession countries needed to upgrade their water systems heavily in order to meet the new requirements from the WFD. The average annual import growth rate pre 2000**

was 7.4%. Following the WFD in 2000, imports surged to 5.7% in the EU-15 and 20.9% in the EU-12 countries (2000-2003). Again, the UK shows a different path with sharp decreases in imports in 2000 and only a slow increase since then, however, even in 2011, the import value was below that of 1996. France's dominant importing role was surpassed by Germany in 2001, which saw a second major surge in 2006.

The immediate effect of the WFD in terms of traded water technologies and products can thus be seen in export and import data: before its implementation, growth rates in European countries remained low or even negative – possibly while waiting for the final wording of the regulation. Once it was in force, exports and imports increased with much higher rates than for the whole period 2000-2011. Those countries that were already leading exporting countries - with the exception of the UK - were able to increase their shares significantly.

The regulation seemed to have benefitted predominantly European companies: with the WFD and the surge of export volumes 2000-2003, Germany had by 2004 surpassed the US as main exporting country, holding the top position since then. In term of a trade balance, despite the large volumes of imports, all EU-27 countries except Cyprus and Malta have an export surplus, the highest being in Germany and Italy, followed by some distance by the UK, the Netherlands, and France (2011).

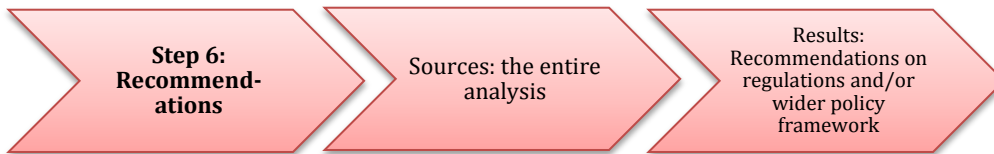
While certainly other (often global) factors have influenced the trade of water technologies, it is nonetheless striking that the trade patterns in particular of the European countries affected by the WFD have evolved as they have, showing reduced investments prior to the adoption year and a significant increase of trade following the adoption. The high growth rates in particular during the first years following the directive are in stark contrast with the previously reduced pace. Several countries with a strong technological position were able to increase their export shares significantly. Only the UK, having been among the leading exporting nations, has lost its position.

At the more focused level, where we can go beyond general data, the identification of structurally similar cases may be instructive. By discussing implementation paths with international experts we were able to identify differences despite structural similarities such as the size of the country. Thus, while analysing a problem which is identified at a focused level, the analysis of macro data may be helpful to identify countries with similar structures but a different performance. In order to understand these differences simple 'story telling' about the cases can reveal what countries or regions have done to successfully foster innovation through regulation. This approach will also highlight shortcomings in the implementation in comparator cases be it in terms of timing or implementation methods. The discussions with various experts can provide those carrying out the screening with a better understanding of why their own implementation may have created fewer beneficial results than expected. This comparative approach enables learning among the authorities and possibly encourages a creative discourse, the identification of more suitable implementation modes and a review of regulation systems against current best practice.

A written analysis should be the final result of this phase. The analysis thus covers:

- A concise analysis of the relevant innovation system including main actors,
- A description of the relations of various regulations, their innovation drivers and barriers,
- Innovation activities and outputs.

### 3.7 Step 6: Recommendations



Recommendations are the last step within the methodology. One could however also call this step ‘reflections’ or ‘further steps to consider’ since this is a recapitulating phase when future action may be envisaged or planned.

Following the analysis of the innovation system and the interplay of regulation and innovation obtained via the collection of data and the qualitative involvement of experts and stakeholders, policy makers may now be tasked to decide on actions. Is it necessary to change a regulation or can it even be abandoned? And if it was not the regulation per se but its implementation that was hampering innovation, what can be done to reduce negative effects?

It is likely that those initiating the screening will also come up with recommendations. These can be more or less complex – very much depending on the nature of particular issue addressed.

One of the outcomes of the screening may be that there is no clear impact of regulation on innovation. Clearly this is a valid finding and one that can be accepted without further ado. If the analysis has identified only positive impact(s) of innovation, this would also not require immediate action. Political concern will only arise if regulation has clear and persistent negative effects or conflicting negative effects. Policy makers need to consider various effects: short term (temporary) and long term (persistent) as well as whether single or multiple stakeholder are affected. A new regulation may have immediate negative effects on firms since it requires substantial adaptation costs which could have been spent differently or would have simply be profits. In the long-run, the initial high costs may turn into a competitive advantage (see the Porter hypothesis) and thus, in the longer run, the regulation may create positive innovation effects. The broader the sphere of a regulation and thus, the broader the range of innovation actors and affected stakeholders, the more likely it is to find a wide variety of reactions to and assessments of the regulation. Any change of the regulation can thus create numerous ripples.

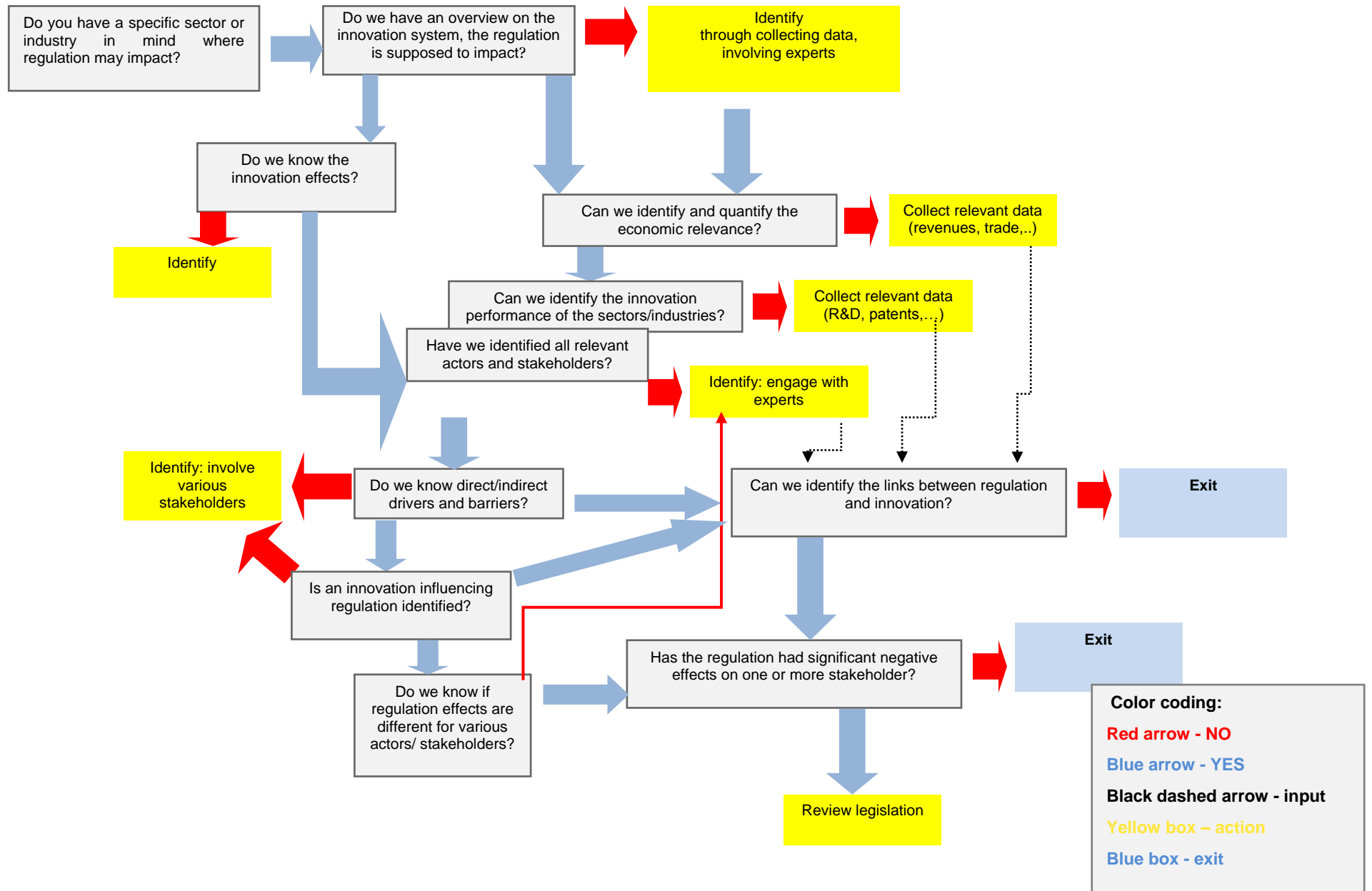
Given that during the scoping phase intended and direct but also unintended and indirect effects can be identified, changes of the regulation will equally affect various economic actors e.g., various industries or consumers. Unintended and indirect effects are unlikely to be taken into account in the ex-ante assessment of a new regulation, but decisions about changes of an existing regulation are made once the regulation has had and still has perceived effects and is being reviewed.

Following the broad scoping phase addressing various stakeholders and having identified various barriers and drivers, proposed changes can be based on the evidence collected. It will, thus, be a more conscious and informed political judgement to decide which groups and to what extent will benefit and which will lose out than at the implementation phase of the regulation.

Often, the strongest lobbying groups are more able to convey their demand and push for a regulation in their favour. The broad stakeholder involvement recommended in this report may at least have helped to identify broader interests – and thus amendments of regulation or new regulation may reflect the various stakeholder views better. To follow up new or altered regulations accompanying measures will be designed, such as fiscal incentives, counterbalancing or softening negative impacts of the regulation and maximising benefits.

The following graphic provides help concerning the various steps and what can or should be done from the perspective of those analysing the innovation effects of regulation.

Figure 4 Visualisation of decisions



## 4 Impact of Regulation on Innovation in the Field of Water

### 4.1 Water innovation challenges

Europe, as in many parts of the world, is increasingly facing problems of water scarcity and stress, sustaining water quality and water and climate change related disaster management (EIP-Water, 2012; EEA, 2012). Addressing these problems represents a significant societal challenge requiring innovative and economically viable solutions.

At the same time the problems associated with water supply, treatment and risk management are expected to create growing demand and economic opportunities for solution providers both within the EU and globally.

The Europe 2020 Flagship Initiative for an Innovation Union<sup>1</sup> has recognised the importance of these challenges and economic opportunities and has facilitated development of the European Innovation Partnership on Water (EIP-Water)<sup>2</sup>. The role of the EIP-Water is to bring together all relevant stakeholders across policies, sectors and borders to speed up innovations that address all water-related challenges and support economic growth by bringing innovative solutions to the market.

With the aim of focusing on the innovative actions, which deliver the highest impact and provide the most opportunities, the EIP-Water has identified the following thematic priority areas:

- Water re-use and recycling
- Water and wastewater treatments, including recovery of resources
- Water – energy nexus
- Flood and drought risk management
- Ecosystem service

In addition, the EIP-Water has identified cross-cutting priorities that address framework conditions, promote connections between the different priority areas of work and are enablers for all other actions. These are ‘water governance’, ‘decision support systems and monitoring’, ‘financing for innovation’ and ‘smart technology’.

The EIP-Water thematic priority areas have been defined to be the focus areas of the present regulatory screening study.

### 4.2 Scoping the water area

The first step following the screening methodology consists of scoping the area. The exercise here is looking at five priorities as mentioned above. The titles of the priorities suggest varying important aspects of water, however, in terms of the main actors in the innovation system, innovation activities and the regulation, the five priorities have commonalities.

#### 4.2.1 Important actors in the water innovation system

The generic innovation system (IS) around water innovation can be described as the interplay of a network of public and private actors who directly or indirectly promote technological and non-technological innovations in the water area under specific framework conditions (Figure 5).

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<sup>1</sup> [http://ec.europa.eu/research/innovation-union/index\\_en.cfm?pg=why](http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=why)

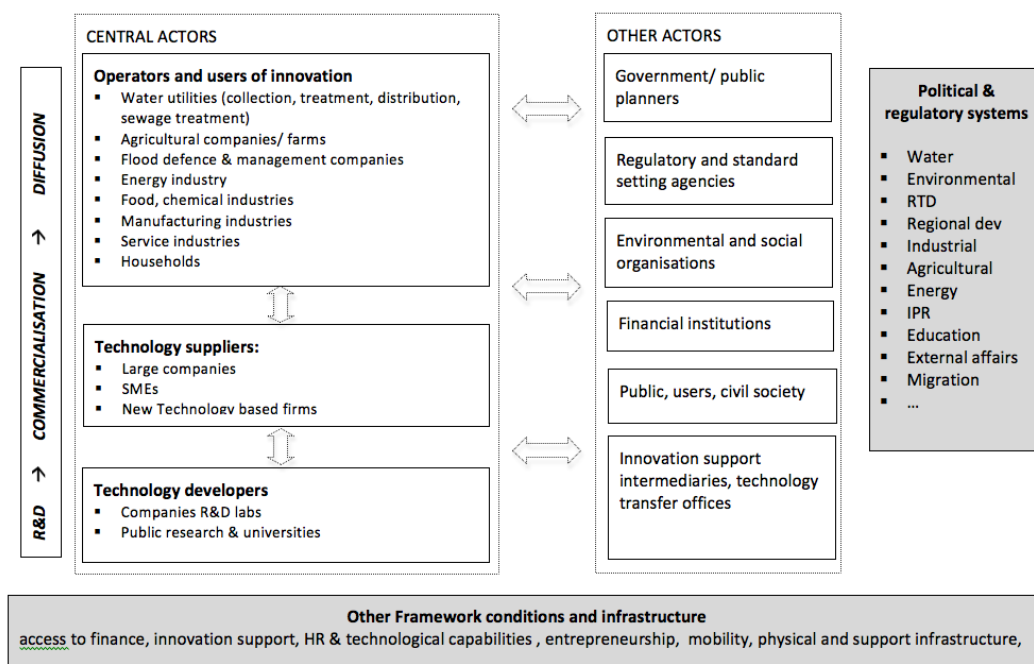
<sup>2</sup> [http://ec.europa.eu/research/innovation-union/index\\_en.cfm?pg=eip](http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=eip)

We identified the following groups of actors:

- Innovation developers: this includes large and small companies, public R&D research (in particular at universities), and users;
- Suppliers of an innovative solution: often these are innovative, technology developing companies or intermediaries;
- Users of innovation: water utility companies, agricultural, energy related, manufacturing, and service companies, households and individual users.

It is important to mention that **users can and often do innovate** by enhancing the management, introducing process, organisational, marketing and business model innovations. Moreover, many of the large utility companies have R&D units that develop the technologies for their own use, as well as for the wider market.

Figure 5 The water innovation system (IS) and its main actors



Source: Technopolis Group

Another group of important actors include government and public planners, as well as regulatory agencies who set the political agenda and the regulatory framework that directly or indirectly influences the research, development, commercialisation and diffusion of novel solutions. Public bodies are also important in the area since this sector is largely regulated and managed by governments and dominated by public utility companies; therefore the government has an important role in promoting and diffusing innovation.

Environmental and social organisations such as NGOs can also play a role in promoting innovations and their diffusion by implementing some solutions on a local level or by lobbying for environmental improvements, mobilising and informing citizens in this process. Their role is also important in promoting non-technological innovation and social and behavioural changes that contribute to more sustainable consumption practices, thus promoting social innovations.

The interaction among innovation actors and the process of innovation is facilitated by a wide range of factors, such as: the availability of funding for R&D and commercialisation; the availability of research and supporting infrastructures (e.g., ICT, energy grids and Global Positioning System Receiver (GPSR) which are needed for the adoption, diffusion or exploitation of new technologies); the availability of human capital (e.g., engineers and researchers); a collaborative environment and mobility for knowledge exchange and spillover; entrepreneurship skills that are needed for promoting innovation in the market; users' acceptance and awareness, etc. These conditions could be created by the appropriate policies and regulation by governments.



### 4.3 Innovation activities

The measurement of innovation in the area of water is commonly focussed on water technologies. Other indicators such as access to clean water or water use do not tell us much about innovation; however, they can illustrate social conditions and demand.

Water technologies can be found in most of the EIPs priorities. They are however less of an issue in the Flood and drought risk management and Ecosystem service priorities. These more service oriented priorities may be more in need of ICT innovations, for example.

A challenging issue concerns the collection of evidence in particular of non-technological innovations, such as water governance innovation which is an important aspect covered in the EIP. A coherent picture based on the available data is almost impossible to obtain. This is due to the fact that different definitions and classifications are used for the collection of water-relevant information and there is no standardisation of the different indicators. One is basically left with a rather patchy data coverage. The analysis of specific examples (case studies) cannot fully remedy this lack since it provides micro information where macro-level comparisons are required.

Thus, the limited availability and the relevant breakdown of data – in particular since the EIP priorities do not match existing classifications – poses a serious limitation to the scoping exercise.

In order to get an overview of the EU market (i.e., what is the innovation potential in terms of innovation performers, R&D investments as well as output measures such as patents and trade performance) data was collected from Eurostat and extra data analysis was performed.

From the available industry statistics, water is covered by the NACE (Rev.2) in section E36 – Water collection, treatment and supply. Very often, R&D statistics do not provide data on this section alone, but in combination with E37 (sewerage), E38 (waste collection), and E39 (remediation and waste management).

Since we want to obtain firstly an overview of potential innovating actors in the EU, we used company data and Community Innovation Survey (CIS) data, available from Eurostat. The EU has about 14.000 companies in the water sector. This number may be higher since some countries' data is not available. For CIS, the available category is 'Water collection, treatment, supply and sewerage', which can include both larger utility companies, as well as the companies that supply the technologies and services related to water utilities<sup>3</sup>. On average 35 to 56% of the surveyed companies in the water industry introduced process or product innovations in 2008-2010 (see Table 5) which is about average for innovation activities across all sectors. Combining the number of companies with the CIS information gives us a rough idea that there is a lot of unexplored innovation potential.

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<sup>3</sup> These include NACE E36: "Water collection, treatment and supply" and E37 "Sewerage"

Table 5 Number and share of innovative companies in the water industry (2010)

	<b>Nr of companies</b>	<b>CIS 2010</b>
<b>Austria</b>	571	62%
<b>Belgium</b>	:	72%
<b>Bulgaria</b>	81	38%
<b>Cyprus</b>	14	61%
<b>Czech Rep</b>	337	52%
<b>Germany</b>	1.660	48%
<b>Denmark</b>	1.994	80%
<b>Estonia</b>	74	100%
<b>Greece</b>	:	:
<b>Spain</b>	2.660	54%
<b>Finland</b>	676	56%
<b>France</b>	:	45%
<b>Croatia</b>	124	31%
<b>Hungary</b>	331	37%
<b>Ireland</b>	11	75%
<b>Italy</b>	865	52%
<b>Lithuania</b>	75	50%
<b>Luxembourg</b>	8	100%
<b>Latvia</b>	53	27%
<b>Netherland</b>	30	79%
<b>Poland</b>	533	25%
<b>Portugal</b>	144	67%
<b>Romania</b>	204	36%
<b>Slovenia</b>	70	36%
<b>Slovakia</b>	46	100%
<b>Sweden</b>	196	36%
<b>UK</b>	118	38%
<b>Total / Average</b>	13.989	56%

Source: Eurostat: Annual enterprise statistics for special aggregates of activities (NACE Rev. 2) [sbs\_na\_sca\_r2]; CIS calculation by authors based on Eurostat data

The above data looks basically at a large user group where innovation can be implemented. In order to obtain an idea about the innovators in terms of technologies or services, there is no available industry data. There is, however, data on R&D investments, although again, not separately broken down for the water sector but in combination with another industry sector – NACE D – ‘Electricity, gas, steam and air conditioning supply’. Even if the data in Table 6 (below) only includes information R&D on water folded into data from a range of other fields, it shows however large variations of R&D expenditure by businesses in the EU Member States. France, followed by Germany, Spain and Romania have the highest absolute R&D investments. In terms of R&D investment per capita, there is a range between zero to around six Euro (the latter in France and Portugal).

Table 6 Business expenditures on R&D (BERD) in electricity, gas, steam, air conditioning and water supply industries, in million Euro and Euro per capita in PPS

	2007		2008		2009		2010	
	Mn €	€/cap	Mn €	€/cap	Mn €	€/cap	Mn €	€/cap
<b>Belgium</b>	:	:	22,513	2,1	14,52	1,3	...	...
<b>Bulgaria</b>	:	:	0	0	...	...	...	...
<b>Czech Rep</b>	7,715	0,7	7,229	0,7	8,162	0,8	8,09	0,8
<b>Denmark</b>	:	:	:	:	72,849	12,2	28,46	4,5
<b>Germany</b>	121,42	1,4	123,772	1,5	201,321	2,5	186,586	2,2
<b>Estonia</b>	2,712	1,9	4,224	2,9	4,022	2,8	3,637	2,5
<b>Spain</b>	:	:	137,006	2,8	165,006	3,4	181,505	3,7
<b>France</b>	356,212	5,3	356,888	5,3	416,397	6,2	422,606	6,1
<b>Croatia</b>	:	:	:	:	0,06	0	0,006	0
<b>Italy</b>	45,025	0,7	80,377	1,2	19,03	0,3	16,855	0,3
<b>Cyprus</b>	:	:	0,135	0,2	0,124	0,1	0,107	0,1
<b>Lithuania</b>	:	:	0,184	0,1	1,451	0,4	0,436	0,1
<b>Hungary</b>	4,864	0,5	5,756	0,5	7,567	0,7	5,986	0,5
<b>Malta</b>	:	:	:	:	...	...	0,07	0,2
<b>Austria</b>	12,752	1,5	:	:	11,544	1,4	...	...
<b>Poland</b>	1,63	0	1,39	0	14,98	0,4	3,411	0,1
<b>Portugal</b>	54,165	4,8	100,169	8,9	86,716	7,7	67,9	5,9
<b>Romania</b>	:	:	42,551	1,6	32,928	1,3	49,231	1,8
<b>Slovenia</b>	:	:	0,104	0,1	1,127	0,6	1,186	0,6
<b>Slovakia</b>	0	0	0	0	0	0	...	...
<b>Finland</b>	:	:	29,029	5,2	32,354	5,8	34,184	6
<b>Sweden</b>	8,591	0,9	:	:	9,964	1	...	...
<b>UK</b>	40,267	0,7	29,91	0,5	35,694	0,6	34,511	0,6

Source: Eurostat Notes: PPS – Purchasing Power Standard; : data is not available, no data for IE, EL, LV, LU, NL

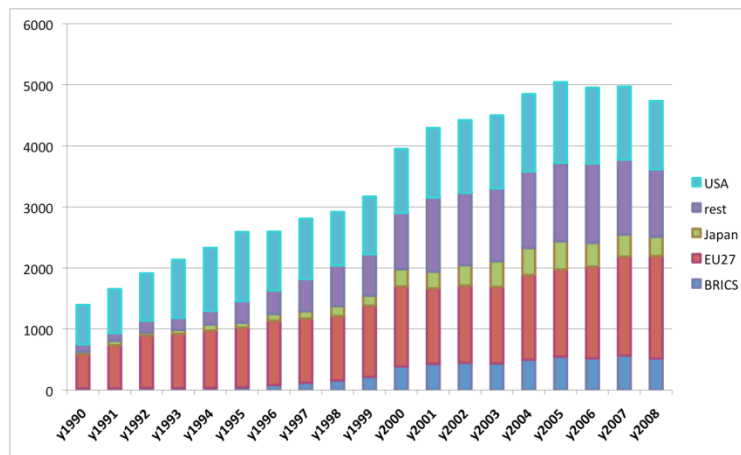
For the above data there can be several explanations. The high absolute investments of France and Germany can signal a strong R&D performance in the water sector. Romania being an R&D laggard country may have large infrastructure investments in the utilities sectors which is mixed in this bundle of statistics and shows up as R&D. The number of companies and the share of innovative companies in Romania (Table 5) does not suggest the presence of a large internal R&D capacity base in the water sector.

In terms of R&D output, patent and trade data is often used to construct indirect indicators. Patent and trade data, being based on patent classes and products respectively, need to be extracted according to specific needs of each study. For this exercise, we have asked water experts to identify relevant patent<sup>4</sup> and trade classes. Based on this expertise, patent and trade data was extracted from PATSTAT and COMTRADE databases.

Overall, patenting activities have almost quadrupled globally since 1990 up from 1.000 to about 5.000 patent applications annually. The EU27 inventive activities have tripled in this period and this group is now the global leader in water technologies, followed by the US. However, the major growth rate in patenting activities is seen in the BRICS countries, Japan and rest of the world. This means that although the EU is still leading, other countries are catching up.

<sup>4</sup> The extraction strategy was based on the innovation priority areas of the EIP on Water: water re-use and recycling, water treatment and resource recovery, water-energy nexus, flood and drought risk management, and ecosystem services. Across these areas same patent classes were found to be relevant in several cases. See also Annex Table 5 with the list of classes identified for all priority areas covered in this study.

Figure 6 Patent applications in the water area

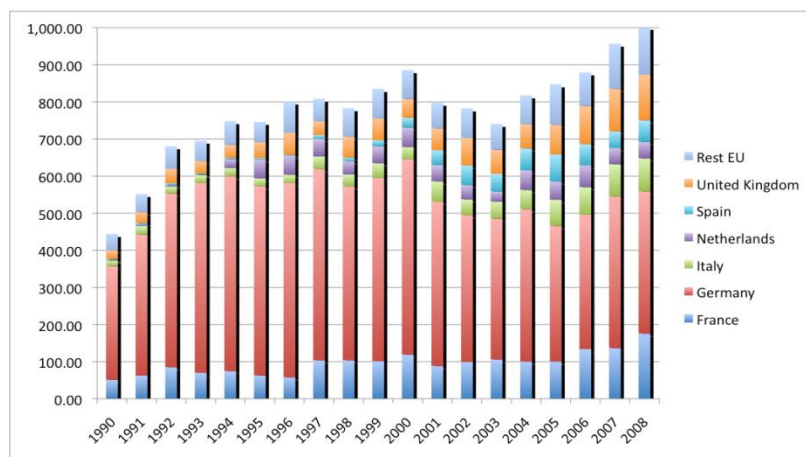


Source: PATSTAT; calculations: Technopolis

Looking at four priority areas, the focus on patenting is in the field of *water reuse, recycling, treatment and recovery of materials*. A sharp increase in patenting leading up to 2005 can be observed in the *energy nexus* priority and the *ecosystem services* area; for the latter the increase is largely due to the increase in inventions of ICT based monitoring tools.

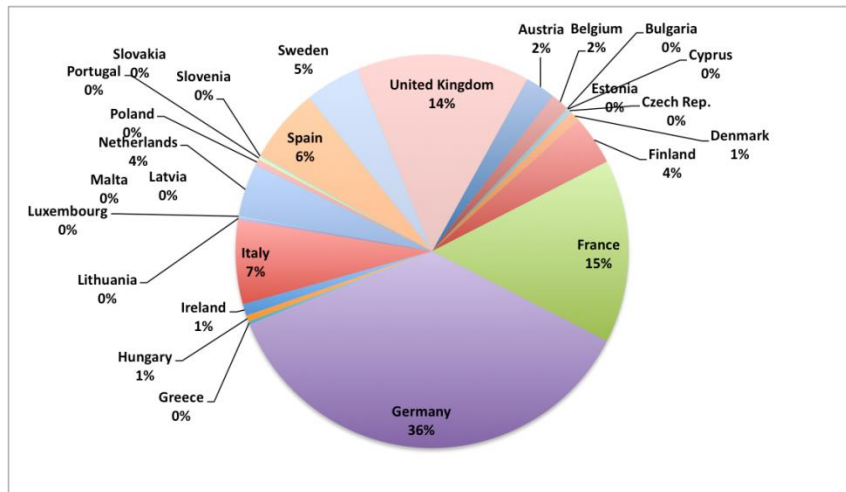
Patenting activity in the EU (Figure 8) is dominated by German applicants (36%), followed by French (15%) and UK (14%) ones. The shares seem to support the idea that high R&D investments (see Table 6) lead to high patenting activities (Figure 8). Germany and France have in this respect a very similar high level of performance. Spain, has slightly more R&D investments but a lower patent share whereas the UK shows the reverse. For the UK and Finland with the same R&D investments, the lower share of patents (despite having a large share of innovative companies) needs further investigation if it is to be explained completely. The differences may however be partly due to the mix of industries included in the different indicators.

Figure 7 Patenting activities in water supply, treatment and recycling technologies, 1990-2009, selected EU countries



Source: PATSTAT; calculations: Technopolis

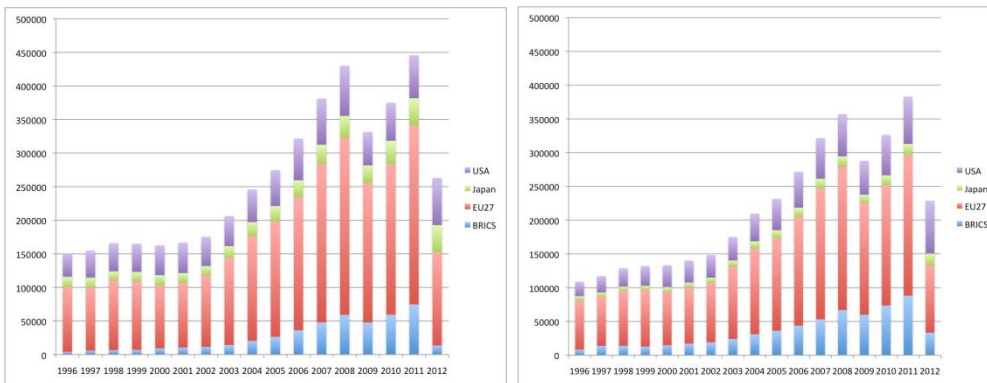
Figure 8 EU27 water patents cross country comparison, %



Source: PATSTAT; calculations: Technopolis

The level of innovation also shows in trade data. Figure 9 shows the exports and imports in million US\$ in water technologies by major trading blocks. The trade in water technologies has more than doubled globally since 1990. The EU is shown to be the leading supplier (and manufacturer) of these technologies over time.

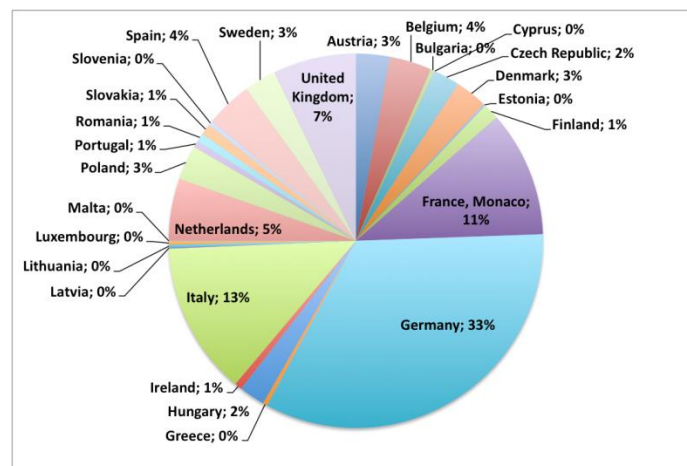
Figure 9 Exports (left) and imports (right) of water technologies (in million US\$)



Source: UN Comtrade; calculations: Technopolis

In terms of EU exports, Germany counts for one third of the total EU exports, followed by Italy (13%), France (11%), and the UK (7%).

Figure 10 Export of water technologies across EU27 Member States, 2011, %



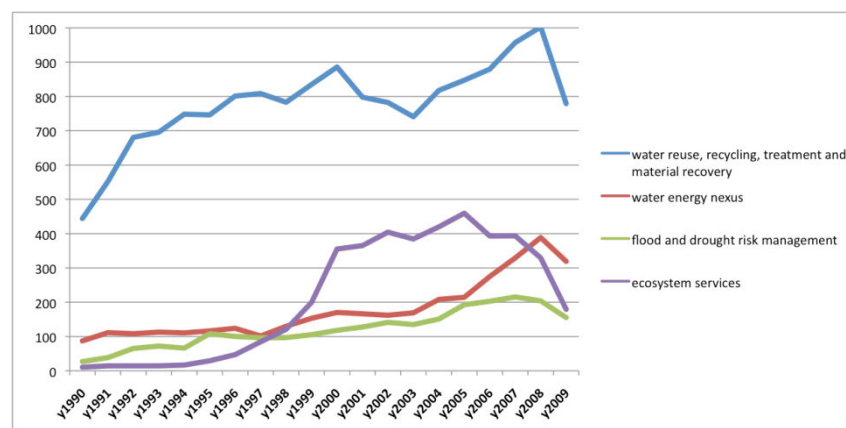
Source: authors' calculation based on UN Comtrade data

#### 4.4 Innovation trends in the EIP – water priority areas

The comparison of innovation trends in each priority area can be made by looking at patent and trade data. Looking at four priority areas, the focus on patenting is in the field of water reuse, recycling, treatment and recovery of materials. A sharp increase in patenting in the years before 2005 can be observed in the energy nexus priority and the ecosystem services area. The rapid progress of the water based energy technology innovations is largely explained by the important push generated by the enforcement of the Kyoto protocol in 1997, which is reflected in patent filing trends (WIPO 2009<sup>5</sup>).

For the ecosystem services area the increase in patenting activities is largely due to the increase in inventions of ICT-based monitoring tools.

Figure 11 EU27 patent applications by EIP priority area

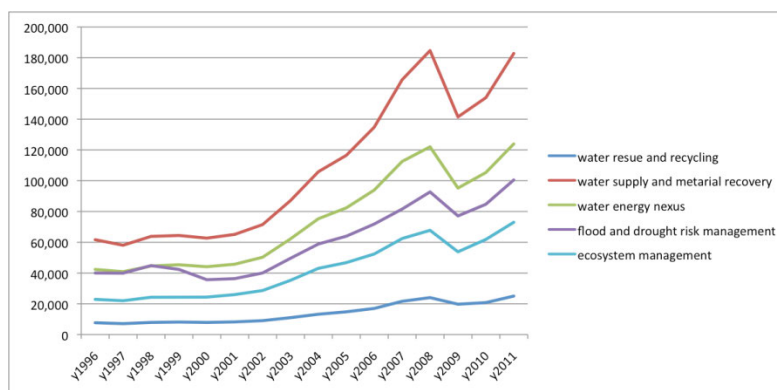


Source: PATSTAT; calculations: Technopolis

<sup>5</sup> WIPO, Patent-based Technology Analysis Report  
 – Alternative Energy Technology,  
[http://www.wipo.int/patentscope/en/technology\\_focus/pdf/landscape\\_alternative\\_energy.pdf](http://www.wipo.int/patentscope/en/technology_focus/pdf/landscape_alternative_energy.pdf)

EU export values by each EIP-Water priority shows that the EU aggregated export of water supply and treatment and material recovery technologies are the largest and the most dynamic area over time. Export in water reuse and recycling technologies has been the least dynamic, but it still saw a large increase in last two decades<sup>6</sup>

Figure 12 EU27 export values in five water innovation areas (in million US\$)



Source: authors' calculation based on UN Comtrade data

#### 4.5 Barriers to and drivers of innovation in the water sector

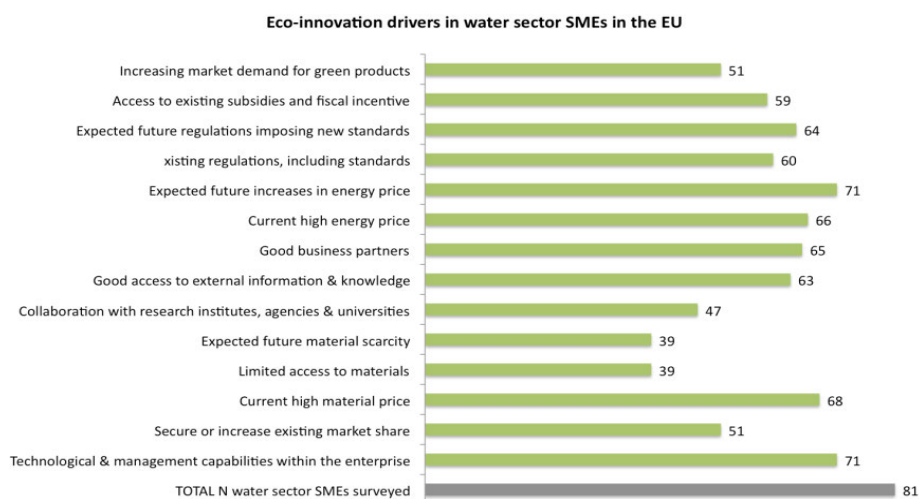
Through a literature review that revealed a number of drivers and barriers and in particular through the stakeholder consultations, additional insights on important driving and hindering factors as well as on the role of regulation in promoting innovation was obtained. Annex Table 4 summarises the barriers and drivers.

While there are a few differences between the priority areas it seems that, by and large, the same drivers and barriers exist throughout the water area. They are also quite similar to those faced by companies in many other industries. The overview of barriers to innovation by enterprises has been addressed by the CIS 2006 survey. The companies in water sectors experience the following barriers to innovation: lack of funding for innovation (58% experience internal funding problems, 55% - external funding), high innovation cost (53%), lack of demand for innovation (23,6%), competition by dominant enterprise (18,5%), lack of qualified personnel (17,5%) and suitable partners (16%), uncertain demand for innovative good/service (11,4%), lack of information on markets (6,9%) and on technology (11,1%).

Most of these barriers are independent of regulation. The lack of external funding opportunities could be addressed by other means than forcing banks to provide loans by law. In some countries this barrier (which is by no means exclusive to the water sector) is addressed by public guarantees. In terms of drivers, regulation is mentioned by water companies. Figure 13 includes the drivers for eco-innovations. Clearly, existing regulation and expected regulation score high as drivers for eco-innovations.

<sup>6</sup> Further details on innovation dynamics can be seen in the thematic report on Water innovation and regulation produced within the frame of present study.

Figure 13 Drivers of innovation reported by SMEs in the water sector in the EU



Source: Flash Eurobarometer N 315

#### 4.6 Role of regulation in innovation in water area

The data on water innovation presented in section 4.3 show an uneven performance among EU countries. The literature provides some explanation and insights on the possible role of regulations for the success of innovation leaders like Germany, the Netherlands, and France. It seems that the high level of patenting activity in these countries is, on the one hand, due to mature industrial sectors that maintain their global competitiveness by investing in advanced R&D development. On the other hand, strategic state policies that encourage innovation in many industrial sectors, including water technologies, are important factors. Furthermore there is a strong agreement in the literature that, for example, the German leadership in environmental technologies (including water) results from the long tradition of environmental protection, which led to corresponding legal regulations early on<sup>7</sup>. Similar developments concerning environmental regulation were seen in the Netherlands which is also discussed in the case study of the Dutch Surface water pollution Act (see Annex, C.3). According to this case study, the Dutch Pollution of Surface Waters Act (from 1970), imposed effluent charges which drove significant investment in wastewater technologies and their further diffusion.

As discussed earlier (Box 10) the effect of the WFD in terms of traded water technologies and products can be seen in export and import data. Once the WFD was in force, exports and imports of water technologies and products increased with much higher rates in that early phase (2000-2005) than for the whole period 2000-2011. The already leading exporting countries Germany, Italy, Netherlands and France were able to increase their shares significantly. However, less direct links can be drawn from the patent data (available time series is 1990-2008) reflecting R&D activities. The data shows the gradual increase in patenting over the last two decades in most of the EU countries (especially in UK, Spain, France, Italy, and the Netherlands) as well as in EU as a whole, but no immediate effect of the WFD implementation in 2000 can be observed. Patenting activities in this area from the second largest patenting country in this field, Germany, in fact declined after 2000. Since the patent trends are in contrast to trade data, one may conclude that the **WFD played a larger role in helping water technology diffusion rather than in promoting R&D activities.**

<sup>7</sup> UBA and BMU (2001) THE GERMAN WATER SECTOR: Policies and Experiences [http://www.umweltbundesamt.de/wasser/wsektor/wasserdoku/english/index\\_e.html](http://www.umweltbundesamt.de/wasser/wsektor/wasserdoku/english/index_e.html); UBA and BMU (2008) Instrumente zur Förderung von Umweltinnovationen Bestandsaufnahme, Bewertung und Defizitanalyse, Forschungsprojekt im Auftrag des Umweltbundesamtes Förderkennzeichen (UFOPLAN) 206 14 132/01, ZEW GmbH, Mannheim und Freie Universität Berlin, Forschungsstelle für Umweltpolitik; Waltz et al (2008) Research and technology competence for Sustainable development in the BRICS countries, Fraunhofer IRB verlag;



The companies also seem to concur with the driving role of regulations in regards to innovation. Hans Huber, for example, shareholder and board of the Huber Group which is among the worldwide leading suppliers in the field of wastewater/sludge treatment and process engineering, stated that his company's success results from the strict German legislation and environmental requirements<sup>8</sup>. The 2008 CIS data demonstrated that current and expected government regulation is a main driver for innovation. A national module in CIS 3 confirmed that regulation is particularly important with regard to pushing companies to reduce water wastage, as well as other emissions in Germany<sup>9</sup>.

It should be noted that available data (based on surveys) which is used to explain the innovation performance in the water area is rather limited; available data often does not separate water from other environmental areas, thus, further complicating the extraction of relevant information.

Since quantitative indicators alone cannot explain effects of regulation on innovation, the screening methodology has deliberately included a qualitative perspective, which can be used with individual experts or stakeholder groups in dedicated meetings or workshops. In the water case, the expert meetings were slightly biased towards academia and public policy representatives and slightly weak on including private sector views. Since the EIP had already established a list of interested stakeholders, a survey was carried out among these parties. The advantage of the survey is clearly its broader scope and a chance to obtain views also from industry.<sup>10</sup> The survey was simple in that it comprised a small number of questions. More than 60 responses were obtained. 53% of the respondents indicated that regulation played an important role in driving their innovation. For 25%, regulation plays only a minor role and for 22%, regulation is hampering or blocking innovation. This mixed view may mirror the two dominant views of companies: there are companies that either perceive regulation as a barrier - it possibly drives up costs, while others perceive the economic benefits the regulation induced innovations may bring in the longer run.

The **Water Framework Directive** (or its national transposition) was mentioned as the **most relevant regulation driving innovation**. Other regulations explicitly mentioned were the Directives concerning Drinking Water, Groundwater, IPPC and Urban Wastewater as well as the Blueprint to safeguard Europe's Water. Respondents also mentioned the relevance of water pricing policy; innovation subsidy regulation; procedures concerning safety monitoring and inspection; certification of new products and permissions.

Several innovation blocking mechanisms were mentioned, including: insufficient harmonisation of rules within the European market as well as unnecessary bureaucracy; some regulations concerning public procurement (e.g., blocking co-development of innovation between technology providers; unintended results from rules to favour operational costs over investment costs); a bias towards big, traditional players over smaller innovators when distributing governmental funds for R&D; non aligned EU initiatives in terms of their timing; hindering national regulations and compliance costs of inspections and testing water quality.

Based on the OECD/Blind classification, the survey helped to screen wider regulation effects and identify their relevance for innovation in the water area (Figure 14). In general, most regulations are considered to be a driver rather than a barrier. Only in two cases, is a regulation considered to be a barrier by more respondents than those who say it is a driver. In two other cases, respondents' opinions are very divided.

When looking more closely at the type of regulation, environmental and social regulations are perceived as drivers of innovation. On the other side of the spectrum, economic regulations are predominantly seen as barriers. Institutional regulations are more often perceived as drivers rather than barriers.

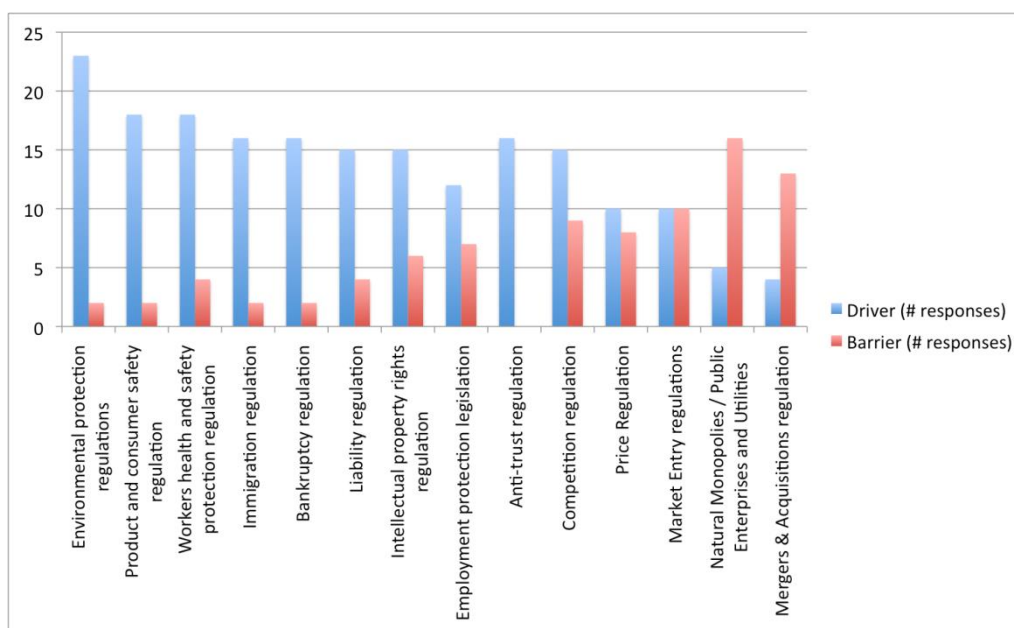
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<sup>8</sup> Von Petersdorff W. Im Portrat: Hans Huber. Der Saubermann. Frankfurter Allgemeine Sonntagszeitung 2007;17(April 29):48.

<sup>9</sup> Jens Horbach, Christian Rammer, Klaus Rennings (2012) Determinants of eco-innovations by type of environmental impact — The role of regulatory push/pull, technology push and market pull, Ecological Economics, Volume 78, June 2012, Pages 112-122

<sup>10</sup> The survey was distributed among the Water EIP related parties that had voiced interest in an earlier public call. The survey collected a total of 62 responses from over 30 countries. Within this sample, companies are best represented (49% of the sample), followed by research organisations (31%) and public sector bodies (20%).

Figure 14 Types of regulations as drivers or barriers (1)



Source: Technopolis, based on own survey

More details on the specific questions on barriers and drivers in each type of regulation is presented in Annex Table 4.

Evidence drawn from the literature, our survey and discussion with stakeholders highlighted the importance of the role of regulation (and in particularly environmental regulation) in the promotion of environmental or eco-innovation. According to the CIS 2008, water industries (in comparison to other industries) consider regulation or taxes as a highly relevant driver for innovation. Nearly half of the innovating firms in the water sector (47%) introduced environmental innovations in response to regulation.

#### 4.6.1 Role of regulation in priority areas of EIP-Water

##### **Water reuse and recycling:**

Water recycling is still not widely done and the majority of the existing practices have limited impact due to low value application such as in irrigation. Large volumes of recycled water are wasted. Technologies that can deliver the highest grade water for re-use - ultra filtration, reverse osmosis and ultraviolet disinfection - are still expensive and need significant efficiency improvements. Research is still needed on how to remove certain impurities, such as pharmaceuticals, for water re-use (Futran 2013).

Furthermore, there is a lack of well-developed and robust industrial processes using different qualities of water and an absence of EU harmonised safety and quality standards for re-used water (EIP-W 2012, Bixio et. al 2006, MED-EUWI 2007). In addition to the technical barriers there are also bottlenecks such as a limited institutional capacity to formulate and institutionalise recycling and reuse measures and a lack of financial incentives.

Despite the fact that no guidelines or regulations yet exist at the EU level, several member states or autonomous regions have now published their own standards or regulations.

Table 7 EU Member States with regulation or guidelines on re-used water (2012)

Country grouping	Countries
Regulations or Guidelines	Cyprus, France, Greece, Italy, Portugal, and Spain.
Contemplating Regulations or Guidelines	Belgium, Bulgaria, Germany, Hungary, Malta, Poland, Romania, and UK.
No Regulations or Guidelines	Austria, Czech Republic, Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Luxembourg, Norway, Slovenia, Slovakia, Sweden, Switzerland, and the Netherlands.

Source: Angelakis (2012)

In terms of rainwater use, national legislation in general permits the use of rainwater for certain applications and under certain conditions. Untreated, the water can be used only for external water uses, such as irrigation and automobile washing or where there is suitable plumbing preventing cross-contamination or cross-connections it can be used inside homes for toilet flushing or washing machines. Examples are the Portuguese Standard NP 4434; Spanish Re-use of Reclaimed Water: Quality Criteria; Greek regulations based on Common Ministerial Decisions, regulations in Cyprus, Italy and France, etc.) (Angelakis, 2012)<sup>11</sup>.

Thus, regulatory instruments promoting water re-use and recycling are not widely introduced throughout the EU. The Water Framework Directive encourages systems for saving water, but does not specifically address water recycling.

Existing successful practices showed a promising potential in the application of water demand-side management strategies, where **regulation** can play a **direct role in promoting** water re-use and recycling technologies. Some countries or local administrations have introduced regulatory measures promoting water recycling and re-use via sustainable construction codes and standards (Belgium, municipalities in Spain, see Box 11). Such regulatory measures can be applied in practically every EU Member State and enforced on different lower governance levels, such as municipality, province and regions where there is a need to adapt regulations to local circumstances.

According to the stakeholders consulted, water pricing is also seen as an effective regulatory instrument. Water tariffs in domestic water supply, agriculture and industry can play an important role in promoting water recycling, as well as pushing for water saving in general. Several cases of increasing water tariffs have shown increased efficiencies and a fall in consumption. In Israel, for example, a gradual 50% drop in freshwater use was reported after a series of tariff increases. Freshwater use in agriculture declined from 74% to 62% between 1986 and in the early 1990s whilst use of reclaimed wastewater proportionally increased and the overall productivity per unit of land doubled (Sanz 1999; Ahmad 2000). Setting water prices closer to their economic or financial true value has been a relatively reliable tool to reduce freshwater consumption, ensure more efficient allocation and productive use, and simultaneously raise revenues for maintaining the infrastructure (Perry 2001; Johansson et al. 2002).

The case study of the French water supply system showed that **public procurement** used for the construction of new buildings can also incorporate technical requirements to promote water saving or encourage procurement of innovative technologies (see Box 13).

It is however not only regulation that can be decisive: experience and learning push the development of better technological solutions (e.g., as seen in the case of Barcelona). At the same time, mandating technologies also calls for organisational innovation, learning and acceptance by users.

<sup>11</sup> Countries contemplating regulations or guidelines on quality of recycled water for use: Belgium, Bulgaria, Germany, Hungary, Malta, Poland, Romania and UK.  
Countries with no regulations or guidelines: Austria, Czech Republic, Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Luxembourg, Norway, Slovenia, Slovakia, Sweden, Switzerland and The Netherlands. (Angelakis, 2012)

### **Role of water saving ordinances in promoting water innovation in Barcelona municipalities**

In the context of the historically dominant, centralised water supply and treatment system, on-site rainwater harvesting and greywater reuse can be seen as radically new alternatives. This was the major innovation that came out of the water saving ordinances mandating water reuse and recycling systems in all new building in a number of municipalities of Barcelona.

From the innovation cycle perspective the regulation played an important role in:

- (1) introducing new alternative technologies and
- (2) further diffusion (although only within the segment of newly constructed housing).

Other impacts of this regulation:

- **The technology substantially evolved over a decade of experience with the decentralised systems, especially greywater reuse systems. *More sophisticated and efficient technologies have replaced less sophisticated ones.* New systems using biological and extremely fine filters in the form of membranes have been introduced to replace chlorine treatment based installation. This came along with the *improvement of expertise and experience of the construction companies* in dealing with the novel water recycling installations<sup>12</sup>.**
- **In addition to technology implementation and adoption, *social and institutional learning and innovation* was an important outcome of the experience. Municipalities had to learn how to promote through communication and public dialogue, building and maintaining trust among residents. At the same time the residents had to learn to maintain and share responsibility over the new installation and in this way to become involved in local water system governance.**

The impacts were felt locally, however the wider adoption of such ordinances can potentially scale up the impact and create a substantial market for rainwater harvesting and greywater collection technologies.

Source: Technopolis Group

The current regulation on water re-use is less developed than regulations imposing control over the quality of recycled water. These are more developed due to health and safety issues. It was however suggested that the reclaimed water quality control regulation might play a dual role in innovation. While allowing improvements of the wastewater treatment technologies, it can also hamper some potentially promising solutions. For example, for some processes within the chemical industry, secondary effluent water from sewage facilities may be used, since several processes do not require high quality water (e.g., cooling and heat exchange). While re-use may be technically and economically viable, there may be some national regulations not allowing the use of municipal sewage water for re-use, thus putting an obstacle in the way of the application of recycling solutions<sup>13</sup>. Clearly, this hampering effect does not exist throughout Europe – there are also several successful cases. As discussed, the regulations in the various member states differ in terms of availability of re-used water standards (see Table 7). In the absence of well-defined, harmonised standards for safety and quality of re-used water, this barrier will persist in many regions of the EU. It was suggested by the stakeholders that the concept “fit-for-purpose water quality” should be considered where possible to allow for wider applications of water recycling processes, while securing the monitoring of health related aspects.

<sup>12</sup> However there is no evidence that this particular case spurred innovations such as the development of the mentioned more sophisticated filter technologies. Ultra membrane and biological treatment based systems were already available, but at a higher cost than the chlorine treatment based systems. The case can be seen as fostering diffusion of (existing) technological innovation in combination with changes in governance structures.

<sup>13</sup> Interview with representatives of the European Chemical Industry Council (CEFIC)

## Water and waste water treatment and material recovery

At the EU level, the Drinking Water Directive addresses the quality of drinkable water. The Urban Wastewater Treatment Directive (UWWD) marked a shift from legislation aimed at end-use standards to a stricter legislation regulating water quality at the source. The directive applies both to domestic and industrial wastewater.

On the national and local levels, a number of regulatory instruments play a role in promoting new applications:

For example, utilities pay a wastewater discharge fee which is supposed to provide an incentive to treat water beyond what is legally required.

Tariffs must cover the full costs of water supply and sanitation. Potentially higher tariffs are also motivational in switching to the more efficient solutions.

Water metering regulations are widely applied throughout the EU27, enforcing consumers to control use of water for drinking, irrigation and industrial processes.

Water quality standards (set by UWTD) mandate water suppliers to ensure high quality drinkable water, which in turn encourages new applications in water supply.

European environmental regulation since the 1980s has delivered substantial improvement of water regulating bodies via improvement of and investment in wastewater treatment technologies. The case study “pollution of surface water act” in the Netherlands (see box below) demonstrates how this law allowed the Netherlands to diffuse water treatment installations on a large scale and reduce pollution despite industrial expansion.

Wastewater treatment continues to face a **tightening of the standards** in the European Union with EU institutions continuing to push for better and more innovative solutions.

Consultation with the stakeholders suggested that the quality and safety standards can serve as a driver of better water supply and treatments' solutions. However at the moment, these standards are no barriers to investment in new innovation. If set too high, the standards can prevent companies investing in innovation.

### Box 12 Water and water treatment in the Netherlands

#### **Pollution of Surface Waters Act and diffusion on waste water treatment technologies in the Netherlands**

The Pollution of Surface Water Act came into effect in the 1970s and introduced a large-scale and structural approach to tackle water pollution with a long-term vision. The regulation is considered to be very successful, as the total discharge of oxygen-binding substances has been reduced by over 80% in 25 years.

While innovation was not on the mind of the policymakers when designing the Act, it had significant effects on the development and diffusion of water treatment technologies. The law stimulated innovation using market-based instruments following the Polluter-Pays principle. The major regulatory impact came from the application of effluent charges.

The effluent charges were earmarked *to finance public water treatment systems*, making sufficient resources available to improve technology and learn from scaled-up experience. Yet the charges also succeeded in *changing the behaviour of industries*: effluent charges on a Polluter-Pays basis were the key factor in inducing water polluters to *invest in biological wastewater technologies on their own industrial sites*.

Furthermore, while the effluent charges have been crucial, *other non-regulatory aspects of policy have played an important role*:

- **Subsidies have speeded up the development of technologies;**
- **a working group on anaerobe treatment created a network that steered the development;**
- **cooperation with universities was necessary for developing new fundamental knowledge.**

Source: Technopolis Group

Furthermore, resource and energy recovery is not addressed by the water treatment legislations at national and regional levels in the EU.

In terms of the governance of water supply and treatment, it is largely kept in the hands of the local municipal authorities that supervise public utilities. Many of them do not manage to ensure cost recovery and often suffer from underinvestment, as demonstrated in the case of the Milan water and sanitation services (see Annex C.4). A case study on the French experience showed that the delegation of the contract to private utility service providers effectively solves the above-mentioned underinvestment problem (see Box 13). However, the lack of transparency in contract delegation (procurement) in water supply and wastewater treatment services add uncertainties and hamper water innovations.

#### Box 13 Innovation effects in France

##### **Promoting innovation via delegation of services to private companies – experience of France**

The French local municipalities can either manage water services in-house (direct public management) or they can entrust the service to private operators through various *contractual delegation agreements* which differ according to the degree of the operator's involvement in the service and the ratio of the risk that the private operator bears. The participation of the private sector has progressively increased in France since the 1980s and is estimated today to be around 80% of the market share.

For long years, municipal organisations have operated and managed their services under vague statutory mandates. Both public management and delegation processes were criticised. In the 1990's, the French legislator elaborated new and more specific delegation rules in order to eliminate organizational failures. These reforms created new sources of *good governance mechanisms* by allowing water customers to be informed, to take part in the decision-making process and to have the right to an expeditious redress procedure before the judiciary or administrative authorities.

Driven by EU and National legislations, the French model of delegation of water services has evolved during the last 3 decades. Recent studies show that *delegation might be a source of innovation*. According to Huet and Porsher (2012), reputation building acts as an implicit incentive mechanism to invest: the private operator strategically invests in innovative capital because its behaviour is affected by the degree of competition for the market and the life cycle of the delegation contract. Thus, strategic innovation decisions increase the quality of the service and corporate reputation<sup>14</sup>. Furthermore, competition for the market could encourage better ways of doing business by incumbent operators due to the threat of new entrants.

Source: Technopolis Group

### **Water - energy nexus**

The broad nature of water-energy nexus explains the wide and rather fragmented regulatory landscape which includes: regulations in water supply treatments; energy, more specifically hydro; marine; wastewater; resource-based energy production; environmental regulation related to the construction of hydro, marine and offshore energy generation facilities. It also includes an array of national/local regulations in one policy domain that often take into account objectives in another domain such as permitting, building codes, zoning, etc. The wide coverage, lack of interconnectedness, and the lack of regulations clearly targeting the water-energy nexus render the identification of evidence-based impacts difficult. Thus neither through the initial scoping nor through stakeholder involvement was it possible to identify and collect a larger body of evidence on the impact of regulation on innovation in this topic.

Water and energy policies in the EU are well established, but both lack integration and consideration of interconnected effects. The WFD provides for the harmonisation at EU level of environmental protection, however the energy policies remain more nationally determined within an EU framework. While this might not be a major problem, it does not contribute to creating a formal dialogue between the two areas on the same level across the EU. So far, no-regulation addresses water-energy nexus issues in a comprehensive and holistic manner or tries to identify possible synergies (e.g., energy and water saving). However, it may simply be the case that the topic is only just gaining momentum in the policy agenda.

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<sup>14</sup>For example investment in innovative leak detection systems.

A part of the discussion of the policy and regulatory links has been in the context of hydropower. For example, the document “WFD and Hydro-morphological pressures”<sup>15</sup> which focuses on hydropower, navigation and flood defence, stipulates that “the guidelines for authorisation procedures, especially regarding guidance on the relationship with the WFD, should be established in Member States as recommended in the Commission Communication on support of electricity from renewable energy sources”<sup>16</sup>. It suggests regions and municipalities should create lighter procedures for small renewable (including hydropower) projects and should encourage projects that use the best available techniques to reduce environmental impact. Thus, the regulations seem to be aimed at addressing environmental concerns. Other examples that have been brought up include wastewater pollution control regulations in biogas and biofuel production, mandatory environmental impact assessment procedures before construction of hydro, tidal and geothermal plants as well as off-shore wind power facilities (e.g. OECD 2012b). At the same time, there is no regulatory instrument either at national or EU level mandating energy recovery from waste water. This is not surprising since regulations could only come after the recycling water quality is well defined and this is not the case throughout the EU. So far building codes have been stressing energy saving aspects of water heaters while an analysis on the water saving potential is largely missing. At the same time, the water saving in building codes is addressed via measures that are independent of energy saving matters (e.g., metering, double flush toilets, efficient water taps and shower heads etc.).

A consensus seems to have been reached on the need for synergies between energy efficiency and water efficiency goals which can be tackled simultaneously by the same set of regulatory instruments e.g., a building code mandating solar water heaters can achieve significant water savings and reduce reliance on traditional energy sources for heating water (such as gas and electricity).

The literature also provides some analysis of the role of economic instruments, such as water pricing, in reducing water use for electricity production (e.g., Ecologic 2007, OECD 2012b). Most European electricity comes from thermal power plants, with a lifetime of several decades. There is a link between the price of water and the price of energy. However, water pricing in this sector is only an issue with respect to new investments. In the case of existing plants, higher water prices might increase the costs of electricity but they are unlikely to have an impact on their energy production. Other factors such as a steady growing electricity demand or changes in fuel costs are much stronger drivers. Even if water prices will not change water use in the short term, the revenue gained from a water pricing scheme in the sector could be used to cover its environmental and resource costs (ibid).

### **Flood and drought risk management**

Regulation and policies in the field of flood and drought management can be split up into broad categories involving, for instance, spatial planning or broad water regulation. European level policies are the main sources of influence on innovation in flood and drought management due to the implementation of regulation in the assessment and management of flood risk or on water scarcity and drought in the EU.

At the national and local level governments can apply such instruments as land-use planning and emergency management plans, coastal change management strategies, risks and hazards mapping, insurance obligations, drought management plans, flood management plans and building regulations.

The EU-level regulation in the field of flood risk is the Directive 2007/60/EC on the assessment and management of flood risks. The EU Floods Directive is legally binding and requires that the member states will go through a planned and obligatory three steps implementation as follows:

Preliminary flood risk assessment of EU member states' river basins and associated coastal zones (by 2011)

Flood hazard maps and flood risk maps for identified areas (by 2013)

Flood risk management plans (by 2015). These must encompass all phases of the flood risk management cycle, however focusing on prevention (i.e., construction), protection (i.e., actions to restore flood plains and wetlands) and preparedness (awareness and instructions to the population in the event of a flood)

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<sup>15</sup> [http://www.sednet.org/download/Policy\\_paper\\_WFD\\_and\\_Hydro-morphological\\_pressures.pdf](http://www.sednet.org/download/Policy_paper_WFD_and_Hydro-morphological_pressures.pdf)

<sup>16</sup> COM(2005) 627

Various stakeholders confirm that the EU Floods directive had positive effects and did not hamper the development of innovations in the field (see Box 14). As the regulation required the mapping of flood risk, it was mostly regarded as an encouraging innovation in this field. These regulations also have an institutional objective that allocated clear responsibilities for flood management and response. Several stakeholders also mention the role of industry standards in flood response. In the insurance field for example, the design of common industry standards has been one consequence. In a 2005 communication<sup>17</sup>, the European insurance committee discussed flood prevention in Europe and the role of the insurance industry, trying to encourage a common approach. One of the recommendations of the report was to “share detailed guidance on technical standards for flood prevention produced by the insurance industry in particular European markets, with a view to development of specific recommendations for European technical standards”. A stakeholder interviewed in the frame of the Northern Ireland Strategic Flood Map case study (see Box 14) highlighted the importance to work on such standards.

Box 14 Flood mapping in Northern Ireland

### **Innovative Strategic Flood Map in Northern Ireland**

**Northern Ireland was one of the first regions to transpose the EU Flood Directive, through its 2009 Water Environment Regulations. The national legislation requires the completion of the preliminary flood risk assessment by December 2011, flood risk and flood hazard maps for significant risk areas by December 2013 and flood risk management plans by 2015. At the same time it offers flexibility in terms of implementation paths, although its requirements have to be respected.**

**The Rivers Agency in Northern Ireland is the statutory authority for flood management in the country. In 2008 it developed the Strategic Flood Map, a novel web-based GIS solution<sup>18</sup>. It is the only country in the UK where such a map is publicly available, although it is not required by the legislation. This geospatial technology won the Northern Ireland Area Water Innovation award in 2012 for its very innovative features. The strategic flood map is composed of different data sets: historical maps, present day maps, climate change maps and a flood defence map. The flagship feature of the map is its surface water flood map.**

**One of the innovative aspects of the map is its interactive and user-friendly format. To avoid misunderstandings there is also a guidance notes for potential users. The technology developed is also innovative. The map encourages a more proactive approach to flood risk management. Involvement of various stakeholders in flood risk protection, prevention and preparedness, from the general public for which crowd sourcing and inclusion of local communities in flood response can be seen as another innovative feature. From the organisational innovation point of view, a new public-private association was set up (after a call for tenders) which involves private sector parties such as insurance companies and IT providers.**

The Strategic Flood Map has been applied extensively: planning authorities use it in their land use decisions, insurance companies for their business. The visit tracking reveals a strong public interest for the map, with 15 000 visits in the first week to 300 weekly since then. The feedback received from users is very positive and flood awareness and better flood response are cited as positive effects since the implementation of the map.

Concerning the policy priority of **drought risk management**, there is no legally binding regulation. The EC Communication on water scarcity and drought in the EU (2007) sets down seven policy actions for the member states such as putting the right price tag on water, allocating water and water-related funding more efficiently, or improving drought risk management. The Drought Communication is not binding but encourages countries to take actions in the seven identified fields.

<sup>17</sup> [http://www.insuranceeurope.eu/uploads/Modules/Publications/1225358733\\_annexe234.pdf](http://www.insuranceeurope.eu/uploads/Modules/Publications/1225358733_annexe234.pdf)

<sup>18</sup> The tool can be seen on <https://mapping.dardni.gov.uk/strategicFloodMap/index.aspx>



**Implementation of EC Communication on water scarcity and drought in the EU (2007)**

In 2012, the communication from 2007 was reviewed. It is noted that some progress has been made in the seven areas, however progress was rather slow and no progress concerning reverting the water scarcity and drought were made. According to the review, the implementation level of the cost-recovery and incentive pricing requirements of the WFD were low.

Also in agriculture, “an important share of water abstractions for agriculture in the EU is not priced, even in water-stressed areas and there is no financial mechanism for recovering the environmental and resource costs of individual abstractions or for giving incentives to using water more efficiently”.

The allocation of water and water-related funding could be more efficiently organised if authorisation procedures for water abstraction or use are generally in place in all EU countries. So far, the procedures differ significantly and illegal abstractions remain an important barrier.

Ecological flow schemes – being another policy actions of the communication - are increasingly used. It is noted that Spain is the only country where the trading of water use rights is possible. Also adapting land use to reduce the vulnerability of water resources is not common in EU countries.

Actions to improve drought risk management show some progress in the implementation of drought management plans but other actions remain limited.

The action on additional water supply infrastructures is on track although the development or upgrade of desalination plants is only presented in a few management plans, even though its importance for River Basins in Southern Europe is highlighted. Conversely, the environmental effects of desalination are not always sufficiently considered in the plans according to the review.

Fostering water efficient technologies and practices through modernising technologies is still an unmet objective. For the action ‘Fostering the emergence of water-saving culture in Europe’, the review states that although countries are implementing various awareness-raising activities, “other tools such as incentive pricing, financing mechanisms for water saving eco-design for water using appliances etc. are not always sufficiently present”. There has also been slow progress with improving knowledge and data collection and the lack of data remains an important issue.

According to a study realised in the context of the 2012 review<sup>19</sup>, the main actions taken by countries concern the improvement of knowledge and governance, efficiency, increase in water supply, including economic/pricing-orientated measures and restrictions to land use.

**Ecosystem services**

Ecosystem services are seen as a door opener to a new economy, which takes into account the value of nature and creates new markets for growth. The Water Innovation Partnership defines ecosystem services in the water sector as: “An innovative approach that tries to value the benefits that humans receive from ecosystems (e.g., in monetary terms) in order to integrate them into water management.”

Ecosystem services in the water sector, also called “watershed services” are mechanisms that place (monetary or non-monetary) value on the benefits that can be achieved for the natural environment and human well-being by using and maintaining the ecological infrastructure provided by the wetlands.<sup>20</sup>

<sup>19</sup> <http://ec.europa.eu/environment/water/quantity/pdf/Assessment%20WSD.pdf>

Innovation opportunities in this sector can be found at the level of models for valuing watershed services and at the level of watershed management practices and supporting technologies.

While comprehensive data reflecting the level of innovativeness in this area is missing, there are examples of valuation models for biophysical and socio-economic impacts being developed (see Russi et al 2013). The environmental accounting tools such as NAMEA (National Accounts Matrix including Environmental Accounts) and the UN System of Environmental-Economic Accounts for Water (SEEA-Water) are common frameworks that provide an internationally agreed methodology. However, some of their components are still at an experimental level, such as the measurement of the capacity of ecosystems to provide services.

ICT developments lead to new software and tools that improve valuation methods. Since the mid 1990s the EU, as well as many other regions of the world saw a significant growth in ICT patent filings in the field of ecosystem services and smart ICT/monitoring for water management. A rapid increase in the trade of ecosystem services management technologies has been observed since the early 2000s. EU-based companies have been the dominant player in the international market so far.

Based on the literature and the findings from the case study, water ecosystem services are influenced by regulation on three dimensions:

The regulatory framework on water protection, water quality and water management such as the WFD may influence the design of the larger-scale scheme. In principle, the WFD and ecosystem services approaches are thought to be complementary, as the WFD does not hamper nor particularly drive such initiatives. Due to the fact that the WFD takes an ecosystems-wide approach and is flexible in defining water services, stakeholders believe that this has left room for innovation. Nevertheless, since the concept of incorporating the benefits of ecosystem services is not promoted explicitly in the implementation requirements of the WFD and the river basin management plans, the development of such innovations is slow to happen. The case study on the Danube river basin provides a more in-depth analysis on how the WFD interacts with innovations in ecosystem services delivery.

Further regulations of water discharges that set standards for emissions or land management practices (e.g., for agricultural activities) can help drive particularly the practices of farmers towards delivering measures that benefit the water ecosystem.

At a national and/or regional level, spatial planning regulates land uses and establishes protected areas (e.g., Integrated Water Resources Management and Integrated Coastal Zones Management). Depending on the national set-up, private sector actors and intermediaries can drive the process by working with local landowners and local/regional/national authorities to promote an integrated river/wetland basin management.

Furthermore, the water ecosystem services innovation can potentially be influenced by such regulations as the Flood Directive, the Bathing Water Directive, regulations on marine and coastal zones, fisheries, spatial planning, etc. However the evidence is not available yet.

Ecosystem services approaches can be used as complementary to implementing existing regulation. They are not hampered by the existing regulation at EU level, as an environment for innovation is fostered through the flexible provisions of the Water Framework Directive and the Floods Directive, for instance.

The Water Framework Directive's requirements for reaching "good ecological status" and the promotion of ecosystems-wide thinking leaves room for the member states and local stakeholders to take different compliance paths, which may be innovative including ecosystem services schemes as measures to comply with the WFD.

Nevertheless, taking a systemic perspective, innovation in the area of ecosystem services depends on overcoming other barriers. A fundamental barrier is the need for standardised methodologies and guidance for assessing the benefits of ecosystem services, as well as their distribution among the stakeholders. Good governance and flexible institutional mechanisms from the public sector that would enable national and regional authorities to act across administrative boundaries, as well as the presence

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<sup>20</sup> According to the Millennium Ecosystem Assessment (2005, p.2), wetlands are lakes, rivers, marshes and coastal regions to a depth of 6 meters at low tide.

of intermediary organisations to facilitate the expansion of such schemes, are some of the features that require further development.

## 4.7 Conclusions and key messages

Europe is an innovation leader in water technologies as demonstrated by the number of patents as well as trade shares. Although there is no proven correlation between direct innovation effects and regulation, there is a widely agreed causal link between early, strict legislative standards (regulation) and advanced water service and technology (innovation) (UBA 2011, case studies, Annex C.3).

There are already a wide range of EU regulations that address water issues. Existing EU legislations, including several EU Directives (e.g., on water, ground water, urban wastewater treatment, pollution control, etc.), are seen as important drivers as they provide room for innovation in all priority areas. The analysis in this study has shown that environmental regulations are the most influential in promoting technological innovation in the water sector (in comparison to other regulations, such as those with economic or institutional goals). As demonstrated in the cases of Germany, France and the Netherlands several factors acted as drivers, including: imposing stricter environmental standards, use of polluter-pays-principle based instruments (e.g., levies), and environmental regulation promoted the diffusion of advanced solutions that improved the environmental status of water bodies. Some cases of institutional or governance innovations have also been observed, like the Flood risk management plan in Northern Ireland and in the River basin management/ecosystem service development for the Danube (Annex C.6 and C.7). The innovative activities in these cases were due to a higher degree of freedom by the otherwise mandated actions imposed by EU regulation.

Environmental as well as other regulations need to develop further in order to be able to create the larger changes needed to address the current and upcoming water challenges and market failures. More precise guidelines, innovative regulatory and economic instruments (e.g., water pricing) along with clear institutional arrangements are needed to create a truly favourable environment for novel, more efficient water solutions.

At the same time, by imposing high costs and inflexibilities, regulations can also be barriers to the introduction of new water technologies and processes. This problem emerges due to a lack of coherence between various policies and policy goals (e.g., economic vs. environmental). In this respect, it is important to maintain a dialogue between policy makers and regulators from different areas and ensure transparency and information exchange by involving various stakeholders in decision-making.

This study also highlighted that there are diverse approaches in the implementation of regulation in the various EU countries. It also brought to the attention that the lack of well-defined standards and guidelines (e.g., for reused water applications) can also create hurdles for cross-border diffusion of some new promising technologies. It is important that on EU and international levels, harmonisation of regulations as well as products- and other standards is better supported. The stakeholders however argued also in favour of flexibility: through the concept of 'fit for purpose water quality', various applications on water recycling processes will be possible while, at the same time, securing the monitoring of health related aspects.

The study showed that regulations can be among the most important drivers for diffusing technologies in water areas, but it does not always bring the state-of-the-art innovation to the market. Our analysis of patent and trade statistics suggested that the WFD seemed to have played a role in technology dissemination rather than giving an additional spur to R&D activities. In this respect, the concept of 'best available technologies', as well as ambitious technology standards could play a supporting function, for example when introduced into service procurement or building codes.

Regulation is not the exclusive defining factor of innovations. Novel technologies, practices and changes in any of the thematic areas are influenced by a mix of economic, social, governance, technological, climatic and other factors. It is necessary to consider these factors both for developing new regulatory instruments, as well as in putting them into practice and managing the implementation at the local or national level. As several case studies have shown, social factors such as public awareness raising or a new participatory governance are the key elements in transition to new water management systems.

## 5 Impact of Regulation on Innovation in the Field of Raw Materials

### 5.1 Policy context

The EU, recognising the importance of continuous and affordable availability of raw materials for industry aims to address the issue of raw materials scarcity from an innovation perspective. The EIP focuses on the pillars of domestic supply and reducing demand. The EIP has accordingly developed a threefold strategy for innovation pathways:

- Alternate or substitute away from scarce resources by finding alternative, less scarce materials;
- Recycle more materials already in circulation, or recycle them more efficiently by stimulating innovation in recycling technology;
- Extract more raw materials; increase domestic production and innovate on mining and extraction technologies.

In other words, the strategy is to reduce demand for virgin raw materials by substitution, use the materials already in circulation more efficiently and to increase domestic output of these materials. There are the following foci for innovation:

- Innovation in exploration and mining to increase domestic (EU) supply (and thus reducing the import dependency);
- Innovation in recycling to reduce demand and to develop alternatives in supply through substitution.

The screening methodology applied to this EIP treats both aspects separately. The case studies are focused on innovation in the waste and recycling area. The following is a synthesis of the steps using the screening methodology and the case studies.

### 5.2 Scoping the waste/recycling area

In Europe, about 95% of waste is industrial waste, the rest being municipal waste coming from individual households. Within industry, the mining and quarrying sector produces about 63% of waste, followed by the manufacturing sectors with 25%. This may suggest that in order to reduce waste or promote recycling, the main addressee is industry rather than private households. However, even if private households are only responsible for a small amount of the overall waste, much of that waste is interesting for recovery and recycling purposes. In terms of regulation, the Mining Directive is the main regulation for the waste of mines. All other waste is regulated through waste treatment regulations. In terms of treatment paths, basically landfill, incineration and recovery are the three options commonly used.

### 5.3 Innovation system in the waste management sector

The innovation system in the European waste management sector is mainly confined to the national and also regional/municipal levels and characterised by a public-private split in municipal waste collection (which is roughly 50:50 in the largest countries such as Germany, France and UK) (PSIRU 2012). There are several large multinational companies prevailing in the sector (such as Veolia, Suez, FCC, Remondis, AVR/van Gansewinkel, and Biffa) who are contracted mainly by municipalities. Furthermore there is a trend of re-municipalisation of services; for instance in Germany the main drivers for this development were the demand for improving the quality of service, greater control over policy, desire to avoid oligopolies, and social concerns for the workers' pay and conditions (Heinrich-Böll-Stiftung 2010). Evidence reviewed by PSIRU (2012) shows that the public sector has increased its levels of efficiency. While efficiency gains were the main reason for previous privatisation, the public sector's efficiency gains in the waste sector no longer provide a clear justification for private sector involvement.

Regulation plays an important role in the sector. This can be seen by the large number of relevant EU regulations in this field which exist alongside many national regulation (see Annex Table 9). Existing regulation is often focused on specific waste streams such as batteries, ships, or end-of-life vehicles.

**Recycling certificates & Tax refunds**

As indicated in an early version of the EIP's priorities, the promotion of the use of recycled materials in the manufacturing of new products was included in the final draft. Furthermore, the European Commission in its 'Roadmap to a Resource Efficient Europe (COM/2011/571)' envisages the introduction of minimum recycled material rates for key products in order to strengthen Europe's recycling market.

However, standards for the use of recycled content in products are not in place in the EU and there are only a few examples where quality standards for recycled material were established such as a standard scheme on the re-use of recycled paper in the United States. This case is however not fostering innovation as it only included a static target and a punishment for failure to comply but did not offer a reward for outperforming basic requirements. Voluntary standards exist on the other hand in the EU where producers have agreed to prioritise minimum recycled content (e.g., UK's standards on construction and demolition waste, Germany's "Blauer Engel" product label). Instead of command and control measures, member states seem to prefer softer policy instruments. In the packaging waste streams, the instruments differ. The most common instruments are demand-side policies such as public procurement, financing of research programmes, awareness-raising campaigns, or other information activities such as recycled product labelling. Product taxes/fees/charges are rarely found within the regulatory framework for products, yet they are increasingly used for waste prevention purposes.

Given that despite individual voluntary measures recycled content is not widely used, analyses of different policy options conclude that market-based instruments, and in particular recycling certificates and/or tax refunds, seem most promising for promoting the use of recycled materials and leading to product and process innovation in industrial sectors. Moreover, these instruments are likely to lead to higher collection and recycling rates of waste treatment companies, and contribute to raise the product end-of-life recycling rate. Despite several challenges that need to be overcome the two instruments have characteristics which are likely to be effective in spurring innovation:

- Greatest possible flexibility and creativity in achieving the (technological) targets;
- Do not impose technological choices;
- Encourage companies to perform better than the norm;
- Uniform application thus no creation of competitive advantages/disadvantages for companies or sectors that are not affected by a regulation;
- These instruments are compatible with and can complement other regulations. Positive effects can be expected in particular when a comprehensive mix of regulative instruments is designed.

### 5.3.1 Key determinants of innovation: drivers and barriers

The list of drivers and barriers (see Annex Table 8) was used in order to identify barriers and drivers that can influence product and process innovations in the waste management sectors. This list of factors does not claim to be exhaustive but is intended to provide some key ideas for possible driving or hampering issues in the innovation landscape. They have been extracted from workshops and expert interviews conducted in the framework of case studies. Annex Table 13 summarises the findings and sets out a long list of diverse drivers and barriers which illustrates the complex environment in which the waste sector is embedded. It also indicates that a simple regulation will not be sufficient to address the manifold issues that are often interconnected

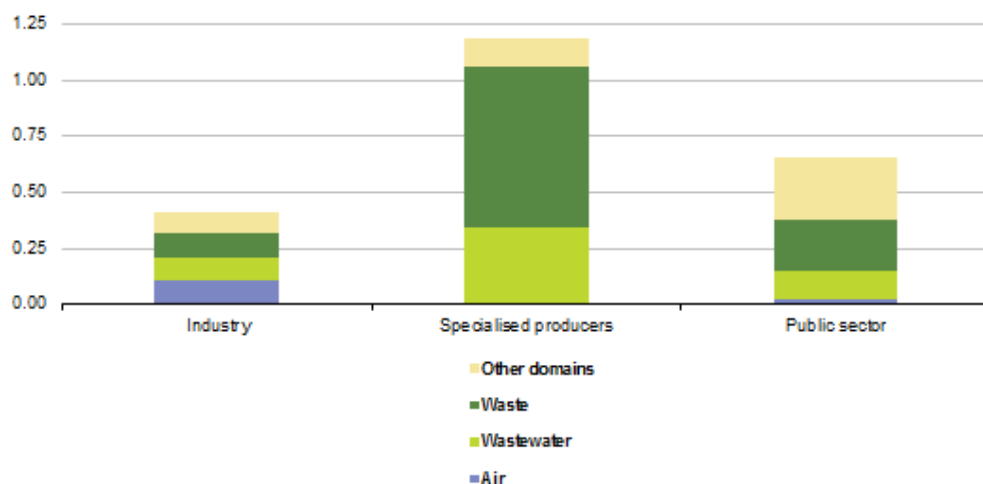
### 5.3.2 Statistical definition

In the **field of waste management** there are basically two broad industry classes in NACE which are relevant from the innovation perspective. The first industry is 'Manufacturing' (Division C), (except for food, tobacco and beverages, leather and wood manufacturing), because the product regulatory framework plays a role in influencing innovation. The other relevant industry class is 'Water supply; sewerage, waste management and remediation actions' (Division E), namely E89 and E39.

### 5.3.3 R&D expenditure

For the waste and recycling area, business R&D expenditure is only available bundled together with water supply (see Table 6 in Chapter 4). Another source of information such as the Government's budget appropriations are also only available at a higher aggregated level (i.e., 'environmental sciences'). As a proxy indicator it may be useful to look at 'environmental protection expenditure' that is carried out in the EU with the purpose of protecting the environment. It covers spending on activities that are directly aimed at the prevention, reduction and elimination of pollution or any other degradation of the environment. The following data is on specialised producers of environmental services (public and private enterprises specialised in environmental services such as waste collection). Figure 15 provides information relating to the various domains which account for environmental protection expenditure in the EU-27. The largest domain in 2011 concerned waste management, followed by wastewater treatment, with almost two thirds of the expenditure within these two domains accounted for by specialised producers.

Figure 15 Total environmental protection expenditure by domain, EU-27 (2011, as a share of GDP)



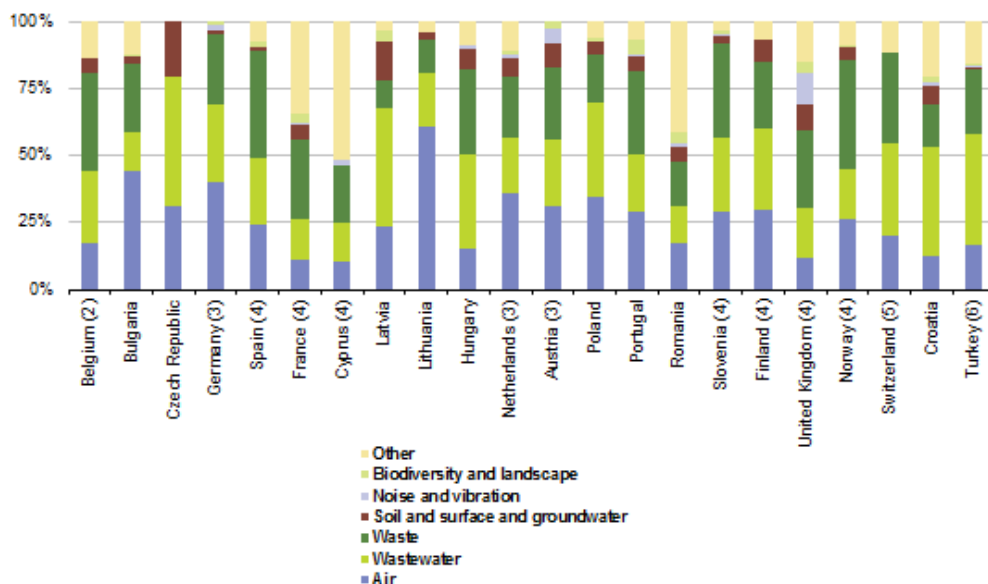
(1) Estimates.

Source: Eurostat (online data codes: env\_ac\_exp1r2 and env\_ac\_exp2)

Waste management and wastewater treatment are the two main domains for public sector expenditure in most EU Member States. Exceptions to this included Spain (where the public sector principally directed its expenditure towards biodiversity and landscape protection) and Cyprus, Denmark and France (where more than two fifths of expenditure was in the ‘miscellaneous’ category, covering general environmental administration and management, education, training and information relating to the environment, as well as activities leading to indivisible expenditure and activities not elsewhere classified).

Environmental protection expenditure made by the industrial sector was concentrated on air protection measures, wastewater treatment and waste management activities (see Figure 16).

Figure 16 Industrial environmental protection expenditure by environmental domain (2011, as share of total)



- (1) Denmark, Estonia, Ireland, Greece, Italy, Luxembourg,
- (2) 2002.
- (3) 2009.
- (4) 2010.
- (5) 2003.
- (6) 2007.

Source: Eurostat (online data code: env\_ac\_exp1r2)

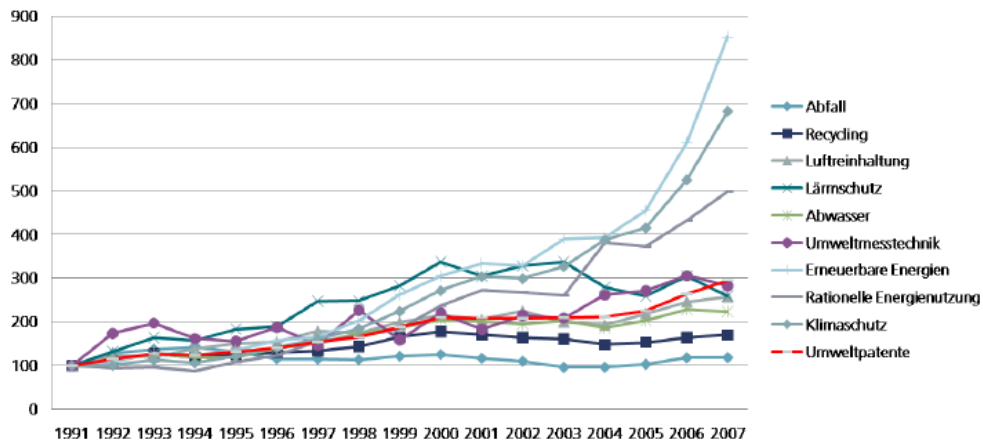
Analysis of this data shows that in some countries, the innovation expenditure on waste is clearly not a priority (such as in CZ), or of relative lower priority (e.g., CY, LV, PL, RO, HR). On the other side, Belgium, Spain, or Hungary seem to invest relatively more in waste management measures. Since public expenditure will most likely boost the innovation capacities of firms, the ‘revealed preferences in public funding’ indicate those countries which are likely to show increases in innovation goods and processes and possibly, with a time lag, also trade.

### 5.3.4 Patents

Since the required fine level of IPC classes (3-digit level) for using available PATSTAT data from Eurostat is not available, we looked at available material from empirical studies.

According to a worldwide patent analysis of environmental goods (UBA 2011), the total patent applications in the field of waste (“Abfall” in Figure 17) increased over the period 1991 to 2007. However, in the middle of that period there was a lower application growth rate for environmental goods compared to all patent applications at the European Patent Office. Among the stagnating fields was waste as well as recycling. This is explained in the report by the advanced technological development stage of these technologies and thus a lower propensity for further innovations.

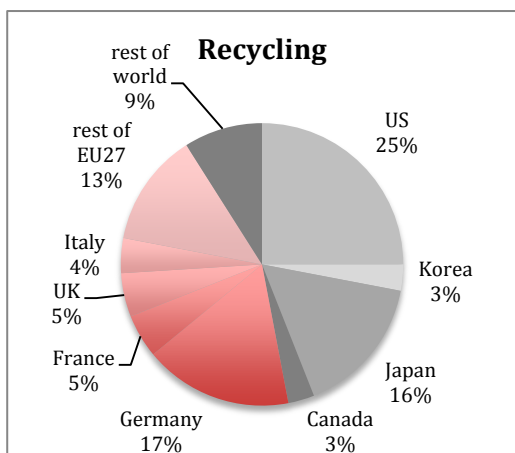
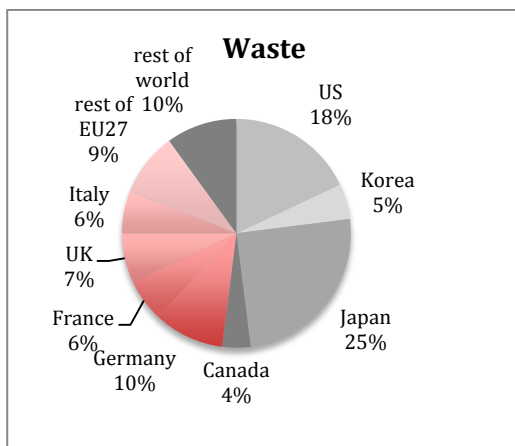
Figure 17 Patent dynamics by environmental technologies



Source: UBA 2011, p. 51

In terms of patent shares in waste 2004-2007, the dominating country is Japan with one quarter of all patents, followed by the US with 18%. There are four EU countries with Germany, the UK, France and Italy in the range of 6-10% shares. The rest of Europe accounts for 9%. The patent situation in the field of recycling is different: here, the USA holds a quarter of all patents, followed by Germany (17%), and Japan (16%). France, the UK and Italy have shares of 4-5%.

Figure 18 Patent shares in the field of waste and recycling



Data: UBA 2011, p 94f



Given the decreases in patenting activities in the last years and thus a relative low innovation focus on waste and recycling in terms of environmental technologies, plus the fact that current innovation leadership is outside of Europe, the current activities may be insufficient to meet ambitious targets in terms of resource efficiency and securing resources (UBA 2011). If Europe wants to foster the recycling and recovery of resources, some external push seems necessary to trigger innovation in these fields.

**Screening of regulatory framework for secondary raw material recovery and re-use and its impact on innovation**

The case-study for the scoping exercise in the field of secondary raw material recovery and re-use identified the current market failures to exploit secondary raw materials and barriers preventing potential significant value being added to the EU economy. Legislation in place has triggered innovation in many EU countries, primarily through command and control measures, to redirect key waste streams away from landfill and towards waste-to-energy. It has been less effective at driving disruptive innovation that is capable of delivering quality secondary raw materials that can compete with primary raw materials.

A series of regulatory changes are proposed to deal with the following barriers in both product and waste legislation which are hampering innovation:

- Waste legislation, which has driven secondary materials away from landfill, is now acting as a barrier to the recovery and re-use of secondary raw materials. Most innovators are still seeking to move waste to the next cheapest disposal and are still far from the paradigm of the 'circular economy'.
- The creation of open and transparent commodity markets that are underpinned by quality standards is crucial. However today's already existing secondary raw material markets (scrap metals, paper and cardboard) remain immature.
- The approval process for 'end of waste' definitions remains a major blockage. The EU has seen examples where technology was exported first to international markets due to restrictive EU legislation. There is lack of a simple effective decision making process across regulatory bodies and innovative companies face difficulties in gaining approval for new ways in developing new materials from waste.
- The use of market based instruments and fiscal support to foster these market changes has largely been left to EU Member States. Market demand would remove the incentive to freeloader and reduce pressure on enforcement agencies.
- The legislation does not deliver good quality data and information on the flows of secondary raw materials that can inform product designers. Such data is crucial to secure the investment required in infrastructure, both to collect and secure quality secondary raw materials.
- The complex interaction between waste legislation and primary product legislation places further technical and commercial barriers in the way of recovering secondary raw materials. Some legislation designed for primary raw materials blocks the entry of secondary raw materials into the market place.
- Suggestions are made as to how to improve European funding mechanisms to support the recovery of secondary raw materials. Firstly by fast-tracking solutions from research, to demonstration, innovation and final market delivery. Secondly by providing financial support to existing European platforms, organisations and mechanisms to capture best practice and drive common solution across the EU.

## 5.4 Analysis of the evidence in waste/recycling

Waste reduction, increase of recycling and a trend towards resource efficiency (including energy and material use) benefitted greatly from regulative measures not only in terms of reduction of environmental pressures, but also in terms of innovations. These developments are however more visible in those countries, which implemented strict environmental legislation early. The innovation leaders such as Germany, Austria, or the Netherlands have introduced 'older' command-and-control instruments such as bans prior to EU environmental legislation. When environmental legislation was introduced with the Single Act, it was in fact largely inspired by the experiences of individual front-running Member States. Even if the portfolio of environmental regulation and instruments is changing, the first-mover advantage of those early adopters is continuing through continuous innovation. The opposite is true for the late-comers: where environmental issues were not treated through regulation and an industry formed prior to EU-legislation or the need to fulfil environmental requirements prior to accession to the EU, 'environmental upgrading' is mainly achieved through the import of environmental goods.

According to the literature, regulation has undergone a qualitative transformation and so has the innovation behaviour changed. Modern environmental regulation is designed within a supra-national complex multi-actor, multi-stakeholder set with a less clear hierarchy of power. Thus regulation is integrated with or replaced by soft law. The set of individual measures still includes top-down bans, however voluntary agreements, voluntary quality standards (ISO, EMAS), and technical standards have gained importance as leading instruments, leaving command-and-control instruments as a last resort of policy makers. These developments are however difficult to quantify and evaluate in particular since their impacts are achieved within a set of formal regulations.

Since environmental regulation is manifold and different regulations are often enacted simultaneously, it is difficult or impossible to disentangle the results and to relate them to a particular regulation other than through a qualitative approach. This is in particular true for waste regulation, designed at EU-level implemented at national, regional and local level with the result that the implementation modes and paths are innumerable. Quantitative indications are unlikely to capture much of the diversity as they are collected on a relatively aggregated level. This limited the scoping exercise somewhat since the exercise cannot account of the many facets of waste management regulation implementation at local level.

Innovation as such is not necessarily the main aim of regulation, however, market pressures such as growing material costs and consumers' environmental concerns provide incentives for companies to innovate. These drivers can be enforced via demand-side policies such as eco-efficiency standards in public-procurement, a material input taxes, labelling systems, and technical standards. One or the other of these measures may be in place when it comes to recycling efforts – however, they are largely designed and implemented within individual EU-MS and wider adoption and diffusion is not supported by coherent, EU-wide regulation (see Annex O).

The scoping exercise showed the quite low innovation activities of the waste and recycling sector in the EU. Only by looking at individual cases and discussing these cases with stakeholders and experts was it demonstrated that present waste regulation is not fostering the use of secondary raw material and that previous legislation has been used to take one particular technological avenue (namely incineration) as the preferred waste disposal technology. This led to massive infrastructure investments that needed to provide a return. Waste reduction is, in fact, something of a threat for these investments. They respond lowering incineration prices even further (see Annex C.8, C.11). Recycling on the other hand is by far more expensive option and not currently competitive as alternative. Thus, in order to foster the recycling avenue, public interventions are necessary such as temporary fiscal incentives for recycling, or levies on the producer's side. Since the reduction of primary raw materials and reuse of material is the main goal of recycling, one needs to create demand and markets for recycled, secondary raw material. This can be achieved through demonstration projects, testing and international standardisation by product group or material taking the quality requirements of individual products/industries into account (see Annex C.11).

The scoping exercise together with discussions with stakeholders and case studies suggested that

Previous waste regulation goals focused on reducing landfilling. Industry then developed a particular technology (incineration) followed by a set of incentives and disincentives (price, quantity) that shaped the waste collection and disposal process in several EU countries. This dominant technology (and the incentives surrounding it) for waste disposal cannibalizes other goals such as waste reduction or recycling.

While recycling is a goal, policy makers also need to pave the way for recycled material and its reuse. This cannot be achieved without further policies to create markets for recycled material and influencing prices. As long as recycling is economically not competitive compared to incineration there needs to be, for example, fiscal incentives to combat the problems faced by this infant industry.

The declared policy goals on recycling need a mix of ambitious regulation and other demand-side policies (demonstration projects, technical standards, labelling, etc.) to create the push necessary to overcome barriers in current legislation.

## 5.5 Evidence of innovation in the raw material nexus

### 5.5.1 *The sectoral innovation system of mining*

Following the national/sectoral innovation system approaches (Nelson 1993; Malerba/Orsenigo 1996) the raw material innovation system comprises sub-systems such as the industrial system (including the relevant user and producer industries), the science system, and framework conditions, including for example public infrastructure or regulation. For the raw materials case, an important deviation or extension of the model is the fact that the innovation system is not geographically bounded. European mining companies exploit mines wherever material is discovered. Since exploration and exploitation of mines is a costly investment, financing is an important factor in this sectoral system as well.

The system is characterised by a number of multinational companies with their main extracting businesses abroad. Before explorations can start, investors need to be identified (either institutional or private ones) to fund test drilling and if successful, to build the large capital-intensive infrastructures required. Mines are at the centre for concerted and coordinated activities that include specialised upstream industries to provide services such as technological consulting renting of equipment, or transport of equipment necessary for the infrastructure. Mining thus needs a heavy upfront investment but later on, the mines can be exploited with minimal continuous costs for several years.

Mining, produces large amounts of waste and the various permits required due to regulation takes up to several years to obtain.

Where mines exist in Europe there are usually public R&D capacities. A number of specialised mining universities exist and public research institutes provide basic research as well as the necessary graduates of specialised engineers and geologists.

Table 8 Key EU regulations in mining

Regulation/Directive	Title	Effects
<b>Directive 2006/21/EC</b> (entered into force in 2008)	Management of waste from extractive industries	<ul style="list-style-type: none"> <li>Extraction waste has to be processed in specialised facilities in order to limit risk for public health and the environment<sup>21</sup></li> </ul>
<b>Directive 92/91/EEC (follows from Directive 89/391/EEC)</b>	Minimum requirements for improving health and safety of workers in the mineral-extracting industries through drilling	<ul style="list-style-type: none"> <li>For both prospection and extraction for sale, employers are responsible for ensuring optimal health and safety for workers<sup>22</sup>.</li> </ul>
<b>Directive 92/104/EEC (follows from Directive 89/391/EEC)</b>	Minimum requirements for improving the safety and health protection of workers in surface and underground mineral-extracting industries	<ul style="list-style-type: none"> <li>For both prospection and extraction for sale, employers are responsible for ensuring optimal health and safety for workers<sup>23</sup>.</li> </ul>

### 5.5.2 Statistical definitions

For the EIP focus on **non-energy mining activities**, there are basically two broad industry classes relevant from the innovation perspective. The first industry is ‘mining and quarrying’ (Division B), and specifically the group 07, which includes mining of all types of metal ores, as well as the machinery industries providing the necessary equipment (C 28.92). Another industry class, namely M71.12 engineering activities can be considered as R&D service although mining is only one of a number of areas covered in this class. We can leave out the classes dealing with repair, renting, leasing or wholesale activities of mining equipment since these are rather low R&D intensive service activities. This delineation however leaves out the innovators: since part of the business model in the mining industry is based on leasing, one needs to look at the specialised machinery sector providing the necessary equipment.

### 5.5.3 R&D expenditure

The most basic but readily available data concerns R&D expenditure by industries. Since mining and quarrying is not done in all EU member states, about two-thirds of the member states report little to no R&D activity. Of the member states, only the UK reports comparatively high expenditures (€162m in 2010), the other reporting countries are much lower such as Lithuania (€29,000), Germany (€12m), France (15m) or Spain (€18.6m), The only non-EU country reporting more than the UK is Norway with €162m. In terms of Euro per inhabitant, the expenditure is rather insignificant: it amounts to €2.6 for the UK and Slovenia, while in the other countries it is in the range of cents.

### 5.5.4 Patents

While patents are in general a good indirect indicator to measure innovation output, their use in the raw material nexus is ambiguous.

There are certainly a number of patents applied for by the extracting companies themselves. However, typically innovation takes place within the specialised machinery and tools industries that provide the equipment to the mining companies. It is thus to see only one side of the coin when looking at the number of patents by the mining industries. However, the inclusion of the upstream industries renders the innovation performance more dynamic than it is.

In order to obtain a detailed and reliable patent analysis, it is worth involving experts who can identify the relevant patent classes down to a very fine level. Patent searches can be done online for example from the European Patent Office for free.<sup>24</sup>

<sup>21</sup> Policy Rationale, [http://europa.eu/legislation\\_summaries/environment/waste\\_management/l28134\\_en.htm](http://europa.eu/legislation_summaries/environment/waste_management/l28134_en.htm)

<sup>22</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0091:en:HTML>

<sup>23</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0104:en:HTML>

<sup>24</sup> In some cases, a less fine resolution search will also provide some insights about a country’s inventive capacity. Eurostat provides access to PATSTAT where an analysis at broad IPC 2-digit level is included and simple to extract. Given the publication period of patent applications and the processing time for providing the data, data including 2009 can be used (2010 data is provisional at the time of writing). The patent data by

The relevant patent class for mining activities E21 – ‘Earth and rock drilling; mining’ can provide us with partial information on the industry’s competitiveness.

The share of patents in mining as a share of all patents is small with 0.65% (820 patents) in 2009. However, between 2005 and 2009, the average absolute growth rate of mining related patents is 18.4%, if EU28 countries are taken out, the growth rate is lower at 16.3%. From an EU28 perspective, mining patents play an even more minor role: in 2009 only 0.55% (307 patents) were in this area, however, the average annual growth rate was slightly above the rest of the world at almost 23%.

Table 9 Patent shares related to mining activities (selected countries and regions)

	2005	2006	2007	2008	2009	% growth of absolute patent number
<b>Share of EU28 in all patents</b>	0,24	0,33	0,49	0,50	0,55	22,9
<b>Denmark</b>	0,12	0,35	2,13	1,39	2,71	158,3
<b>Germany</b>	8,09	8,17	7,15	8,94	8,67	20,4
<b>France</b>	5,26	5,70	5,51	6,97	4,90	16,3
<b>UK</b>	5,12	10,82	15,34	13,13	11,77	45,7
<b>Norway</b>	10,05	7,27	6,84	7,25	6,86	7,6
<b>Canada</b>	4,15	2,45	1,12	3,25	4,22	18,9
<b>US</b>	45,99	44,53	45,88	40,85	44,27	17,2
<b>Brazil</b>	0,12	0,26	0,30	0,38	0,25	42,8
<b>China</b>	0,02	0,37	0,14	0,15	0,43	143,2
<b>Australia</b>	0,79	1,58	0,81	1,45	1,74	-30,4
<b>EU28</b>	33,01	36,22	39,84	39,33	37,48	22,2
<b>All countries</b>	0,31	0,39	0,55	0,58	0,65	18,4 (without EU28: 16,3)

Source: EUROSTAT, PATSTAT data. Calculation: Technopolis

If only the mining patents are analysed, we can see that the EU28 hold a share of 37% in 2009, compared to the 44% of the USA, the single most important patenting country in this field. Within the EU, the UK has the highest share with almost 12%. An impressive growth can be recorded for some countries starting with very low patent numbers such as Denmark, which surpassed even in absolute numbers countries such as Italy, Austria, or Sweden, which had higher numbers than Denmark in 2005. However, Denmark as other countries holds only small numbers which taken individually are statistically insignificant. The data shows however, that the (albeit few) inventions are not made by inventors of the countries where mines are located (with the exception of the US) as the EU28 has a significant share in patents even though there is very little mining activity within Europe.

An interesting case is Australia, which is home to many mines. While Australia has relatively low overall patent applications at EPO, its share of 0.79% in 2005 means in absolute figures a slightly lower number of applications than Denmark. Over the years however, the absolute patent applications in the mining sector have dropped sharply by an average of 30%.

None of the BRIC countries has larger numbers or shares. We can thus conclude that mining-related technology knowhow is largely based in the US and - as a region - the EU. This finding supports the notion that innovation in the mining sector is not coming from within the sector, but it is by and large to be found in those supply firms that provide the necessary machinery and technology.

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country is based on the country of residence of the inventor. Patents involving inventors from different countries are proportionally assigned to the countries, thus avoiding double counting.

The information of filed patents is in general available 18 months after filing, thus, as of now the full 2010 and most of 2011 data is available. If more recent data needs to be taken into account, espacenet from the European Patent Office offers access although data is in larger quantities and is not simple to export.

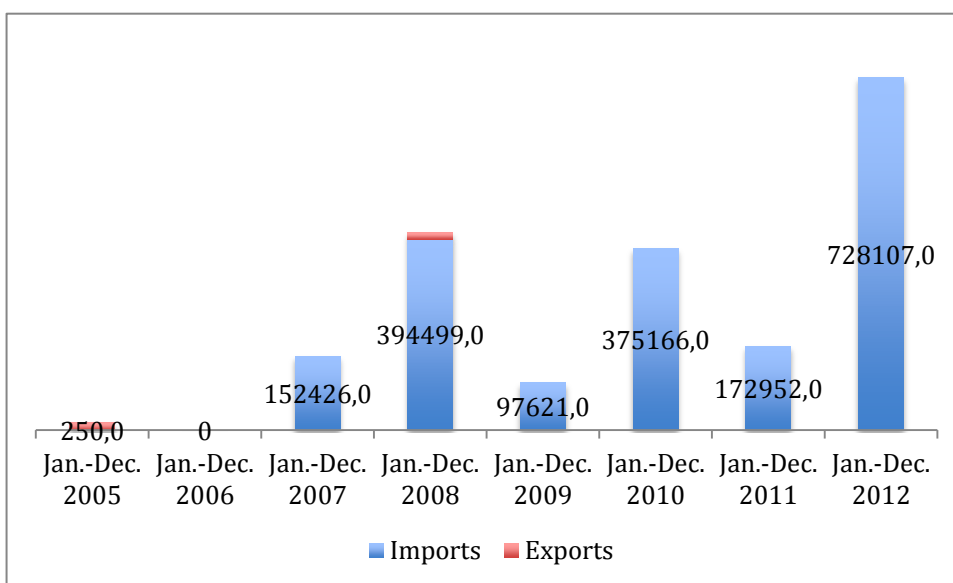
### 5.5.5 Trade

Trade data, and in particular export shares can be used as an indirect indicator for the competitiveness of products from a given country. The high shares of imports of commodities like the figure for EU countries relating to raw materials demonstrates the heavy import dependency and does not tell us anything about innovation as such (Figure 19).

In terms of trade, the relevant SITC product group for the raw materials covered here can be found under group 2 Crude materials, inedible, except fuels, sub-group 28 Metalferrous ores and metal scrap. This sub-group includes various ores as well as ferrous and non-ferrous waste and scrap.

Based on COMEXT data available via Eurostat, including (a limited share of) intra-European trade, the EU-27 imports of metalferrous ores and metal scrap mirrors the general economic situation. Import value rose from €39bn in 2005 to €63bn in 2008. The financial and economic crisis led to a sharp import drop (€34bn in 2009). In the past three years, the demand and value of imports in ores is non-linear. The EU-27 do export, however, to a limited extent. In 2012, the value of their exports came to €17.7bn.

Figure 19 Export and import value of metalferrous ores and metal scrap for the EU27 (in bn Euro)



Data: COMEXT; calculation: Technopolis

## 5.6 Analysis of the evidence concerning raw materials

The business of extraction and trade of materials can be found in all resource-rich countries throughout the world. Within Europe, raw materials are comparatively scarce. Analysing from an innovation system point of view, one can see that the main actors are multinational mining firms, backed by financial institutions. Patent analysis showed that the mining sector is the least innovative of all sectors and industries.

The scoping exercise and stakeholder involvement showed that EU regulation is not a key issue for innovation for the raw material and mining area. Price mechanisms are by far the dominant driver or barrier concerning investment decisions and the business is based mainly in mines outside of Europe. Existing regulation in this field concerns environmental protection and planning procedures. The latter was mentioned as the main barrier for new exploitation sites within Europe but it was also acknowledged that the long procedures are mainly due to administrative burden and non-concerted permitting processes within national and regional authorities.

By analysing the field of raw materials – in particular when identifying the main actors, it is obvious that the framework is not within a geographical ‘national system of innovation’ but rather is a highly international one: in general raw materials are thus regulated by foreign, non-EU regulation and general access is secured by trade agreements. Commercial mining objectives and technical needs are detrimental to urban planning and environmental concerns of many European countries; a shift towards more mining activities in Europe faces strong objections from the consumers (and voters). This limits the scope regulations related to the mining sector within Europe to waste (environmental) and employment regulation which deal with quality and security issues. Perceived by the sector as hampering for mining activities – but not for innovation – are the processes for granted mining permissions which are suboptimally administered at national or regional level (‘excess red tape’), and which are, thus, time-consuming.

Based on R&D, patent and trade data it is obvious that mining is mostly happening abroad and that research and innovation play only a marginal role. In this respect it is interesting to note that EU as well as foreign environmental regulation has an impact on innovation in the mining industries, since improved technologies and a sound environmental policy are more and more required by the investing and guaranteeing financial market organisations.<sup>25</sup>

Most innovation, of the little there is, comes from specialised supply firms. Innovation in mining technologies may be found in the future in deep-sea mining or the exploration of extreme depth underground mining – as addressed in the EIP. However, these avenues require basic and applied research before commercial endeavours are viable.

Stakeholder consultation confirmed the insight that existing European regulation has no major impact on the innovation behaviour of mining within Europe and innovation is only of minor importance to the multinational firms, being in general concession holders for a given period only.

The scoping exercise thus did not identify clear direct links between existing regulation and innovation.

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<sup>25</sup> Warhurst, A.; Bridge, G. (1996): Improving environmental performance through innovation: recent trends in the mining industry, *Minerals Engineering* 9/9, pp. 907-921.



## 6 Review on the methodology for screening regulation

The screening methodology was tested in the fields of the European Innovation Partnerships on Water and on Raw Materials. A number of issues evolved and were addressed during these pilot exercises. During a final workshop these were discussed with the study team and external experts.

Throughout the project, insights of what is useful and what should be taken into account for the tested methodology were received. In general, the methodology was seen as useful for assessing existing regulation. Since the approach can be adapted to specific needs and levels of analysis, it may prove also to be useful for ex-ante assessments in areas where new regulation is being prepared. It would work as complementary process, addressing innovation aspects which are too often not taken into account as a key planning dimension for new regulation.

The methodology can be used for analysing innovation effects for any geographical level of regulation although EU and national level may, in most cases, be more relevant than regional level regulation

The following is a collection of comments on the individual steps employed during the workshops and the various methodological concepts used. It leaves out step one since the identification of the subject matter was not necessary. This list is complemented by a short list of more general recommendations.

### Step 2: Scoping

For the two EIP cases, the relevant level of assessment was at the level of 'priorities' or 'work packages'. They turned out to be very broad for the scoping activity providing room only for a limited number of indicators and descriptions at EU-level. Thus a narrowing down of the analysis in the form of case-studies seemed appropriate.

The near ideal scale for a scoping analysis may be at 'field' or 'industry' level, looking at a particular country and including comparisons to other countries.

The innovation systems approach is considered useful since it provides a systematic method to identify the innovation agents and various other stakeholders and their different roles in the innovation process as well as the drivers and barriers. This very early step can point out if other factors seem to be more important as a driver or barrier such as governance issues (e.g., in the water sector, the ownership structure (public or private) influences the capacity to make investments in water innovations).

### Step 3. Policy objectives, drivers and barriers for innovation

The approach based on identifying and discussing drivers and barriers for innovation and business gives a broader perspective on the regulation that may be relevant for innovation. Having a starting point of possible drivers and barriers can be an eye opener for the various stakeholders involved and brings seemingly remote factors to their attention.

From the perspective of industry, the economic perspective on regulations is important. Regulations may put restraints on the profits of companies, but they may also trigger profits. This industry perception of regulation often depends on the timing: compliance costs are high(er) when a regulation is introduced and companies may perceive this as a barrier (i.e., it reduces their profits, or lowers their R&D budget) but in the longer run, costs are internalised and the regulation may lead to competitive advantages.

#### Step 4. Screening of regulatory landscape relevant for the area in focus

One may start with a specific regulation in mind but soon one will be faced with a number of by-laws, acts, provisions etc. In many cases, not only is sector-specific regulation relevant but generic or horizontal regulation may have a large impact on innovation behaviour and outputs as well. This aspect will most likely be identified with stakeholders and through the discussion about drivers and barriers. Looking holistically at wider policy instruments (such as governance issues, standards and tariff setting or pricing regulation) provides a added value to the analysis of regulation and the new regulation planning process.

Time-related analysis of regulation and its effects is an important issue: the assessment of a regulation's innovation effects can depend on time (e.g., timeframes, time horizons and timeliness) in a number of ways. For example, a short interval between development of the regulation and its implementation may favour incremental innovation over radical innovation or the diffusion of existing technology (as seen in case of the WFD). The screening should indicate whether timing issues existed for the specific case and whether these can be identified as a driver or barrier. Timing as much as stringency of regulation are quality characteristics of a regulation and can be assessed once a regulation creates impacts such as technological lock-ins, low generation of options, etc.

Benchmarking of regulation. While most regulations are planned and implemented at the national level, comparative information is useful and should be a part of any analysis of regulation. This may include comparing the relevant regulatory setting with those of other European or international competitors and to analyse how regulation is implemented there. Combined with statistical data on patents or trade (see Step 2), the identification of the different ways in which regulations are implemented and managed is a useful input to better understanding how regulations create both positive and negative effects.

#### Step 5. Analyse impact of regulations on innovation

The relation between regulation and innovation is complex and context dependent. The effects on innovation are determined by details. Developing a generic model for the relation between regulation and innovation is, therefore, extremely difficult. Some generalising and structuring principles however (e.g., presented by Stewart, Blind and BERR frameworks) are useful. The analysis could start with analysing the actors' strategies in using the regulation in the particular field.

Determining impacts may not be a correct term for the assessment of the results of regulation. The suggestion that it is possible to determine quantitative impacts should be avoided due to the complexity of the relationship between regulation and innovation, the influence of innovation drivers other than regulation, the limited availability of relevant data and the resulting methodological issues. It is more realistic to focus on (determining) the relation between regulation and innovation and the importance of regulation for innovation in comparison to other drivers and barriers. Internal market aspects must be considered when EU regulation is assessed.

Availability of relevant data is an important issue. Indicators for environment, economy and innovation are often not available at the necessary level of detail (sector, geographic location, etc.). In order to identify and analyse impacts one has to make an informed choice, try to obtain the most relevant data and rely on available indirect indicators.

In addition to quantitative data, qualitative evidence can also be useful and may be available ('story telling').

International comparison of regulation and innovation on specific issues (benchmarking and international case studies) may be a good way to see whether regulation has innovation effects.

Life cycle aspects must be taken into account in the analysis, e.g., comparing regulations promoting large-scale implementation of available technology to regulations promoting the development of options for new technology that may have larger societal effects in the future, but which are less certain.

Often in the absence of stringent data and evidence, it depends on the perspective of stakeholders as well as political realities whether an impact is considered positive or negative. The impact assessment should however strive to be based on neutral evidence as much as possible and avoid a political bias.

Stakeholder involvement is considered essential. However, stakeholder views tend to be biased and stakeholders follow their different interests when presenting their arguments. There needs to be an abstraction of knowledge beyond interest groups from various sources. Views from various stakeholders should be taken into account, stakeholders should be approached with various means and precise, truth-

revealing questions should be used and all responses should be carefully analysed. Expert interviews could also be a source used alongside typical stakeholder consultation.

It is difficult to involve smaller companies as stakeholders in the discussions. The use of a survey for a targeted population (as was tried with the EIP on water) was considered successful.

The following are general recommendations for successful use of the methodology:

**Involve stakeholders** from early on. The screening methodology is built on a set of steps and structuring concepts which look at the problem from a variety of perspectives, offering the possibly to identify factors which were neither the target group of the regulator nor necessarily immediately in scope for the screening body – assuming that this body is a single authority.

During the full screening exercise **involve several possibly affected authorities**. This might mean that you will have to engage a number of units in different ministries or other agencies. If the screening is organised as a shared exercise and recommendations are developed and shared by several authorities then follow-up actions, including changes in regulation as well as better alignment of supporting policies have a higher chance of being successfully planned and implemented.

**Include comparisons**. Several case studies have shown that innovation is not hampered per se by regulation but rather by its implementation or enforcement in a specific environment. It is instructive to compare different implementation modes of regulation in different settings.

**Invite international experts**. Stakeholder meetings with experts from different countries or interviews with international experts provide information about hands-on experiences in different settings and how regulations are being implemented differently. This may prove to be a benefit to the planning process for new regulation as it is an opportunity to take into account good practices from other countries or regions. Clearly, it is unlikely that a one-to-one transfer is possible given the varying local, regional or national circumstances. Nevertheless, comparison can identify enabling conditions in which regulation promotes emergence and diffusion of innovations.

## Appendix A Literature

- Angelakis, A.N. (2012), Wastewater recycling and re-use in EU countries: Necessity for Establishing EU Legislation, Presentation at the Workshop on The Quality of Recycled Water and its Application in Agriculture. 27th of April 2012, Limassol, Cyprus
- Anwandter, Lars, and Piero Rubino (2006), "Risks, Uncertainties and Conflicts of Interest in the Italian Water Sector: A Review and Proposals for Reform". *Materiali UVAL - Analisi e Studi*. <http://www.dps.mef.gov.it/materialiuval>.
- Armstrong M. and Sappington, D.E.L. (2006), "Regulation, Competition, and Liberalization". *Journal of Economic Literature*, Volume XLIV, pp. 325 – 366.
- Armstrong, M., Cowan, S. and Vickers, J. (1994), *Regulatory reform: Economic analysis and British experience*, The MIT Press.
- Arnold, E.; Kuhlman, S. (2001): RCN in the Norwegian Research and Innovation System. Background Report No. 12 in the evaluation of the Research Council of Norway. Brighton, Technopolis.
- Ashford, N.; Hall, R. P. (2011): The Importance of Regulation-Induced Innovation for Sustainable Development. *Sustainability*, 3(1), 270–292. doi:10.3390/su3010270
- BERR (2008): Regulation and Innovation: Evidence and policy implications.
- Blind, K. (2012): The impact of regulation on innovation. Manchester Institute of Innovation Research.
- Braat, L. (eds) (2008): The Cost of Policy Inaction (COPI): The Case of Not Meeting the 2010 Biodiversity Target, European Commission, Brussels.
- Carlsson, B.; Stankiewicz, R. (1991): On the nature, function and composition of technological systems, *J. Evol. Econ.* 1 (2), 93 – 118.
- Carlsson, B.; Jacobsson, S.; Holmen, M.; Rickne, A. (2002): Innovation systems: analytical and methodological issues, *Research Policy* 31 (2) 233–245.
- Chong E., Saussier S. and Silverman, B. S., (2012), *Water under the Bridge: City Size, Bargaining Power, Prices and Franchise Renewals in the Provision of Water*, Discussion Paper Series, EPPP DP N° 2012-5, IAE, Ponthéon-Sorbonne.
- Christensen, C., (1997): *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Cambridge, MA: Harvard Business Review Press.
- Conseil d'Etat (2010), *L'eau et son droit*, Etudes et Document du Conseil d'Etat, Rapport public 2010, La Documentation Française, 580 pages.
- D. Bixio, C. Thoeve, J. De Koning, D. Joksimovic, D. Savic, T. Wintgens, T. Melin (2006), Wastewater reuse in Europe Original Research Article, *Desalination*, Volume 187, Issues 1–3, 5 February 2006, Pages 89–101
- DEFRA (2013), Realising Nature's Value: Ecosystem Markets Task Force Final Report, March 2013, <http://www.defra.gov.uk/ecosystem-markets/files/Ecosystem-Markets-Task-Force-Final-Report-.pdf>
- Duke, G., Conway, M., Dickie, I., Juniper, T., Quick, T., Rayment, M., Smith, S., (2013). EMTF Second Phase Research: Opportunities for UK Business that Protect and/or Value Nature. Final Report. ICF GHK, London
- Ecologic (2007), EU Water saving potential, Report, ENV.D.2/ETU/2007/0001r, Ecologic, Institute for International and European Environmental Policy, National Technical University of Athens, Universidad de Córdoba, ACTeon
- Edler, J. and L. Georghiou (2007), "Public Procurement and Innovation: Resurrecting the Demand Side", *Research Policy*, Vol. 36, pp. 949–963.
- EEA (2013) Urban wastewater treatment (CSI 024) - Assessment published Jan 2013, <http://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment/urban-waste-water-treatment-assessment-3#toc-1>

- Elnaboulsi J. (2001), "Non-linear pricing and capacity planning for water and wastewater services", *Water Resources Management*, 15, 1, pp. 55 – 69.
- Elnaboulsi J. (2001), "Organization, management and delegation in the French water industry", *Annals of Public and Co-operative Economy*, 72, 4, pp. 507 – 547.
- Elnaboulsi J. (2009), "An Incentive Water Pricing Policy for Sustainable Water Use", *Environmental and Resources Economics*, Volume 42, Issue 4, pp. 451 – 469.
- Elnaboulsi J. (2011), "An Efficient Pollution Control Instrument In Achieving Sustainability: the Case of EU Urban Wastewater Pollution". *Environmental Modeling and Assessment*, Volume 16, Issue 4, pp. 343 – 358.
- Elnaboulsi J. and Houser M. (2012), On the Management of Europe's Water Resources: Economic Challenges in Water Policy, 13<sup>th</sup> Mediterranean Research Meeting, Robert Schuman Center for Advanced Studies, European University Institute, Florence, Italy,
- European Commission (EC 2013), Green Infrastructure Communication, 6 May 2013  
[http://ec.europa.eu/environment/nature/ecosystems/docs/green\\_infrastructures/1\\_EN\\_autre\\_document\\_travail\\_service\\_part1\\_v2.pdf](http://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructures/1_EN_autre_document_travail_service_part1_v2.pdf)
- European Environmental Agency (EEA, 2012), European waters - assessment of status and pressures, EEA Report No 8/2012. Accessible on: <http://www.eea.europa.eu/publications/european-waters-assessment-2012>
- European Innovation Partnership on Water (EIP-Water, 2012), Strategic Implementation Plan, [ec.europa.eu/environment/water/innovationpartnership/pdf/sip.pdf](http://ec.europa.eu/environment/water/innovationpartnership/pdf/sip.pdf)
- Flash Eurobarometer 315 (2011) 'Attitudes of European entrepreneurs towards eco-innovation', [ec.europa.eu/public\\_opinion/flash/fl\\_315\\_en.pdf](http://ec.europa.eu/public_opinion/flash/fl_315_en.pdf)
- Futran, V. (2013), Tackling water scarcity: Israel's wastewater recycling as a model for the world's arid lands?, Global Water Forum, March 18, 2013 · <http://www.globalwaterforum.org/2013/03/18/tackling-water-scarcity-israels-wastewater-recycling-as-a-model-for-the-worlds-arid-lands/>
- Gautier A. and Yvrande-Billon A. (2013): "Contract Renewal as an Incentive Device. An Application to the French Urban Public Transport Sector". *Review of Economics and Institutions*, 4, 1, Winter.
- Global Water Intelligence and Singapore Public Utilities Board (GWI and SPUB, 2010), "Municipal Water Re-use Markets 2010" report, <http://enterpriseinnovation.net/article/future-water-re-use>
- Grupp, H. (1999), Umweltfreundliche Innovation durch Preissignale oder Regulation? Eine empirische Untersuchung für Deutschland, *Jahrbücher für Nationalökonomie und Statistik*, Bd. 219/5+6, 611-631.
- Guérin-Schneider L. and Nakhla M. (2012), "Emergence of an Innovative Regulation Mode in Water Utilities in France: Between Commission Regulation and Franchise Bidding". *European Journal of Law and Economics*, 33, pp. 23 – 45.
- Guest, J. S. et al (2009) A new planning and design paradigm to achieve sustainable resource recovery from wastewater, *Environmental Science and Technology* feature, 2009, 43, 6126–6130
- Hekkert, M.; Suurs, R.; Negro, S.; Kuhlmann, S.; Smits R. (2007). Functions of innovation systems: A new approach for analysing technological change, *Technological Forecasting and Social Change* 74(4): 413-432.
- Horbach J.; Rammer, C., Rennings, K. (2012) Determinants of eco-innovations by type of environmental impact — The role of regulatory push/pull, technology push and market pull, *Ecological Economics*, Volume 78, June 2012, Pages 112-122
- Huet F. and Porcher S. (2012), *Innovation and Regulatory Outcomes: Evidence from the Public-Private Contracts for Water Supply in France*, Discussion Paper Series, EPPP DP N° 2012-11, IAE, Ponthéon-Sorbonne.
- Kemp, R. (1997), *Environmental Policy and Technical Change*, Cheltenham.
- Laffont J. and Martimort D. (2002), *The Theory of Incentives, The Principal-Agent Model*, Princeton University Press.

- Martimort D. and Pouyet J. (2008), "To Build or not to Build: Normative and Positive Theories of Public-Private Partnerships", *International Journal of Industrial Organization*, 26, 393 – 411.
- Massarutto, A., and Ermano P. (2013): "Drowned in an Inch of Water: How Poor Regulation Has Weakened the Italian Water Reform." *Water Utility Regulation in Developed Countries* 24 (0) (March): 20–31. doi:10.1016/j.jup.2012.09.004.
- Mediterranean-EU Water Initiative (MED-EUWI, 2007) Wastewater Reuse Working Group. Mediterranean wastewater reuse report. See on [http://ec.europa.eu/environment/water/water-urbanwaste/info/pdf/final\\_report.pdf](http://ec.europa.eu/environment/water/water-urbanwaste/info/pdf/final_report.pdf)
- Miller, M. (2013): Articles summary from the International Conference on Nutrient Recovery From Wastewater Streams, Vancouver, 2009
- OECD (2006), *Water: The Experience in OECD Countries*, Environmental Performance Reviews, OECD Publishing, Paris, France.
- OECD (2007): *Instrument Mixes for Environmental Policy*, OECD Publishing, Paris, France.
- OECD (2009a): *Managing Water for All: An OECD Perspective on Pricing and Financing*, OECD Publishing, Paris, France.
- OECD (2009b): *Strategic Financial Planning for Water Supply and Sanitation*, OECD Publishing, Paris, France.
- OECD (2010a): *Pricing Water Resources and Water and Sanitation Services*, OECD Publishing, Paris, France.
- OECD (2010b): *Innovative Financing Mechanisms for the Water Sector*, OECD Publishing, Paris, France.
- OECD (2011a): *Policy coherence between water, energy and agriculture*, Working Party on Biodiversity, Water and Ecosystems, 10–11 March 2011, OECD Publishing, Paris, France.
- OECD (2011b): *Fostering Innovation for Green Growth*, OECD Green Growth Studies, OECD Publishing, Paris, France.
- OECD (2011c): *Benefits of Investing in Water and Sanitation: an OECD Perspective*, OECD Publishing, Paris, France.
- OECD (2011d): *Fostering Nanotechnology to Address Global Challenges: Water*, OECD Publishing, Paris, France.
- OECD (2012a): *The Environmental Outlook Baseline*, via <http://www.oecd.org/env/resources/environmentthewaterchallengesharingapreciouscommodity.htm>
- OECD (2012b): *Meeting the Water Reform Challenge*, OECD Studies on Water, OECD Publishing <http://dx.doi.org/10.1787/9789264170001-en>
- OECD (2012c): *OECD Environmental Outlook to 2050: the Consequences of Inaction*, OECD Publishing, Paris, France.
- OECD (2005): *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, 3<sup>rd</sup> Edition, OECD Publishing, Paris, France.
- Popp, D. (2002), *Induced Innovation and Energy Prices*. *American Economic Review* 92(1), 160 – 180
- Ries T. and V. Mertsch (2006) "New requirements and future prospects of waste-water treatment", presentation at enviroWater 2006 conference, <http://www.envirowater.de/Programme/index.htm>
- Russi D., ten Brink P., Farmer A., Badura T., Coates D., Förster J., Kumar R. and Davidson N. (2013), *The Economics of Ecosystems and Biodiversity for Water and Wetlands*. IEEP, London and Brussels; Ramsar Secretariat, Gland
- Sanz, L. (1999) *Irrigated agriculture in the Guadian River High Basin Agricultural Water Management* 40, 171–181.
- Stewart, L. (2010). [The Impact of Regulation on Innovation in the United States : A Cross-Industry Literature Review](#) , (June), 1–29.
- Thomas, D. A. and Ford, R. R. (2005), *The Crisis of Innovation in Water and Wastewater*, Edward Elgar Publishing Limited.

UBA (2008): Instrumente zur Förderung von Umweltinnovationen, Bestandsaufnahme, Bewertung und Defizitanalyse. Studie durchgeführt von ZEW und FU Berlin, Forschungsstelle für Umweltpolitik. UBA Schriftenreihe Umwelt, Innovation, Beschäftigung 02/08

UBA (2011): Ausgewählte Indikatoren zur Leistungsfähigkeit der deutschen Umwelt- und Klimaschutzwirtschaft im internationalen Vergleich Produktion, Außenhandel, Umweltforschung und Patente. Studie durchgeführt von NIW und ISI. UBA Schriftenreihe Umwelt, Innovation, Beschäftigung 02/12

UBA and BMU (2001): The German water sector: Policies and Experiences  
[http://www.umweltbundesamt.de/wasser/wsektor/wasserdoku/english/index\\_e.html](http://www.umweltbundesamt.de/wasser/wsektor/wasserdoku/english/index_e.html);

United Nations Environment Programme (UNEP) (2008): Vital Water Graphics: An Overview of the State of the World's Fresh and Marine Waters, 2nd Edition, accessible on  
<http://www.unep.org/dewa/vitalwater/index.html>

Urban Water Security Research Alliance (UWSRA) (2009): Definition of Decentralised Systems in the South East Queensland Context, Technical Report No. 12.

von Petersdorff, W. (2007): Im Portrat: Hans Huber. Der Saubermann. Frankfurter Allgemeine Sonntagszeitung 2007;17(April 29):48.

Waltz, R. et al (2008): Research and technology competence for Sustainable development in the BRICS countries, Fraunhofer IRB Verlag;

Walz, R.; Kuntze, U. (1999): Ordnungsrecht, Abgaben und Innovationen. Berlin: Analytica.

Water Environment Research Foundation (WERF) (2010): Nutrient Recovery State of the Knowledge, [www.werf.org/c/2011Challenges/Nutrient\\_Recovery.aspx](http://www.werf.org/c/2011Challenges/Nutrient_Recovery.aspx)

Watershed Connect (2012): "Charting New Waters. The State of Payments for Ecosystem Services 2012", [http://www.watershedconnect.com/documents/charting\\_new\\_waters\\_state\\_of\\_watershed\\_payments\\_2012](http://www.watershedconnect.com/documents/charting_new_waters_state_of_watershed_payments_2012)

WIPO & Cambridge IP (2012): Patent Landscape Report on Membrane Filtration and UV Water Treatment: A report on selected water treatment technologies and their application in desalination systems, [http://www.wipo.int/patentscope/en/programs/patent\\_landscapes/reports/water\\_treatment.html](http://www.wipo.int/patentscope/en/programs/patent_landscapes/reports/water_treatment.html)

World Intellectual Property Organisation (WIPO) (2009): Patent-based Technology Analysis Report – Alternative Energy Technology, available on [http://www.wipo.int/patentscope/en/technology\\_focus/pdf/landscape\\_alternative\\_energy.pdf](http://www.wipo.int/patentscope/en/technology_focus/pdf/landscape_alternative_energy.pdf)

## Appendix B Tables

Annex Table 1 Functions of innovation (“Hekkert classification”)

Function	Description
<b>Function 1. Entrepreneurial activity:</b>	Entrepreneurs are very important in overcoming the uncertainties that are present in the early stage of development of a new technology.. The role of the entrepreneur is to turn the potential of new knowledge into concrete actions to take advantage of business opportunities and stimulate learning by doing. Entrepreneurs can be new entrants that have the vision of business opportunities in new markets, or incumbent companies who diversify their business strategy to take advantage of new developments.
<b>Function 2. Knowledge creation</b>	Mechanisms of learning are at the heart of any innovation process. For instance, according to Lundvall (1992): <i>“the most fundamental resource in the modern economy is knowledge and, accordingly, the most important process is learning”</i> . This function encompasses learning by searching and is associated with R&D and patenting activities that create a variety in the knowledge base.
<b>Function 3. Knowledge diffusion through networks:</b>	The diffusion of knowledge through networks of actors contributes to learning by interacting and facilitates the exchange of information, e.g. by workshops, conferences and research collaborations. This is important in a strict R&D setting, but especially in a heterogeneous context where R&D meets government, competitors and market. When the development of knowledge (Function 2) is diffused throughout the network, learning at system level takes place, which enhances diffusion, as well as further technology development.
<b>Function 4. Guidance:</b>	This system function represents the selection process necessary for the convergence in technology development. Activities within the Innovation System that can positively affect the visibility and clarity of specific needs among technology users fall under this system function. Guidance can take the institutional form of policy targets, but is often realised through formulation of expectations regarding the technology as expressed by various actors. This grants a certain degree of legitimacy to the development of the technology and stimulates the mobilisation of resources.
<b>Function 5. Market formation:</b>	Innovations often have to compete with existing products and processes in existing markets, while they are still not advanced in the learning curve. Therefore it is important to create protected spaces for new technologies. One possibility is the formation of niche markets for specific applications of the technology. This can be done by governments but also by other actors in the Innovation System. Another possibility is to create a temporary competitive advantage by favourable tax regimes, minimal consumption quotas, or other activities in the sphere of public policy.
<b>Function 6. Resources mobilisation:</b>	Human and financial resources are a necessary and basic input to all the activities in the innovation process. Both R&D and the construction of production facilities require financial resources, either from internal or external funds, e.g. government subsidies and venture capital. In terms of human capital, one could think of well-educated professionals in all parts of the Innovation System.
<b>Function 7. Creation of legitimacy/ counteract resistance to change</b>	The new technology and its proponents need to be considered as desirable by the other actors in the system in order to be accepted. Parties with vested interests often oppose to the new technology. This function describes activities that influence the acceptance of technology with respect to policy and society, as the new technology should comply with legislation and relevant institutions. Advocacy coalitions are of great importance in this process, as they can put a new technology on the (political) agenda, lobby for resources or favourable tax regimes and by doing so create legitimacy for the new technological trajectory.

Source: Hekkert et al 2007



Annex Table 2 Classification of regulation (“Blind classification”)

Type of regulation	Positive effects	Negative effects	Empirical evidence
<b>Economic</b>			
<b>Competition</b>	Increases incentive to invest in innovation	Reduces rents for innovators Reduces R&D co-operation	Ambiguous
<b>Antitrust</b>	Competitive pressure by market entrants		Anecdotal
<b>Merger &amp; Acquisitions</b>	Restrictions protect management from short term market pressure	M&A restrictions limit takeover pressure and innovation incentives	Ambiguous, evidence for U-shaped relation between innovation and market pressure regulation
<b>Market entry</b>	Can protect infant industries	Restricts market entry of (innovative) newcomers	Indirect evidence
<b>Price regulation</b>	Minimum prices decrease risk	Price caps reduce innovation incentive	
<b>Natural monopolies/ public enterprises</b>	Stability allows for long time-horizons	Monopoly results in low incentives	Positive effects of deregulation
<b>Social</b>			
<b>Environmental protection</b>	Creates incentive for new eco-friendly products and processes by creating temporary market barriers (Porter Hypothesis)	Compliance costs limit R&D budget	Mainly positive
<b>Workers health and safety protection</b>	Creates incentive to develop new processes with higher work safety	Compliance costs limit R&D budget	Not available
<b>Product and consumer safety</b>	Increases acceptance/demand for new products among consumers	Compliance costs limit R&D budget	Limited ambiguous evidence
<b>Institutional</b>			
<b>Liability</b>	Increases acceptance and diffusion among consumers	Too high liability reduces incentives to develop new products	Ambiguous
<b>Employment protection legislation</b>	Job security	Higher adjustment costs	Mostly positive
<b>Immigration</b>	More competitive/flexible job market	Integration costs	No effect
<b>Bankruptcy</b>	Increased confidence of creditors to invest in innovation	Restriction to acquire external funds for risky investments	Negative
<b>Intellectual property rights</b>	Additional incentives to invest in R&D due to monopoly rights	Restricts development and diffusion of new technologies	Ambiguous

Based on Blind (2012)

Annex Table 3 Stewart framework

	<b>Negative effects (Compliance burden)</b>	<b>Compliance innovation (successful)</b>	<b>Compliance innovation (unsuccessful/'dud')</b>
<b>Flexibility</b>			
<b>Command and control</b>	Higher	-	-
<b>Incentives-based</b>	Lower	-	-
<b>Specification standards</b>	Higher	-	More
<b>Performance standards</b>	Lower	-	Less
<b>Information</b>			
<b>Information added (such as certification)</b>	Lower	-	Lower
<b>Compliance uncertainty (uncertain regulatory approval)</b>	Higher	-	
<b>Stringency</b>			
<b>Moving target</b>	Lower	None/Incremental	Less
<b>Disruptive regulation</b>	Higher	Radical	More

Based on Stewart (2010)

Annex Table 4 Barriers to innovation in the water area – based on stakeholder consultation

Barriers	Relevance for the priority area of EIP – Water				
	Water recycling	Water treat. & mat. recovery	Water/energy nexus	Flood & drought man't	Ecosystem services
<b>Economic &amp; Market</b>					
Price of water, water services and materials that could be recovered ( <i>often wrong water pricing mechanism, lack of tariff innovation to offer new product/services configurations</i> )	X	X		X	X
Inadequate economic incentives to adopt new technologies	X	X	X	X	X
Lack of market/demand for new/high value added developments which could be more expensive than less efficient alternatives ( <i>problem of pushing from R&amp;D to Market</i> )	X	X	X	X	X
<b>R&amp;D capabilities, expertise</b>					
Strong R&D base, but lack of knowledge/expertise/experience in application (importance of demonstration projects), and commercialisation (long timescale from invention to diffusion)	X	X	X	X	X
Lack of expertise in specific methodologies (e.g. valuation on water ecosystem services)				X	X
Lack of connection between research and industries/private firms	X	X	X	X	X
<b>Technological &amp; technical</b>					
Lock-in in old water infrastructures ( <i>due to high costs of modernisation</i> )	X	X	X	X	X
lack of well-developed and robust industrial processes using different qualities of water	X	X	X	X	X
Lack of solutions for “new” water contaminants (e.g. pharmaceuticals, hormones, etc)	X	X			X
<b>Policy, regulations, governance</b>					
Lack of agreed upon goals and targets ( <i>e.g. water reuse, efficiency, and innovation</i> )	X	X	X	X	X
Too much focus on cost recovery (e.g. WFD) rather than on incentives.					
Lack of integration of water policies with other policy fields ( <i>e.g. inter-linking water use planning, spatial planning and land use planning policies is important</i> )	X	X	X	X	X
Ownership structure of water infrastructure ( <i>empirics shows varied evidences on effect, e.g. privatization can improve efficiency and management, but in other cases it can also limit investment</i> )	X	X	X	X	X
Lack of flexible safety and quality standards for reused water ( <i>many EU countries prevent the reuse of water for non-drinking purposes, such as technological processes</i> )	X	X			X
Lack of Risk assessment approach, which is proactive and preventive approach, allowing faster adoption of innovations in comparison to existing top-down approach, where local authorities just monitor, but not push for innovation)	X	X	X	X	X
<b>Socio-cultural</b>					
Public awareness/attitude toward water (and ener-gy) consumption is important factors for adoption, promotion of innovative practices	X	X	X	X	X
Risk aversion, negative perception of recycled water and material by the users/people can sometimes hamper new solutions	X	X			
Lack of methodology capable of including social factors	X	X			X
<b>Other (geographical, climatic, etc)</b>					
Increasing water stress	X	X	X	X	X
Difficulties in coordination of actions at across different geographical / territorial boundaries			X	X	X

Source: Technopolis 2013

## B.1. : Patent classification for water innovation

Identification of relevant patent classes was done by an external expert, who screened the EPO ECLA classes and allocating them according to the definition of priority area of EIP on Water. The table below shows the coverage of the topics and provides additional explanation for each area. A list of the covered patent classes is available in a separate data file, along with the raw patent data extracted for this study.

PATSTAT patent data archive from 2012 has been used to extract patent statistics.

Annex Table 5 Patent classification for water priorities

<b>Patent classification for water innovation</b>			
<b>Grouping</b>	<b>Item</b>	<b>Topic</b>	<b>Comment</b>
<b>A</b>	i	Water re-use and recycling;	No specific classes for water recycling were found, so terms combined with ii) water supply and wastewater treatment
	ii	Water supply and wastewater treatment, including recovery of resources;	A large number of classes were found. Only the parent classes listed (unless particularly relevant breakdown identified); classes related to the treatment of water within domestic apparatus (like dishwashers, fishtanks) were excluded
<b>B</b>	iii	Water-based energy technologies;	Large number of relevant classes identified
<b>C</b>	iv	Flood and drought risk management technologies	Very few classes relating to prediction of flood/drought found; very general classes that may be relevant to sensor network technology have not been included (due to large number of classes), only specific to water sensor systems
<b>D</b>	v	Ecosystem service management in aquatic and other habitats (e.g. nature conservation, monitoring of natural water resources, developing green infrastructure, etc.)	Overlapping classes with smart water management, so combined
	vi	Smart/ICT/monitoring/modelling technologies for water management	General classes to smart/ICT technologies not included due to large no. of such classes

## B.2. Commodity goods classification for water technologies

Identification of relevant commodity codes was done by an external expert, who screened the UN Comtrade commodity codes and allocated them according to the definition of priority area of EIP on Water. The table below shows the coverage of the major codes. A list of the covered codes on extended digit levels for each priority area is available in separate data files, along with the raw trade data extracted for this study. The data has been extracted from the UN Comtrade database.

Annex Table 6 Trade classes used for the water priorities

<b>Major class</b>	<b>Name</b>	<b>Related information</b>
<b>84</b>	Name: Nuclear reactors, boilers, machinery, etc.	
<b>85</b>	Name: Electrical, electronic equipment	851610- electric storage water immersion heaters; instant water heaters
<b>22</b>	Name: Beverages, spirits and vinegar	2201 - drinking water
<b>34</b>	Name: Soaps, lubricants, waxes, candles, modelling pastes	cleaning, detergents
<b>35</b>	Name: Albuminoids, modified starches, glues, enzymes	enzymes, cleaning; bio materials
<b>38</b>	Name: Miscellaneous chemical products	3822 (prepared diagnostic and laboratory reagents; 3821 (prepared culture media for developing microorganisms) - mje for water treatment/energy capture? 3820 (anti-freeze); 3815 catalysts;
<b>39</b>	Name: Plastics and articles thereof	3925 (plastic tanks, reservoirs); plastic doors, windows and frames; 3922 (flushing systems); 3917 tubes and pipes
<b>40</b>	Name: Rubber and articles thereof	401693 - seals, gaskets of vulcanised rubber
<b>69</b>	Name: Ceramic products	6910 bathroom ceramics;
<b>73</b>	Name: Articles of iron or steel	7322 radiators for central heating; 7309 reservoirs, tanks, vats etc.; 7303-6 pipes;
<b>74</b>	Name: Copper and articles thereof	7417 copper cooking and heating apparatus
<b>76</b>	Name: Aluminium and articles thereof	7611 aluminium tanks; 7608 tubes and pipes;
<b>88</b>	Name: Aircraft, spacecraft, and parts thereof	satellites
<b>89</b>	Name: Ships, boats and other floating structures	special purpose vessels
<b>90</b>	Name: Optical, photo, technical, medical, apparatus etc.	automatic regulating or controlling equipment; checking instrumentation
<b>91</b>	Name: Clocks and watches and parts thereof	time switches; time of day recorders; instrument panel clocks
<b>23</b>	Name: Residues, wastes of food industry, animal fodder	[products to be treated..]

### B.3. Details on the specific role of regulations – results of the survey

The question was built on the typology of regulations developed by Blind (2012) and his elaboration of the possible role of different types of regulation on innovation. The following table provides the share and number of times, a particular role was ticked by respondents. Multiple ticking without limitation was given.

Annex Table 7 Role of regulations

<b>Regulation with economic goals</b>	Share of respondents	Number of respondents
<b>Competition regulation:</b>		
Increases incentive to invest in innovation	71.4%	15
Reduces 'rents' for innovators	9.5%	2
Reduces R&D co-operation	33.3%	7
<b>Anti-trust regulation:</b>		
Drives innovation by increasing competitive pressure for market entrants	94.1%	16
Other	5.9%	1
<b>Mergers &amp; Acquisitions regulation:</b>		
M&A restrictions protect management from short-term market pressure	22.2%	4
M&A restrictions limit takeover pressure and innovation incentives	72.2%	13
Other	11.1%	2
<b>Market Entry regulations:</b>		
Can protect infant industries	47.6%	10
Hinder innovations by restricting market entry of (innovative) newcomers	47.6%	10
Other	4.8%	1
<b>Price Regulation:</b>		
Drives innovation because minimum prices decrease risk	47.6%	10
Price caps reduce innovation incentive	38.1%	8
Other	14.3%	3
<b>Natural Monopolies / Public Enterprises and Utilities:</b>		
Drives innovation because stability allows for long-term horizons	22.7%	5
Blocks innovation because monopolies result in low incentives	72.7%	16
Other	9.1%	2
<b>Regulation with social (environmental) goals</b>		
<b>Environmental protection regulations:</b>		
Creates incentive for new eco-friendly products and processes by creating temporary market barriers	92.0%	23
Hinders innovation because high compliance costs limit R&D budget	8.0%	2
Other	4.0%	1
<b>Workers health and safety protection regulation:</b>		
Creates incentive to develop new processes with higher work safety	81.8%	18
Hinders innovation because compliance costs limit R&D budget	18.2%	4
Other	4.5%	1
<b>Product and consumer safety regulation:</b>		
Increases acceptance/demand for new products among consumers	90.0%	18
Hinders innovation because the compliance costs limits R&D budget	10.0%	2
Other	0.0%	0
<b>Regulations with institutional goals</b>		
<b>Liability regulation:</b>		
Increases acceptance of innovation and diffusion among consumers	75.0%	15
Reduces incentives to develop new products if liability is too high	20.0%	4
Other	5.0%	1
<b>Employment protection legislation:</b>		
Drives innovation by ensuring job security	60.0%	12
Hinders innovation due to higher adjustment costs	35.0%	7
Other	5.0%	1

<b>Immigration regulation:</b>		
Drives innovation by ensuring more competitive/flexible job market	89.5%	17
Hinders innovation due to high integration costs	10.5%	2
Other	0.0%	0
<b>Bankruptcy regulation:</b>		
Drives innovation due to increased confidence of creditors to invest in innovation	88.9%	16
Hinders by imposing restrictions to acquire external funds for risky investments	11.1%	2
Other	0.0%	0
<b>Intellectual property rights regulation:</b>		
Provides additional incentives to invest in R&D due to monopoly rights	71.4%	15
Restricts development and diffusion of new technologies	28.6%	6
Other	0.0%	0

Annex Table 8 List of drivers and barriers

<b>Factors</b>	<b>Barrier</b>	<b>Driver</b>	<b>Neutral</b>
<b><i>Policy, regulation, governance</i></b>			
Governance structures (e.g., monopolies, ownership structures...)			
Multi-stakeholders approach in governance			
Coherence with other existing regulation			
Risk assessment approach for harmonized EU regulation			
National/international (demand-side) policies:			
- Innovation procurement			
- Regulation			
- Standardisation			
- Demonstration projects			
- Prototyping			
- Tax incentives			
- Labeling			
- Information campaigns			
Competition law (incl. State Aid rules)			
Trade agreements			
Dedicated sectoral (supply-side) policies			
...			
<b><i>Economic and market</i></b>			
Pricing			
Current market demand			
Current industry structure			
Market power of competing products / substitution potential of these products			
Rebound effects			
Lack of transparency			
Industrialization			
Deindustrialization			
Facility of transportation			
Technological challenges (use and integration of spillover)			
Enabling infrastructures			
...			
<b><i>R&amp;D capabilities</i></b>			
Own financial resources (High/Low)			
Access to finance (Good/poor)			
Innovation costs (High/low)			
Qualified internal technological skills (good availability/shortage)			
Skills related to innovation management (good availability/shortage)			
Abilities to spot market opportunities – lack of information on markets (EU and global) (good /lack of ability)			
Risk perception			
Abilities to test market readiness (limited/good)			
...			
<b><i>Socio-cultural</i></b>			
Population (growth/decline)			
Ageing of the population			
Environmental concerns			



<b>Factors</b>	<b>Barrier</b>	<b>Driver</b>	<b>Neutral</b>
Geopolitics and world conflicts			
Quality of life			
Urbanisation			
User sophistication level			
Personalisation			
...			

Annex Table 9 Key EU regulations in waste/recycling

Official title	Name/Affecting	Requirements
<b>Directive 2008/98/EC (replaced 2006/12/EC, 75/493/EEC)</b>	Waste Framework Directive	<ul style="list-style-type: none"> <li>• Sets out the basic concepts and definitions for waste management, distinguishing between waste and secondary raw material (through end-of-waste criteria)<sup>26</sup>.</li> <li>• Waste has to be managed without endangering human health and the environment according to the 'polluter pays' and 'extended producer responsibility' principles.</li> <li>• Includes a 50% re-use target for household (and similar) waste, and 70% for construction/demolition materials.</li> <li>• MS are required to adopt Waste Management Plans and Waste Prevention Programmes</li> <li>• Communication 2007/0059/COM<sup>27</sup> provides the interpretation of by-products (including decision mechanism)</li> <li>• Decision 2000/532/EC created a European Waste List which provides reference nomenclature which can serve as a common terminology and classification for waste.</li> </ul>
<b>Regulation 333/2011/EC</b>	establishing criteria determining when certain types of scrap metal cease to be waste under Directive 2008/98/EC of the European Parliament and of the Council	<ul style="list-style-type: none"> <li>• Establishes criteria under which iron, steel and aluminium scrap ceases to be waste under Directive 2008/98/EC. These criteria include required treatment processes and techniques.</li> <li>• Requires producers and importers to implement a quality management system and to issue statements of conformity</li> <li>• A conformity assessment body is put into place to monitor producers' and importers' compliance</li> </ul>
<b>Directive 1999/31/EC</b>	Landfill Directive	<ul style="list-style-type: none"> <li>• Stipulates stringent operational and technical requirements for landfills in order to prevent environmental damage.</li> </ul>
<b>Directive 2002/96/EC, recently replaced by 2012/19/EU</b>	Waste Electrical and Electronic Equipment Directive (WEEE)	<ul style="list-style-type: none"> <li>• Sets recovery targets for all types of electrical goods (min. 4kgs per head per year by 2009, 20kg by 2019)</li> <li>• MS have to encourage lean/recyclable product design</li> <li>• MS have to adopt separate collection of WEEE, but responsibility for collection lies with distributors</li> <li>• MS have to set up treatment, recovery and disposal facilities for WEEE</li> <li>• Producers bear the cost of these facilities, but may set up individual/collective schemes themselves</li> <li>• Provides tools to combat illegal export of waste</li> </ul>
<b>Directive 2002/95/EC</b>	Restriction on Hazardous Substances in EEE	<ul style="list-style-type: none"> <li>• Prohibits the use Lead, Mercury, Cadmium, Hexavalent Chromium, Polybrominated biphenyls /diphenyl ether.</li> <li>• Solar Panels (Cadmium) and Medical devices are exempted from the directive.</li> </ul>
<b>Directive 92/112 EEC (recast in 2010)</b>	Procedures for elimination of pollution caused by waste from the titanium dioxide industry	<ul style="list-style-type: none"> <li>• The Directive lays down rules for the titanium dioxide industry.</li> </ul>
<b>Regulation 1013/2006</b>	Waste Shipment Regulation	<ul style="list-style-type: none"> <li>• Establishes rules, procedures and requirements for shipment of waste</li> </ul>
<b>Directive 2006/66/EC</b>	On Batteries and Accumulators Waste	<ul style="list-style-type: none"> <li>• Prohibits the use of batteries/accumulators with hazardous substances</li> <li>• Established rules and requirements for collection, treatment, recycling and disposal of waste batteries and accumulators.</li> </ul>
<b>Directive 2000/53/EC</b>	End-of-life vehicles	<ul style="list-style-type: none"> <li>• Established measures for prevention of waste</li> <li>• Prohibits the use of hazardous substances</li> <li>• Requires MS to set up instruments for collection, treatment, recycling and disposal of end-of-life cars.</li> </ul>

<sup>26</sup> <http://ec.europa.eu/environment/waste/framework/>

<sup>27</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007DC0059:EN:NOT>

#### B.4. Patents in the waste/recycling sectors

The World Intellectual Property Organisation (WIPO) has established an 'IPC Green inventory' in order to provide information on environmentally sound technologies. For waste and recycling, different IPC classes are relevant as identified by WIPO. There can be a distinction for example by the use of recycled material, going down to the three digit level of classes.

Annex Table 10 Patent classes related to reuse of waste materials

Reuse of waste materials	IPC classes
Use of rubber waste in footwear	A43B 1/12, 21/14
Manufacture of articles from waste metal particles	B22F 8/00
Production of hydraulic cements from waste materials	C04B 7/24-7/30
Use of waste materials as fillers for mortars, concrete	C04B 18/04-18/10
Production of fertilisers from waste or refuse	C05F
Recovery or working-up of waste materials	C08J 11/00-11/28

Source: WIPO

Within this inventory, 'Harnessing energy from manmade waste' offers relevant patent classes

Annex Table 11 Patent classes related to 'Harnessing energy from manmade waste'

Harnessing energy from manmade waste'	IPC classes
Agricultural waste	C10L 5/00
• Gasification	C10J 3/02, 3/46, F23B 90/00, F23G 5/027
• Chemical waste	B09B 3/00, F23G 7/00
Industrial waste	C10L 5/48, F23G 5/00, 7/00
• Using top gas in blast furnaces to power pig-iron production	C21B 5/06
• Pulp liquors	D21C 11/00
• Anaerobic digestion of industrial waste	A62D 3/02, C02F 11/04, 11/14
• Industrial wood waste	F23G 7/00, 7/10
Hospital waste	B09B 3/00, F23G 5/00
Landfill gas	B09B
Municipal waste	C10L 5/46, F23G 5/00

Source: WIPO

Waste treatment would be another aspect covered by the following patent classes:

Annex Table 12 Patent classes related to 'Treatment of waste'

Treatment of waste	
Waste disposal	B09B, B65F
Treatment of waste	
• Disinfection or sterilisation	A61L 11/00
• Treatment of hazardous or toxic waste	A62D 3/00, 101/00
• Treating radioactively contaminated material; decontamination arrangements	G21F 9/00
• Refuse separation	B03B 9/06
• Reclamation of contaminated soil	B09C
• Mechanical treatment of waste paper	D21B 1/08, 1/32

Source: WIPO

For the German Umweltbundesamt, the NIW (UBA 2013) has worked out a new list-based classification of potential environmental goods<sup>28</sup> which can be used.

Annex Table 13 Drivers and barriers of innovation in the waste management sector

	<b>Drivers</b>	<b>Barriers</b>
<b>Economic &amp; Market</b>	<ul style="list-style-type: none"> <li>• Pricing signals are critical to drive change: increased costs for waste management create incentive to reduce waste</li> <li>• Market power of competing products/ substitution potential of these products (niche players are needed to drive through change with the support of market leader customers)</li> <li>• Industrialisation: Opportunities to re-industrialize exist by using secondary raw materials. It is increasingly clear that gaining a cost advantage by using secondary raw materials could stimulate EU manufacturing industry in a market where an increasing number of profit warnings relate to raw material costs.</li> <li>• Facility of transportation: for instance low cost shipping has had a strong impact on resource recovery.</li> <li>• International competitiveness (however e.g. recovery market is competing with low-labour disassembly in non-EU countries)</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of market demand is a major barrier for a circular economy (secondary materials market only in place for a few metals)</li> <li>• Current industry structure with high share of larger incumbents: Difficult for new players to beat old-fashioned ideas and entrenched interests. When profit margins are tight and companies become owned by venture capitalists a short-term drive for profits entrenches a risk-averse culture.</li> <li>• Market transparency: Data &amp; good quality transparent information is critical to drive change</li> </ul>
<b>R&amp;D capabilities, expertise</b>	<ul style="list-style-type: none"> <li>• Environmental sector sees increased income available for R&amp;D</li> <li>• Increasingly clean and separated streams for secondary raw materials</li> <li>• International competitiveness offers opportunities to export skills, knowledge and technology (export knowledge is however dependent on the willingness of other countries to adopt a similar waste hierarchy and cost policy)</li> <li>• Developed expertise in specific recycling and waste management technologies enables waste imports and processing</li> </ul>	<ul style="list-style-type: none"> <li>• Inadequate own financial resources: Low rates of return on capital invested and low profit margins in the industry inhibits research</li> <li>• Lack to access of finance; may relates more to uncertainty on how to obtain finance</li> <li>• High innovation costs: Risk capital is in short supply; even where loan schemes exist to lower risk exposure of financiers some MS are slow to use them</li> <li>• Shortage of qualified internal technological skills: Skills transfer is a real issue right across the EU and another issue is attracting and retaining skills in an industry that is seen as unattractive to join.</li> <li>• Shortage of skills related to innovation management: A big issue EU-wide. The European Environment Agency (EEA) have also highlighted this issue</li> <li>• Limited abilities to spot market opportunities – lack of information on markets (EU and global): General lack of exchange of best practice between global leaders. ISWA's (International Solid Waste Association) EU section has a key role to play</li> <li>• Risk adversity: The waste and resource management industry is risk adverse at every level, e.g. long-term infrastructure investments do not foster innovative behaviour.</li> <li>• Limited abilities to test market readiness</li> <li>• Producers responsibility introduces costs for newly imported products</li> <li>• Not sufficient technology-based firms doing R&amp;D available in some MS in order to push new technologies</li> </ul>
<b>Policy, regulations, governance</b>	<ul style="list-style-type: none"> <li>• Innovation procurement (however possibility of risk averse procurement processes in the public and private sectors, at times no incentive exists to innovate)</li> <li>• Standardisation (but can be critical to recovery of raw materials; can also have no or negative impacts when set too low or too high)</li> </ul>	<ul style="list-style-type: none"> <li>• Governance structures (e.g., monopolies, ownership structures...): Distortion of the recycled market when ownership structure is too high (for certain materials/waste streams). Monopolies hamper the secondary raw materials market.</li> <li>• Lack of coherence with other existing regulations: Example REACH Directive and Waste Framework</li> </ul>

<sup>28</sup> UBA (2013): Umweltschutzgüter - wie abgrenzen? Methodik und Liste der Umweltschutzgüter 2013. Methodenbericht zum Forschungsprojekt „Wirtschaftsfaktor Umweltschutz: Analyse der wirtschaftlichen Bedeutung des Umweltschutzes durch Aktualisierung wichtiger Kenngrößen“, Report prepared by NIW.

	<ul style="list-style-type: none"> <li>• Demonstration projects: good examples such as Life+ that however need widespread dissemination</li> <li>• Prototyping: FP7 (H2020)-programme outputs should be widely promoted and the programme be used for prototypes (especially for SMEs).</li> <li>• Taxes: Tax incentives/tax refunds (e.g. fuel tax) or disposal taxes</li> <li>• Labelling: good tool for information of the public</li> <li>• dedicated sectoral supply-side policies (depends however on their implementation, e.g. several municipalities don't make use of SBRI innovation funding)</li> <li>• Harmonisation (but separate approving procedures in every MS, e.g. producer compliance schemes/WEEE)</li> </ul>	<p>Directive or Waste Framework Directive and Large Combustion Plant Directive/ IPPC Directive</p> <ul style="list-style-type: none"> <li>• Risk assessment approach for harmonized EU regulation, such as risk assessment for End-of-waste standards is very risk averse and inhibits innovation in finding a final solutions</li> <li>• Competition law (incl. State Aid rules); can slow down agreements (e.g. on End-of-waste specifications)</li> <li>• Trade agreements (depends on the case; might be too restrictive for trade of secondary raw materials)</li> <li>• (Lack of) adequate performance/ quality monitoring (may lead to quality drawbacks of secondary raw materials)</li> </ul>
<b>Socio-cultural</b>	<ul style="list-style-type: none"> <li>• Higher awareness through labelling, extended producer responsibility EPR, other information campaigns</li> <li>• Overall increase of environmental concern</li> <li>• Population growth: By increasing societal pressures this is a driver for innovative thinking.</li> <li>• Increased quality of life and urbanisation as drivers to societal change</li> <li>• Higher user sophistication levels</li> <li>• Personalisation/personal ownership</li> <li>• Geopolitical and world conflicts: Stronger efforts to become independent of virgin raw material imports</li> </ul>	<ul style="list-style-type: none"> <li>• Consumers: need of assurance about the quality of the products that have recycled content</li> <li>• Manufacturers: lack of acceptance of recovered materials use</li> <li>• Population decline</li> </ul>

## Appendix C Case studies

Title of case study	Case number
<b>Implementation of greywater and rainwater re-use systems in the housing sector in the Barcelona Metropolitan Area</b>	1
<b>Innovation in the Water Sector in France</b>	2
<b>Pollution of Surface Waters Act in the Netherlands</b>	3
<b>Unlocking the underinvestment circle in Milan's water and sanitation infrastructure</b>	4
<b>Wetsus Desalination technology providers</b>	5
<b>The Strategic Flood Map in Northern Ireland</b>	6
<b>Introducing the Ecosystem Services Approach to Water Management in Bulgaria and Romania</b>	7
<b>Landfill and incineration ban for recycled waste in the Netherlands</b>	8
<b>WEEE waste electrical and electronic equipment directive in the UK</b>	9
<b>Recycling certificates</b>	10
<b>Screening of regulatory framework for secondary raw material recovery and re-use and its impact on innovation</b>	11

## C.1. Implementation of greywater and rainwater reuse systems in the housing sector in the Barcelona Metropolitan Area.

Author: Asel Doranova

Key words: Water harvesting system, greywater recycling, regulation in construction of new buildings, local ordinances approved in the Barcelona area

### Key messages of the study

- Successful introduction and diffusion of decentralised water recycling and reuse technologies depends on several factors, including regulatory, economic, and social factors
- Introduction and enforcement of local regulation mandating these technologies in the new construction buildings appeared to be the major push factor for application and diffusion of these technologies in a number of municipalities Barcelona
- Higher water prices can provide additional incentives for application of these technologies. While the current prices are still a weak incentive it is expected to experience the increase of water tariffs overtime
- The social and technical learning are an important component of the implementation of regulation on decentralised water reuse and recycling systems. The success of the implementation of the regulation and adoption of the technology is ensured by educating people on maintaining the technology as well as by promoting communication and public dialogue, building and maintaining trust.

### C.1.1. Introduction

Increasing trends of urbanisation and growing number of urban population are expected to continue in coming decades. This means that the demand for safe water supply will be growing as well. Furthermore, climate change will likely to cause more frequent drought episodes, especially in semi-arid zones. In Europe, the Southern European countries have highest risks of water shortage due mainly to the expanding urban population, the development of different economic activities, such as tourism, in regions with major hydrological constraints and under the effect of global climate change. These trends show urgent needs in improving management and efficiency of the available water resources. In this perspective the water recycling and reuse are increasingly seen as the core of an integrated water management.

Water reuse and recycling allow access to affordable and safe water, while decreasing energy needs and reclamation costs. The potential market for innovations in water reuse and recycling, through implementing technological solutions and adoption of policy and legislative measures, is expected to grow and develop significantly within and outside Europe, particularly in highly water stressed regions (EIP Water SIP, 2012).

On the other hand, the principle of “fit-for-purpose water use” has been increasingly explored to maximize the efficient use of water resources. It is based on the assumption that water has many qualities and not all water uses require the same level of quality (Brown et al., 2009, Domenech, 2010). Currently in Europe in the domestic use the high quality water is used for all purposes while it is actually needed only for drinking purpose, which is just a fraction of the total domestic water demand. The water demand for toilet flushing, laundry cleaning and irrigation can be met with decentralized water sources like rainwater and greywater. The greywater reuse and rainwater harvesting solutions have already demonstrated their economic viability in the households.

The present case study brings an example of the municipalities from the Metropolitan Area of Barcelona (MAB), who have gained an interesting experience in promoting the rainwater harvesting, greywater reuse and swimming pool water reuse installations. The approval of the water saving regulation was influenced by the Local Agenda 21 process which was initiated in many municipalities of MAB after the 1992 Earth Summit.

### C.1.2. Implementation of greywater and rainwater reuse systems in the housing sector in Barcelona Metropolitan Area

The Barcelona Metropolitan Area is the largest demographic and economic concentration in Catalonia. Its 636 km<sup>2</sup> only represent 2% of the surface area of Catalonia, whereas its 3.2 million residents are equivalent to 43% of the population of Catalonia. It is therefore a densely populated area (5,000 inhabitants per km<sup>2</sup>, 20 times higher than the Catalan average of 234) and also very intensely urbanized. The economical influence of the metropolitan area is even greater: it houses 51% of all the jobs in Catalonia. It concentrates, especially, the most dynamic economic sectors: 56% of all services and between 60 and 70% of services with highest added value and high technological content such as research, information technologies and telecommunications. 305,000 companies carry out their economic activities there<sup>29</sup>.

Urban water management in Metropolitan Barcelona has undergone important transformations in the last decade. The main drivers of these transformations are environmental and socio-political. The Barcelona region has suffered several droughts in the last few years in 1998-2002, 2004-2005 and 2007-08. The 2007-08 drought was the most severe of the last decade. After these droughts, city councils started searching for new ways to promote water savings in their municipalities (Domènech & Valles, 2013).

In addition to water scarcity, the emergence of demand-side management strategies and a Nueva Cultura del Agua have also influenced the policies that some city councils have adopted. The hydraulic paradigm based on the construction of large infrastructures such as water transfers and dams to meet a growing demand is on the decline, especially in western countries (Saurí and Del Moral 2001). In Spain, the Nueva Cultura del Agua based on water rationalization and the recognition of the recreational and emotional properties of water started gaining momentum as a response to the 2001 National Water Plan which involved water transfers from the Ebro River to Eastern and Southern Spain. The reasons behind the decline of the hydraulic paradigm include more restrictive environmental legislation, the opposition from donor basins to water exports, the growing physical scarcity of high quality sources and the increasing costs and difficulties to finance large infrastructures (Dziegielewski, 1999).

In the Metropolitan Area of Barcelona, the Agenda 21 process has become the setting scene for a number of local regulations to promote the use of local water resources. At the municipal level the water saving ordinances were put in place to mandate the installation of water saving devices such as water pressure regulators or dual flush toilets and the (re)use of local water resources such as rainwater, greywater and swimming-pool water in new buildings.

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<sup>29</sup> [http://www.waterloss-project.eu/?page\\_id=123](http://www.waterloss-project.eu/?page_id=123)



**Agenda 21 is a non-binding, voluntarily implemented action plan of the United Nations with regard to sustainable development. It is a product of the UN Conference on Environment and Development held in Rio de Janeiro, Brazil, in 1992.**

**Local Agenda 21 is a process which facilitates sustainable development at community level. It is an approach, based on participation which respects the social, cultural, economic and environmental needs of the present and future citizens of a community in all its diversity and which relates that community and its future to the regional, national and international community of which it is a part.**

**Almost two hundred organisations and several thousand citizens were involved in preparing Barcelona's Agenda 21, which has been subtitled the "Citizen Commitment to Sustainability" and approved in 2002.**

The first municipality that approved such water saving ordinance was Sant Cugat del Vallès in 2002. By 2005, fourteen municipalities had local regulations concerning water. In view of the growing interest, the Diputació de Barcelona (provincial government) approved in 2005 a framework ordinance to help municipalities to develop their own ordinance. In 2006, national (Spanish) and regional (Catalan) legal instruments were also approved regarding the installation of water saving devices in toilets, showers and washbasins. At the end of 2011, in Catalonia more than 50 municipalities - totalling 1.2 million people - had approved a regulation for saving and conserving water.

### C.1.3. Regulation

The main focus of the case study is the water saving regulations which aims promote alternative water resources such as rainwater harvesting and greywater reuse in the housing sector, which are based on decentralised water supply systems. The use of these water sources is based on the principle of fit-for-purpose water, allowing varied quality water to be used e.g. for drinking, toilet flushing, laundry or irrigation (Domenech 2011, Brown et al, 2009).

The analysis showed that in the implementation of the water efficiency via receiving greywater and rainwater the following regulations played a role:

- *Building code* mandating the installation of rainwater and greywater harvesting in the new buildings, which plays a direct role in promoting the water efficiency installation, and
- *Water pricing*, which proved to create enabling condition or motivation for implementation of the water efficiency measures and reducing the payback time period.

In addition, the subsidies have been used for co-investment for the installations.

In 2002 Sant Cugat del Vallès was the first municipality approving a building code that mandated the installation of rainwater harvesting systems in buildings with more than 300 m<sup>2</sup> of garden. In addition, subsidies up to 1200 € but without exceeding 50 percent of the cost of the system, are granted to those households installing rainwater harvesting systems on their own initiative.

Over time, many municipalities in Catalonia have also followed the example of Sant Cugat del Vallès and initiated local regulations to promote the use of rainwater harvesting in new buildings. The emergence and establishment of decentralized technologies in the Barcelona area provides a good example of a transition process in which much learning has been generated by trial and error. In total, at least ten municipalities have modified the initial regulation approved to incorporate the experience acquired during the last few years. For example, new design criteria for greywater and rainwater harvesting systems have been introduced in some regulations.

#### C.1.4. Innovation effects

The most innovative, outstanding feature of the water saving ordinances in BMA municipalities concerns the installation of small scale water systems to reuse rainwater and greywater on-site. Traditionally, these local water sources have been treated as “nuisances” in urban areas but with these regulations, they become valuable resources and promising alternatives to centralized end-of-pipe approaches. The use of alternative water resources triggers important transformations in the existing water cycle including institutional and social changes related with water decentralization. From the innovation cycle perspective the regulation played important role in the diffusion on the technologies, which is seen in enforcement of application of these technologies in the newly constructed buildings.

However there was also a dynamic element in this case study. The technology has substantially evolved over a decade of experience with the decentralised systems, especially greywater reuse systems. More sophisticated and efficient greywater technologies have displaced less sophisticated ones. In Sant Cugat del Vallès, the first greywater systems installed were quite simple and usually involved a basic filtration device to capture coarse elements and a tank for the chlorine treatment. Maintenance requirements included the removal of refuse from the filtration devices and the periodic replacement of the chlorine pill (usually once a week). Greywater systems performance was at times not completely satisfactory and complaints for the generation of unpleasant smells were common (Domènech and Saurí, 2010). A rather usual scenario was one of satisfaction at the beginning (in part related to the more pro-environmental attitudes of dwellers) that turned into dissatisfaction when the first problems in maintenance appeared.

Many of the problems of the first installations have been taken into account and mitigated and the more recent greywater systems are not experiencing them anymore. As in other parts of the water cycle, a major breakthrough has been the proliferation of systems using extremely fine filtration procedures in the form of membranes. The most advanced systems installed in Sant Cugat in 2010 and 2011 use a much more sophisticated and reliable technology with biological and ultra-filtration procedures. Instead of the weekly or more frequent maintenance tasks, these newer systems can operate for months, and maintenance is performed by a specialized company. Hence, many of the problems associated with the early greywater systems have disappeared, especially those related to odours and the management of chemicals.

Furthermore, maintenance costs have also decreased. For a system serving some 20 apartments, maintenance costs are about 800 euro/year; that is, below the 1,500 Euros or more of other systems. However, membrane technologies imply higher energy costs. The energy consumption of a system treating 4000 litres/day is calculated in 1.7 kWh/m<sup>3</sup> of water.

#### C.1.5. Drivers and barriers to innovation

It appears that the regulation adopted by the municipal authorities is the main important factor driving the installation of the decentralised water recycling system in Barcelona Municipal Area. The larger commitments stem from the Agenda 21 process aimed at introducing the sustainable development principles in metropolitan development and the Nueva Cultura del Agua policy on water rational consumption of water resource adopted in Spain in 2001. A greater pressure for exploitation of alternative and more sustainable water resources is coming from the increasing risks associated with climate change and growing water scarcity.

However, since 2010 the economic crisis has reduced the importance of the initiatives and the new regional government has didn't continue with the expansion of the experience with water recycling installation.

There are still doubts about the economic feasibility of these type of projects as the prices for water are not very high. At the same time one needs to expect the increase of water tariffs overtime; the estimates show that these systems will be able to reach profitability and justify their economic feasibility in the future.

The decentralised water recycling and reuse technologies have developed over time; the local developers too have built stronger expertise in these fields. Nevertheless there is still a need in development even better technologies that reduce health risks, maintenance requirements and costs, and which are also tailored to the local conditions.

Another unresolved issues is that there is lack of the external monitoring mechanisms and water quality standards for the alternative water sources, like rainwater and greywater.

Despite increasing of the people awareness about environmental issues, the social acceptance for greywater reuse is still an issue, as the uneven adoption of recycling technologies suggests. Some local environmental managers and other water actors are still reluctant to enforce its use because they have reservations regarding the potential and performance of the technology. On the other side people's ability to handle the technology has proved to be an issue.

Table 10 Drivers and barriers in the Barcelona case

<b>Types of Barriers and driver</b>	<b>Driver</b>	<b>Barriers</b>
<b>Policy/regulation/governance</b>	<ul style="list-style-type: none"> <li>• <i>Nueva Cultura del Agua</i> policy adopted in Spain</li> <li>• <i>Agenda 21 process commitments</i></li> <li>• water saving local (municipality level) regulations to promote the use of local sources such as rainwater, greywater, including new design criteria for greywater and rainwater harvesting systems were introduced in some regulations</li> </ul>	<ul style="list-style-type: none"> <li>• reduced importance of the initiative: the new regional government (since 2010) has dismantled many of the initiatives undertaken by the previous administration</li> <li>• lack of external monitoring mechanisms and water quality standards for the alternative water sources</li> </ul>
<b>Economic and market</b>	<ul style="list-style-type: none"> <li>• water prices are an important driver for such installations. There have been doubts about the economic feasibility of this type of project considering current water rates. However if the price reached €1.86/m<sup>3</sup> it could be profitable<sup>30</sup></li> </ul>	<ul style="list-style-type: none"> <li>• long pay-back period of the rainwater and greywater harvesting systems</li> <li>• current water prices are not sufficient to ensure economic feasibility of projects</li> <li>• the economic crisis has held back the construction of new buildings and accordingly, the installation of rainwater and greywater reuse systems has declined.</li> </ul>
<b>R&amp;D capabilities</b>	<ul style="list-style-type: none"> <li>• sufficient R&amp;D capabilities exist that could be appropriated in the further development of the</li> <li>• solutions have developed over time and currently more efficient technologies are available</li> </ul>	<ul style="list-style-type: none"> <li>• still need technological solutions that better reduce health risks, maintenance requirements and costs and also are context specific</li> </ul>
<b>Technological and technical (infrastructure, etc)</b>	<ul style="list-style-type: none"> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• incomplete understanding of principles and benefits of greywater use technologies before installation by the users</li> <li>• the new systems are installed only in the new buildings</li> <li>• residents require additional skills in order to secure proper functioning of the installations</li> </ul>
<b>Socio-cultural factors</b>	<ul style="list-style-type: none"> <li>• environmental awareness of the users has been increasing in general</li> </ul>	<ul style="list-style-type: none"> <li>• social acceptance for greywater reuse: users complain about unpleasant odour and appearance of the water, system breakdowns and maintenance costs.</li> <li>• Perceived risk, skepticism regarding the use of rainwater harvesting technologies. Some local environmental managers and other water actors are still reluctant to enforce its use because they have reservations regarding the potential and performance of the technology</li> </ul>
<b>Other factors</b>	<ul style="list-style-type: none"> <li>• repeated droughts and increasing risk regarding the accessibility to water resources</li> </ul>	<ul style="list-style-type: none"> <li>• sunk investments and well-established socio-technical regimes create path dependencies that favour the prevalence of the existing centralised model for water supply and treatment<sup>31</sup></li> </ul>

Source: Technopolis

<sup>30</sup><http://esciencenews.com/articles/2011/10/24/experts.recommend.inclusion.rainwater.collection.systems.cities>

<sup>31</sup> Krozer, Y.; Hophmayer-Tokich, S.; Van Meerendonk, H.; Tijmsa, S. and Vos, E. (2010). Innovations in the water chain: Experiences in The Netherlands.

### C.1.6. Conclusions

The case is presenting an interesting experience when proactive position of the local governmental actors has brought about change and innovation in the traditional water supply and treatment system.

One important lesson is that it is possible to push change of local technological systems and innovation with the regulatory instruments, but additional strategies and activities need to be ensured in order to succeed. In the case of the municipalities of the Barcelona Metropolitan areas, the regulation came before the demand for the technology and public acceptance. With the new regulations there was a change in the local water system governance. Citizens' got an important role in the operation and maintenance of the systems; their actions directly impact the system and the resulting water quality. At the same time, municipalities have to make sure that health risks are minimal and safe water is reliably distributed (Domènech & Valles, 2013).

In addition to the technology implementation and adoption challenges, the social and institutional learning was an important area where much efforts and changes had to take place. It was important to promote communication and public dialogue, building and maintaining trust.

Promotion of the wider application of the decentralised water recycling and reuse systems will need to consider the above mentioned technological and social factors. Water pricing is an important determinant of the technology's economic feasibility, therefore the appropriate policies on water pricing (reflecting the real economic price of water) need to be implemented. In addition it is important that on the national level the external monitoring mechanisms and water quality standards for this alternative water sources are developed, that there are clearer institutional arrangements and water reuse guidelines.

### C.1.7. References

Domènech, L. and Valles, M (2013): Local regulations on alternative water sources: greywater and rainwater in Metropolitan Barcelona

Domènech, L. and Saurí, D. (2011): A comparative appraisal of the use of rainwater harvesting in single and multi-family buildings of the Metropolitan Area of Barcelona (Spain): social experience, drinking water savings and economic costs. *Journal of Cleaner Production*, 19 (6-7), 598-608.

Domènech, L., March, H. and Saurí, D. (2013) Degrowth initiatives in the urban water sector? A social multi-criteria evaluation of non-conventional water alternatives in Metropolitan Barcelona. *Journal of Cleaner Production*, 38, 44-55.

Domènech, L. and Saurí, D. (2010): Socio-technical transitions in water scarcity contexts: Public acceptance of greywater reuse technologies in the Metropolitan Area of Barcelona. *Resources, Conservation and Recycling*, 55 (1), 53-62.

Dziegielewski B. (1999): Management of Water Demand: Unresolved Issues. *Journal of Contemporary Water Research and Education*, 114:1-7.

March, H., Domènech, L. and Sauri, D. (2013): Water conservation campaigns and citizen perceptions: the drought of 2007–2008 in the Metropolitan Area of Barcelona, *Natural Hazards* 65 (3) 1951-1966.

Saurí D. and del Moral L., (2001): Recent developments in Spanish water policy. Alternatives and conflicts at the end of the hydraulic age. *Geoforum*, 32:351-362.

BMCES (2002): "Agenda 21 of Barcelona - The People's Commitment towards Sustainability" Municipal Council on the Environment and Sustainability, Ajunament Barcelona

Farreny, R., Gabarrella, X., Rieradevalla, J. (2011); Cost-efficiency of rainwater harvesting strategies in dense Mediterranean neighbourhoods, *Resources, Conservation and Recycling* 55 (2011) 686–694

Morales-Pinzón, T., et al (2012): Financial feasibility and environmental analysis of potential rainwater harvesting systems: A case study in Spain, *Resources, Conservation and Recycling* 69, 130– 140

## C.2. Innovation in the Water Sector in France

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Key words: Water Industry, Regulation, Innovation, Pricing, Delegation, Asymmetric Information, Water Framework Directive, EU Water legislation.

Key messages:

Major roles for innovation in the water sector:

- Saving costs, facilitating access to finance and providing better ways to sector development;
- Curbing water demand and improving sustainability;
- Designing a relevant EU water policy, allocating efficiently water resources and addressing climate change and water scarcity issues;
- Reducing water resources pollution and improving water quality;
- Better engaging with the community and improving water governance and public-private partnerships.

### C.2.1. Introduction

In France, the institutional organization of the water sector is characterized by the complexity of public authority intervention at different levels, from the European level to the local level. Most of environmental regulation takes place at the European level. At the national level, the role of the central state has been limited to water law enforcement since the decentralization acts (1982, 1983). At the local level, the municipalities are responsible for providing water and sanitation services which must have the characteristics of “public service”: equality, continuity of the service and adaptability to technical innovations and regulation. The French water utilities have to optimize the use of water resources, combat water pollution, and protect the environment. They also coordinate the related water planning and management strategy (SAGE and SDAGE Plans).

The size of the French local municipalities varies greatly that it is simply in line with the size of the Commune. Today there are around 14 900 separate water services and 14 500 separate wastewater services (Chong et al., 2012; Guérin-Schneider et al, 2012). This is a good indication of the scale of the French water market.

France has a greater history and acceptance of private companies running water and sanitation services (Elnaboulsi, 2011a). The French local municipalities can either manage water services in-house (direct public management) or they can entrust the service to private operators through various contractual delegation agreements which differ according to the degree of the operator’s involvement in the service, the ratio of the risk that the private operator bears, and the pricing scheme.

The French water industry is now on the move under the process of the implementation and transposition into national legislations of EU regulations<sup>32</sup>. Hard and soft innovation plays a major role in promoting and achieving sustainable water resource management and allocation. Over the last 30 years, the French water industry has evolved much and has improved service level and quality standards. Therefore, there are significant and widespread shortcomings in order to meet ever higher customer expectations and to tackle the new challenges facing the water industry, particularly sustainability and climate change (Elnaboulsi and Houser, 2013). This will require alternative and sustainable approaches and new ways of working which means that changes have to be made in order to encourage the industry to become more innovative and to find new and more efficient ways of allocating, treating and using water, not only to improve and ensure sufficient supply, but also to protect the environment. Therefore, compliance with drinking water quality, wastewater treatment, and environmental standards, has caused significant increase in prices of water services since the end of the 1980’s. Increases in water prices are likely to continue as water users are required to pay the additional costs of networks renewal and extension, and of expenditures required to meet tighter standards for environmental quality (Conseil d’Etat, 2010; OECD,

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<sup>32</sup> In the present paper we do not consider the proposal for a Directive of the European Parliament and the Council on the award of concession contracts, COM(2011) 897 final, 2011/0437 (COD). This proposal will affect heavily the water industry in France.

2010a; République Française, 2011). The burden of water prices increases may be politically an obstacle to innovation in the water sector because increasing prices generate considerable resistance amongst water and sewerage customers. As long as politics and the water sector do not have the same time horizons, politics has incentive to continually adapt and perform u-turns just to keep pace with opinion polls and electoral trends. These considerations are bound up with the short-run and discontinuity whereas the water sector needs continuity and long-run optimal decision.

### C.2.2. Economics of the water sector

The legal basis for regarding water provision as a public utility was laid down in the 19th century when Pasteur discovered that contaminated water was an important cause of infectious diseases. Local municipalities were charged by law to provide pure drinking water to their inhabitants, and to collect and treat wastewater.

Today, water utilities have different objectives (Armstrong and al., 1994; Elnaboulsi 2001b). First, they might want the most optimal resource allocation. Second, they have objectives with respect to the level of deficits of water management authorities. Third, they have to respect financial constraints (budget constraints). Finally, and the most important objective in the context of growing water scarcity, is reducing water consumption to prevent further depletion of the resource. Thus, Water utilities are facing different water pricing options provided by economic theory which generally requires that a pricing structure meet the four criteria of: efficiency, equity, financial viability, and simplicity. Also, any entity, public or private, that manages water services, has the obligation to ensure characteristics of a public service: continuity and dependability, mutability, equality. Furthermore, they have to ensure that the interests of users are protected with respect to both prices and quality (water and level of service), and that there is no undue discrimination.

Compared to the electricity, telecommunication and gas industries, the water industry is the one where natural monopoly conditions are most prevalent (Elnaboulsi 2001a, 2009). Its natural monopoly derives from the established local networks of drinking water pipes and sewers. Duplication of the fixed network of mains and sewers is economically inefficient. The fixed assets have little or no alternative uses, their resale values are well below the cost of replacing them, and so are largely sunk costs. Environmental improvement and high quality standards require new processes and thus new capital sophisticated equipment. Given these sunk costs, it would not be economical for potential competitors to install rival networks.

Water supply involves the extraction of water from reservoirs, rivers or aquifers, its treatment in various ways, and its distribution under pressure to consumers through networks of mains (Armstrong et al., 1994; Elnaboulsi, 2009). Raw water is extracted from underground (aquifer) and/or surface sources (rivers, lakes, or reservoirs). This extracted water is then treated to remove natural, manmade and synthetic pollutants in order to make it potable for consumption, and is distributed via a network of mains to the consumer. Groundwater usually needs less treatment than surface water due to the natural filtration process, but it is more expensive to abstract since it requires pumping from wells. The raw water treatment process involves filtration to remove suspended matter, disinfection with chlorine to kill harmful bacteria, and pH correction to minimize corrosion in the distribution system. Water quality is regulated, stringently for domestic purposes, by minimum standards related to microbiological, chemical, physical, and aesthetic properties.

Wastewater services are also a network-based activity and operate under environmental quality laws, pollution control standards and national water resources management policies (Elnaboulsi, 2011). Sewerage services involve the collection of domestic sewage, industrial effluent and surface water, and the provision and maintenance of an adequate sewerage system to convey it. Sewage treatment plants and also some pumping stations are usually designed to accept a certain maximum flow expressed as a multiple of the Dry Weather Flow (usually three times DWF). Any flow above the designed flow is discharged through Combined Sewer Overflows (CSOs) without further treatment to the aquatic environment. The frequency and duration of the overflows or spills depend on the frequency and intensity of rainfall and the design of the sewer system and treatment plant. To reduce the frequency and duration of the spills, storm tanks are provided at sewage works and/or storm sewage retention tanks are built into the sewer system. The content of the tanks is generally returned to the sewage treatment plant after the rainfall event. Discharges from sewage works are generally well regulated. But, the control of CSOs varies widely in Europe. CSOs are in fact generally based on design parameters which are independent of the dilution available in the receiving water.

The sewage may be treated in various ways before final discharge (e.g., primary or tertiary treatment, depending on the receiving environment and prevailing standards), which must meet pollution control standards and national water resources management policies. In fact, used water is collected and pumped to wastewater treatment facilities, where solids and harmful bacteria usually are removed by sedimentation (residuals management). Sludge or bio solids are removed, incinerated and then dumped at sea or other specific discharge areas, or utilized as fertilizer on farm land.

Externalities exist at several stages of the water cycle. For example, uncontained raw sewer flows into water bodies ultimately contaminating the environment. Wastewater discharges (aluminium, cadmium, mercury, lead, nitrates, pesticides, etc.) have wide-ranging impacts on ground waters, rivers, lakes and aquifers as well as on regional seas. Impact on drinking water supplies, over-fertilization or eutrophication, and loss of biodiversity are few examples of these impacts. Effluent discharges are not the only pollution sources: underground water resources can be polluted by fertilizers or pesticides used in agriculture. These sources of pollution increase the costs of water treatment to achieve acceptable quality. Ocean dumping of sewage sludge can cause harm to fish stocks and raw sewage that is pumped out to sea or rivers can lower the quality of bathing beaches or recreational areas. These direct pollution (point sources of pollution) externalities must be controlled to improve raw water resources, environmental quality, and other environmental recreational public goods. In cases where polluters behave badly, legal penalties must be taken. However, since it is not always possible to establish who has caused pollution (in particular the indirect pollution or non-point sources of pollution) only indirect methods of control are feasible, such as taxation, legal restriction uses, etc. This increase of environmental pollution underscores the need for an efficient environmental resources management.

Domestic water demand is usually price-inelastic and is seasonal<sup>33</sup>, reaching its peak period in summer time when the availability of raw water is at its lowest level. Customers in urban zones have metered drinking water supplies. In housing complexes metering is often performed collectively and then, water charges<sup>34</sup> are mostly based on the number of people by apartment or on the habitation surface. In the other cases, water charges are based on individual demands.

The wastewater pricing regime is somewhat different than for water supply. Generally, households' wastewater charges are either fixed or based proportionally on drinking water demand or the size of the building but bear no relation to actual pollution. In general, only industrial users pay in accordance with the quantity of pollution they create.

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<sup>33</sup>Some background is provided by American Research on the price-elasticity of demand to seasonal and other non-linear tariffs, and how elasticities depend on the type of use, the time horizon, etc. The basic finding is that peak summer demand is much more elastic than average yearly demand, and that elasticities are much higher in the long run than in the short run.

<sup>34</sup>In France, since 1992, flat rates are prohibited by law which suggests the use of nonlinear pricing rules. The recommended pricing system involves a two-part tariff: an access tariff covering fixed costs of service (consumer's hook-up) and a linear charge based on usage, which can be increasing or decreasing with the quantity of water consumed.

Water demand is determined by the quality of the water and the standard of service provided by the supplier, which can be public or private, among other factors. Water quality has many dimensions. In fact, consumers can easily judge whether drinking water tastes or smells bad, or can see its discoloration. These aspects are observable to consumers. However, there are different aspects of water quality which are very important because they can affect public health. For example, high concentrations of metals such as lead, pesticides, nitrate, etc., which cannot be checked by households, are dangerous to public health.

An external regulation is necessary to ensure that drinking water is not harmful and meets European Union standards. This biological and physical regulation of drinking water is the responsibility of the local municipal organization in collaboration with central states and governments departments and agencies (environment, agriculture, and public health). Another aspect of quality is the level of service provided by a water utility. Consumers want adequate water pressure, do not want to suffer flooding from sewers or from drinking water distribution systems failures, and require that leaks in the public system must be mended promptly.

Sewerage demand is complementary to the demand of indoor water use. Domestic wastewater services are priced homogeneously within a local community and wastewater charges are based on drinking water demand. Industrial wastewater (also called trade effluent) produces different types of effluent which vary in strength and nature depending on the corresponding industrial activity. Industrial wastewater services are priced according to effluent discharges in relation to both strength and quantity discharged. However, we may notice that these industrial users have the option of partially or totally pretreating their effluent: they can affect their costs by partially treating effluent before it enters the sewer system and so they reduce the costs of treatment by the sewerage firm or by bypassing the sewerage company altogether and doing all treatment on site. Finally, water prices vary across regions and municipalities and reflect substantial variations in costs (OECD, 2007, 2009a, 2009b, 2011c). Cost differentials are driven by a number of factors. These include the availability and proximity of water, environmental protection, variations in the quality of drinking water, and urban density (economies of scale). In general, less urbanized countries and regions face proportionately greater cost increases than more heavily urbanized countries and regions.

### C.2.3. The French water sector: legal and regulatory frameworks

In France, local municipalities, as in most OECD countries, are legally responsible for the provision of pure drinking water to their inhabitants, and to collect and treat wastewater under optimum conditions in terms of techniques and cost-effectiveness, and subject to respect different kind of standards in terms of water quality and level of services. Today, almost the entire population is connected to a water distribution system (99%) and over 80% of the French population is hooked up to a wastewater sanitation system<sup>35</sup>.

The French model of drinking water supply is deeply rooted in the spatio-political subdivision of the French territory and the French democracy, into 36 682 “communes” whose mayors hold legal responsibility under the Communal Code (Art. L 2224-7 and L 2224-8, CGCT) for the provision of clean drinking water, collecting and treating wastewater, and the supply of other local public services. Water services belong to a specific category of public services known as industrial and commercial public services and must respect the principles of equality, adaptability and continuity.

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<sup>35</sup>This slightly smaller number can be explained by the fact that on-site sanitation possibilities are used in low density rural areas.



Statutory responsibilities for water regulation and planning within France are split amongst a large number of authorities and agencies, all of whom operate at different levels (commune, department, region, state) depending upon the nature of the water (ground water, surface water, domanial rivers, estuaries and ports), the use and the type of intervention. Water resources management is based on the principle of integrated river-basin management (6 water basins). Water related activities within a catchment area are performed by a Water Agency<sup>36</sup>. Since the decentralization Acts of March 1982 and of January 1983, the role of the French central State has been limited to water law enforcement. The French government is highly involved in the definition of the French water policy. The parliament establishes the status of water resources, sets quality standards, and defines water resources monitoring and control instruments. The administration of the French water policy is shared by the state's local representatives and the Mayor assisted by different decentralized state bodies.

In France, there exist around 14 900 services dealing with water supply and 14 500 services dealing with sewage. The French communes can either directly manage their water services (in-house management) or may entrust the management of these services to a specialized private company through various contractual agreements. The participation of the private sector has progressively increased in France since the 20<sup>th</sup> century and is estimated today to be around 80% of the market share. In fact, after the extensive destruction during World War II the French local municipalities faced enormous financial and technical difficulties in filling their obligation to provide public services including the supply of potable water and collecting and treating wastewater. Furthermore, the demographic and economic booms that followed led many French municipalities to seek outside help to provide water services to their inhabitants. During this period, the French administrative law clarified, developed and refined the legal terms used in the context of delegation contracts. Note that, full privatization is not possible under the French Law: the public domain, including the infrastructure such as water and wastewater networks, is inalienable which means that no one can own it except a public authority. Thus, the French local communities remain the owner all waterworks and plants.

Under the French law, the delegation of a public service which may cover all or part of the service, takes the form of a contract through which a local municipality gives a private firm the right to build and/or to operate a public service. When water services are delegated to a private company four contractual agreements are mainly used depending on the risk-sharing rule and the payment scheme: management contracts, commissioner management contract, affermage or lease contract, and concession. Affermage is the most common form of delegation contracts, usually awarded for a period of 10 to 12 years. Delegation contracts specify the nature of the expected service, water pricing schemes (including the price revision formula), etc.

Since the end of the 1970's, the General Accounting Office (and the Regional Auditor Offices) has largely criticized the myth of competition in the French water sector. Delegation of water services is currently governed by the Sapin Law (23/01/1993) which tried to establish a strict procedure to foster transparency in public procurement, and to avoid corruption at the local level<sup>37</sup>. Thus, according to the Sapin Law, the delegation agreements are concluded after a procedure of publicity, tendering and public consultation (Art. L 1411-1 CGCT). Therefore, local authorities have a high degree of freedom to negotiate the delegation contract that will govern their relationship with the private operator that wins the right to provide the service (nature of the expected services, price structure and price revision formula, policy objectives, investment needs, etc.). In fact, the selection mechanism consists in a two-step procedure. In the first step, the local authority organizes an open call for tenders and sometimes publicly specifies and priorities the ranking criteria of offers. The second step is a negotiation stage where the local municipality has the right, by the law, to negotiate with one or more operators in order to obtain specifications and detailed

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<sup>36</sup>The French Water Agencies are public and administrative organizations created by the 1964 Water Act (Also cf. the 1992 and 2006 Water Acts). These agencies are in charge of the resource conservation policy and levy different water-related charges by application of the "polluter pays" principle (effluent emissions taxes and extraction charges). These charges are then allocated (partially) to municipalities in order to subsidize different kind of investment needs in order to improve water resources (pollution abatement technologies and resource management facilities). Note that since 2006 central State subsidies are prohibited (Administrative Instruction of 08/12/2006). Also note that there is no centralized public authority in charge of regulation of the water industry in France.

<sup>37</sup> Opaque practices have led to corruption that mainly takes two forms: corruption in business relation with the private sector which concerns in particular the awarding of delegated contracts (personal enrichment, use of "access fees" for other purposes, etc.); and corruption in public procurement contracts concerning investment in water and sanitation projects.

information about the content of their bids. Then, the local authority decides on the private operator that will be in charge of the service, according to the criteria that it considers appropriate. Thus, the awarding of contracts is based on the principle of free choice (*Intuitu Personae*). Furthermore, the Sapin Law limits the duration of the delegation contracts and specifies conditions under which delegation contracts can be re-negotiated. Finally, the 95-127 Law of February 8<sup>th</sup> 1995 established an obligation for all companies contracted by public authorities to submit an annual report about the activities carried out during the year, and subject to audit control.

But delegation is not the only way to provide water services: to achieve their missions under optimum conditions many of the French local municipalities have formed geographically coherent groups (inter-communal grouping) to pool resources, such as syndicates, districts, “communautés”. By merging into a single water utility, several local communities have the possibility to share sunk costs and to limit the risk of shortage in the event of drought. This feature also allows public water utilities to achieve a better efficiency. This is made possible by the nature of water and wastewater networks that allow an easy increasing of consumers’ connection. The benefit from such cooperation depends crucially on the existence of economies of scale.

#### C.2.4. Innovation in the French water sector

The water industry is facing a series of new challenges driven by climate change, population growth and urbanization. Increased water demands and lower supply require that the industry has to find new and more efficient and sustainable ways of allocating, treating and using water resources and protecting the environment. Innovation has a major role to play in promoting sustainable water resources management and to deliver a better service and improve environmental outcomes.

In order to address the issue of innovation in the water sector, it is important to define what innovation is. We consider the following definition (OECD 2005): “The creation, development and implementation of new product, technology, service, tariff design or process of production with the aim of improving efficiency, effectiveness or competitive advantage. It includes new ways of acquiring or deploying inputs, such as financial resources. The change may be incremental or fundamental”. From this definition, it is clear that innovation can come in two main forms: improvements in processes, methods, markets, services, etc. which could be defined as “soft” innovation; and improvements in technologies known also as “hard” innovation. Today, the French water industry<sup>38</sup> is well aware of the benefits of innovation driven by new water and environmental quality standards, and has implemented processes in order to meet efficiency performance targets, reduce costs and improve the quality of the service.

Therefore, it is necessary to note that innovation is not always seen or measured. Measuring innovation reliably can be difficult. In the following we address innovation-related issues in the French water industry which cover a number of activities not necessarily related to R&D, i.e. phases of development, implementation of new processes, new organisational methods, etc.

##### *Product innovation*

New information technologies (IT) and the Internet have developed a positive environment towards innovation within the water industry and generated new ideas and business strategies. Interestingly, efficiency performance targets are the main driver of innovation in the water sector (costs reduction, quality of the service improvement, customer services, etc.). For example, internet-based technologies help organizations tackle the energy consumption of their IT operations as well as related costs and emissions. Moreover, these web-based technologies may improve customer services by reducing the time for intervention in the case of system failure.

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<sup>38</sup> In particular the multinational French water companies are best equipped to promote innovation because they dedicate very significant resources to innovation activities. The French water supply companies provide state-of-the-art technologies for the conception, treatment and management of water services. Furthermore, they are financially strong, have qualified personnel to provide an almost complete line of professional skills, enabling them to assume the design and construction as well as management of the most complex systems. According to OECD database, during the 2000’s, the French companies have the highest effort in R&D intensity spending around 0.7% of their production in R&D. Between 2000 and 2006, Germany and France were the countries with the highest number of patent applications for water collection.

Furthermore, information technologies (hardware, software, telecom, networking and services for water control) play an integral part in managing water resources and enable dynamic sustainable pricing and foster price sensibility. Thus, the internet-based innovation is a vector to engage consumers, businesses and public authorities more effectively in their sustainable efforts. It implies changes in lifestyle and acts as a source of information and knowledge about environmental issues, the environmental impact of consumption behaviour and lifestyle decisions, and the practical actions that all players in the market can take to support sustainability goals.

For example, sensor-based networks that collect information and software-based interpretation of data can be used to adapt lifestyles and to orient individuals and businesses towards more sustainable consumption behaviours.

These technologies can also be used to inform policy decisions by simplifying the access to and display of data (e.g. smart meters) which facilitate monitoring, measuring and reporting changes in the industry (supply and demand modelling and management, drought management, valuing of hydrological ecosystems services, strategic asset management, climate modelling, least costs planning, etc.). Thus, innovation can pave the way to better ecologically-based and low-cost approaches to address some of the challenges identified in the water sector. These new techniques improve the collection, processing and presentation of data that support policy-making and water operations.

For example, up to the 1980's, studying public operational practices in the French water sector reveals that they are inefficient. Regular maintenance, especially in small and rural public utilities, is inadequate or absent. Neither preventive nor curative maintenance actions exist. Very few urban utilities started by the end of the 1980's and the mid 1990's curative and preventive actions to reduce physical losses<sup>39</sup> through old pipes, which are neither properly maintained nor replaced in a timely manner (a lot of the French water distribution systems have been built by the end of the 1800's). Some of them, like Strasbourg Water Utility, started thinking very lately on the adequate renewing water distribution systems policies and the optimal economic renewal strategies to perform. Internet-based innovation would improve the operators' knowledge about the state of the installations, the need for replacement, rehabilitation and expansion, and the resulting operational risk that the installation will not perform as expected.

The French public and private operators are widely using the web-based technologies in providing water services. They are seeking new web-based solutions (through internal innovations or adopting innovations from other sectors) in order to develop better service delivery mechanisms. Therefore, because of a lack of awareness about what IT can do, the water industry is not leveraging it to its potential.

#### *Process innovation*

The French water sector is making the most of its investment in securing drinking water supply and improving water use efficiency which includes the adoption of new technologies that improve the treatment and reduce the consumption or the availability of water. The main objective is to promote sustainable water resource management as requested by national and EU legislations. Particularly, innovation in the French water sector includes (but is not limited to) technologies covering a wide range of fields. This covers:

- The development of water-saving devices in order to increase the efficiency of water use: plumbing devices to save water (including low water consumption toilets, water saving tap attachments, low-flow showerheads, front-loader washing machines, etc.
- The development of innovative devices in order to increase the availability of water: rainwater harvesting devices, rainwater tanks (especially in rural areas), recycling technologies, etc.
- The development of treatment technologies in order to improve the quality of water to required levels: water treatment (microscopic membranes techniques, micro and ultra-filtration, biological treatment, grey water treatment) and measurement and control of water quality.
- The development of efficient irrigation systems and ecological farming techniques to reduce fertilizers run-off, crop research, etc.

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<sup>39</sup> The occurrence of network leaks as part of the production and distribution process can be considered part of the overall inefficiency of the system. This is clearly a concern for water utility managers in terms of opportunity costs for part of the water that is lost for potential customers.

- The development of biotechnology and nanotechnology (OECD, 2011d) which can help address a range of environmental, social, and global challenges in the water sector. These technologies have the capacity to spur innovation, help the water industry to reduce water pollution, and deliver eco-efficiency.

Furthermore, new and advanced metering technologies (telemetry) provide the French water sector<sup>40</sup> with an important tool to achieve sustainable water resource management. Smart meters allow water utilities to read meters with a very short frequency and to proceed to a consumption-based metering and billing. Nevertheless, this is not just a matter of new technology. It is also a way to meet new consumers' demands: users refuse estimates and want to monitor and manage their own water uses more effectively<sup>41</sup>.

Telemetry has different advantages. First, it makes the work of the meter readers easier (easy access, independent of customer being at home). It can identify the source of unexplained losses and establish consumption trends for a fairer billing. Third, it avoids transcription errors, allows a more frequent billing and improves meters inventory management. Finally, it allows the implementation of dynamic pricing mechanisms. Efficient water pricing can be combined with environmental externality pricing or taxes which reflect the external impacts of abstraction and discharges in order to apply the polluter pays principle and thus to achieve sustainability.

Note that the French private water companies are global leaders in water technology innovation. Some existing areas of leadership cover skilled staff and technical expertise, project management, customer services, leakage/asset management, real time process control, research consultancy, materiel science (including smart nanotechnologies, chemistry and functionalized membranes), desalination, process optimization, risk based approach to water safety, managing aging infrastructure and manufacturing, etc. They are also quite active in leading areas of research and develop solid partnerships with academics.

#### *Marketing innovation*

In response to the growing consumer concerns about environmental degradation and climate change, the French water operators (public and private) are expanding the use of "self-declared" claims as a corporate marketing tool. Furthermore, public and private operators in the water industry are pro-active in building external networks for the development of innovative projects in the water sector and have permanent links with universities and research institutions (For example Chaire industrielle sur l'eau, Lyonnaise des Eaux).

In addition, the central state (via different public agencies and ministries) addresses information issues in the water market by providing water users with comparative information, or by encouraging private operators to do so, mandatorily or on a voluntary basis. This may help consumers reduce their search costs by making it easier for them to compare product. Furthermore, the publication of technical specifications like safety and environmental requirements or performance measurement methods incorporated in the standards encourage the development of new technologies and products reducing the uncertainty regarding courses of innovation and improving consumer acceptance through reducing potential risks. For example, the French Environment and Energy Management Agency (ADEM) or the Direction Générale de la Concurrence et de la Répression des Fraudes (DGCCRF) publish on their websites information on the characteristics of different water and energy consuming products.

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<sup>40</sup> In France, Schlumberger provides a service allowing water utilities to read water meters instantaneously and automatically route the information from the consumer's location to the utility's management unit. Remote interrogation systems enable meters to be read from outside the premises and provide fuller supervision of metering points on a distribution system. With cheaper and more frequent reading, more regular monitoring of consumption and shorter intervals between bills are possible.

<sup>41</sup> Several OECD studies confirm the importance of providing the right incentive to spur behavioural change. These studies show that price-based incentives have encouraged energy and water saving. Households charged for their consumption on a volumetric basis were found to consume approximately 20% less water than those who are not charged. In addition, consumers are more likely to install water-efficient and sanitary equipment at home.

And last, but not least, in order to achieve EU environmental objectives, the 1992 Water Law has attempted to reduce water resources depletion and to promote equity between users. It has prohibited the use of flat rates, ruling out entirely non-volumetric pricing schemes. In addition, environmental taxes were adopted in the water sector in order to apply the polluter pay principle: water withdrawal tax, household pollution tax, and industrial pollution tax. These taxes work as give and take circular financial flow because most of the revenues raised by the French water agencies are returned to the same tax payers in the form of subsidies.

#### *Organizational innovation*

Technologies need to be supported by innovative business models, organization methods and corresponding regulatory regimes to improve water resource management and to integrate water priorities into other policy areas such as energy or special planning.

For long years, municipal organizations have operated and managed their “services” under vague statutory mandates. Both public management and delegation process were criticized. Direct public management was criticized for being overstuffed, inexpert, and having poor financial management, inadequate invoicing, and inadequate controls. Private participation was criticized for corruption and the inadequate competition in delegating water services in particular the “repeated use of negotiated procedures”, allowing operators privileged access to associated works contracts without competition, and a tendency to roll forward existing arrangements which results in substantial profit margins. This situation forced the French legislator to elaborate new and more specific delegation rules in the 1990’s in order to eliminate organizational failures.

Driven by EU and National legislations, the well-known French model of delegation of water services has evolved during the last 3 decades. Improving contract-based regulation is not an easy task to implement and meets increasing difficulties due to the adversarial relationships and the regulatory opaqueness.

The 1995 Public Service Management and Delegation Laws stipulate that local municipal organizations must monitor the level and price of service: two documents must be published every year concerning the price evolution, the quality and the level of service. These reports cover essential aspects of the price setting and revision, the quality of the service other than the quality of the water itself, such as water pressure, the avoidance of hosepipe bans, incidences of any nature, leaks, etc., among others. The most important advantages in publishing of such reports are: (1) it would provide for better understanding by customers and more informed public debate; (2) it would be used as comparative performance indicators; and, (3) it would be used as evidence to enforce the statutory conditions with respect to the present duty to supply and the proposed duty to improve levels of service.

Furthermore, since water services are considered as industrial and commercial public services, water utilities must have a separate budget enabling them to determine the cost of the service and ensure its balance. The price of the service must correspond to the investment and running costs of the service, including the remuneration of the private operator. Water must pay water through the water bill. In addition, the 1995 water Law requests an active public participation in the delegation process in order to limit the mounting public discontent concerning regulatory opaqueness.

Recent studies show that delegation might be a source of innovation. According to Huet and Porsher (2012), reputation building acts as an implicit incentive mechanism to invest: the private operator strategically invests in innovative capital because its behavior is affected by the degree of competition for the market and the life cycle of the delegation contract. Thus, strategic innovation decisions increase the quality of the service and corporate reputation<sup>42</sup>. Furthermore, competition for the market could encourage better ways of doing business by incumbent operators due to the threat of new entrants. The design of the market-like incentives for upstream competition should, however, be considered carefully to avoid gaming of the market-like system (Armstrong and Sappington, 2006; Laffont and Martimort, 2002).

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42 For example investment in innovative leak detection systems.

In addition, public procurement can be implemented as innovation policy tools to address structural failures and inefficiencies affecting translation of needs into functioning markets for innovative products and services (Edler and Georghiou, 2007). It also raises the quality of public infrastructures and services through up-to-date solutions. To this end, it is necessary today to review and enforce the rules governing the French water sector. This may be achieved by limiting the discretion given to regulatory decision making and increasing transparency and accountability, which lead to pragmatic design features in regulation.

#### C.2.5. Barriers to innovation

In this section we briefly address the barriers to innovation in the French water sector.

- EU water policy: the current water policy lacks of coherence between the community level and the national level. Its relevance depends mainly on domestic operationalization. Furthermore, it is necessary to improve coordination across all players with different objectives in the market.
- Contract delegation design: such a flexible framework should be coupled with greater transparency in order to avoid corruption and favouritism. The incentive design literature (Laffont and Martimort, 2002; Martimort and Pouyet, 2008) such as the principal-agent model of regulation could help in the design of delegation contract to include reward and penalty incentives to encourage better ways of doing things either through lower costs and/or new solutions.
- Common agency problem: there is a need to simplify the institutional regulatory framework within France and clarify public policy concerning new challenges such as climate change targets.
- Water conservation and economic assessments are providing conflicting incentives in some areas such as agriculture. Thus, it is urgent to clarify the institutional regulatory framework in order to avoid cross-subsidies between domestic and agricultural water users.
- Public management at the local level: public management may sometime block innovation in the water sector due to the lack of adaptive efficiency. It is important to encourage the development of decentralized decision processes that will allow societies to many alternative ways to solve problems and eliminate organizational failures which, in the case of the public water utilities, are not only probabilistic but systematic, due to preferences with respect to ideologies, politics, economics, among others, which may give people, on the basis of imperfect knowledge and asymmetric information, preferences for the kind of solutions that are not oriented to such efficiency.

#### C.2.6. Conclusions

For decades we closed our eyes to the inconvenient truth that every extracted material from the environment is a potential source of pollution causing environmental damage and resulting in unpaid social costs. Today substantial changes and investments are needed to clean up old messes and to enforce measures to treat efficiently water resources and to reduce water and environmental pollution.

Technological advances have placed an increasing reliance on specialists, and today, the water industry cannot be considered an industrial activity consisting solely of water treating and laying down pipes. The ability to achieve environmental objectives and improve sustainable water management depends crucially on the water sector capacity to be innovative. It also strongly depends on the political will and further hard work, on the full participation of all stakeholders, as well as on a clear harmonized implementation of EU water policy in all EU Member States (and other EU sectoral, structural and cohesion policies, OECD, 2011a), and on a comprehensive trading off the complex and sophisticated actual framework in favor of simplicity.

In the case of the European water regulation, the French water industry has achieved a great deal over the last 30 years. France's institutional framework presents a closer match to the aim, policy style, and institutions required by the EU legislations. Thus, France has been able to transpose the EU water and environmental legislation relatively smoothly, whereas other EU countries are likely to fail. Therefore, the process of implementation, rather than being automatic, is extremely complex and depends on developing and implementing new technologies and achieving the necessary improvements in the management of water resources. This will require economic, social and policy changes where innovation (hard and soft) plays a major role. Better regulation, by improving innovation, could minimize ecological damages and enhance economic efficiency. Thus, there is an urgent need to implement a new regime of metrics for measuring economic, social and environmental progress. Furthermore, more innovation funding and visionary leaders are required to drive innovation forward.

## C.2.7. References

- Armstrong M. and Sappington, D.E.L. (2006): "Regulation, Competition, and Liberalization". *Journal of Economic Literature*, Volume XLIV, pp. 325 – 366.
- Armstrong, M., Cowan, S. and Vickers, J. (1994), *Regulatory reform: Economic analysis and British experience*, The MIT Press.
- Chong E., Saussier S. and Silverman, B. S., (2012), *Water under the Bridge: City Size, Bargaining Power, Prices and Franchise Renewals in the Provision of Water*, Discussion Paper Series, EPPP DP N° 2012-5, IAE, Ponthéon-Sorbonne.
- Conseil d'Etat (2010), *L'eau et son droit*, Etudes et Document du Conseil d'Etat, Rapport public 2010, La Documentation Française, 580 pages.
- EC (1991a), Council of the European Communities, Directive concerning urban wastewater treatment (91/271/EEC). *Official Journal*, L135, 40-52.
- EC (2000), European Union Water Framework Directive 2000 /60/EC, October 23rd 2000, published in December, *Official Journal*. L 327, 22/12/2000.
- EC (2008), The Marine Strategy Framework Directive (MSFD, 2008/56/EC), published on June 17<sup>th</sup> 2008.
- Edler, J. and L. Georghiou (2007): "Public Procurement and Innovation: Resurrecting the Demand Side", *Research Policy*, Vol. 36, pp. 949-963.
- Elnaboulsi J. (2001a): "Organization, management and delegation in the French water industry", *Annals of Public and Co-operative Economy*, 72, 4, pp. 507 – 547.
- Elnaboulsi J. (2001b): "Non-linear pricing and capacity planning for water and wastewater services", *Water Resources Management*, 15, 1, pp. 55 – 69.
- Elnaboulsi J. (2009): "An Incentive Water Pricing Policy for Sustainable Water Use", *Environmental and Resources Economics*, Volume 42, Issue 4, pp. 451 – 469.
- Elnaboulsi J. (2011): "An Efficient Pollution Control Instrument In Achieving Sustainability: the Case of EU Urban Wastewater Pollution". *Environmental Modeling and Assessment*, Volume 16, Issue 4, pp. 343 – 358.
- Elnaboulsi J. and Houser M. (2012), *On the Management of Europe's Water Resources: Economic Challenges in Water Policy*, 13<sup>th</sup> Mediterranean Research Meeting, Robert Schuman Center for Advanced Studies, European University Institute, Florence, Italy, March 21 – 24.
- Guérin-Schneider L. and Nakhla M. (2012): "Emergence of an Innovative Regulation Mode in Water Utilities in France: Between Commission Regulation and Franchise Bidding". *European Journal of Law and Economics*, 33, pp. 23 – 45.
- Huet F. and Porcher S. (2012), *Innovation and Regulatory Outcomes: Evidence from the Public-Private Contracts for Water Supply in France*, Discussion Paper Series, EPPP DP N° 2012-11, IAE, Ponthéon-Sorbonne.
- Laffont J. and Martimort D. (2002), *The Theory of Incentives, The Principal-Agent Model*, Princeton University Press.
- Martimort D. and Pouyet J. (2008): "To Build or not to Build: Normative and Positive Theories of Public-Private Partnerships", *International Journal of Industrial Organization*, 26, 393 – 411.
- OECD (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, 3<sup>rd</sup> Edition, OECD Publishing, Paris, France.
- OECD (2006), *Water: The Experience in OECD Countries*, Environmental Performance Reviews, OECD Publishing, Paris, France.
- OECD (2007), *Instrument Mixes for Environmental Policy*, OECD Publishing, Paris, France.
- OECD (2009a), *Managing Water for All: An OECD Perspective on Pricing and Financing*, OECD Publishing, Paris, France.

- OECD (2009b), *Strategic Financial Planning for Water Supply and Sanitation*, OECD Publishing, Paris, France.
- OECD (2010a), *Pricing Water Resources and Water and Sanitation Services*, OECD Publishing, Paris, France.
- OECD (2010b), *Innovative Financing Mechanisms for the Water Sector*, OECD Publishing, Paris, France.
- OECD (2011a), *Policy coherence between water, energy and agriculture*, Working Party on Biodiversity, Water and Ecosystems, 10-11 March 2011, OECD Publishing, Paris, France.
- OECD (2011b), *Fostering Innovation for Green Growth*, OECD Green Growth Studies, OECD Publishing, Paris, France.
- OECD (2011c), *Benefits of Investing in Water and Sanitation: an OECD Perspective*, OECD Publishing, Paris, France.
- OECD (2011d), *Fostering Nanotechnology to Address Global Challenges: Water*, OECD Publishing, Paris, France.
- OECD (2012), *OECD Environmental Outlook to 2050: the Consequences of Inaction*, OECD Publishing, Paris, France.
- République Française, Assemblée Nationale, rapport d'information N° 4070, *La géopolitique de l'eau*, Décembre 2011, 312 pages.
- Thomas, D. A. and Ford, R. R. (2005), *The Crisis of Innovation in Water and Wastewater*, Edward Elgar Publishing Limited.



### C.3. Pollution of Surface Waters Act in the Netherlands

Author: Pieter Tuytens

Key words: Polluter-Pays Principle, Water Treatment Systems, Effluent Charges, Environmental Standards, Market-based Policy Instruments, Policy Decentralisation

Key messages:

- The significant regulatory impact of the Pollution of Surface Waters Act was, to a large extent, the result of the effluent charges it introduced (rather than the standards and permit system).
- Effluent charges were earmarked to finance public water treatment systems, but also succeeded in changing the behaviour of industries (on basis of a market-based, polluter-pays principle). The result was a widespread diffusion and significant incremental improvement of water treatment technologies.
- For successful implementation, it is crucial that the level of the levy is set right (gradually increasing over time to make more companies apply, yet without making the burden for companies too high in order to prevent drop-outs). Furthermore, the levy base should be well defined, as this is very important in determining the direction of technological development.
- The effect of the two policy-instruments (permit system and levies) has to be understood within the broader governance context. This context combines a highly decentralised approach with a governance structure that stimulates cooperation.

#### C.3.1. Introduction

The Dutch “Pollution of Surface Waters Act” (Wet Verontreiniging Oppervlaktewater) provides an interesting case of the impact of regulation on water treatment technologies. The law stimulated widespread diffusion of water treatment technology, using market-based instruments following the Polluter-Pays principle. Because the Act is introduced in the 1970s, it allows a longer-term overview of the results of the regulation. As a broad, nation-wide regulation, it also provides evidence on a more aggregate level.

The aggregate effect of the Pollution of Surface Waters Act is significant. The Act introduced a large-scale and structural approach to tackle water pollution. The total discharge of oxygen-binding substances has been reduced by over 80% in 25 years (Van Erkelens and Olman, 1996). In 2004, 98% of produced wastewater was treated before discharging it, this by almost 400 water treatment installations (Mels, 2008). Today, the Netherlands has one of the oldest and most advanced wastewater control systems in the world (Kemp, 1995).

#### C.3.2. The Pollution of Surface Waters Act: background

The 1970 Pollution of Surface Waters Act was proposed in 1964 after serious deterioration of surface water quality in large parts of the Netherlands had emerged and widespread recognition of the problem. The broad objective of the law was to ‘obtain a quality of surface water that enables as much diversity of organisms and aquatic life-communities as nature can possibly give’. Besides this ecological goal, the Act states that surface water must also be appropriate for serving human ends such as drinking water, agricultural and industrial use (Bressers and Lulofs, 2002).

The Act was not passed until 1969 because all kinds of governments lobbied to become the principal authority in this field. The Act distinguished between national and regional waters, assigning tasks to various authorities in a very decentralised fashion (see below). Apart from arranging the governance of surface water management, the Act introduced two main policy instruments (see Van Dijk, 1994).

- Environmental standards including a system of permits: every discharge of wastewater into surface water (and in some listed cases into municipal sewers) requires a permit from the competent authority.
- Effluent charges: A system of levies where all discharges are liable to pay a pollution levy according to the ‘polluter-pays-principle’. This levy is earmarked to finance the public water treatment plants and the costs related to the management of water-quality.

As will be explained in the following section, **particularly the levies had a significant regulatory impact and innovation effect** in water treatment systems. However, interviewees confirm that innovation was not yet in the mind of policymakers when they were designing the regulation (only in the 1980's policymakers started to be aware of the technological consequences of environmental policy). The main concern of legislators was improving water quality and public health. The levy was intended to finance the technology needed to achieve these environmental objectives. However, by leaving the choice to companies to reduce pollution or pay levies, the Act allowed for flexibility in the implementation. As a market-based policy-instrument, the Act used incentives to change industrial behavioural. Apart from the market-based element, two other characteristics of the Act attracted widespread attention: it introduced the 'polluter-pays-principle' and it provided a well-defined base for the levy, which was important for the direction of the technological development. As a result of its success, the law was copied in several countries (though with varied results).

### C.3.3. Innovation Effects

Two key features can be distinguished:

- Levies, not permits, had the biggest regulatory effect on the behaviour of industry.
- Main innovative effects took place through technological diffusion and incremental innovation.

The regulatory effect of effluent charges

As explained in the previous section, the "Pollution of Surface Waters Act" has two main components: environmental standards and a system of effluent charges. A main conclusion of the literature is that the major regulatory effect of the Act was not a result of the standards (and the accompanying system of permits), but of the effluent charges. Research by Hans Bressers (1983, 1988) and Jaap Schuurman (1988) has revealed that, of all the factors that caused polluters to invest in (biological) wastewater treatment technologies, the effluent charge was far and away the most important factor (see also Kemp, 1995).

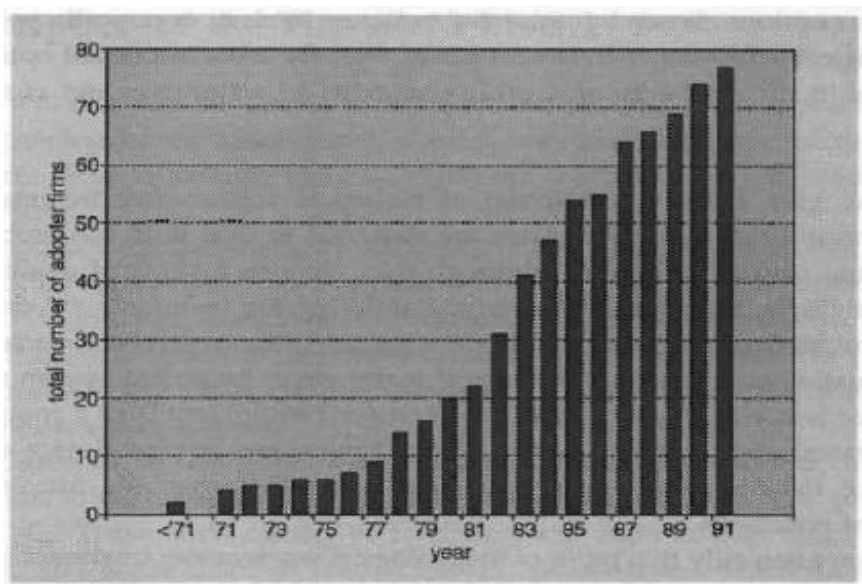
The levy was earmarked for financing the public water treatments plants and the costs related to the management of water-quality. Companies paid for the amount of waste they discharged. This levy, that was originally intended to finance the public treatment of wastewater, eventually had a regulatory effect as it changed the behaviour of firms (Interview; Bressers and Lulofs, 2002). The levy functioned as a financial incentive for firms to take measures themselves to reduce pollution. Because the charges could easily be a million Euros for a company, it was often cheaper for a company to treat the wastewater themselves. In 60% of the companies researched by Schuurmans and Tegelaar, the effluent charge was the crucial factor to take these measures (Schuurmans and Tegelaar, 1983). Of the total reduction in pollution between 1975 and 1980, 80% can be explained by the levy and only 20% by the role of non-levy factors (such as the permits).

The effect of the regulation and permits increased, however, after 1985 (Bressers and Lulofs, 2002). Before 1985, it was the task of the permitting organisation to prove that a substance was harmful. Accordingly companies almost always paid attention only to the substances that determined the levy. After 1985, licenses became more ambitious. Nearly always research-obligations are imposed on companies to limit or reduce the discharge of certain substances. In interaction with the company the company has to proof that a discharge has no negative influence. The impact, however, of these more ambitious licenses differs: it is smaller for those sectors that were already ahead of the licensers and bigger for those that were more passive before (Bressers and Lulofs, 2002).

### *Innovation through technological diffusion*

If we take a closer look at the innovation effects of the regulation, we see that the main effects took place later in the innovation process. As a result of the levies, the Act was responsible for a large-scale diffusion of water treatment technology throughout the Netherlands. Furthermore, as the levies were earmarked to finance public water treatment plants, sufficient resources were available to improve the technology and learn from scaled-up experience (one interviewee notes that especially the engineering company DHV<sup>43</sup>, now a global player, was able to expand its expertise and activities on basis of this growing market).

Figure 20 The diffusion of biological wastewater treatment technologies across indirect polluters in the Dutch Food and Beverages Industry, 1970-1991.

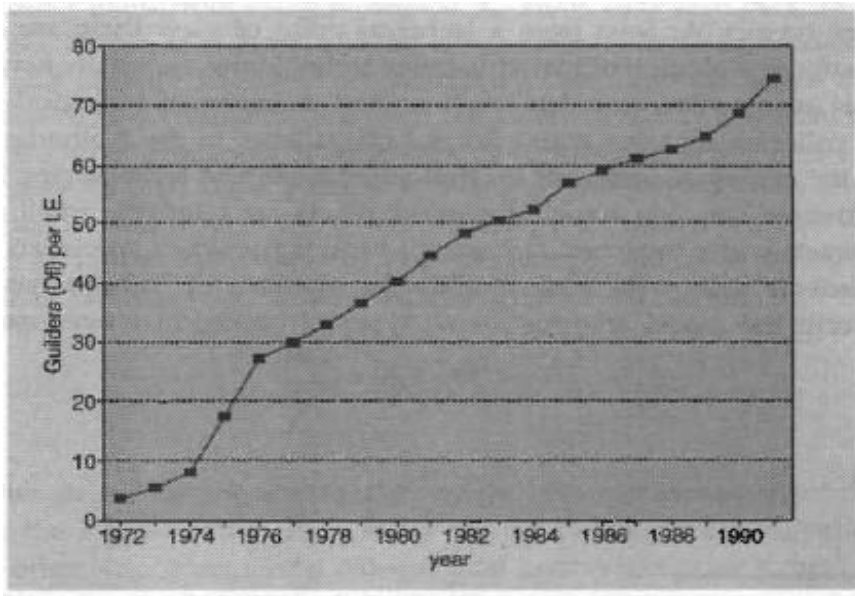


Source: (Kemp, 1995 – on basis of RIZA, CBS and own calculations).

The regulation was implemented nation-wide, hence all industries involved in polluting biological wastewater were affected. However, some industries reportedly reacted more strongly than others to the regulation. Especially in the Food and Beverages industry, effluent charges were the key factor in inducing water polluters to invest in biological wastewater technologies (Kemp, 1995). Figure 20 shows the diffusion of biological wastewater treatment technologies in the Dutch Food and Beverage Industry. The steady increase over time is explained by the fact that companies are not forced to invest in water treatment technology; hence companies could choose to invest when it became cost-effective for them to do so.

<sup>43</sup> <http://www.dhv.nl/Over-ons/Historie>

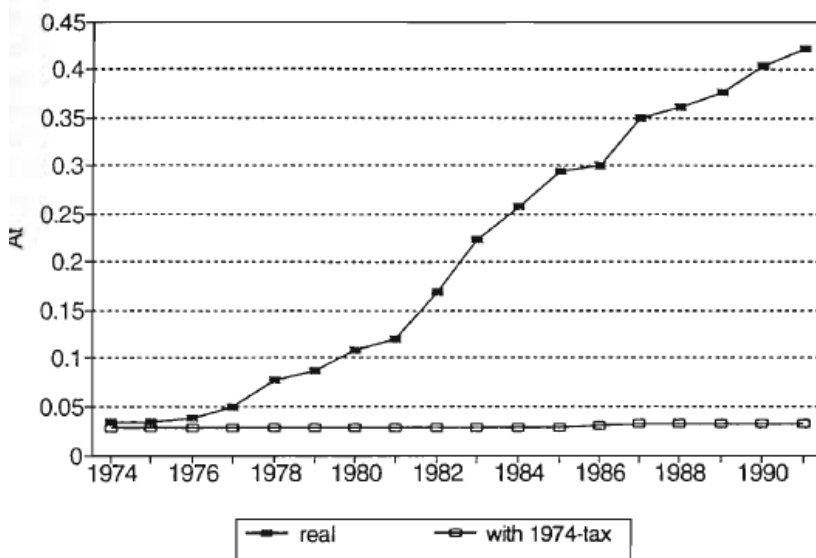
Figure 21 Average effluent charges for organically polluted industrial wastewaters in the Netherlands.



Source (Kemp, 1995).

Kemp (1995) also shows that, for diffusion to take place, it was important that the effluent charges increased steadily over the years (see Figure 21). If effluent taxes had been fixed at the 1974 level, the expected diffusion is rather almost non-existent (see Figure 22). On the other hand, Schuurman and Tegelaar (1983) warn that companies are willing to pay, but will pull out if the burden becomes too high.

Figure 22 The diffusion of biological wastewater treatment plants (1)



Source: (Kemp, 1995) (1): According to the partial adjustment payback model with the effluent tax rate fixed at the 1974 level

Apart from the level of the levy, one interviewee notes that the direction of the technological development crucially depends on what precisely is included in the levy base. For example, originally only aerobic organic pollutants were included, requiring particular biological water treatment systems. In the 1980s, it was considered to also include anaerobic pollutants – yet this is potentially difficult as a result of possible path-dependency of earlier equipment.

### C.3.4. Broader governance system

In order to understand the impact of the regulation on innovation, it is not sufficient to focus on the policy instruments (i.e. the levies and permit-system). Several authors note that the “law is only one element in a broader policy system” (Bressers and Lulofs, 2002, p9; see also Bressers, Huitema and Kuks, 1994). The conclusion of Bressers, Huitema and Kuks is that the institutional and administrative structure of surface water management in the Netherlands is very complex, but that within the group of agencies directly involved there exists a common belief system and a substantial degree of commitment and inter-relatedness.

While it is not in the scope of the case study to explain the full governance system regarding water regulation in the Netherlands, it is important to mention the highly decentralised nature of the Dutch wastewater management system (see also Kemp, 2005) The Pollution of Surface Waters Act designated responsibilities at different levels of government (a process that took five years of negotiations). In short, while the national government is responsible for national waters (including the big rivers and coastal waters) and general direction, the regional governments received a lot of responsibility for the regional waters. All provinces, however, delegated authority to so-called Water Boards who are, amongst others, responsible for setting the levies. The governors of the Water Boards are democratically elected and thus include representations from many interests (such as agriculture and inhabitants of the region). This decentralised approach not only stimulates cooperation and commitment from the industry (see also Bressers and Kuks, 1994), but also allows for taking into account regional differences into decisions concerning levies.

### C.3.5. References

Bressers, H. (1988) A Comparison of the Effectiveness of Incentives and Directives: The Case of Dutch Water Quality Policy, *Policy Studies Review*, 7(3): 500-518;

Bressers, H. and Kuks, S. (1994) Policy Networks in Dutch Water Policy, in: *Environmental Politics*, 3 (4). pp. 24-52.

Bressers, H. and Lulofs, K. (2002) Charges and other policy strategies in Dutch water quality management. Report for Center for Clean Technology and Environmental Policy.

Kemp, R. (1995) Environmental Policy and Technical Change – A Comparison of the Technological Impact of Policy Instruments. Universitaire Pers Maastricht.

Mels, A. (2008) Nieuwe Nuts: Duurzaam Ontlasten, naar een lokaal gebruik van afvalwater. Report for InnovatieNetwerk.

Schuurman, J. (1988) De prijs van water. Een onderzoek naar de aard en omvang van de regulerende werking van verontreinigingsheffing oppervlaktewateren. Arnhem Uitgeverij.

Schuurman, J. and Tegelaar, J. (1983) De regulerende werking van de verontreinigingsheffing oppervlaktewateren (een kwatificering). *Weekblad voor Fiscaal Recht* 1983/1561

Van Dijk, G. (1994) The Enforcement of the Pollution of Surface Waters Act in The Netherlands. Third International Conference on Environmental Compliance and Enforcement, 1994.

Van Erkelens, P. and Olman, M. (1996) The Pollution of Surface Waters Act in the Netherlands – A Story of successful enforcement. Fourth International Conference on Environmental Compliance and Enforcement, 1996.

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## C.4. Unlocking the underinvestment circle in Milan’s water and sanitation infrastructure

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Key words: underinvestment, full industrial cost, waste water treatment plant, urban water, sanitation, Milan

Key messages of the study:

- Keeping the water and sanitation service (WSS) budget fully within the global municipal budget might threaten the investment policy of the WSS.
- External regulation both from the EU and national authorities turned out to be key drivers of innovation in Milan’s WSS.
- Full industrial cost recovery and WSS’s corporatisation might improve the investment policy depending on the quality of the performed regulatory process.
- Considering debt of corporatised WSS as sub-sovereign might heavily jeopardise their investment policy (regulation with a negative effect on innovation)

The most relevant aspects of the proposed case study are summarised in the table below. The last column indicates the number of the paragraph to which the reader should refer.

Table 11 Water innovations within Milan’s case study

	<b>Water innovation</b>	<b>Description</b>	<b>Year</b>	<b>Regulatory instrument</b>
(a)	Technology	Drinking water treatment plant (stripping and activated carbon)	1994	EU directive + National legislation
(b)	Technology / process	Waste water treatment plant	2005	EU directive + infraction procedure + special commissioner procedure
(c)	Business model	Corporatisation of the water and sanitation service + switch to industrial cost recovery	2003	EU directive + national legislation + municipal acts
(d)	Financing Model	Borrowing constraints (internal stability pact)	2012	National decree

Source: author’s elaboration

### C.4.1. Introduction

Milan’s Water and Sanitation Service was under municipal direct provision (gestione in economia) from its creation in 1888 until 2003.

In November 2002, to comply with a national regulation, Milan city administration decided to award a 3 to 5 year water supply and sanitation concession for the ATO Città di Milano to Metropolitana Milanese (MM) which was formerly responsible for the engineering and design services in the urban public transport sector. MM is a joint stock company fully owned by Milan’s municipality. WSS operations were fully transferred to MM in June 2003.

The next section is focused on the postponed investments in waste water treatment plants. Further sections describe another underinvestment story concerning drinking water treatment plants. The two stories have many similarities.

The following section gives instead a broader view on Milan’s WSS business model in the second half of the 20<sup>th</sup> century. The case further describes the regulation measures which imposed a major shift in the WSS’s business model. It concludes with underlining the threat which would be imposed if the Italian internal stability pact was to be fully applied to municipally owned joint stock companies.

#### C.4.2. Postponed investments in waste water treatment plants

In the late 19<sup>th</sup> century when Milan's sewer system was designed and built, the choice was made to use the collected waste water to large farming areas downstream of Milan (the so-called marcite). While using waste water for land farming without any treatment was common practice at that time, through the 20<sup>th</sup> century progressively, European cities installed waste water treatment plants in order to mitigate their negative impact in terms of water pollution. The long story of Milan's waste water treatment plants started in the 70's but due to postponed investment until 2004, Milan's waste water was still discharged with no treatment in the River system ending up in the Adriatic Sea.

Indeed, the story of Milan's waste water treatment plant started in 1972 when the Municipality chose to build two waste water treatment plants designed by the Municipal engineering department in Gratosoglio and Chiaravalle. A first tender took place in 1975 but a controversy arose since the Nosedo plant was to be localised in a sensible area (Massarutto et al. 2006). Furthermore "the project proposal was hindered by the protest of the residents of the concerned areas (i.e. NIMBY syndrome)" (Lobina and Paccagnan 2005). Between 1989 and 1998 various tenders were launched and building contractors selected. However the judicial enquiries during Tangentopoli "de facto blocked public works for several years" (Lobina and Paccagnan 2005).

At the beginning of the 21<sup>st</sup> century, Milan's raw sewage was still discharged directly into the river system. In 2000 an emergency procedure was authorised by the environment ministry and Milan's mayor, Gabriele Albertini was awarded the role of special commissioner. Works were awarded and their rhythm sped up. Meanwhile however, an infraction procedure (concerning the waste water directive 91/271) was started in 2000 by the European Commission against the Italian Republic. Although Europe won the procedure in 2002, no pecuniary sanction was imposed. In 2004 and 2005 the three waste water treatment plants (S. Rocco, Nosedo and Peschiera Borromeo) were brought to completion and have been in operation since then.

Although the waste water quality problem was known since the early 1970's, the problem was only solved in the late nineties when effective investments were undertaken in a rush under the "emergency procedure" to respect the law-limit imposed by the EU waste water directive 91/271 and avoid the infraction procedure.

#### C.4.3. Postponed investments in drinking water treatment plant

Until the early 1970's it was thought that Milan's underground water was clean and ready to drink. The only pollutant noticed at that time was hexavalent chromium and the wells which were not respecting the WHO limit of 50µg/l were put out of service. In the mid 1970's major innovations took place in the water quality analysis technology and other pollutants were noticed in Milan's groundwater: trichloroethylene, trichloromethane and other chlorinated solvents. A study commission (including experts from the public health department of the University of Milan) was created and established a temporary limit of 250 µg/l on chlorinated solvents. Such a limit was strengthened by the EU directive (80/770) converted in Italian law by the law n°183 16<sup>th</sup> April 1987 and the decree of the President of the Republic 24<sup>th</sup> May 1988 n°236.

Although the groundwater quality problem was known since the early 1970's, the problem was only solved in 1994 when effective investments<sup>44</sup> (activated carbon technology and stripping) were undertaken in a rush (a decree had allowed Milan's municipality to adopt exceptionally fast procurement rules) to respect the law-limit (30 µg/l) prior to the deadline (8th May 1994).

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<sup>44</sup>Prior to 1994 only minor solutions had been found (new pumping stations in a polluted part of the aquifer and deeper wells).

#### C.4.4. Underinvestment in Milan's WSS after WWII

After WWII a price regulation regime for various goods and services was implemented in Italy in order to fight against the high inflation of those years and preserve consumers' purchase power<sup>45</sup>. It was only with the reforms of the 1990's (particularly the Legge Galli of 1994) that the price control policies were softened according to the principle that WSS should be financed through tariffs rather than through taxes (full industrial cost recovery).<sup>46</sup>

In the decades after WWII till the 1990's, water tariffs in Italy were heavily regulated to pursue the general interest goals of anti-inflation policies. Data collected by the author on Milan's WSS in those years confirm this trend (**Error! Reference source not found.**).

In those years, yearly investment amounts were approved each year by the municipal council. There was little or no connection between the gross profit of the service and the planned investments. The water and sanitation service made their investment plan which was analysed by the municipal budget department and approved by the municipal council. Former employees of the municipal administration told us that it was quite frequent for the authorised Capex amounts to be below the investment plan need since, "investments in the water and sanitation infrastructure were not as politically visible as those in nursery schools". Indeed there are two well-known stories of postponed investments in drinking water treatment and waste water treatment (see previous sections).

Our data on Milan's WSS financial flows after WWII show that starting in the 1970's, tariff revenues were not high enough to cover OPEX. As a consequence, gross profit was negative. It was only in the 1990's that tariff revenues were high enough again to cover OPEX. Three kinds of factors can explain the imbalance of the years 1970-1990: i) the water tariff regulation policy in Italy in those years aiming at controlling inflation (tariff revenues were capped while operational expenditures increased significantly as inflation was very high in those years), ii) the reduction in sold water volumes and iii) the impact of the 1976 Merli law on sanitation levies<sup>47</sup>.

Table 12 Revenues, Opex and gross profit of Milan's WSS (1956-2000), (in Italian Lira)

	<b>Water and sanitation</b>		
<b>Year</b>	Revenues	Opex	Gross profit
<b>1956</b>	2 816 016 441	2 412 666 026	403 350 415
<b>1960</b>	4 129 720 834	2 957 839 125	1 171 881 709
<b>1965</b>	5 728 731 413	4 101 642 482	1 627 088 931
<b>1970</b>	6 904 790 660	6 871 698 861	33 091 799
<b>1975</b>	7 286 197 460	7 809 942 946	-523 745 486
<b>1980</b>	14 647 478 995	18 329 273 360	-3 681 794 365
<b>1985</b>	37 283 747 950	48 308 083 461	-11 024 335 511
<b>1990</b>	63 334 093 303	61 066 857 635	2 267 235 668
<b>1995</b>	60 372 081 708	58 008 451 527	2 363 630 181
<b>2000</b>	107 337 122 233	66 531 867 852	40 805 254 381

Source: author's elaboration based on *ContoConsuntivodell'anno...* [various years]

<sup>45</sup>DecretoLegge 19 ottobre 1944 n°344, Dpr 18 Maggio 1968 n°126,CIP 45/1974, CIP 46/1974 and Delibera 26/1975

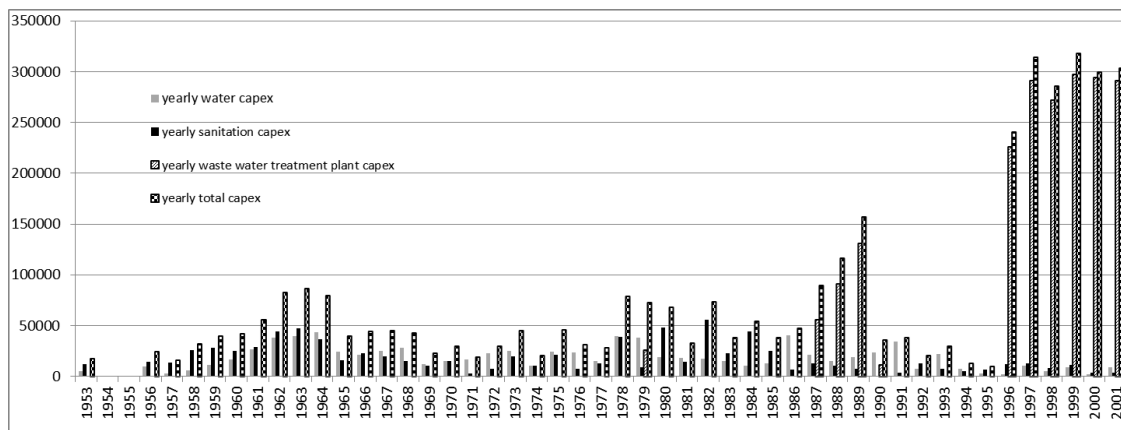
<sup>46</sup> (Massarutto 1993)

<sup>47</sup> Indeed, since the creation of the sanitation service in 1888 a sanitation levy (higher than opex) had been charged to the users by Milan's municipality. After 1976, Milan's municipality could not charge any more for the water treatment part of the sanitation levy since no waste water treatment plant was in operation. It could charge a sanitation levy only in the limitation imposed by the *Merli* law.



From our point of view some of the pursued general interests' goals (particularly the anti-inflation policy) were in conflict with public service missions': on one hand anti-inflation policies capped WSS tariff revenues while on the other hand the municipal decision-making process often gave the allocated investment budget (from tax revenue) to other municipal sectors. The joint effect of these two processes contributed to keep Milan WSS's in underinvestment as the following graph shows.

Figure 23 Yearly CAPEX expressed in thousand euros (2011 value)



Source: author's elaboration based on *Conto consuntivo dell'anno* [various years] and inflated using an index from ISTAT serie storiche

#### C.4.5. Pricing the full industrial cost, corporatisation and investments

In 1994 an ambitious reform of the water sector was launched in Italy (Legge Galli – Legge n°36 1994). A vast amount of literature<sup>48</sup> has already analysed such a reform and it is not the purpose of our work to make a new analysis. However a synthetic summary of the main features of the legal regulatory framework of the Italian water sector might be useful for the reader. The principal features of the implemented reform were:

- The concept of integrated water and sanitation services (*Servizio Idrico Integrato*) meaning that water and sanitation had to be run jointly by the same entity.
- Economies of scale: WSS were to be run at a larger geographical scale, the *Ambito Territoriale Ottimale* (ATO).
- WSS could be operated through various organisational solutions: i) direct municipal management, ii) the municipally-owned “azienda speciale”, iii) the partly municipally-owned PLC and iv) concessions to a private partner.
- Regulatory powers were awarded to local regulators to be created for such a purpose (Autorità d'Ambito Territoriale Ottimale – AATO). A national regulatory committee, the *Commissione Nazionale di Vigilanza sulle Risorse Idriche* (CONVIRI)<sup>49</sup> was also created.
- AATO were responsible for the following tasks: i) designing an investment plan (*Piano d'ambito*), ii) choosing how to operate the service (in-house provision, bid for a concession...) iii) signing the contract with the operator (*Convenzione*), iv) approving the business plan and v) periodic and extraordinary regulatory revision of the ATO investment plan (*Piano d'ambito*) and of the tariff
- The CONVIRI was mainly responsible for preserving the users' interest and supervising tariff regulation. It was also responsible for an observatory and database on the water services. In practice it was an understaffed institution, suffering from huge information asymmetries and having little regulatory power.

<sup>48</sup>An updated evaluation of the reform has been recently done by Massarutto and Ermano(2013) and by Massarutto et al (2012). Many interesting papers are included in Muraro and Valbonesi(2003).

<sup>49</sup>At first it was called *Comitato Nazionale di Vigilanza sulle Risorse Idriche* (COVIRI)

- Last but not least, the water and sanitation services were to be self-financing and transfers from the central state were forbidden. A revised tariff methodology (*Metodo Tariffario Normalizzato – MTN*) based on the full cost recovery principle was approved in 1996 (*decreto ministeriale 1 agosto 1996*). Exceptions to the MTN were made for concessions existing prior to the Galli Law. As a result in 2011, many operators were still applying the former CIPE tariff methodology instead of the MTN one (AEEG 2012, 25).

The CONVIRI turned out to be very weak and many experts and policy makers argued in favour of a more independent and powerful national regulatory authority. After the 2011 referendum,<sup>50</sup> the regulatory power on water services was transferred<sup>51</sup> to the Autorità per l'Energia elettrica ed il gas (AEEG), the national regulatory authority for gas and energy.

To comply with these legislations, Milan's WSS was corporatised and transferred to a fully municipally-owned joint stock company, Metropolitana Milanese SpA, which fully recovers its costs (including investment costs) through tariff revenues.

In 2007 the AATO approved the Piano d'ambito<sup>52</sup> for the 01/01/08 – 31/12/2027 timeframe. Waiting for such a plan, the most urgent investments (94 million euros in sanitation to be spread over 20 years) were inserted in a first investment plan (Piano stralcio) approved in 2001<sup>53</sup>. In 2010 the Piano d'ambito was revised (ATO Città di Milano 2010), postponing a significant part of the investments to the second half of the concession period (2018 - 2027). In 2013, MM is proposing to the ATO Città di Milano to adopt a new revision of the Piano d'ambito (ATO Città di Milano 2013) which would modify once again the investment plan. Total figures of the three versions of the investment plan are summarised in

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<sup>50</sup>Just prior to the referendum, the decree 70/2011 had created the *Agenzia nazionale per la regolazione e la vigilanza in materia di acqua*, which was never effectively in operation.

<sup>51</sup>Decretolegge 6 dicembre 2011 n°201 enforced with the Legge 6 dicembre 2011 n°214

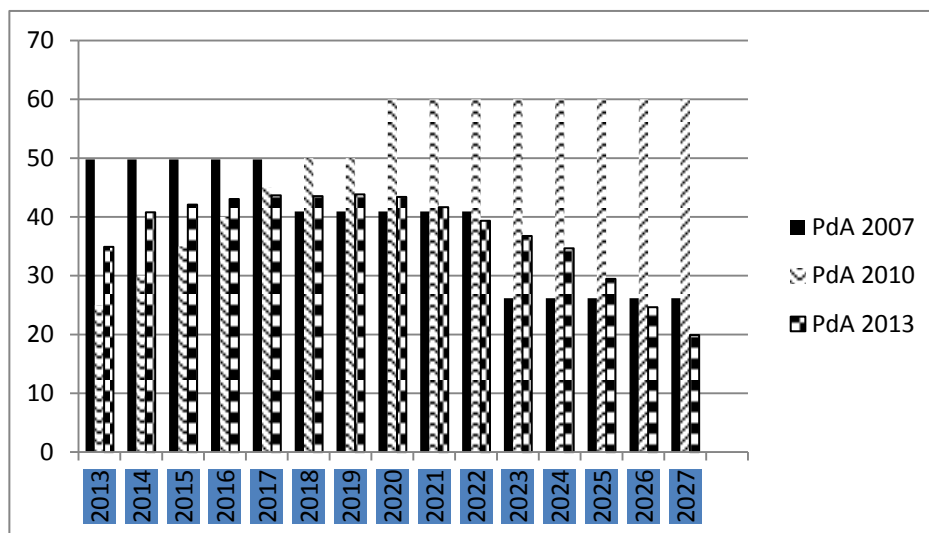
<sup>52</sup> The *piano d'ambito* (ATO Città di Milano 2007) was approved by the ATO on the 3/08/07 after the municipal council approval on the 26/07/07.

<sup>53</sup>The *Legge 23/12/2000 n°388* (Finanziaria) had made it compulsory to draft a *Piano stralcio* in order to fix the investment's rhythm concerning the sanitation part of the water cycle.

Figure 24 and more details are given in Appendix 4. The 2013 revision proposal of the Piano d'ambito is based on a very different investment plan for 2013-2027. Major differences with the PdA 2010 consist of:

- 153.5 M euros less investments as a whole than in the PdA 2010
- A more “reasonable” and “realistic” investment plan based on the idea that MM and Milan’s urban system cannot implement more than 40 M euros of investment per year (due to the risk of congestion and to the contracting out process). As a consequence,
- More investments in the years 2013-2016 than in the previous version
- Less investments in the years 2017-2027
- Many investment savings are justified on a better technological choices basis (No-dig techniques, better chosen investments in waste water treatment plant)

Figure 24 Yearly investments in Milan's WSS according to various versions of the investment plan



Source : author's elaboration based on data from Massarutto 2011 and PdA 2013

Massarutto and Ermano (2013) have pointed out that one of the major weaknesses of the Italian regulatory setting is the subjectivity left to the AATOs for the revision of the ATO's investment plan and their lack of capability to correctly implement such a regulatory process. Indeed in Milan, investments amounts were progressively curbed down in order not to increase the water tariff.

In other words, the switch to an industrial cost recovery business model implemented by a corporatised entity succeeded only partially in unlocking the underinvestment vicious circle since the local regulator is reluctant to approve a water tariff increase and make the investment plant bankable (Anwandter and Rubino 2006).

#### C.4.6. Borrowing constraints

Water and sanitation services are concerned not only with formal regulation of the water sector but might also be constrained by other external factors. In particular from our perspective, the borrowing constraints faced by Italian WSS are a key issue in a phase where they have huge investment needs.

For decades, investments in WSS in Italy (and Milan) were undertaken by municipalities. The WSS's budget was not clearly distinct from the global municipal one. Debt<sup>54</sup> issued to finance WSS investments was considered as municipal debt to all means. Nowadays Italian WSS have been privatised (Section C.4.5) and are provided by joint stock companies. Some of these such as Metropolitana Milanese are fully municipally owned. To what extent is debt issued by those public entities accounted for as sub-sovereign debt and in fine as sovereign debt? Furthermore, in a normative view, should such a debt be considered as sub-sovereign debt?

In Italy, an Internal Stability Pact<sup>55</sup> was approved by law in 1998 (Legge 448/1998) to make the local public authorities (in particular the municipalities) to contribute to the goals of the European Stability and Growth pact (SGP) in terms of the percentage of consolidated sovereign debt / GDP (Fraschini 2002, 177). Such an internal stability pact is seen as a major constraint on Italian municipalities' autonomy and is presently criticised for constraining public investments and slowing down the economic recovery.

<sup>54</sup> Debt was subscribed at concessional rates with public lending entities such as the *Cassa Depositi e Prestiti*. More details on these aspects are given in another working paper (Crespi Reghizzi 2013).

<sup>55</sup> Not all European countries chose to approve an internal stability pact in order to apply the European agreement. For example France did not create such a tool.

However according to the EU legislation, WSS's debt should not be considered as sub-sovereign debt. Indeed the European legislation (Council Regulation n°2223/96 – SEC95) established that “market” public enterprises with a tariff covering at least 50% of the total costs, should not be included in national public accounting<sup>56</sup> used for yearly reports to EU institutions in the framework of the European growth and stability pact (SGP).

Italy follows a twofold approach: although it obviously complies with EU guidelines for computing national public debt, the government also requires (decree n°1/2012) the local public companies owned by local public entities providing “in-house” services (such as WSS's), to fulfill the internal stability pact previously applied to local public authorities only. One of the ideas behind such a decree was that local public authorities were by definition guarantors of those local public companies' debt in case of financial imbalance (Corte dei Conti 2012). Until now the constraint deriving from the decree n°1/2012 has not been implemented yet since no implementation ministerial decree has been published yet. It seems that a second stability pact to be applied to fully publicly owned companies could be created in addition to the existing one which applies to local authorities<sup>57</sup>.

An argument in favour of the privatisation of Italian WSS was that privatised WSS would be more autonomous from the municipal administration. From our perspective, considering their debt as sub-sovereign raises a striking paradox. It is agreed by most experts that the tariff level of Italian WSS does not allow a high level of self-financing for investments. If their access to debt is constrained too, the critical underinvestment in WSS infrastructure is not going to diminish. It is clear that both their economic and environmental sustainability goals will not be met if their access to debt is limited. Indeed how will the infrastructure capital be reproduced? How will the huge investments to restore the good ecological status in rivers be undertaken (as required by EU directives)?

Capital expenditures and investments are a key pattern in the water and sanitation service. One of the weakest point of the implementation of the Galli reform in Italy was that the investment plans (Piani d'ambito) were too ambitious and often not “bankable”. Things got even worse after the 2011 referendum due to the regulatory uncertainty it created. The new tariff methodology implemented by AEEG should help to restore the bankability of the Italian water sector.

However all efforts made by AEEG will be useless if the Damocles sword of an effective deployment of a Internal Stability Pact to constrain the debt of publicly owned companies will not be neutralised. Indeed, the low tariff level of Italian WSS does not allow an elevated level of self-financing of the planned investments. If their access to debt was to be constrained by the Internal Stability Pact, Italian WSS would be condemned to stay in the under-investment status in which they have been for the last decade. Their sustainability would be challenged even more.

#### C.4.7. Conclusions

Milan's Water and Sanitation Service (WSS) in the second half of the 20<sup>th</sup> century might be pointed out as a paradigmatic example of public policy failure in the water sector when considering the decades of postponed investments both in drinking water treatment and waste water treatment plants which were brought to completion (in 1994 and 2005) only thanks to the tight pressure put on Milan's municipality by EU directives and national legislation. In both stories, investments were in fine undertaken in a rush within an “emergency procedure” framework.

More generally speaking, after WWII, Milan's water and sanitation service was still operated under direct municipal provision. In those decades, Milan's municipality, like many other Italian municipalities, kept under-investing in water and sanitation infrastructure since other investments were more visible.

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<sup>56</sup>National public accounting made by ISTAT in Italy or by INSEE in France apply such a definition and does not include debt of Water and Sanitation services within national public debt.

<sup>57</sup> Press article of Gianni Trovati on *Il Sole 24 Ore* on the 30/01/2013 and 04/02/2013.

In the 1990's and early 2000's, national legislation (the Legge Galli in 1994) imposed a corporatisation of the water and sanitation service. To comply with these legislations, Milan's WSS was corporatised and transferred to a fully municipally owned joint stock company, Metropolitana Milanese SpA, which fully recovers its costs (including investment costs) through tariff revenues. The switch to an industrial cost recovery business model implemented by a corporatised entity succeeded only partially in unlocking the underinvestment vicious circle since the local regulator is tempted to curb down the investment plans in order to keep a low water tariff.

The new national regulator (AEEG) should help to restore the bankability of the Italian water sector. However all efforts made by AEEG will be useless if the Damocles sword of an effective deployment of a Internal Stability Pact to constrain the debt of publicly owned companies will not be neutralised.

#### C.4.8. References

AEEG. (2012), "Consultazione pubblica per l'adozione di provvedimenti tariffari in materia di servizi idrici - documento per la consultazione 204/2012/R/IDR."

Anwandter, Lars, and Piero Rubino (2006), "Risks, Uncertainties and Conflicts of Interest in the Italian Water Sector: A Review and Proposals for Reform". Materiali UVAL - Analisi e Studi. <http://www.dps.mef.gov.it/materialiuval>.

ATO Città di Milano (2007) "Piano d'ambito dell'ATO Città di Milano." <http://www.atocittadimilano.it/default.asp?pag=23&tipo=9>.

ATO Città di Milano (2010) "Primo aggiornamento - Piano d'ambito dell'ATO Città di Milano." <http://www.atocittadimilano.it/default.asp?pag=23&tipo=9>

ATO Città di Milano (2013) "Aggiornamento - Piano d'ambito dell'ATO Città di Milano." <http://www.atocittadimilano.it/default.asp?pag=23&tipo=9>.

Corte dei Conti (2012) "Rapporto 2012 sul coordinamento della finanza pubblica."

Crespi Reghizzi, Olivier. forthcoming. "Providing and Financing a Municipal Infrastructure: a Long Run Analysis of Water and Sanitation Investments in Milan (1888-2000)."

Crespi Reghizzi, Olivier (2013) "Providing and Financing a Municipal Infrastructure: a Long Run Analysis of Water and Sanitation Investments in Milan (1888-2000)." In Venice: CESIFO Summer Institute.

Lobina, Emanuele, and Vania Paccagnan (2005) "D33 Water Time Case Study - Milan". Water Time. [www.watertime.net](http://www.watertime.net).

Massarutto, Antonio (1993) *Economia del ciclo dell'acqua: regolamentazione ambientale ed economica nei servizi pubblici*. F. Angeli.

Massarutto, Antonio, Barbara Antonioli, Monica Monacina, Paolo Ermano, and Matteo Graffi (2012) "La riforma della regolazione dei servizi idrici in Italia - L'impatto della riforma: 1994-2011". IEFE - Università Bocconi. <http://www.iefef.unibocconi.it>.

Massarutto, Antonio, Anna Basoni, Alessandro de Carli, Elisabetta Linares, Alessandro Lodi, and Vania Paccagnan (2006) "Il sistema di depurazione di Milano dall'emergenza alla sostenibilità". IEFE - Università Bocconi.

Massarutto, Antonio, and Paolo Ermano (2013) "Drowned in an Inch of Water: How Poor Regulation Has Weakened the Italian Water Reform." *Water Utility Regulation in Developed Countries* 24 (0) (March): 20-31. doi:10.1016/j.jup.2012.09.004.

Muraro, Gilberto, and Paola Valbonesi (2003) *I servizi idrici tra mercato e regole*. Roma: Carocci.

## C.5. Wetsus Desalination technology providers

Author: Pieter Tuytens

Key words: desalination technology innovation, desalination of seawater or brackish water, brine discharge, environmental regulation, Netherlands, Wetsus, Oasis, Vitens

Key messages of the study:

- Innovation in desalination technology is only indirectly driven by regulation. The environmental and consumer protection regulations have the most impact. European and national regulations act as both a driver and a barrier.
- Regulation is reported to act as a driver at the early phases of the innovation process (R&D and pre-implementation phase). Increasingly strict environmental regulation requires firms to develop new innovative solutions (i.e. compliance innovation).
- At later stages of the innovation process (testing and demonstration phase), regulation also hinders innovation. In most cases, it concerns regulation related to discharging brine.
  - On a national level, an overly complex regulatory framework is responsible for long procedures to obtain permissions and creates legal uncertainty. This diverts resources and delays testing of new technologies.
  - On a European level, regulation that is not adjusted to desalination technology can create unnecessary compliance costs.
  - European and national regulation is not always perfectly adjusted – for example with respect to the conditions to obtain exemption for discharging brine. This requires efforts at national level but also stronger guidance at European level.

### C.5.1. Introduction

On a global level, water scarcity emerges when there are imbalances between fresh water availability and demand<sup>58</sup>. Water demand is increasing as a result of an exponential growth of the population in areas that are considered 'dry', as well as an increase in individual demand and demand caused by industrialisation and excessive use for agriculture. At the same time, fresh water resources are decreasing. This is due to dropping levels of ground water, the intrusion of salt water, the emptying of non-regenerative ground water reservoirs and the pollution of surface water.

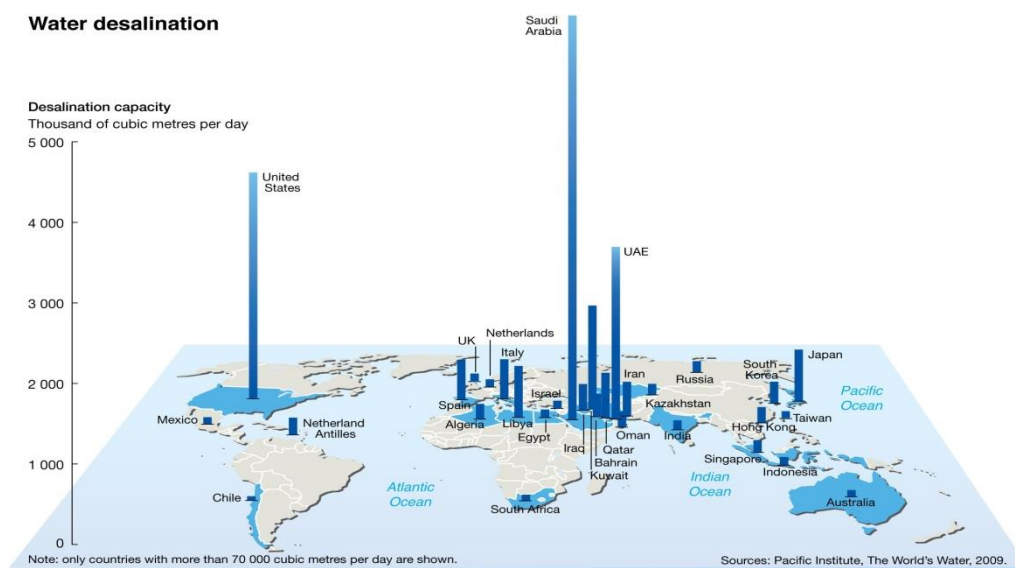
To face the current and future demands for fresh water and water re-use, the sustainable desalination of seawater, groundwater and wastewater is required. In this context, the desalination of seawater or brackish water can be an important technology to decrease water scarcity. Low energy use and avoidance of harmful chemical discharge are further demands from sustainable desalination.

The general advantages of desalination include that seawater is an 'unlimited' source with many large cities located next to the sea. For some countries it is the only access to fresh water. Finally, it can prevent further migration from the country site (countryside?) by reducing fresh water scarcity.

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<sup>58</sup> [http://ec.europa.eu/dgs/jrc/downloads/jrc\\_aaas2011\\_energy\\_water\\_koschikowski.pdf](http://ec.europa.eu/dgs/jrc/downloads/jrc_aaas2011_energy_water_koschikowski.pdf)

Figure 25 Water desalination capacities in different countries



Source: [http://www.grida.no/graphicslib/detail/water-desalination\\_11e4#](http://www.grida.no/graphicslib/detail/water-desalination_11e4#)

On a European level, desalination is mentioned within the European “Droughts and Water Scarcity” strategy<sup>59</sup>. Water supply infrastructures can be set up as a solution, as long as all prevention solutions, water saving and water efficiency measures have been implemented. Furthermore, the impact on the environment should be minimised as much as possible.

Today, Europe accounts for 10% of the world’s desalination capacity – the Middle East is the global leader, with 70% of capacity – and Spain’s production doubled in the last decade. There are some 180 European companies involved in the manufacture and supply of plants and technology<sup>60</sup>.

### C.5.2. Challenges to the development of the desalination technologies

Several factors (mainly related to economic, environmental or other social concerns) create a number of challenges to the development of desalination technology<sup>61</sup>. First, desalination is an energy-intensive process. Besides the environmental impact, increasing energy prices also increase the input cost and hence the price of the end product. Secondly, the process of desalination separates the low-salinity product water from a very saline concentrate called brine. Brine also often contains substances such as chloride, metalloids and metals. Accordingly, the discharge of brine is problematic when it has an effect on the environment and bio-systems. Thirdly, the investment and operation costs of desalination are very high. Especially in difficult locations (e.g. very remote areas, urban areas with limited space, or when a decent water grid is lacking) where this can hamper the development and diffusion of desalination technology.

These challenges are also the main drivers behind the direction of the technological development of desalination<sup>62</sup>. First, several projects aim at increasing the energy efficiency of desalination (through improving components or devising new technologies), or try to partially or fully integrate desalination plants with renewable energy (e.g. solar-based desalination within the ADIRA project<sup>63</sup>). Secondly, other projects try to remove ions without chemicals or focus on brine management. Thirdly, new solutions are developed to prepare desalination for location-specific challenges (for example, mobile desalination plants for rural areas or modular plants in rural areas with limited space).

<sup>59</sup>[http://europa.eu/legislation\\_summaries/environment/water\\_protection\\_management/l28196\\_en.htm](http://europa.eu/legislation_summaries/environment/water_protection_management/l28196_en.htm)

<sup>60</sup> <http://www.euractiv.com/specialreport-delivering-water-2/desalination-solving-water-probl-news-512771>

<sup>61</sup> [http://ec.europa.eu/dgs/jrc/downloads/jrc\\_aaas2011\\_energy\\_water\\_koschikowski.pdf](http://ec.europa.eu/dgs/jrc/downloads/jrc_aaas2011_energy_water_koschikowski.pdf)

<sup>62</sup> [http://www.wipo.int/export/sites/www/freepublications/en/patents/948/wipo\\_pub\\_948\\_2.pdf](http://www.wipo.int/export/sites/www/freepublications/en/patents/948/wipo_pub_948_2.pdf)

<sup>63</sup> <http://smap.ew.eea.europa.eu/fo1120392/prj929532/>



### C.5.3. Desalination technologies in the Netherlands

Desalination needs in the Netherlands stem from the growing problem of coastal saltwater intrusion caused by the depletion of fresh groundwater as well as by increasing inland brackish surface and groundwater. This problem is experienced in agriculture and the municipal water supply. On the other hand, the industry is increasingly seeing a strong financial incentive to reduce industrial water use, while many solutions require desalination.

In the Netherlands, desalination is not explicitly mentioned within the “Deltaprogramma Deelprogramma Zoet Water”<sup>64</sup> – aimed at preserving the long-term supply of fresh water – yet fits within its objectives. One of the major water companies, Oasen<sup>65</sup>, has started developing desalination technologies in order to prepare for the effects on climate change in the Netherlands. A rising sea level is expected to increase the intrusion in the mouth of main rivers such as the Rhine, reaching the water sources. As a consequence, the level of salinity might increase to an extent that current water treatment technologies do not suffice, given the high quality requirements.

New research and developments are facilitated at Wetsus, the Dutch cross-institutional organisation and one of the Technological Top Institutes (TTI)<sup>66</sup> (Dutch: Technologisch topinstituut). It is the centre of excellence for sustainable water technology, which among other things focuses on the development of the desalination of seawater, brackish/fresh water and wastewater<sup>67</sup>. Several new approaches based on various know-how disciplines are being studied by Wetsus. Fields like electrochemistry, crystallisation, membrane separation and absorption are combined in the research projects.

As these developments are still at an early phase (R&D), the case study will also consider two projects that are already at a further stage of development (demonstration and early implementation). Both are improvements developed by the water companies Vitens and Oasen, based on the more established technology of reversed osmosis.

### C.5.4. EU and Dutch regulations related to desalination technologies

This section will discuss the impact of regulation on the development of desalination technology, within the broader setting that has been outlined. First, the main European and national regulations that are relevant for desalination technology will be introduced shortly. Secondly, an outline will be given of how these regulations can influence innovation. This will be discussed in more detail in the following section.

#### **Short overview of the relevant regulation**

The main European regulations that are relevant for desalination technology include the Water Framework Directive (WFD)<sup>68</sup>, the Drinking Water Directive<sup>69</sup>, the Priority Substances Directive<sup>70</sup> and the Groundwater Directive<sup>71</sup>.

The WFD states that all water bodies used for human drinking water must be identified, analysed for contaminants and regularly monitored. Additionally they must comply with the EU Drinking Water Directive. Also the other Directives provide minimum quality standards for water, both regarding environmental and human health.

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<sup>64</sup><http://www.rijksoverheid.nl/onderwerpen/deltaprogramma/deelprogramma-s/deelprogramma-zoetwater>

<sup>65</sup> <http://www.oasen.nl/drinkwater-maken/Paginas/klimaatverandering-Artikel.aspx>

<sup>66</sup> Technological Top Institutes (TTI) (Dutch: Technologisch topinstituut) in the Netherlands. is a special type of research institute at a Dutch research university. A TTI carries out scientific research in areas that: [1] have been designated to be of key importance to the Netherlands by the Dutch government; and that [2] is subject to such industry interest that it can be funded by public-private partnership agreements.

<sup>67</sup> [www.wetsus.nl](http://www.wetsus.nl)

<sup>68</sup> <http://ec.europa.eu/environment/water/water-framework/> (Directive 2000/60/EC <<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:NOT>> )

<sup>69</sup> [http://ec.europa.eu/environment/water/water-drink/legislation\\_en.html](http://ec.europa.eu/environment/water/water-drink/legislation_en.html) (Directive 98/83/EC <<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31998L0083:EN:NOT>> )

<sup>70</sup> [http://ec.europa.eu/environment/water/water-dangersub/pri\\_substances.htm](http://ec.europa.eu/environment/water/water-dangersub/pri_substances.htm) (Directive on Environmental Quality Standards (Directive 2008/105/EC) <[http://ec.europa.eu/environment/water/water-dangersub/pri\\_substances.htm#dir\\_prior](http://ec.europa.eu/environment/water/water-dangersub/pri_substances.htm#dir_prior)> )

<sup>71</sup> <http://ec.europa.eu/environment/water/water-framework/groundwater/framework.htm> (2006/118/EC) <<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32006L0118:EN:NOT>> )

In the Netherlands, the WFD is transposed by the national Government. Issues that need to be addressed on a national level include basic monitoring principles and the criteria for denominating the various types of water bodies. The State Secretary of Infrastructure and Environment is responsible for the implementation and a National Basin Area Coordinator has been appointed for coordinating the drafting of the basin area management plans. As far as possible, however, decisions are made in close cooperation with other relevant ministries, provinces, water boards and municipalities. (Helpdeskwater.nl<sup>72</sup>; Gibbons, Papapetrou and Epp, 2008). For each basin area, the regional directorate of the water management ministry, provinces, water boards and municipalities have partial responsibility for water issues and must closely cooperate in drawing up the management plans as well as executing the programme of measures contained in these plans.

Next to the transposition of these EU Directives, a number of national regulations in the Netherlands are relevant for desalination:

- Waterwet (Water Act)<sup>73</sup>
- Mijnbouwwet (Mining Act)<sup>74</sup>
- Wet Milieubeheer (Environmental Management Act)<sup>75</sup>
- Wet algemene bepalingen omgevingsrecht (General Provisions Environmental Law, Wabo)<sup>76</sup>
- Lozingenbesluit Bodembescherming (Discharge Decree Soil Protection, until January 1, 2013)<sup>77</sup>, followed by the Besluit algemene regels voor inrichtingen voor milieubeheer (Decree on general regulations for environmental (the environment?))<sup>78</sup>

The most important regulation is the “Waterwet”, as it brings together eight older laws into one and arranges the governance of ground and surface water, as well as the coherence between water policy and spatial planning. It provides rules and standards regarding water quality and (quantity?) – based on the European Directives. The “Wet Milieubeheer” provides quality standards for the protection of drinking water sources. While the central government provides the general objectives, it is the provincial level which is responsible for realising these objectives. The Lozingenbesluit provides the legal basis for policy on discharging brine. Also this is used to implement the WFD and the Ground Water Directive. The Mijnbouwwet is relevant insofar as it regulates underground water discharging below 100m.

#### C.5.5. Regulatory barriers and drivers in the development of desalination technology

As indicated earlier, all relevant regulations belong to the family of environmental regulations (following the classification of OECD / Blind, 2012). This does not mean that economic and/or institutional regulations are not important for desalination technology. It merely reflects the fact that both written sources and interviewees indicate that the most direct impact stems from these environmental regulations.

Environmental regulations can be both a driver of and a barrier for innovation (Blind, 2012). It works as a driver when it enables better performing players to enter the market. While adapting to stricter requirements might be challenging in the beginning, it can lead to improved competitiveness in the longer term. However, environmental regulations can also work as a barrier. For example when they cause additional compliance costs or restrict companies in their innovative activities. This can impact on their competitiveness and consequently on their capability to innovate.

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<sup>72</sup><http://www.helpdeskwater.nl/algemene-onderdelen/serviceblok/english/legislation/eu-water-framework/>

<sup>73</sup> <http://www.helpdeskwater.nl/onderwerpen/wetgeving-beleid/waterwet>

<sup>74</sup> [http://wetten.overheid.nl/BWBR0014168/geldigheidsdatum\\_11-07-2013](http://wetten.overheid.nl/BWBR0014168/geldigheidsdatum_11-07-2013)

<sup>75</sup> [http://wetten.overheid.nl/BWBR0003245/geldigheidsdatum\\_11-07-2013](http://wetten.overheid.nl/BWBR0003245/geldigheidsdatum_11-07-2013)

<sup>76</sup> [http://wetten.overheid.nl/BWBR0024779/geldigheidsdatum\\_11-07-2013](http://wetten.overheid.nl/BWBR0024779/geldigheidsdatum_11-07-2013)

<sup>77</sup> [http://wetten.overheid.nl/BWBR0009092/geldigheidsdatum\\_11-07-2013](http://wetten.overheid.nl/BWBR0009092/geldigheidsdatum_11-07-2013)

<sup>78</sup> [http://wetten.overheid.nl/BWBR0022762/volledig/geldigheidsdatum\\_11-07-2013](http://wetten.overheid.nl/BWBR0022762/volledig/geldigheidsdatum_11-07-2013)

Also with respect to desalination, regulation works both as a driver and a barrier. There are three different ways in which to discern how regulation has an impact. Firstly, stricter water quality standards require companies to invest in better technologies in order to comply, hence working as a driver. Secondly, regulation concerning brine disposal can create direct barriers for certain technological improvements. Thirdly, maladjusted regulation can require useless monitoring requirements and hence increase compliance costs. Each of the cases are discussed below:

#### C.5.6. Water quality requirements and compliance innovation

Stricter quality requirements with respect to drinking water or groundwater may require companies to improve their technologies in order to comply with this regulation. One researcher at Wetsus explains that their research is very much demand-driven: water companies are confronted with new regulations (such as the Water Framework Directive or the Lozingenbesluit) and turn to researchers at Wetsus to develop solutions to reduce the level of chemicals or salt. Accordingly, this is a clear case of compliance innovation. Indirectly, higher quality standards for drinking water can raise the price or reduce the availability of freshwater. This also raises a longer-term interest in desalination.

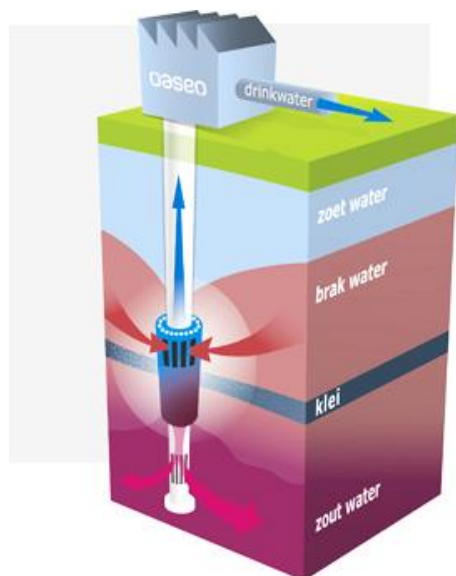
Research at Wetsus focuses on the early phases of development (both R&D and pre-implementation) and can be both incremental and radical. At this stage, another Wetsus (director? interviewee?) notes that regulation does not yet form a barrier. However, the hampering impact of regulation does become visible at later stages of the innovation process.

#### C.5.7. Brine discharge regulation as a barrier to innovation

The Water Framework Directive contains objectives that need to be transposed in European and national standards regarding water quality and quantity. If these requirements are not met, a member state needs to take action or request an exception to the general objectives that allow for less stringent objectives, an extension of the deadline beyond 2015, or the implementation of new projects, providing a set of conditions are fulfilled.

Also the discharge of brine is regulated, both as a consequence of European and of national requirements. The Water Framework Directive names substances that are often present in brine (e.g. chloride, metalloids and metals) and the Priority Substances Directive and Groundwater Directive require that brine disposal needs to be limited if not completely prevented when they contain certain substances. In the Netherlands, brine disposal has been tolerated until 2013. However, both underground water extraction and discharging requires permission according to the 'Waterwet' and 'Wet Milieubeheer' (responsibility for permissions are delegated to the provinces). Furthermore, if brine is discharged at a depth more than 100m, permission is also needed on the basis of the 'Mijnbouwwet' and 'Wet algemene bepalingen omgevingsrecht' (responsibility for permissions is still at the level of the Ministry of Economic Affairs).

Figure 26 Visual representation of the PURO project by Oasen



Source: Technopolis Group

Obtaining these permissions has created obstacles to testing new innovative technologies. One example is the PURO project<sup>79</sup>, developed by the water company Oasen, which aims to increase energy efficiency by performing the Reversed Osmosis process under the ground<sup>80</sup>. Brackish water is immediately filtered at the level of extraction and brine is diverted to an even deeper level that is already saline and separated from the brackish level by a clay layer (see figure below for a visual representation).

One way in which regulation hampers progress is by increasing compliance costs as a result of overly complex procedures. As the PURO project also involves discharging at a depth of more than 100m, it also requires permissions from the national level according to the 'Mijnbouwwet'. As it is formally treated as an oil-treating company, the whole procedure requires many unnecessary steps. This prolongs the process of obtaining permissions (adding 1.5 years), increases legal uncertainty about whether the project will be viable and diverts resources from other activities. Accordingly, overly complex regulation increases compliance costs and consumes valuable time from the innovation process. While Oasen is used as an example, the same legal considerations also count for other water companies such as Vitens<sup>81</sup>. A group of Dutch water companies (including Oasen, Vitens, Brabant Water and the professional organisation Vewin) intends to make an effort to simplify this regulation.

A second way in which regulation is hampering results is the fact that Dutch and European regulations are not completely adjusted<sup>82</sup>. As discharging of brine should be limited or prevented, permission is required for each individual case. Both the European legislation (Water Framework Directive and Groundwater Directive) and the Dutch legislation provide possibilities to permit brine disposal. However, the conditions for this exception are not fully adjusted. This creates regulatory uncertainty and hence a barrier to innovation. This calls for efforts at national level to design clear and unequivocal regulation concerning brine disposal. However, Pelamonia and Keessen (2013) warn that a lack of guidance from the EU creates the risk that the discharging of desalination plants remains unregulated.

<sup>79</sup> <http://www.oasen.nl/drinkwater-maken/Paginas/Oasen-start-procedures-voor-PURO-project-aanvraag-vergunning-volgens-Mijnbouwwetgeving-Artikel.aspx>

<sup>80</sup> While Oasen is used as an example, the same legal considerations also count for other water companies such as Vitens ([www.vitens.nl](http://www.vitens.nl))

<sup>81</sup> <http://www.vitens.nl/overvitens/water/Documents/Ontzilting%20brak%20water%20Noordburgum%20Leaflet%2028okt09.pdf>

<sup>82</sup> see results from Pelamonia and Keessen (2011) on <http://www.oasen.nl/Lists/Downloads/Pres-PURO-bijeenkomst-UU-Brijnlozing-door-drinkwatersector.pdf>

### C.5.8. Barriers resulting from maladjusted European regulation

In their assessment of the implication of EU policy for the implementation of autonomous desalination units, Gibbons, Papapetrou and Epp (2008) conclude that EU policies create both support and barriers. Support stems from the EU Water Initiative but also from the Water Framework Directive as it is supportive of desalination technology by taking a relatively permissive approach to brine disposal. However, barriers exist because desalination has not been “taken into account by the decision makers when the policies were developed”, especially for small autonomous desalination systems (Gibbons et al, 2008, p.429).

Developers of autonomous desalination systems have to comply with unnecessarily strict regulations that apply to all drinking water supplies. The Water Framework Directive states that all water bodies used for human drinking water must be identified, analysed and regularly monitored. To ease implementation, small abstractions of water are exempt from some requirements of the Directive. It is, however, not clear whether the set amounts refer to water abstracted or water provided (which differs greatly with desalination) and how ‘water bodies’ are practically defined. By now, these issues are most likely resolved by the Common Implementation Strategy guidance initiative<sup>83</sup>. Another issue is that most chemical and all biological monitoring requirements of source water should be exempted in the case of desalination – this is because its sources are in any case inherently unfit for human consumption. This exemption could be a significant cost saver, especially for smaller autonomous desalination systems.

### C.5.9. Conclusion

As shown in the case of the Netherlands, the innovation in desalination technology is only indirectly driven by regulation. Environmental regulation and the regulation with respect to consumer protection has most impact. European and national regulations, depending on the case, act both as a driver and a barrier.

Regulation is reported to act as a driver at the early phases of the innovation process (R&D and pre-implementation phase). Increasingly strict environmental regulation requires firms to develop new innovative solutions (i.e. compliance innovation).

At later stages of the innovation process (testing and demonstration phase), regulation also hinders innovation. In most cases, it concerns regulation related to discharging brine. Obtaining permissions for underground water extraction and discharging (of brine) has created obstacles to testing new innovative technologies.

On a national level, an overly complex regulatory framework is responsible for long procedures to obtain permissions and creates legal uncertainty. This diverts resources and delays testing of new technologies.

On a European level, regulation that is not adjusted to desalination technology can create unnecessary compliance costs.

European and national regulation is not always perfectly adjusted – for example with respect to the conditions to obtain exemption for discharging brine. This requires efforts at national level but also stronger guidance at European level.

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<sup>83</sup> [http://ec.europa.eu/environment/water/water-framework/objectives/implementation\\_en.htm](http://ec.europa.eu/environment/water/water-framework/objectives/implementation_en.htm)

#### C.5.10. References

Gibbons, J., Papapetrou, M. and Epp, C. (2008). "Assessment of EU Policy: Implications for the implementation of autonomous desalination units powered by renewable resources in the Mediterranean region" in *Desalination* (220), pp.422-430.

Pelamonia, J. and Keesen A.M. (2013). "Adaptatie aan klimaatverandering: de regulering van ontziltingsinstallaties ten behoeve van zoetwatervoorziening" in *H2O Vakblad*.

Interviews:

Martijn Bijmans (Wetsus) and Pieter de Jong (Wetsus).

## C.6. The Strategic Flood Map in Northern Ireland

Author: Johanna Castel

Key words: GIS, Protection, Prevention, Preparedness, Resilience, Surface water flooding

Key messages of the study:

- Northern Ireland was one of the first regions to transpose the EU Flood directive (2009).
- Previous Water Environment Regulations had been in place since 2003. .
- In the UK, response to flooding is a competence at regional level .
- The regulations requires a detailed flood mapping; implementation, however, is flexible.

Innovative aspects of the map:

- Interactive and user-friendly format; development of publicly available guidance notes. The map encourages a more proactive approach to flood risk management. It is the only region in the UK where such a map is publicly available (which is not a requirement of the regulation).
- Technology developed: J-Flow. This software was a finalist for an innovation award An innovative aspect is the use of a graphic card. Overall, it is a graphic-driven programme.
- Wider use: planning authorities use it in their land use decisions, insurance companies for their business.
- The flagship feature of the map is its surface water flood map. In December 2013, new features will be developed (for river flood, more details on flood depth, etc.).

The impact of the regulation on the development of this strategic flood map was judged positive (David Porter, for Rivers Agency)

### C.6.1. Introduction

The Strategic Flood Map is a web-based GIS solution developed by the Rivers Agency in Northern Ireland, the statutory authority for flood management and the lead authority for the transposition of the EU flood directive in the country<sup>84</sup>.

The context for the development of the map is, among others, the requirements of the EU Flood Directive. According to a 2010 paper, the first generation model of the map was “designed to inform the Preliminary Flood Risk Assessment as required by Article 4 of the Floods Directive (2007/60/EC)”<sup>85</sup>.

Developed in 2008, this geospatial technology designed by private companies (RPS Consulting Engineers, JBA and ESRI, an IT provider in charge of designing and hosting the solution which specialised in the application of geographical information systems<sup>86</sup>) won the Northern Ireland Area Water Innovation award in 2012 for its very innovative features. The strategic flood map is composed of four different data sets: historical maps, present day maps, climate change maps (previsions until 2030) and a flood defence map.

Northern Ireland is traditionally strongly impacted by flooding and has developed various measures, strategies and processes for sound flood response. The risk of flooding in Northern Ireland is quite high and it has very serious impacts, particularly in rural areas of the country.

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<sup>84</sup>The Strategic Flood Map of Northern Ireland: <https://mapping.dardni.gov.uk/strategicFloodMap/index.aspx>

<sup>85</sup><http://www.opw.ie/hydrology/data/speeches/07%20-%20Development%20of%20the%20surface%20water%20flood%20map%20for%20northern%20Ireland.pdf>

<sup>86</sup> <http://www.esri-ireland.ie/about>

Northern Ireland is a 13843km<sup>2</sup> country of 1.8 million inhabitants. It is divided in six counties: Antrim, Armagh, Derry, Down, Fermanagh and Tyrone and administered by 26 local councils. Lough Neagh, at the centre of the country, is one of the biggest lakes in the UK. There are also other lakes in Fermanagh country. Rivers complete this landscape. Rainfalls are particularly frequent in the country and it is regularly affected by flooding. An important number of properties are at flood risk close to rivers and the sea (46 000), reservoirs (36 000), and surface water (21 000).<sup>87</sup>

The latest floodings in Northern Ireland were the flash flooding across Greater Belfast in June 2012, the flooding in eastern and western regions in October 2011, the winter weather emergencies leading to water shortage in December 2010, severe flooding in County Fermanagh in November 2009 and in Belfast in August 2009, as well as flooding in Greater Belfast in August 2008<sup>88</sup>.

### C.6.2. Strategic Flood Map – Northern Ireland: Background

Northern Ireland was one of the first regions to transpose the EU Flood Directive 2007/60/EC on the assessment and management of flood risks. The Water Environment Regulations of Northern Ireland were adopted in 2009 and set the foundation for the implementation of the requirements set under the EU Flood Directive, such as the preparation of flood risk management plans and of flood hazard maps and flood risk maps. The planning policy statement 15 (PP15) regarding planning and flood risk is also an important policy document as it is binding for land use decisions. It is regularly reviewed (latest review from 2010), at the present time to better integrate the role of the Strategic Flood Map, a product innovation that will be further developed in this case but also to better understand surface water flooding and how to integrate this particular risk with decision making in land use. Public consultations will be held shortly after summer 2013. The PPS15 is the key policy mechanism for delivering adaptation actions in Northern Ireland. It contains four policy statements used by planning officers to guide their decisions. We can also put in perspective the PPS15 with the Regional Development Strategy 2025 for Northern Ireland and with which the PPS15 has to be in line.

Relating to the development of the Strategic Flood Map, Northern Ireland was the first region in the UK to build a strategy for the development of geographic information in 2003. A new strategy for 2009–2019 in this field was launched in 2009. This policy document highlights the importance of geographic information (GI) for enhancement of service delivery such as the rapid deployment of emergency services, states that GI is “an enabler and – with access to up to date and relevant data and information – it can be a powerful decision making tool within government”<sup>89</sup>. The strategy “aims to further an infrastructure to ensure effective use of locational information in Northern Ireland”, develop a clear governance and to enable Northern Ireland to become by 2019, “a spatially enabled society”<sup>90</sup>. According to the policy document still, “there are numerous European Directives that contain an element of coordinating the use of geographic information and the creation of European wide datasets, for example the Floods Directive (2007/60/EC) and the Water Framework Directive (2000/60/EC)”<sup>91</sup>.

Laws for flooding matters are devolved to countries in the UK. Although the Northern Ireland law is mostly based on the English Common Law, it also has some differences due to its status.

The Department of Agriculture and Rural Development (DARDNI) was designated as the competent authority of Northern Ireland for the implementation of the Directive. The Rivers agency is an executive agency of this department and acts as the statutory draining and flood defence authority in Northern Ireland (Drainage Order 1973). However, it is not the single lead authority with statutory responsibility for flooding. Along with the Rivers Agency, Northern Ireland Water and the Roads Service, it also holds responsibility in flooding management. Along with these three agencies, the Met Office of the national severe weather warning service and Northern Ireland directly support responses to emergencies.

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<sup>87</sup> <http://www.ice.org.uk/getattachment/6e63a3be-0c54-4e73-822e-b6c4dcedf4b0/Wales-Flooding-Conference-2011-Pat-Aldridge.aspx>

<sup>88</sup> <http://www.climatenorthernireland.org.uk/cmsfiles/resources/files/Cut-off-by-the-floods-report-2012.pdf>

<sup>89</sup> <http://www.gistrategy.gov.uk/>

<sup>90</sup> *ibidem*

<sup>91</sup> *ibidem*



Groups affected by the legislation are the general public through the need for better flood awareness, the public sector with the requirements set by the EU Floods Directive and transposed at the country level and finally private stakeholders with a strong interest and dependence on flood management, such as infrastructure operators or insurance companies.

The Northern Ireland legislation, according to the requirements set in the EU Flood Directive, requires the completion of the preliminary flood risk assessment by December 2011, flood risk and flood hazard maps for significant risk areas by December 2013 and flood risk management plans by 2015, with the goal of setting Northern Ireland objectives, measures and action plans for flood risk management<sup>92</sup>. The implementation of the EU directive is also connected with the country's programme for drainage and flood alleviation measures. However, innovation and its social and economic effects have not been part of the discussion around the implementation the Northern Ireland Water Environment Regulations. The main purpose of the Northern Ireland regulation is to enable the country to meet the requirements set by the EU directive and better respond to flood risk, following important floods in 2008 and 2009.

The transposition of the EU directive in Northern Ireland's legal background has several objectives. In order to meet them, the Directive and the Northern Ireland legislation aim to address flood risk on a catchment-wide scale; a catchment scale being an area drained by a watercourse. Draining involves drainage channels, floodplains, or estuaries and finally areas of water storage. As the Floods Directive requires consideration of flooding by various water sources such as rivers, seas or lakes but also reservoirs and surface water, Northern Ireland integrated a wide approach to its flood risk management. This integrated approach is embedded in the Strategic Flood Map that will be further analysed in this case study.

Table 13 Flood directive implementation timeframe

<b>Stage</b>	<b>Timeframe</b>
Northern Ireland legislation to implement the Directive	<i>December 2009</i>
Preliminary flood risk assessment (identify significant flood risk areas or SFRAs)	<i>December 2011</i>
Flood hazard and flood risk maps	<i>December 2013</i>
Risk management plans	<i>December 2015</i>

### C.6.3. Transposition of the EU Directive, basic elements

Under the EU Flood Directive and the requirement to undertake a preliminary flood risk assessment, the DARDNI has identified the areas in Northern Ireland which have the most significant flood risk, known as Significant Flood Risk Areas (SFRAs). These areas will be the focus for more detailed planning and mapping under the Strategic Flood Map. In line with the EU timeframe, a preliminary flood risk assessment was conducted and is publicly available online. Flood risk management plans are also in the making.

In order to comply with the EU Water Directive requirements, Northern Ireland classified its rivers and coastlines. The identification of three River Basin Districts resulted from this exercise. According to the DARDNI, the North Western and Neagh Bann are classified as International River Basin Districts as the catchments include areas within the Republic of Ireland: 'To help localise our assessment and the eventual output of the flood risk management plans, we have further broken down the River Basin Districts into six local plan areas', according to the DARDNI<sup>93</sup>.

DARDNI is responsible for areas within Northern Ireland but intends to coordinate its plans with the Office of Public Works in the Republic of Ireland; the Irish public authority in charge of implementing the EU Flood Directive.

<sup>92</sup> <http://www.dardni.gov.uk/index/rivers/european-floods-directive/managing-the-risk-of-flooding.htm>

<sup>93</sup> <http://www.dardni.gov.uk/index/rivers/european-floods-directive.htm>

#### C.6.4. Regulation

According to the Blind classification, the EU Flood Directive and its transposition in Northern Ireland through the Water Environment Regulations from 2009 are in line with social objectives. Social objectives encompass the environment, health and civil protection. These objectives are highly relevant in the case of flooding since it involves protection of the environment but also above all, civil protection and actions for health and help (economic help, poverty alleviation) of the affected population. Regulation with social objectives such as environmental regulation has several effects, both positive and negative. This type of regulation enables the creation of incentives for new eco-friendly products and processes by creating temporary market barriers. In terms of negative effects, according to Blind, these mostly involve compliance costs limiting R&D budget. Empirical evidence shows that this type of regulation has mainly positive impacts.

David Porter, Director of Development at the Rivers Agency, confirms that the regulation, mainly the EU Flood Directive and the Water Environment regulation, had positive effects and did not at all hamper the development of the Strategic Flood Map, to take this case as an example. As the regulation required the mapping of flood risk, it was mostly regarded as an encouraging innovation in this field. These regulations also have an institutional objective, especially for the Drainage Order from 1973 that set responsibilities for flood management and response.

The Water Environment regulation in Northern Ireland offers some flexibility in terms of implementation paths, although its requirements have to be respected. This is the case for example for flood risk management plans under the regulation, for which a general path has to be followed, leaving details of its design and implementation to the relevant implementing agencies.

According to the Water Environment regulation, “a flood risk management plan shall address all aspects of flood risk management focusing on prevention, protection, preparedness, emergency response, recovery and review including flood forecasts and early warning systems and take into account the characteristics of the particular river basin or sub-basin”<sup>94</sup>. The regulation also requires that flood risk management plans should be available to the public.

It is also interesting to note that although regulation influences the development of the Strategic Flood Map and its features, its implementation as well as the implementation of other flood risk management tools can also influence regulation. Debates are being conducted on the reshuffling of responsibilities within the DARDNI to better reflect roles, missions and to improve the implementation of the Strategic Flood Map. The PPS15 will also be reviewed to better integrate the Strategic Flood Map in land use decisions.

The development of the Strategic Flood Map led to debates on the need for a common or industry standard approach to risk, to reduce exposure and impact from flooding, especially from pluvial flooding but also to comply with the requirements of the EU Floods Directive<sup>95</sup>.

Requirements for flood hazard maps and flood risk maps under the Northern Ireland 2009 regulation<sup>96</sup> can be found in the box below. There is however no requirement to render it public, to include information on surface water flood nor to make it user-friendly and to widely diffuse it to various stakeholders.

According to the EU directive and Northern Ireland regulation, the preliminary flood risk assessment, flood maps and flood risk management plans will be reviewed and if necessary updated, every six years.

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<sup>94</sup> [http://www.legislation.gov.uk/nisr/2009/376/pdfs/nisr\\_20090376\\_en.pdf](http://www.legislation.gov.uk/nisr/2009/376/pdfs/nisr_20090376_en.pdf)

<sup>95</sup> <http://www.opw.ie/hydrology/data/speeches/07%20-%20Development%20of%20the%20surface%20water%20flood%20map%20for%20northern%20ireland.pdf>

<sup>96</sup> <http://www.legislation.gov.uk/nisr/2009/376/body/made>

### **Flood hazard maps**

11. —(1) Subject to paragraphs (2) and (3), a flood hazard map (or more than one such map taken together) shall show—

(a) The geographical areas which could be flooded according to the following scenarios—

- (i) Floods with a low probability (or extreme event scenarios);
- (ii) Floods with a medium probability (likely return period of 100 years or more) and
- (iii) Floods with a high probability and

(b) The following elements for each of those scenarios—

- (i) The flood extent;
- (ii) Water depths or water level, whichever is appropriate and
- (iii) Where appropriate, the flow velocity or the relevant water flow.

(2) But a flood hazard map need not show information referred to in paragraph (1) regarding a flood with a high probability where the Department considers such a flood would be unlikely to have significant adverse consequences for the area which could be flooded by it.

(3) The Department may decide that for a coastal area which, in its opinion, is adequately protected from coastal floods, the preparation of a flood hazard map (or more than one such map taken together) may be limited to the scenario referred to in paragraph (1)(a)(i).

### **Flood risk maps**

12. —(1) The potential adverse consequences associated with each flood scenario for which any information referred to in regulation 11(1) is shown in a flood hazard map shall be shown in a flood risk map (or more than one flood risk map taken together) by reference to the matters mentioned in paragraph (2).

(2) The matters are—

- (a) The indicative number of inhabitants who potentially could be affected;
- (b) The type of economic activity in the area which could be flooded;
- (c) Installations referred to in Annex 1 to Directive 2008/1/EC of the European Parliament and of the Council concerning integrated pollution prevention and control(a), which might cause accidental pollution if any flood scenario referred to in paragraph (1) occurred;
- (d) Protected areas which potentially could be affected if any flood scenario referred to in paragraph (1) occurred;
- (e) Any area which is within a protected area and could be affected by pollution from any installation referred to in sub-paragraph (c) and
- (f) Such other information as the Department considers useful including the indication of areas where floods with a high content of transported sediments or debris floods can occur and information on other significant sources of pollution.

(3) In this regulation “protected area” has the meaning assigned to it by regulation 8(2) of the 2003 Regulations.

## C.6.5. Innovation effects

Innovation effects of the regulation are multiple. They involve various stakeholders in flood risk protection, prevention and preparedness, from the general public for which crowd sourcing and inclusion of local communities in flood response is an innovative approach; the public sector involved in flooding response such as the Rivers agency, ministries that develop innovative approaches to flooding such as the Strategic Flood Map; finally the private stakeholders such as insurance companies that are affected by floods but also IT providers in the case of the Strategic Flood Map for which a public-private association was set up (under a call for tenders) to develop the Map that received an innovation award. In consequence and following various stakeholders and sectors involved, the types of innovations that can be seen and foreseen with this regulation are multiple, from product innovation to organisational innovation.

The Strategic Flood Map can be seen as both a product innovation and also as a service innovation, since it involved the introduction of a new service in 2008. Its version released in 2011 is significantly improved with respect to its characteristics and intended uses. The 2011 improvements concerned technical specifications, improvement and addition of functional characteristics to render it as user-friendly as possible.

In that case, innovation effects can be seen as incremental<sup>97</sup> rather than radical, in the sense that the EU Flood Directive is implemented in the EU countries. Since Northern Ireland has a long history of flood in addition to a long track record of building adequate flooding response, the capacity, resources and skills to deal with flood management are deeply enrooted in the country. The 2008 and 2009 floods reinforced this will to make sound flood management a priority policy in the country.

<sup>97</sup> . Characteristics of incremental innovations are that they are building on existing knowledge and resources, they are competence enhancing, there are relatively small changes in performances/utility and they are omnipresent.

To take the example of the map, an interview with a stakeholder at the Rivers Agency revealed that the map was designed following the design of similar maps in other countries of the EU. The Rivers Agency, however, decided to make this map public, which is a relatively rare aspect in other similar services developed in the EU countries. It is the first of its kind in the UK, where flood maps are not made public.

Regarding innovation process stages where the regulation shows effects, these are wide and could apply to every innovation developed following the regulation. The innovation process stages generally encompass the R&D stage, implementation/piloting and diffusion/wider application. These are all relevant in the case of the Strategic Flood Map since flood mapping is a requirement of the EU directive and needed strong reflexion on its design, implementation and diffusion. Although not included in the Northern Ireland regulation as such, the need to include information on surface water flooding is a strong political issue, taking into account the country's geological characteristics.

Innovative aspects of the map are that for the first time, it includes a surface water flood map. This novelty reflects the observation that surface water flooding is a significant source of flood risk. Surface water flooding is when water (from rain) does not drain through the normal drainage systems nor get absorbed into the ground. The water stagnates at the surface. Surface water flooding is dependent on ground levels, rainfall but also of the drainage network.

An interview with David Porter, Director of Development at the Rivers Agency, released in an ESRI communiqué, explains the innovative approach to managing floods in Northern Ireland. "Our approach to managing floods in the past and that of the whole flood defence industry, was mainly reactive—we simply dealt with flooding incidents as they occurred. We realised new technology enabled floodplains to be identified with a good degree of accuracy, and this enabled a more proactive approach to be taken whilst still maintaining a capability to react to actual flood events"<sup>98</sup>. The agency started to implement a wider range of measures as part of its flood risk management strategy, in consistency with the requirements of the EU directives in the field.

Apart from the innovative aspect of communities' inclusion, technical features of the map are also considered very innovative. JBA developed a model entitled JFlow. It is a "2D flood model, which solves depth-averaged fluid flow equations to model the movement of water over the ground"<sup>99</sup>. It enables the user to measure flood depth, velocity and extent for different flooding types. The JFlow interface is running on a graphics processing unit (GPU card) and is built within ArcGIS, an SIG model for the creation of interactive maps and additions<sup>100</sup> developed by ESRI. It holds data sharing features aiming to encourage usage by the general public and it also comprises a flood risk metrics tool, Frism.

User-friendly elements of the map are, among others, the simple pan and zoom tools, an intelligent location search and the possibility to maximise the viewable map area<sup>101</sup>.

Measuring impacts of the regulation on innovations in the field of flood management is very difficult. Available data does not really enable the user to measure the impacts of regulation on innovations in the area of flooding management as such, however it gives a big picture of innovation activities in the country, their drivers and barriers<sup>102</sup>.

Regarding patent data, Northern Ireland is below the UK average in terms of applications filed (per 10,000 population). Northern Ireland businesses were innovation-active during 2008-10, slightly below the UK average of 31% but representing a 4% increase within two years. Cost appears as the strongest barrier to innovation in the country.

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<sup>98</sup> <http://www.esri.com/news/arcnews/spring12articles/the-rivers-agency-northern-ireland.html>

<sup>99</sup> <http://www.jbaconsulting.com/products/JFlow>

<sup>100</sup> <http://www.arcgis.com/features/>

<sup>101</sup> [http://www.gistrategyni.gov.uk/index/about-gi/lps\\_marketing\\_-\\_case\\_study\\_-\\_rivers\\_agency\\_strategic\\_flood\\_map.pdf](http://www.gistrategyni.gov.uk/index/about-gi/lps_marketing_-_case_study_-_rivers_agency_strategic_flood_map.pdf)

<sup>102</sup> In Northern Ireland, statistical data is provided by the NISRA, the Northern Ireland Statistics and Research agency. Data related to Trade and Science & Technology are gathered by the Department of Enterprise, Trade and Investment [http://www.detini.gov.uk/2011\\_r\\_d\\_publication\\_pub\\_dec2012\\_v2.pdf](http://www.detini.gov.uk/2011_r_d_publication_pub_dec2012_v2.pdf)

In the case of the Strategic Flood Map, there is no specific instrument or indicator set to measure its impact, apart from visit tracking which reveals a strong public interest for the map, with 15 000 visits in the first week to 300 weekly since then. However, there is a possibility to report any difficulty or, on the contrary, to express satisfaction with the service to the Rivers Agency and in particular the team dedicated to its development and implementation. So far, according to David Porter from the Rivers Agency, feedback received from users is very positive and flood awareness and better flood response can be cited as positive effects since the implementation of the map.

#### C.6.6. Drivers and barriers to innovation

In the case of Northern Ireland, the flood regulation is rather prescriptive and stringent, giving time limits according to the timeframe set in the EU Flood Directive and interacting with other government policies, mainly land use planning, agriculture and regional development policies. The regulation does not however encompass compliance costs as such and although being quite prescriptive allows flexibility, creating a foundation for innovation. Regulation could also be improved to better allocate responsibilities according to David Porter from the Rivers Agency, as the Order from 1973 does not adequately reflect current responsibilities. There are also debates on the attachment of the DARD to regional development departments rather than agriculture that would reflect a different focus in policy response to flood.

In terms of governance, according to a recent report from the British Red Cross, the flood response governance model with three agencies holding responsibility can bring confusion as their respective responsibilities depend on the type of flooding occurring, be it overflowing rivers or blocked sewage mains, etc. Policy response to flooding in Northern Ireland was evaluated at the time of the PPS15 review. A 2010 paper analysed the planning and flood risk in Northern Ireland<sup>103</sup>.

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<sup>103</sup> [http://www.grabs-eu.org/downloads/TCPA\\_Briefing\\_re.\\_Northern\\_Ireland\\_Flood\\_Risk.pdf](http://www.grabs-eu.org/downloads/TCPA_Briefing_re._Northern_Ireland_Flood_Risk.pdf)

Table 14 Drivers and barriers

<b>Types of barriers and drivers</b>	<b>Drivers</b>	<b>Barriers</b>
<b>Policy/regulation/governance</b>	<ul style="list-style-type: none"> <li>Floods directive steering group: representatives from different departments. DARD is the chair of that group. Before the map was public, there were a series of steering group meetings which discussed its launch and comprised representatives involved in quality assuring information</li> <li>Currently undertaking a long-term water strategy for Northern Ireland and has identified a need for new legislation to cover</li> <li>The issues are treated as a priority within the agency and allocated with sufficient resources</li> </ul>	<ul style="list-style-type: none"> <li>DARDNI is the competent authority for the EU directive: leading flood management; two other agencies are in charge of flooding response. There is a need to clarify responsibilities to deal with sources of flooding and bring changes in structure. Is the department of agriculture or of regional development responsible? There are three or four years of process.</li> <li>1973 Order: this does not adequately reflect the roles of the agency</li> </ul>
<b>Economic and market</b>	<ul style="list-style-type: none"> <li>Ensures good value for money but the tool wasn't very expensive</li> </ul>	<ul style="list-style-type: none"> <li>Insurance companies are developing their own systems but for their purposes</li> <li>Funding constraints can limit interventions in flood risk management</li> </ul>
<b>R&amp;D capabilities</b>	<ul style="list-style-type: none"> <li>The mapping unit consists of a small, dedicated professional team of 6 people who are involved with the surface water map and still developing the details of the flood map</li> <li>Partnership with the private sector (JBA consulting and ESRI)</li> </ul>	
<b>Technological and technical (infrastructure, etc.)</b>	<ul style="list-style-type: none"> <li>Availability of good data from 2007 flooding to build the tool</li> </ul>	<ul style="list-style-type: none"> <li>Witnessed some technical issues as the original approach did not integrate an allowance for permeability or urban drainage and was based on the use of a bare-earth DTM (leading to a conservative, broad-scale topographic driven flooding, with no inclusions on the influence of buildings and other flow paths) of 104. The second version was fine-tuned and had improvements based on the shortcomings of the first version. The second version was run for three flood scenarios: low, medium and high probability. The improved accuracy proved useful for drainage infrastructure owners and other stakeholders</li> <li>Experience demonstrated that there is a real need for a common or industry standard approach to risk</li> </ul>
<b>Socio-cultural factors; etc</b>	<ul style="list-style-type: none"> <li>To manage flood risk is considered as a key to facilitate the social, economic and environmental development of Northern Ireland</li> </ul>	<ul style="list-style-type: none"> <li>The public awareness in flooding response is not sufficiently high</li> </ul>

According to the authors, the PPS15 approach was adopting a “narrow, inflexible and simplistic approach to managing flood risk”, however demographic previsions planned that there will be a 7% population increase by 2018 according to a 2008 estimate (Office for National Statistics). The TCPA made recommendations for responsible authorities to adopt adaptable measures and to emphasise the importance of spatial planning and links to up-to-date local development plans.

Socio-cultural factors are also very important in that case since flooding can have major negative effects on society. Building community resilience is an important aspect of flooding management. Northern Ireland acknowledged its importance in the context of the 2009 flooding in the Fermanagh County. The Office of the First Minister and Deputy First Minister published the Fermanagh Taskforce report, highlighting the need for community resilience. The inclusion of local communities is an essential aspect of the strategic flood map as it is available to all and meant as an interactive tool.

<sup>104</sup><http://www.opw.ie/hydrology/data/speeches/07%20-%20Development%20of%20the%20surface%20water%20flood%20map%20for%20northern%20ireland.pdf>

Regarding R&D capacities, academic interest in the field of innovation and environmental regulation is growing in the UK. A conference hosted by the National University of Ireland – Galway on ICT and Environmental regulation: Developing a research agenda, took place in June 2013<sup>105</sup>. Developing academic and research interest in the field could further help in building sound flood risk monitoring systems.

### C.6.7. Conclusions

Regulation for flood management in Northern Ireland is considered to have a positive impact on innovations developed in that area. It enables the design, development and implementation of a strategic flood map that is widely recognised as very innovative, user-friendly and that contributed to improve awareness of floods and better preparedness for flood response. The technology used in the map has improved over the years and the review to occur in December 2013 will also most likely result in a strong improvement of the map.

Elements developed in the case show that some aspects could be improved, mostly regarding governance. According to David Porter, there is a great need for an updated legislation to cover all the work of the agency. This legislation is now under discussion.

The strategic flood map was developed because of legislation, because of recurrent and traumatising flood events such as in 2008 and 2009 and because of a strong political desire for improvement. The combination of these three elements was the condition for the development and implementation of the current strategic flood map. According to the Rivers Agency, legislation contributed to improve their focus on innovation.

### C.6.8. References

- British Red Cross (2012), Cut off by the floods, the impact of flooding in rural Northern Ireland,
- Porter, D. et al (2010), Development of the surface water flood map for Northern Ireland, National Hydrology Conference 2010
- Department of Agriculture and Rural Development, Rivers Agency (2011), The EU Floods Directive, helping protect communities
- DETINI, DFPNI, Northern Ireland Research & Development Statistics, 2011
- DETINI, DFPNI, UK Innovation Survey 2011: Northern Ireland Results, July 2012
- DETINI, Economic Commentary, 2012
- DETINI, Research Agenda 2012-2015, Economic Research, June 2012
- DFPNI, Geographic information Strategy for Northern Ireland 2009-2019, Effectively using information on location, 2009
- ESRI Ireland, Raising awareness of the risk of flooding: The Rivers Agency, Northern Ireland, Case Study Government, 2012
- TCPA briefing, Planning and Flood risk in Northern Ireland, TCPA Briefing Paper 12, September 2010
- The Water Environment (Floods Directive) Regulations (Northern Ireland) 2009

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<sup>105</sup> <http://www.conference.ie/Conferences/index.asp?Conference=205>

**Consulted websites (June 2013):**

<https://mapping.dardni.gov.uk/strategicFloodMap/index.aspx>

<http://www.esri-ireland.ie/about>

<http://www.ice.org.uk/getattachment/6e63a3be-0c54-4e73-822e-b6c4dcedf4b0/Wales-Flooding-Conference-2011-Pat-Aldridge.aspx>

<http://www.esri.com/news/arcnews/spring12articles/the-rivers-agency-northern-ireland.html>

<http://www.jbaconsulting.com/products/JFlow>

<http://www.arcgis.com/features/>

[http://www.gistrategyni.gov.uk/index/about-gi/lps\\_marketing\\_-\\_case\\_study\\_-\\_rivers\\_agency\\_strategic\\_flood\\_map.pdf](http://www.gistrategyni.gov.uk/index/about-gi/lps_marketing_-_case_study_-_rivers_agency_strategic_flood_map.pdf)

**Interview partners**

David Porter, Rivers Agency (DARDNI), Director of Development



## C.7. Introducing the Ecosystem Services Approach to Water Management in Bulgaria and Romania

Author: Laura Roman

Key words: ecosystem services, payments for ecosystem services, water framework directive, governance innovation, eco-innovation, social innovation

Key messages:

- The WFD does matter for the implementation of ecosystem services through promoting an ecosystems-wide thinking through the requirement of reaching “good ecological status” for water bodies in Europe by 2015
- The WFD is generally not perceived by the interviewees to be particularly driving nor impeding the ES implementation, as it mainly takes into consideration the ecological characteristics of ecosystems, not the services and (monetary) values they bring to the users and promotes the 'polluter pays' principle, primarily leaving the ecosystem services approach at a voluntary level
- The WFD leaves room for innovations by creating an opportunity for different compliance paths, which allows the stakeholders to experiment with the implementation of ecosystem services schemes. This is considered appropriate, given the current still incipient level of development of the knowledge in the field, where gaps still need to be covered and given the demonstration phase status of most European projects
- Barriers relate to the need for common methodologies for assessing the value of ecosystem services in the field of water, market entry barriers given the investment costs required by ecosystem services schemes and the lack of clear evidence on the sharing of costs and benefits between buyers and sellers of ecosystem services
- The main drivers of ecosystem services' schemes remain the benefits to the health of the natural ecosystem and the environment they bring, as well as the fact that they can “make business sense” to local, regional and national stakeholders

### C.7.1. Introduction

The European Innovation Partnership on Water defines ecosystem services in the water sector as: “An innovative approach that tries to value the benefits that humans receive from ecosystems (e.g. in monetary terms) in order to integrate them into water management.” The basic principle behind the ES approach is to change the perspective on the consumption of water resources and the use of wetlands.

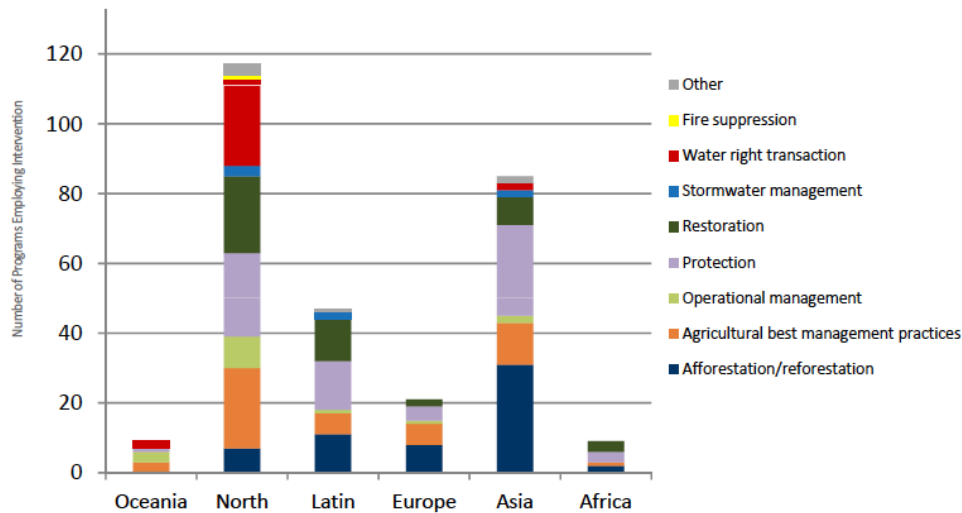
The users of the services provided by wetlands are made aware of their scarcity and of the benefits of their maintenance to their business model and to the local communities through the attachment of a monetary (or non-monetary) value to conservation measures. The integration of the value of the wetlands' natural capital into water management practices can provide a different incentive structure that aims to nudge the users of the ecosystem services towards a more sustainable use of the local natural resources. There are a wide variety of design and governance solutions for introducing such innovations in water management schemes, as they are highly dependent on the characteristics of the local wetland ecosystem. This approach can link upstream and downstream areas, as users of services can be located in a different areas than the service providers.

The Millennium Ecosystem Assessment 2005 categorises water ecosystem services into the following typology:

- Provisioning services (water supply; food provision; non-food goods – e.g. timber, medicine; hydroelectric power)
- Regulating services (regulating water flows; reducing hazards – e.g. flood risks and storm damage, coastal protection; control of soil erosion; water purification)
- Supporting services (supporting wildlife habitats and ecosystem functioning)
- Cultural and amenity services (aesthetic and recreational services; heritage and identity; spiritual and artistic inspiration).

In the EU, water management innovations based on the ecosystem services approach are less spread out. In comparison, there is a higher incidence of such initiatives in the US or Asian countries (see Figure 1 below).

Figure 27 Watershed services' projects around the world



Source: Watershed Connect, 2013: State of Watershed Payments 2012, p.10

The EIP on Water Strategic Implementation Plan highlights the ecosystem services' approach to water management practices as one of the bottlenecks that it intends to tackle. Since ecosystem services' projects are still scarcely implemented in Europe, one of the actions the EIP aims to promote is the demonstration of such approaches on the ground. This means allowing the approach to take a leap forward from the conceptual and R&D phase to the demonstration and implementation phase.

One scheme that has been undertaken on a broader scale outside Europe is the concept of payments for ecosystem services (PES). They are market-based instruments for protecting water ecosystems that require a systemic approach to water basin management. They allow the “translation of ecosystem services that ecosystems provide for free into financial incentives for their conservation, targeted at the local actors who own and manage the natural resources” (Russi D. et al, 2013). As stated by the European Water Innovation Partnership, innovation is particularly needed in the development of programmes involving PES schemes.

### C.7.2. Background of the EU regulatory framework for water ecosystem services

As the most important piece of regulation setting the framework for water management practices in Europe, the Water Framework Directive (WFD) is key to understanding how specific features of the regulatory environment affect the implementation of ecosystem services' approaches to water management.<sup>106</sup> The Directive entered into force in 2000, with the general purpose of protecting inland waters, preventing deterioration of aquatic ecosystems and promoting sustainable water use in the EU.<sup>107</sup>

While the Directive takes a holistic approach to protecting water ecosystems, according to the interviewees, the legislation only hints at the concept of ecosystem services, it does not promote it explicitly. This is due to the fact that the WFD was debated in the late 1990s, whereas the ecosystem services' approach was mainly launched in 2004-2005 with the Millennium Ecosystem Assessment efforts launched by the UN. This is why the concept of ecosystem services has not entered into a legal text per se. The interviewees consider that the WFD was already going in a similar direction as ecosystem services, which was rather an academic concept at the time.

The provisions of Articles 5 and 9 of the Water Framework Directive have been considered a starting point for the development of payments for water ecosystem services and a driver for the national authorities to start working towards assessing ecosystems, including aspects related to the cost of different externalities or anthropogenic impact to be added to the price of water. Article 5 requires the characterisation of ecosystems and the analysis of the impact of human activities on the water status, including the economic analysis of water use. Further relevant articles of the WFD are: Article 6, which requires the registration of protected areas; Article 7 which requires the collection of information about the abstraction of drinking water and Article 8 on the monitoring of the status of surface water and ground water. Article 9 is important for the push for MS to comply with the requirement to ensure the contribution of water uses to the recovery of costs of water services. These WFD provisions can be linked to the implementation of innovative water ecosystem services' projects in European river basins.

### C.7.3. Types of innovation

The WWF project sponsored by the Global Environment Facility and the United Nations Environment Programme aimed at mainstreaming payments for ecosystem services in the Danube River Basin Management. Spanning from January 2010 until December 2013, the project pursued two major goals:

- Demonstrate and promote Payments for Ecosystem Services and other sustainable financing schemes in the Lower Danube river basin
- Derive lessons of relevance for the Danube basin at large and for other international watersheds, creating new markets for biodiversity and/or water-related ecosystem services and increasing knowledge of the benefits of such initiatives

Broadly speaking, the multiple facets of implementing an ecosystem services approach deems it to be categorised into different types of innovation in the field of managing natural resources and ecosystems. In the case of the WWF Danube PES project, the innovation can be disruptive, as it requires new knowledge and resources such as the development of methodologies for assessing the benefits brought by ecosystem services and their integration into policies and business models. Some existing technologies currently used for improving the water quality may become obsolete, as the measures taken to preserve the local water ecosystem may prove more cost-effective and sustainable.

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<sup>106</sup> While there are further regulations relevant to water ecosystem services, such as the Floods Directive, the case study will be restricted to analysing the effects of the WFD more in depth.

<sup>107</sup> The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

- (a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;
- (b) promotes sustainable water use based on a long-term protection of available water resources;
- (c) aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
- (d) ensures the progressive reduction of the pollution of groundwater and prevents its further pollution and
- (e) contributes to mitigating the effects of floods and droughts

As pilot projects, the measures implemented in the WWF Danube PES project serve for the demonstration of the benefits of using the ecosystem services' approach in the Danube Basin and for learning lessons for up-scaling their implementation in the future. The types of innovations the pilots have the potential to drive include governance innovation, eco-innovation and business model innovation, as well as social innovation. The main industry sectors that are prone to changes stemming from the ecosystem services' innovations can be varied. In the case of the WWF Danube PES project, the sectors that are potentially influenced are the water utilities sector, the agro-industrial sector and the aquaculture sector.

- *Governance innovation*: introducing a new concept for governing and using water resources in ecosystem services' schemes driven by the *public sector*
  - In the case of Romania, the Romanian stakeholders saw the opportunity created by the WFD to draft River Basin Management Plans that are based on the cost-recovery analyses of water use and also to integrate ecosystem services into the analyses. This way, the national stakeholders went beyond the assessment of good ecological status of waters, to developing a methodology for assessing “good status”, which includes the human well-being dimension next to ecological concerns. The analyses were applied to wastewater collection and water treatment services. The ES approach was considered a way to recover non-marketable goods and services at the river basin scale, in addition to integrating environmental costs of incoming pollutants in the water resource.
- *Eco-innovation (business model innovation) and social innovation*: ecosystem services' schemes developed with *private partners* to achieve nature conservation purposes, to preserve water resources and biodiversity and to support the regulating function and the health of water ecosystems; the schemes also achieve the goal of providing additional sources of income to the local communities, which is why they can be considered a social innovation as well.
  - During a pilot project in Ciocanesti, Romania proposed the change of the business model of an aquaculture farm in the area of the lower Danube River Basin, which is a Natura 2000 site, very biodiversity-rich, especially in rare birds' species. The scheme was developed with the purpose of improving the natural environment for birds. By adopting the proposed model, the company working in the area would be rewarded with public funds for adopting more eco-friendly practices that contribute to the conservation of the area, such as reducing fish feed to ensure better water quality, maintaining reeds after the bird breeding season and retaining water and fish in commercial basins in winter to ensure food for the birds. Alternative activities such as developing ecological products and developing eco-tourism for bird watching are also encouraged as additional sources of income. The ecosystem services existing in the area were valued as follows: fish production – 3200 EUR/year, conserving the biodiversity – 11000 EUR/year, carbon sequestration – 5850 EUR/year, carbon capture – 3550 EUR/year). Due to conflicting issues in the landscape of Romanian EU-funded operational programmes, the initiative is still ongoing to be implemented.<sup>108</sup>
  - The project initiated two pilots for demonstrating the setting-up of ecosystem services-based schemes supportive of local development and human wellbeing. These materialised through the WWF efforts to build local capacity for the development of two ecotourism schemes in Rusenski Lom, Bulgaria and in Maramures, Romania. In Romania, a payment for ecosystem cultural services was created, which is based on a voluntary commitment between local tourism operators, local guesthouses and the protected area administrator. They created a Biodiversity Conservation Fund for collecting the revenues from eco-tourism activities, which is re-invested in biodiversity conservation measures in the area. To illustrate, the ecosystem services that are taken into consideration are carbon sequestration (accumulating a biomass worth over EUR 2 Million per year and accumulation of CO<sub>2</sub> at the surface worth over EUR 1 Million per year), carbon storage services (in forests where the exploitation of woods is banned – around EUR 226000) and cultural services – high nature value landscapes valuable for tourists.<sup>109</sup>

<sup>108</sup> See WWF, 2013, Danube PES Project – Ciocanesti brochure, [http://awsassets.panda.org/downloads/danube\\_pes\\_ciocanesti\\_brochure.pdf](http://awsassets.panda.org/downloads/danube_pes_ciocanesti_brochure.pdf)

<sup>109</sup> See WWF, 2013, Danube PES Project – case studies, [http://awsassets.panda.org/downloads/danube\\_pes\\_case\\_studies.pdf](http://awsassets.panda.org/downloads/danube_pes_case_studies.pdf)

- In the Persina island Nature Park in the Danube in Bulgaria, the ecosystem services identified were the production of biomass for pellets and briquettes from the residues of farmlands. The farmers owning the farmlands could sell the residues for extra income instead of burning the residues which were harming the soil fertility. In addition, the wetland in the area was restored by managing the reeds that were overgrown in the area, damaging the wetland's regulatory functions. The farmers collect and sell the reeds to a local company that uses them as biomass, thus providing additional income for the local community, supporting the reduction of CO<sub>2</sub> and the maintenance of the wetland ecosystem.<sup>110</sup>

#### C.7.4. Links between regulation and innovation in ecosystem services; WFD and ecosystem services' implementation

In general, stakeholders perceive EU regulation as an enabler for implementing an ecosystem services approach to water management. The EU WFD is perceived to be compatible with it. That said, the WFD is considered to be neither driving nor impeding the development of ecosystem services' initiatives. It mainly makes provisions and sets a general framework where this innovative approach can take place, allowing (inter-) national, regional or local initiatives from the private and public sectors to happen.

The Water Framework Directive promotes the goal of achieving “good ecological and chemical status” of inland and coastal water bodies in Europe by 2015. The “good ecological status” concept is considered an enabling aspect for the ecosystem services' approach, as the WFD is looking at particular parameters that ensure the functionality and health of the ecosystem. It is not looking at particular species by providing stringent numbers for instance but at the maintenance of natural processes, abundance and diversity of species.

However, the step further that some stakeholders consider that the WFD doesn't take is that it does not directly portray the benefits that the ecosystem can be providing. The ecosystem services' approach goes further in the assessment of the ecosystem by taking a very anthropocentric approach, including for instance social, cultural or recreational benefits that ecosystem services can provide into the analysis of the ecosystem. This would not be taken into account explicitly within the WFD's “good ecological status” approach, which leaves flexibility for implementing the directive.

According to WWF project representatives, difficulties in implementing ES schemes also stem from the lack of a commonly accepted or official definition of ES at EU and national level. While this is a positive factor that can drive the further development and conceptualisation of these types of schemes, it has also been a bottleneck in the implementation of the pilot projects, as there were difficulties in finding a common ground with national authorities.

However, another interviewee argued that the flexibility of the definition of water services is needed for the development of the concept of ecosystem services, which is still ongoing. A clearer definition might emerge by 2018, when the WFD is to be reviewed. Common definitions and common approaches have so far been helpful in the Danube River Basin, for instance, where international cooperation has been facilitated based on the ecosystem services' concept development. The advantage of a voluntary (non-compulsory?) basis for the take up of initiatives taking ecosystem services' approaches in water management is still recognised at this point, as it leaves room for further learning.

In line with the findings in academic literature on the impact of regulation of innovation, **the flexibility of a regulation** in encouraging specific innovations **matters for how fast the ecosystem services' innovations develop** (see Stewart, 2011, p. 9). The Water Framework Directive is a command-and-control type of regulation, which provides obligations to stakeholders to achieve minimum standards for complying with its provisions. Since there is no specific requirement to apply ecosystem services' approaches, the development of such schemes is rather slow.

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<sup>110</sup> See WWF, 2013, Danube PES Project – Persina case study, [http://awsassets.panda.org/downloads/danube\\_pes\\_persina\\_case\\_study.pdf](http://awsassets.panda.org/downloads/danube_pes_persina_case_study.pdf)

One further example is the need to deliver River Basin Management Plans to provide an overview of the ecological status of inland water systems, the impact of human activities, the measures to tackle the problems identified as well as the financial means planned for the measures to reach good ecological status of inland waters by 2015. As said, the WFD does not require explicitly that ES approaches be integrated into the RBMP. According to the WWF, a key difference between the WFD approach and the ES approach is the fact that the WFD is primarily promoting the 'polluter pays' principle, whereas the ESA involves the shift to the 'user pays' principle (or 'beneficiary pays' principle).<sup>111</sup> The analyses that the Member States are undertaking based on the provisions of Articles 5 and 9 of the WFD need to feed into the River Basin Management Plans (RBMP) by the end of 2013. The compliance burden on authorities to implement the requirements of the RBMP is thought to not encourage them explicitly enough to develop innovative approaches to implementing the RBMP, such as the integration of the ecosystem services' approach into water management. As a proof, during the first cycle of the RBMP preparation, the Member States have generally not been using innovative methods that show a need for ecological improvements or ecosystem services in their studies on valuating environmental costs of water services.

The clarification of the concept of water services and further guidance on the valuation of the recovery of costs for water services are expected measures that the WWF experts consider as potential drivers of scaling-up the implementation ecosystem approaches.

*Using the WFD for introducing ecosystem services' approach to water policy*

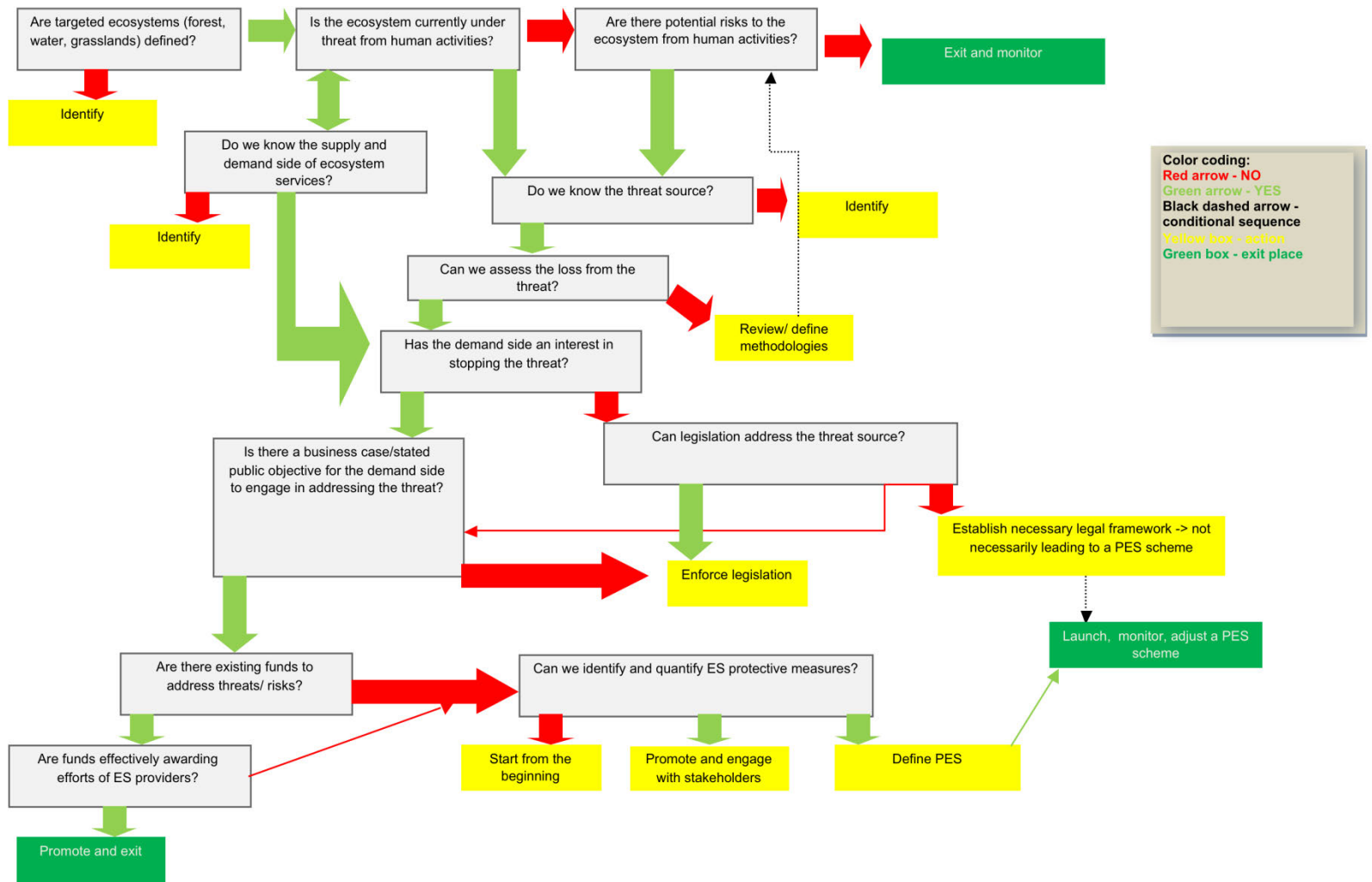
An example of how **governance innovation** can happen following the implementation of the WFD is provided within the context of the WWF Danube River ES Project. The WWF project team has been working with the Romanian Waters Authority to develop integrated River Basin Management Plans for the Danube area that facilitate the application of ecosystem services' initiatives. At EU level, Romania has been recognised for its efforts to integrate the payments for the ecosystem services' concept into water pricing and water management as a voluntary tool.

In the case of Romania, Article 9 of the WFD led to the start of a thinking process within the Romanian National Waters Authority, which has mandated a Working Group to develop solutions to integrate environmental costs into the water price. In order to comply with the provisions of the WFD, the Romanian Water Administration has also tapped into the idea of using ecosystem services and payment for ecosystem services' schemes as an opportunity to cover the budget for implementing the Programme of Measures required to reach good ecological status of the Romanian waters by 2015. According to the stakeholders, PES schemes were considered an opportunity to cover around 30% of the financial needs for the implementation of the first cycle of the Programme of Measures. For this purpose, the Romanian authorities have initiated the process for identifying water-related ecosystem services and their integration into RBMP. This process is also driven by Target 2 – Action 5 of the EU Biodiversity Strategy to 2020, according to which Member States need to engage themselves in a process of mapping and assessing the state of the ecosystems and their services and to better integrate their value into national accounting systems by 2014.

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<sup>111</sup> WWF, 2013: "Recommendations for Romanian River Basin Managers concerning opportunities to integrate PES into the Danube National RBMP", within the framework of the WWF Danube PES Project

Figure 28 WWF Payments for Ecosystems Services' progress diagram



Source: WWF Danube PES project team members.

### C.7.5. Barriers to scaling-up ecosystem services' innovations

As a disruptive type of innovation, the concept of ecosystem services acts along a different paradigm than the current regulatory, policy and governance framework. This is why the operationalisation and diffusion of this concept requires its further mainstreaming into the public, private and civil society spheres. The following sub-chapters list ideas on what particular dimensions need to be tackled for mainstreaming ecosystem services into common practice, based on the experiences of the WWF Danube PES project. The majority of the non-regulatory challenges listed in this chapter relate to the ecosystem services' schemes developed by local actors, as they usually involve partnerships between a constellation of stakeholders, depending on the type of ecosystem services dealt with.

#### *The knowledge and evidence base for assessing ecosystem services and their benefits*

Due to their potential for multi-functionality in linking environmental, social, economic and cultural benefits, initiatives taking ecosystem services' approaches to water management need a clear assessment of their added value and its distribution among the different stakeholders. This is why the ecosystem services' approach is highly dependent on reliable data provided for the ecosystem services under discussion. Currently, there is **no common methodological guidance at EU level on how to assess ecosystem services and their benefits** but the EU Commission and international partners are undertaking several activities to advance the knowledge and standardise the methodologies for assessing ES. The EU Commission has for instance been working on an initiative for Mapping and Assessment of Ecosystems and their Services (MAES) following Action 5 of the Biodiversity Strategy to 2020, in which it provides an "analytical framework for ecosystem assessments."<sup>112</sup> It proposes a typology of ecosystems and ecosystem services, which should also reinforce the efforts to integrate ecosystem services into the efforts to comply with the WFD and into its implementation at national level.

The European Commission is preparing a practical guidance document to support the river basin managers in their voluntary efforts for inclusion of ES principles into implementing RBMP. At the same time, these guidelines will also be useful for data collection purposes within the CIS for Natural Water Retention Measures and Better Calculations of Cost and Benefits of Ecosystem Services.<sup>113</sup> With this document, the legal framework is not changed but the ES approach is used as a tool to achieve more than the basic purposes of the WFD. According to the interviewees, some Member States such as Ireland, France, Romania and the United Kingdom, as well as Norway, have made steps towards this.

In the case of the WWF Danube PES project in Bulgaria and Romania, one further challenge was the **poor status of reliable baseline data**. The national statistics do not link land use to ecosystem characteristics and their services (e.g. data on carbon sequestration and storage or reliable water quality data).<sup>114</sup> Another example from Romania was the lack of local area management plans or development strategies that included data on the assessment of the biodiversity status. This was problematic for the initiation of PES schemes and needed to be included in the project activities. These are challenges that need to be taken into consideration in developing future ecosystem service initiatives.

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See European Commission 2013, "MAES – An analytical framework for ecosystem assessments under Action 5 of EU Biodiversity Strategy to 2020,

" [http://ec.europa.eu/environment/nature/knowledge/ecosystem\\_assessment/pdf/MAESWorkingPaper2013.pdf](http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf)

<sup>113</sup> See European Commission (forthcoming): Support Policy Development for Integration of Ecosystem Services Approach with Water Framework Directive and Floods Directive Implementation. Towards Practical Guidelines to support RB Managers. Document commissioned by DG Environment by COWI, ARUP and DHI.

<sup>114</sup> See WWF, 2013, "Lessons learnt from testing payments for ecosystem services in the Lower Danube Basin", WWF Danube PES Project, April 2013.



### C.7.6. Economic and market barriers

- Market entry and willingness to pay for ecosystem services

**Capacity building for private local stakeholders** for initiating and participating in ecosystem services schemes is crucial. In addition, the initial investments required from private sector actors to setup the PES scheme can deter small companies or NGOs to initiate such projects. The willingness to pay for ecosystem services is low, due to difficulties in assessing the evidence of the economic benefits of participation in the scheme and the long-term timeframe of the return on investment.

The pilot project in Maramures has proved that this can be a decisive factor in project initiation. The WWF team has been encountering difficulties because the initial provider of the PES scheme should have had a better technical and financial capacity to invest in providing eco-tourism services, in order to attract clients. There are usually no immediate gains from ecosystem services, which is why public and private **funding solutions and instruments supporting the initiation of PES schemes** need to be improved.

- Requirements for access to EU public funding

Further EU policies can promote the implementation of ecosystem services' schemes in Europe, due to the multiple ranges of stakeholders and purposes that ecosystem services can cover. As a result, ES initiatives can draw funding from EU Regional Development and Cohesion Funds, as well as the Common Agriculture Policy Funds, the EU Rural Development Programme and the Common Fishery Policy Fund among others. Nevertheless, stakeholders point out the issue that some provisions of the operational programmes of the above mentioned funds may deter the funding of ES projects.

An example is the funding proposal issued by WWF for developing a cross-border cooperation programme that proposed a PES scheme dealing with the restoration of a wetland in Romania and Bulgaria. The project was not approved for funding by Romanian authorities because it was thought not economically viable. This is due to the fact that there is no recognised method to measure the economic benefits from preventing loss of natural capital and such alternative benefits are not considered viable by the operational programme rules. According to the stakeholders, funding decisions are therefore not easily favourable to ES schemes under these circumstances.

In addition, there is no legal **procedure related to monitoring the results** of such projects, which is crucial for the sustainability of the schemes. Stakeholders need to be constantly aware of the costs and benefits of the scheme, as well as of the changes in the ecosystem that may intervene in time. While the WWF pilot projects have budgeted for the monitoring of the project activities, at a macro level there is no framework to be used more widely by initiators of ESA schemes.

The stakeholders have been working on this issue with EU and national agencies, so that it is expected that the provisions of the future programming period 2014-2020 will be more supportive in fostering ecosystem services' innovations.

#### *Contractual law*

Ecosystem services' schemes require new contractual relationships to be created, which in several cases do not have a precedent in national contexts. The interviewees revealed that the setting up of partnerships or the legal basis for the scheme is problematic, as there is no clear terminology for ES and for payments for ecosystem services. In order to implement the project, WWF had to create the provisions for the legal basis of local partnerships in close cooperation with environmental lawyers. The most important provisions relate to stipulating the rights and obligations of buyers and sellers of ecosystem services. The lack of a common framework is imposing an administrative burden on initiators of PES schemes. This, together with the strong basis of trust between the participating parties, were identified as crucial factors in the functioning of a scheme based on the ecosystem services' approach.<sup>115</sup>

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<sup>115</sup> See WWF, 2013, "Lessons learnt from testing payments for ecosystem services in the Lower Danube Basin", WWF Danube PES Project, April 2013.

### *Tax burden*

The interest from the private sector to participate in PES schemes is influenced by the tax incentives offered for such schemes. However, given the lack of a regulatory framework for such projects, the companies are perceived to have little incentive to take up such schemes. As the ecosystem services' approach is still not close to being mainstreamed in national strategies and priorities on a large scale, there has been no real debate and there is no consensus yet whether PES schemes and related investments should be tax-free or not for the private actors. On the flipside, introducing tax incentives related to the companies' income statements might not raise the interest of the private participants at a required level, given the fact that the reporting of tax revenues in countries like Romania and Bulgaria is in general not reliable.

### *The essential role of the local stakeholders and wider governance challenges*

The development of the PES schemes is a process that requires a thorough understanding of the local context and the identification of the costs and benefits of ecosystem services and their implications for the local community. This can only be done if the development of the scheme includes an assessment study of environmental pressures and of existing ecosystem services accompanied by thorough stakeholder mapping as a starting point. Appendix C shows the steps proposed by WWF for the setting-up phase of a PES scheme.

Local municipalities can become drivers of PES as they can prioritise investments in green infrastructures and ecosystem services in local budgets, in addition or instead of grey infrastructure. However, the challenge is to also maintain such priorities irrespective of electoral cycles. This has influenced the set-up of the PES pilot schemes in Romania and Bulgaria. While they are usually designed to last longer because of the long-term horizon of the changes to ecosystems, the WWF pilots were only set to last for 3 years in Romania and 5 years in Bulgaria.

A very important element in the development of initiatives based on the ecosystem services' approach is the existence of **a facilitator** who takes responsibility for guiding the local actors throughout the scheme development process, for **building capacity** for the local community and possibly even providing support in the implementation phase of the scheme. In Bulgaria, the mobilisation of the local stakeholders was also more successful due to the fact that the initiator was trusted and considered a local leader by the local community. In addition, since the concept of a PES is considered highly technical by the majority of stakeholders, there is a need for **enduring communication and training work**, which may be pursued by ecosystem services' project facilitators.

The WWF team has been undertaking training with the media and local stakeholders to promote the ecosystem services' approach. However, the scaling-up of the implementation of ecosystem services' approaches requires concerted action at a broader-scale, including a comprehensive communication strategy from the government and a more **thorough public debate to enable a better understanding** of such endeavours by the public and private sectors, as well as by local communities.

Table 15 Barriers to scaling up ecosystems services' innovations

<b>Types of Barriers</b>	<b>Details and description</b>
<b>Policy/regulation/governance</b>	<ul style="list-style-type: none"> <li>• integration of ecosystem services' approaches in water management policies</li> <li>• integration of water ecosystem services and green infrastructure in priorities of EU funds, OPs, national and local investment priorities</li> <li>• mobilisation and capacity building of private and civil society</li> <li>• coordination of stakeholders across large geographical boundaries</li> </ul>
<b>Economic and market</b>	<ul style="list-style-type: none"> <li>• the market for ecosystem services is at an incipient phase, where the asymmetry of information is high among the service buyers and sellers</li> <li>• clear contractual relations based on trust and evidence of the ecosystem services' benefits need to be developed between the market players engaged in ecosystem services' schemes</li> <li>• poor financial capacity of local stakeholders to initiate PES schemes, difficulty in dealing with the tax burden and lack of incentives to invest in PES schemes</li> <li>• the willingness to pay for ecosystem services is low, due to difficulties in assessing the evidence of economic benefits of participation in the scheme</li> </ul>
<b>R&amp;D capabilities</b>	<ul style="list-style-type: none"> <li>• development of standard methodologies for mapping and assessing the value of ecosystems is ongoing and is crucial for implementing ES schemes</li> </ul>
<b>Technological and technical (infrastructure, etc.)</b>	<ul style="list-style-type: none"> <li>• poor status of existing national statistical records on ecosystem services and their integration with land use statistics</li> </ul>
<b>Socio-cultural factors etc.</b>	<ul style="list-style-type: none"> <li>• challenges in understanding and sometimes legitimising the concept of ecosystem services and payments for ecosystem services among the stakeholders</li> </ul>

### C.7.7. Conclusions

The aims of the WWF Danube PES project were to demonstrate the benefits of ecosystem services approaches in the water sector in Romania, Bulgaria and the Danube River Basin and to promote their integration into River Basin Management Plans. In addition, the project aimed to demonstrate the implementation of payments for ecosystem services as a sustainable scheme for protecting natural resources and generating income. Ecosystem services' initiatives can provide multiple benefits, ranging from biodiversity conservation and better water quality to social and economic benefits to the local community, which can be considered as governance innovation - changing the paradigm according to which the water sector is governed, as well as eco-innovation and social innovation.

The interaction of environmental protection regulation – in this case the Water Framework Directive with the demonstration of ecosystem services' innovations is subtle. On the one hand, the flexibility of the WFD leaves room for the national authorities to take different compliance paths and allows the voluntary mainstreaming of ecosystem services' approaches along the implementation of the directive requirements, such as within the river basin management plans. On the other hand, the basic principle prevailing in the directive is that of “polluter pays” rather than “service user / beneficiary pays.” This does not incentivise the Member States and the river basin managers to apply innovative ecosystem services' approaches, which means that innovation is taking place slowly in this field, in spite of it being disruptive. However, governance innovations can happen and a change of the paradigm in water management can take place, provided the policy actors are convinced of the evidence of the benefits of promoting ecosystem services' schemes in the water sector.

### C.7.8. References

- European Commission (forthcoming): Support Policy Development for Integration of Ecosystem Services' Approach with Water Framework Directive and Floods Directive Implementation. Towards Practical Guidelines to support RB Managers. Document commissioned by DG Environment by COWI, ARUP and DHI.
- European Commission 2013, “MAES – An analytical framework for ecosystem assessments under Action 5 of EU Biodiversity Strategy to 2020,”  
[http://ec.europa.eu/environment/nature/knowledge/ecosystem\\_assessment/pdf/MAESWorkingPaper2013.pdf](http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf)
- Russi D., ten (?) Brink P., Farmer A., Badura T., Coates D., Förster J., Kumar R. and Davidson N. (2013), The Economics of Ecosystems and Biodiversity for Water and Wetlands. IEEP, London and Brussels; Ramsar Secretariat, Gland

Stewart, L., 2010: "The impact of regulation on innovation in the United States: A cross-industry literature review", paper commissioned by the Institute of Medicine Committee on Patient Safety and Health IT [www.iom.edu/hitsafety](http://www.iom.edu/hitsafety)

Watershed Connect, 2013: State of Watershed Payments 2012, p.10, [http://www.watershedconnect.com/documents/files/charting\\_new\\_waters\\_state\\_of\\_watershed\\_payments\\_2012.pdf](http://www.watershedconnect.com/documents/files/charting_new_waters_state_of_watershed_payments_2012.pdf)

#### Project Documents

WWF, GEF, UNEP Danube PES Project Document 2010 and Project Progress Report 2012 provided by the Project Manager.

WWF, 2013, "Lessons learnt from testing payments for ecosystem services in the Lower Danube Basin", WWF Danube PES Project, April 2013.

WWF, 2013: "Recommendations for Romanian River Basin Managers concerning opportunities to integrate PES into the Danube National RBMP", within the framework of the WWF Danube PES Project

#### **Interview partners**

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## C.8. Landfill and incineration ban for recycled waste in the Netherlands

Author: Joost van Barneveld

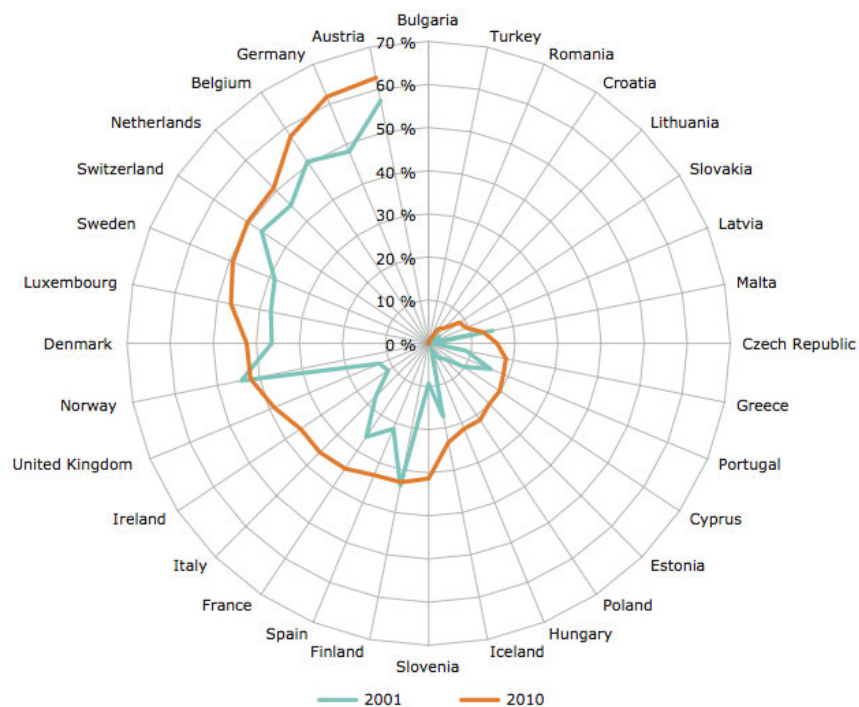
### Key messages:

- The ban was introduced in 1998 on a national level without differentiation for regions or industrial sectors;
- The Netherlands were a front-runner in the 1980s/1990s of reduce, reuse, recycle principles;
- Initially high incineration prices were followed by an increase supply of incinerators and capacity.
- Innovation effects: Increased demand for collection and separation (technology)
- Environmental effects: Increasing environmental quality
- Regulation effects: Additional regulation on incineration emissions
- The main drivers for transforming the market have been a tax and a ban on landfilling.
- Environmental regulations and producer responsibility principle have had significant effects on resource efficiency and minimising environmental harm.

### C.8.1. Introduction

This case study concerns the Dutch ban on landfilling 35 types of waste, regardless of origin (municipal, commercial or industrial), introduced in 1998. It is relevant for the Strategic Implementation Plan (SIP) of the European Innovation Partnership (EIP) on raw materials, because the SIP mentions the option of a ban on landfilling and incinerating certain types of waste, most notably paper, wood, glass and metals. These materials can usually be recovered and recycled into high quality secondary raw materials while their recycling rates are not yet at their optimum. A ban on landfilling and incinerating these materials would lead to higher recycling rates and consequentially an increased supply of secondary raw materials. This would in turn lead to a decreased demand for primary raw materials and accompanying imports, reduced production costs or reduced energy demand. Statistics on recycling for 32 European countries are shown in the figure below.

Figure 29 Gross recycling rates for municipal waste in Europe



Source: European Environmental Agency, 2013

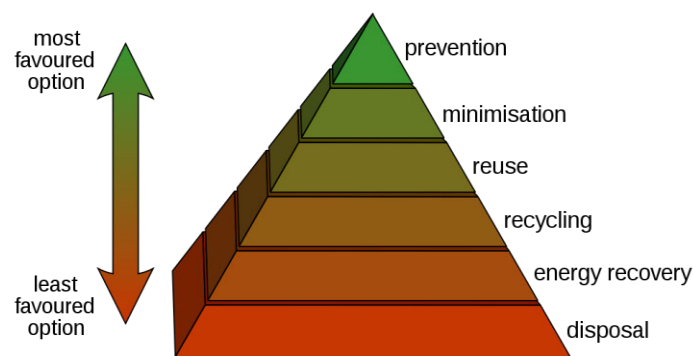
Low municipal recycling rates are an indicator for low overall recycling rates because municipal and non-municipal waste are often processed in bulk, as is the case in most north-western European countries<sup>116</sup>, whereas a low recycling rate may also indicate a lack of infrastructure such that waste regardless of origin is not recycled altogether. Figure 29 clearly shows that recycling rates in Europe leave ample room for improvement, especially in the south-eastern and eastern member states.

The focus of this case is the Dutch ban on landfilling for a list of 35 types of materials that are either well recyclable or reusable, or hazardous to the environment when landfilled. The ban was introduced in 1998 on a national level without differentiation for regions or industrial sectors.

### C.8.2. The Dutch ban on landfilling

The Dutch ban on landfilling was part of a long history of policy formation and increasingly strict regulations concerning waste processing and the environment. A major point of departure for the Dutch progressive waste policy was Lansink's motion, adopted by the parliament in 1979. It defined a waste hierarchy that is similar to Figure 30.

Figure 30 Waste hierarchy



Source: Wikimedia commons 2013

The adoption of Lansink's waste hierarchy started the formulation of policy and incentives to increase implementation of the most favoured options. Policy was formed with three main motivations

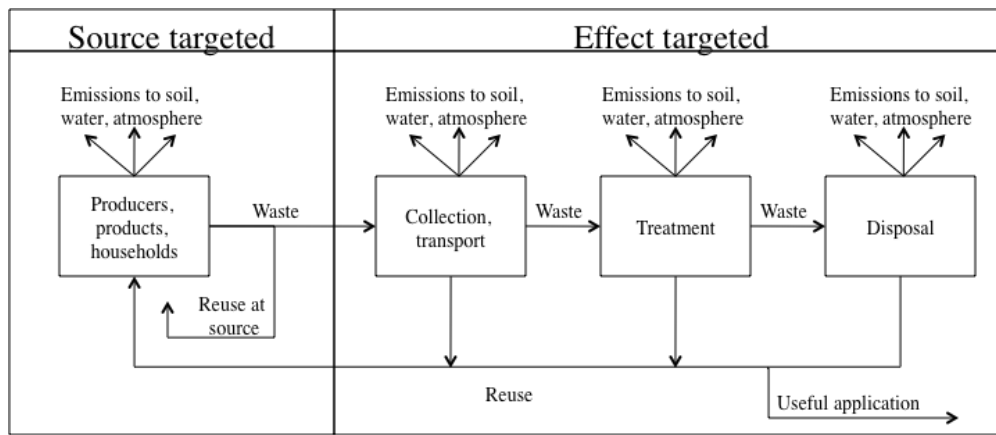
- social cost and acceptance of (methods of) waste processing
- spatial- and planning aspects of waste processing
- environmental harm reduction

Policy was made to address the sources of waste and prevent or minimise waste generation. It recognised international consensus to become self sufficient in waste processing and the need to eliminate incineration and dumping on sea. This led to the parliament's resolution on prevention and re-use of waste<sup>117</sup>, which served as a medium-term reference document for waste policy formulation. In its core it had a two-fold approach: source targeted policy and effect targeted policy. See Figure 31.

<sup>116</sup> Expert meeting on raw materials, June 24<sup>th</sup> 2013, Brussels

<sup>117</sup> Nijpels (1988)

Figure 31 Dutch waste policy targeting scheme



Source: Based on Nijpels (1988)

Source targeted policy was designed to reduce waste generation in any form, be it by households, industry or through the design of products. To this end, the producers' responsibility for waste generation was introduced in 1990 for a selection of products among which cars, batteries, tires, electric and electronic equipment and packaging<sup>118</sup>.

The effect targeted policy focused more on (minimising) the environmental effects of waste generation and emissions. In the effect targeted part, the waste hierarchy was again the point of departure for policy design. The following hierarchy was adopted:

**Reuse.** When waste prevention is a limited option, reusing waste in other production processes is preferred, possibly by upgrading the stream beforehand. If such options for reuse are available, a very stringent permit policy concerning that particular resource will be implemented. Additionally, developing recycling plants will be stimulated while markets for recycled products will be stimulated. Public procurement will play a role in this stimulation policy.

**Useful application.** Where possible, useful application of a waste stream (such as (de)construction debris for road foundations or incineration for the conversion of energy) will be stimulated if no harmful environmental effects are present.

Processing and disposal are considered a last resort and policy is designed to minimise employment this final stage. Eventually, the goal is that environmentally harmful substances are only allowed to be generated if there is an adequate infrastructure for removal of the substance. To this end, specific policy and guidelines per waste stream are formulated.

The instruments mentioned in Nijpels' memorandum are primarily economic, incentivising clean production and design by passing on the real costs of waste disposal, especially when it concerns the costs of longer term management of waste disposal sites; Landfill sites are required to be maintained and cared for for at least 300 years after their decommissioning. Increasing costs of landfilling were a primary motivator for recycling and other means of waste processing higher up the hierarchy, while interviewees also mention public pressure and environmental concerns as an important motivator.

It is interesting to see that possible depletion of primary resources is briefly mentioned in Nijpels' resolution, in relation to the report of the Brundtland commission on sustainable development<sup>119</sup>. However, the notion of waste as a resource has only been gaining popularity since the 2000's. Nijpels memorandum mentions waste policy developments in other European community nations but no European directives or European policy. At that period (1980s, early 1990s) the Netherlands were a front runner in waste policy because of severe space and planning constraints and the costs of reclaiming landfill sites.

<sup>118</sup> Parliament (2007)

<sup>119</sup> Brundtland (1987)

Since waste is generated by every economic actor, a brief overview of the stakeholders that are impacted by waste policy serves to support the following sections. The table below gives an overview of stakeholders effected by the ban on landfilling:

Table 16 Impacted group of stakeholders

<b>Group</b>	<b>Level of impact</b>	<b>Description</b>
<b>Manufacturers and importers of equipment, goods and materials</b>	Dependent on location; high to none	Only national producers that generate waste streams domestically, effected mostly by means of costs for waste processing and by the producer's responsibility
<b>Producers of waste</b>	Medium	Commercial and industrial actors and households increasingly separate waste at the source of production, higher costs of processing
<b>Waste collectors</b>	High	Change in waste collection frequency, volume and number of separate streams collected
<b>Waste processors</b>	High	Changes in differentiation and amount of supply, changes in (costs of) disposal- and processing methods
<b>Governments</b>	Medium	Landfill demand greatly reduced, demand for re-use and incineration greatly increased, means of collection diversified, intensified monitoring and data collection



### C.8.3. Regulation

Nijpels' resolution from 1988 contained a list of 29 types of waste, their current annual quantities produced and directives for the amounts to be processed in the year 2000. An overall decline in waste production of 5% between 1990 and 2000 was foreseen. Stakeholders in industry and producers of those 29 waste streams were involved in defining indicators and developing policy, methods and processing capacity in the meanwhile towards 1998. In the same period, flanking policy was directed towards charging higher rates for landfilling, expanding incineration capacity and to increase recycling rates. The latter for example was helped with the **producers' responsibility** for a number of products. Eventually, the Dutch waste processing sector was ready for a ban on landfilling 35 types of materials 1998<sup>120</sup>. The materials concerned are given in Table 17.

Table 17 Waste types banned from landfilling in 1998 in the Netherlands

Categories of waste banned from landfilling in 1998				
Mainly for environmental protection	Processing of waste is possible higher in the waste hierarchy		Environmental protection and higher level processing possible	
Batteries (single use)	Rechargeable batteries	Fly ashes from waste incinerators	Thermometers containing mercury	Municipal gardens compostable waste
Materials on the European Waste Catalogue belonging to categories 18 01 01, 18 01 02, 18 01 03*, 18 01 04, 18 01 06*, 18 01 07, 18 01 08*, 18 01 09, 18 01 10*, 18 02 01, 18 02 02*, 18 02 03, 18 02 05*, 18 02 07*, 18 02 08, 20 01 31* of 20 01 32;	Waste that is explosive, corrosive, oxidising, (extremely) flammable	Unidentified or new chemical waste originating from research, development or education with unknown effects on public health or the environment	Plastic waste originating from process waste, production processes or the rubber- and plastics industry	Industrial waste with likeness to commercial waste or fractions thereof
Waste Electric and Electronic Equipment (WEEE)	Commercial waste (office, shops and services) or fractions thereof	Packaging material other than packaging material of chemicals	Municipal (household) waste or fractions thereof	Sludge from biological wastewater treatment
Motor vehicle wrecks	Contaminated soil	liquid waste	Waste wood	sand
Sand blasting residues	Auction waste	Market waste	Oil filters	Floating debris
Gas discharge lamps components	Plastic waste from agriculture	Tires originating from motor vehicles	Shredder material from car- or WEEE waste	Biological waste from agriculture
oxylimesludge	compostable waste	Construction waste and residues	Packaging material of chemicals	Paper and cardboard

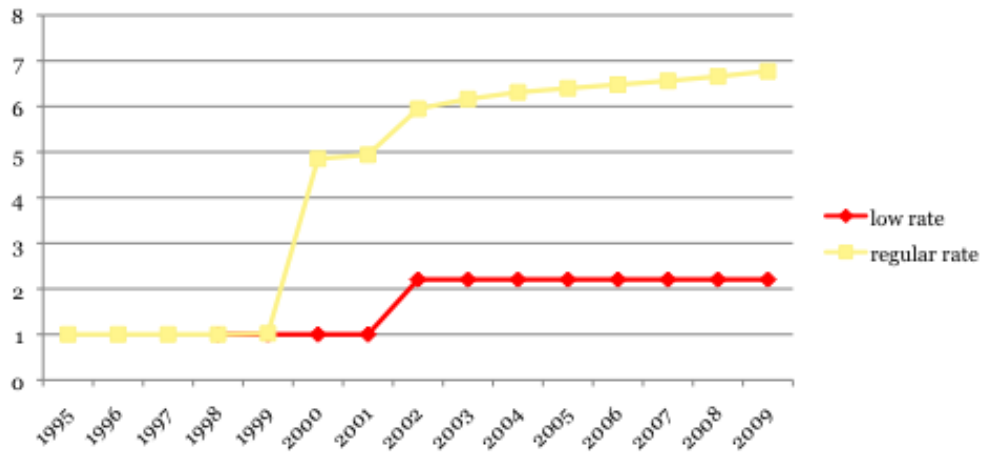
Source: Resolution on landfill sites and landfill bans, December 8<sup>th</sup> 1997

The list of materials banned from landfilling was designed to encourage recycling and to minimise the spatial, economic and environmental effects of landfilling after the ban. Essentially, landfilling after the ban was only possible in cases of shortage of recycling or incineration capacity, or other unforeseen events. The ban was accompanied by the introduction of a distinction in low and high rates for landfilling. The low rates were charged for streams that had no conventional processing methods, whereas the high rate was charged for streams that could be processed higher up the waste hierarchy. This tax on landfilling was intended to eventually lead to equal costs for landfilling or incinerating<sup>121</sup>. The index of these tax rates is given in Figure 32.

<sup>120</sup> Besluit stortplaatsen en stortverboden (1997)

<sup>121</sup> Werkgroep afvalstoffenbelasting (2009)

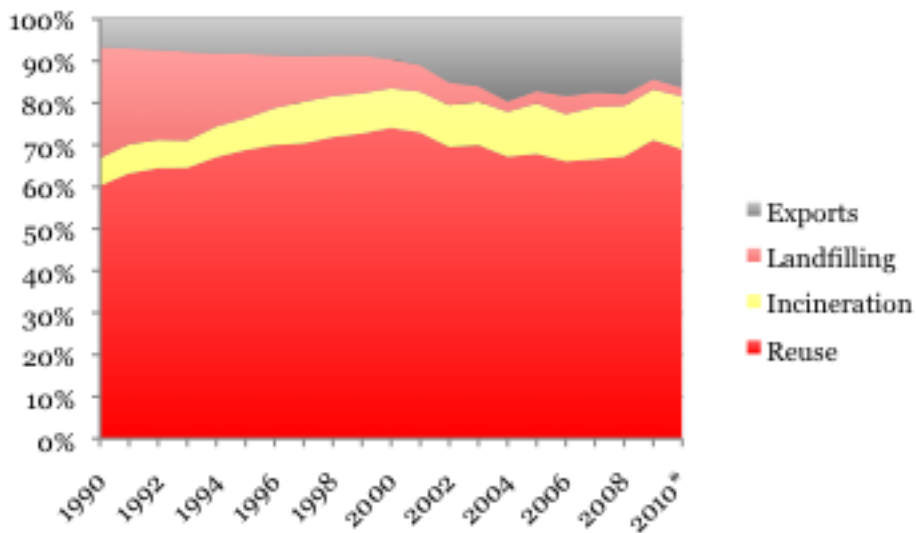
Figure 32 Index of landfilling tax rates



Source: Technopolis 2009

The combined effects of the landfill ban, the landfilling tax and other environmental policy since the early 1990's can clearly be seen in Figure 33:

Figure 33 Municipal waste processing methods in the Netherlands

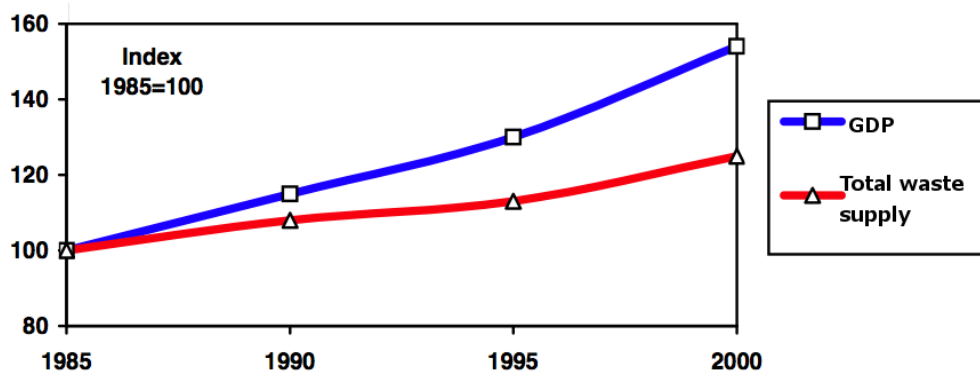


Source: Technopolis 2013

A steep decline in landfilling is visible, which can be linked to the increased tax rates charged for it. The next lowest cost option is incineration, and an increased demand for incineration can be seen in the figure. The decline in reuse (recycling or other useful end-use of waste streams) in the year 2000 remains unexplained. Another development that is clearly visible is the growth in exports of waste since the ban. By EU regulations, these exports are only allowed if the importing country processes them in a way that is higher up the waste hierarchy than the exporting country would. This holds, for example, for waste that is exported from the UK to be incinerated for energy conversion in the Netherlands.

Finally, besides directing the way waste is processed there has also been development in decoupling GDP and waste generation as can be seen in Figure 34. This development may be attributed to the producer responsibility principle.

Figure 34 Decoupling of waste generation and GDP in the Netherlands



Source: VROM 2007

#### C.8.4. Classification of regulation

Classifying the Dutch ban on landfilling and the waste policy preceding it since the early 1990's, using the Blind<sup>122</sup>/OECD methodology, one can distinguish the following aspects:

- Social
  - Environmental protection by creating a disincentive for employing the least favoured options in the waste hierarchy that have the highest negative environmental impact
- Economic
  - Price regulation in the form of steeply rising tax rates for landfilling remove the economic disincentive for incineration or recycling
- Institutional
  - Producer responsibility introduced since early 1990's places liability for waste production towards producers of goods and materials such that the most preferred options of waste prevention and minimisation become more feasible and paid for by the industry.

Following Stewart's<sup>123</sup> model one can describe the regulation in terms of flexibility, transparency inducement and stringency.

On the axis of flexibility the ban on landfilling can be considered flexible in the sense that it left ample room for other options of waste management. On the other hand it meant a strict turnaround for an industry that had existed for decades if not centuries; landfilling stopped being an option unless all other means of processing had been exhausted.

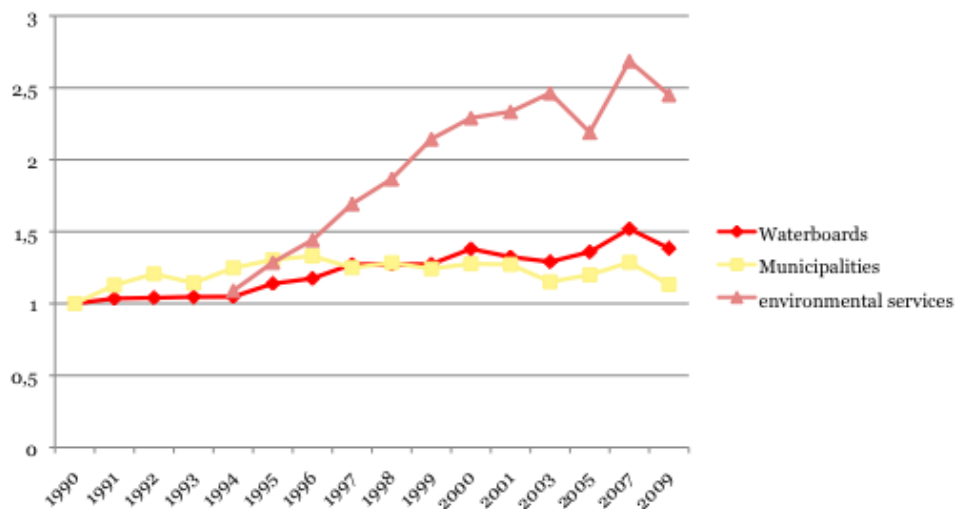
When it concerns information availability or disclosure of information as a result of the ban it is hard to draw a conclusion. The waste processing market is an artificial market and exists by virtue of regulations. That means that there is a great matter of collective action and discussion to implement new policy or to shape future policy in cooperation with government actors and industry. Interviewees indicate that best practices are usually exchanged, specifically in the landfilling sector where government owned companies cover the great majority of the market. Recycling and incineration companies do have proprietary technology for separating, managing and upgrading waste streams that they do not share with their peers. However, in the case of incinerators this technology is often owned by (international) engineering companies that build the installations. This means the technology is often available on the market. On the recycling and separation side, processors have some interest in being open about their inputs, outputs and technology surrounding it to uphold compatibility of streams nationwide and preferably in European context. This is because common standards for collection and processing benefit the purity and thus value of secondary raw materials. These effects do not originate from the ban directly, but the monitoring and indicators that the environmental waste policy requires enables the industry to process streams efficiently and discover niches that were previously untreated.

<sup>122</sup> Blind (2012)

<sup>123</sup> Stewart (2010)

Finally, on the axis of stringency the ban on landfilling scores high. The regulation and policy surrounding it practically heralded the end of landfilling in the Netherlands, where it shrunk from a 30% market share in the early 1990's to around 2% in 2010. Practically ending a business model, the ban induced a spur of activity in new methods of waste processing, most notably recycling and incineration. The compliance costs were high (see Figure 35. Environmental services consists largely of waste processing and disposal), with the taxation on landfilling for most materials increasing fivefold in one year, creating a level playing field for most employed methods of waste processing.

Figure 35 Environmental costs for various sectors



Source: Compendium voor de leefomgeving (2010)<sup>124</sup>

The Dutch policy flanking the ban on landfilling was consistent over at least a decade period with no known conflicts with other regulations as confirmed by interviews. Before the introduction of the ban there had been a long period of policy uncertainty, as defined by Stewart (2010). However, the ban on landfilling had been anticipated long before the introduction. This can be seen in the diversion away from landfilling in Figure 33.

#### C.8.5. Innovation effects

Policy surrounding waste management has effects that span the entire economy. Taking into account the introduction of producers responsibility, emission standards to either soil, air or (ground)water, recycling targets and waste export regulations, the collection of stakeholders ranges across each and every sector of industry or even society. To keep the study practical the study on innovation effects will keep close to the scope defined in the introduction. The sectors considered are:

- Waste collection
- Landfilling
- Incineration
- Recycling

<sup>124</sup> <http://www.compendiumvoordeleefomgeving.nl/indicatoren/nl0424-Milieukosten-per-sector.html?i=10-73>

- These sectors cover the “effect targeted” portion of the waste policy scheme in Figure 31. The basic mechanism of action was by economic means. The ban on landfilling and the tax on landfilling seem contradictory but had an interesting mechanism of action. Landfilling for materials on the ban-list was prohibited *unless* there was no capacity available to process them. In that case, they were permitted to be landfilled but still at the high rate. This incentivised the creation of processing capacity. So, by increasing the price of landfilling by such an amount that it became equally priced to – or higher than – more preferred methods of waste processing, more streams were diverted away from landfilling. Some waste streams have no other processing method than landfilling, and cannot move up the hierarchy. They are kept in the low tax regime, and their environmental impact can be minimised by continually improving the way landfill sites are created, maintained or closed.
- However, landfill sites have a considerable cost component that is forwarded to the future by the duty to care for them for at least 300 years. Also, by innovating a processing method for a waste stream that falls in the low tax regime, that stream will afterwards fall into the higher tax regime, such that a guarantee for income on at least the level of incineration is created for that process. These are two different drivers for innovation: avoiding future costs and possible income at a guaranteed level for new methods.
- The following sections are based on interviews with stakeholders in the industry. A list of interviewees is given in the appendix.

### **Waste collection**

Although separate waste collection had been common for some streams such as glass, cans and paper, separate collection or processing was not mandatory and the rest fraction of municipal waste contained many of these streams. By drastically increasing the costs of landfilling these streams to the level of incineration, recycling became a viable option over incineration. This was particularly true for bulky waste such as furniture. Later on, to increase the quality and consequently the value of the secondary raw materials that these streams generate, separate collection became a necessity. An example for such a stream is municipal biodegradable waste. With its high water content, this stream is lucrative to keep out of the incineration. However, to use this stream as a secondary raw material in compost required absence of contaminations because of environmental regulations. It is important to keep in mind that during the 1990's, the incentive towards separate collection and recycling was mainly driven by avoiding costs of landfilling or incineration, and not material recovery.

The extended producer responsibility has also had important innovation effects. Initially, high costs were made for setting up the infrastructure for taking back and disassembling goods, for which the consumer paid a fee at the time of purchase. Over the years producers have been able to reduce or even discontinue the fee because of improvements in infrastructure, but also due to technological innovations in disassembly and recovery. This has led to a higher quality secondary material stream for which a higher price is paid. This process has been observed in most of the sectors with an extended producer responsibility. A remark has to be made that many of the secondary materials that are recycled through the extended producer responsibility have seen considerable increases in price in the last decade, as is the case for aluminium and copper.

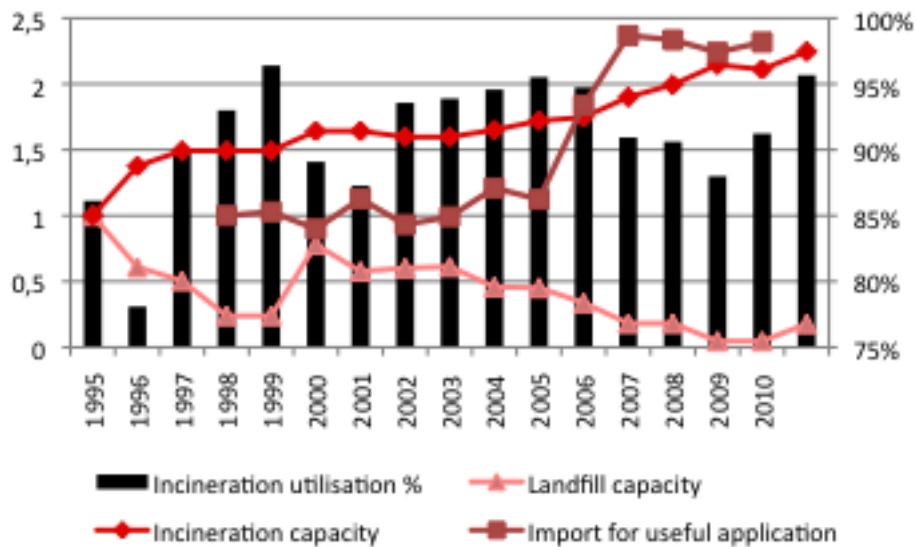
## Landfilling

Although landfilling has become an option of last resort for waste in the Netherlands, there is still innovation for which an important driver is environmental regulation. Increasingly strict regulations for emissions to soil, water and air combined with the requirement to maintain the sites for at least 300 years after decommissioning have stimulated scientific research in this area. To avoid costs for centuries ahead, there is an incentive to have the landfill sites release as much emissions as possible in a minimal time frame, such that the mass is inert and free of emissions afterwards. An example of technology that became practically required by environmental regulations for landfills was capturing landfill gas, because of its greenhouse potential<sup>125</sup>. This development was an effect of the decision on landfilling and soil protection in 1993<sup>126</sup>.

## Incineration

As shown in Figure 33, the Dutch waste policy after 1990 had clear effects on demand for incineration. The development of installed capacity for incineration and the landfill sites with active permits is shown in Figure 36.

Figure 36 Development (index, left axis) of waste processing capacity and utilisation rates<sup>127</sup> (percentage, right axis) in the Netherlands



Source: Technopolis 2013

Between 1990 and 1995, the capacity for incineration was increased by 50% by building new installations and expanding existing ones. Although this led to considerable overcapacity in 1995, the diversion of waste from landfills to incinerators resolved the issue. Towards the landfill ban, capacity utilisation exceeded 95%. Accordingly, landfilling permits were expanded and new incineration capacity was installed. Increased environmental standards led to decommissioning of the oldest incinerators around the turn of the century. This in turn led to higher utilisation rates of the remaining plants, which again led to an increase in capacity. This time however, incineration plants were increasingly designed to maximise the useful employment of the heat generated by incineration, both by electricity generation as was already conventional, but also by urban and industrial heat grids. Interviews point out that this led to a cost advantage (by selling energy) for the most efficient plants that could accordingly charge lower rates for incineration, thus increasing their utilisation rates. A Dutch regulation that helped installing more efficient waste to energy plants was the stimulation package for renewable energy (Stimuleringsregeling Duurzame Energie, SDE). European regulation for waste exports are also said to contribute to technology

<sup>125</sup> G. Verbong (2001)

<sup>126</sup> Parliament (1993)

<sup>127</sup> Utilisation rate is calculated as the fraction of waste incinerated (annually) divided by the current installed capacity

development, because exports are only allowed if the resource can be more efficiently used elsewhere. This is the case for example for the Amsterdam AEB (waste to energy plant) which imports UK waste to reach better utilisation rates. This is a clear example of innovation driven by regulation, not only national but also European and between member states.

Imports also point out that there is overcapacity for incineration in the Netherlands. The domestic supply of waste suitable for incineration was 6.5 Mton in 2011, whereas the incineration capacity was 7.5 Mton; the overcapacity amounted about 15%. This gap is partially filled with imports, most notably from the UK: imports from the UK to the Netherlands have increased fivefold between 2010 and 2011<sup>128</sup>. Figure 36 also shows that there is a correlation between increasing capacity, decreasing utilisation and rising imports for useful application. Although the category for useful application contains many waste streams that are not incinerated, the trend is obvious and interviewees point out that overcapacity seriously affect the market. This is because another effect of the overcapacity is that incineration rates drop, such that direct competition with more favourable methods of waste processing (according to the waste hierarchy) redirects streams from these methods towards incineration.

## Recycling

In the early 1990's the incentive for recycling was driven by cost avoidance for incineration. A business model developed that started separating bulk streams into fractions for recycling or other useful application. Keeping their rates just under those of incineration while significantly minimising the fraction sent to incinerators left a margin for operation and profits. The separated streams were still disposed of at a cost, except for metals. Towards the turn of the century, two developments were driving innovation towards more advanced separation and recycling techniques; the public pressure for corporate social responsibility (CSR) and the increasing resource prices. CSR created a demand for recycled or re-used products, whereas increasing resource prices provided the economic justification of developing technology. These two drivers work both in interaction as well as separately. For example, industry long resisted the development towards using building debris for road construction until Rijkswaterstaat, the Dutch national infrastructure service, started using this stream. The main motivations were the environmental benefits and clean image, and an increase in quality of the roads built with this material. Examples of purely cost driven innovations can be found in improved separation technology for non-ferrous metals, driven by the rising costs of energy.

It is interesting to see that in this sector there is an interplay of product, process, marketing and organisational innovation. Representatives of the Dutch recycling industry are proponents of a circular economy which requires innovations on all of these aspects, as is the case for example with artificial turf or sporting fields. In this case, the recycling industry and the producers of these sporting fields cooperate to fine-tune each others processes and the use of materials to develop a circular product chain.

### C.8.6. Analysis

The Dutch ban on landfilling and surrounding policy has been gradually introduced but had some disruptive effects in the sector. The sudden increase in demand for incineration has led to oscillations around the optimum, leading to alternating over- or undercapacity. The price effects that accompany these oscillations hamper predictive business models and stable income for incinerators, but it also has effects on neighbouring sectors because of competition for waste that is suitable for incineration as well as recycling.

On the positive side, the recycling industry has seen a very rapid professionalisation and many innovations in separation and processing technology, most of them incremental. Innovations in recycling are driven by both policy regulated prices for incineration (the least preferred alternative) as well as prices for secondary raw materials. CSR as a driver for innovation is also mentioned but it remains to be seen if the premium price that is attached to this mechanism will be upheld in the future.

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<sup>128</sup> Rabobank, 2012

In the waste collection industry, process innovation is driven by a demand for more pure streams of secondary raw materials and the producers responsibility. Examples are the separate collection of batteries, packaging plastic, waste electronic and electrical equipment and many other streams. Finally, although landfilling plays a minimal role, environmental regulation drives process innovation towards stable and emissions free landfill sites.

### C.8.7. Conclusion

The case study has covered an interesting period in which the notion of waste has transformed from something to dispose of to a possible resource. This last notion however was not the driver of policy formation; in the early 1990's the Dutch government acknowledged the future costs of environmental degradation and devaluation of public space that landfilling imposed and formed a coherent policy to stop the practice. It focused on the following aspects:

- Developing or supplying alternatives to landfilling
- Increasing the cost of landfilling
- Incentivising the most effective methods of waste processing

Concisely, the policy development was as follows: Increase incineration capacity and introduce price equality for incineration and landfilling. After that, if a method of waste processing is cheaper than incineration, it will automatically be preferred. Also, research started for streams that had no conventional processing method to discover options that had a price level of incineration instead of landfilling, a sevenfold increase in potential turnover.

Innovations in the waste processing sector have almost been exclusively policy driven, as there is no market for things without value. Only since 2010, resource costs appeared as an additional driver for innovations in waste processing. The main drivers for transforming the market have been a tax and a ban on landfilling. Environmental regulations and the producers responsibility have also had significant effects to either improve resource efficiency or minimise environmental harm. Innovations have mainly been in the area of processes for collection, separation, recycling and landfilling. Product and organisational innovations are beginning to appear towards the development of a circular economy.



Table 18 Landfill ban: Drivers and barriers

<b>Factor</b>	<b>Driver</b>	<b>Barrier</b>
<b>Economic and market factors</b>		
<i><b>Current industry structure</b></i>	+++ increased costs for waste management create incentive to reduce waste	-- Increased production costs for Dutch companies hamper international competition
<i><b>Pricing</b></i>	+++ Environmental sector has seen increased income available to innovate	-- price fluctuations and overcapacity divert waste away from recycling towards incineration
<i><b>Market demand</b></i>	+Increasingly clean and separated streams for secondary raw materials	Overcapacity in incineration competes for resources with recycling industry
<i><b>International competitiveness</b></i>	+Resource efficiency reduces production costs ++ opportunities for export of skills, knowledge and technology	--Local production costs increase
<b>Trade</b>	+Developed expertise in recycling and incineration enables waste imports and processing	Producers responsibility introduces costs for newly imported products
<b>R&amp;D Capabilities</b>		
<b>Research organisation structure</b>	+Increased research into landfill maintenance, recycling and incineration	--- Ability to export knowledge is solely dependent on the willingness of other countries to adopt a similar waste hierarchy and cost policy.
<b>Socio-cultural</b>		
<b>Environmental awareness</b>	+++ waste is increasingly seen as a resource	
<b>Environmental quality</b>	+++ landfilling practically stopped, emissions from incinerators minimised, re-use of materials considerably increased	

### C.8.8. References

Blind (2012). The Impact of Regulation on Innovation: Compendium of Evidence on the Effectiveness of Innovation Policy Intervention

Brundtland (1987). Our common future

Nijpels (1998). Preventie en hergebruik an afvalstoffen, 1988-1989 20877 nr. 2

Parliament (1993). Besluit van 20 januari 1993, houdende regels inzake het storten van afvalstoffen

Parliament (1997). Besluit van 8 december 1997, houdende een stortverbod binnen inrichtingen voor aangewezen categorieën van afvalstoffen (Besluit stortverbod afvalstoffen)

Parliament (2007). Neveneffecten van producentenverantwoordelijkheid in het afvalstoffenbeleid

Rabobank (2012). De grondstoffenrotonde uitgelicht.

Stewart (2010). The Impact of Regulation on Innovation in the United States: A Cross-Industry Literature Review

Verbong (2001). Een kwestie van lange adem: de geschiedenis van duurzame energie in Nederland. Aeneas publications, Boxtel, the Netherlands

Werkgroep Afvalstoffenbelasting (2009). Tariefstructuur afvalstoffenbelasting: Onderzoek naar de mogelijkheden van de tariefstructuur van de afvalstoffenbelasting

#### **Interview partners**

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Otto Feenstra, Afvalzorg Nederland, consultant in policy and process development for a Dutch landfill operator

Dick Hoogeveen, Dutch Waste Management Association, Director

Max de Vries, Branchevereniging Recycling Breken en Sorteren, Director of the professional association for companies in recycling, disassembly and sorting

## C.9. WEEE waste electrical and electronic equipment directive

Author: Matthias Ploeg

### Key messages:

- The Directive was implemented with a considerable delay in the UK in 2007.
- UK's WEEE implementation is under a (market-oriented) clearing house system;
- WEEE regulation changed the way WEEE collection, recycling and re-use is administrated and financed. Effects on improving collection and recycling not obvious. Some positive effects on collection and recycling rates observable.
- Implementation using generalisation of 'kg mass' across all products has led to a focus on the collection and recovery of bulk metals (steel, copper etc.) of large and heavy appliances (such as washing machines, tumble dryers, fridges etc.) instead of increased efforts in collecting critical metals in relatively lightweight appliances
- Implementation of the WEEE Directive has had slight positive effects on innovation, but did not achieve its explicit aim of fostering and inducing innovation by producers of EEE. A few new collection methods were implemented and a minority of companies adopted new processes in their waste treatment procedures. Most innovations applied originated from elsewhere and were only 'new to the market' in the UK. Real disruptive innovations did not materialise.
- Potential innovation effects could have been much higher if the regulation was better and earlier designed or if raw material markets had functioned differently.

### C.9.1. Background

WEEE makes up a substantial and growing share of total waste. In the EU it is already 8% of all municipal waste (Table 19).

Table 19 WEEE Key figures

	<b>World</b>	<b>EU</b>	<b>UK</b>
<b>Annual production of WEEE</b>	20-50 million tonnes (growth rate 3%-5% per year)	6.5 million tonnes a year (2005), estimated at 12 million for 2015	±2 million tonnes a year (representing 93 million items)

Source: Ogondo (2011) / WEEE guide

The WEEE Directive of 2002 (EC/2002/96) was the first major step at the European level aimed at addressing this growing challenge. It is specifically aimed at reducing the use of raw materials in production and increasing the recycling rate of WEEE. As a European Directive, the WEEE Directive has been transposed into national law in all 27 European Member States, resulting in heterogeneous implementation mechanisms. The implementation of WEEE in the United Kingdom was chosen as it is a large Member State, a country with a clearing-house system, and a market-based producer responsibility allocation mechanism with supposedly more innovation incentives. Additionally, a UK case study can benefit from the fact that the Department for Business Innovation and Skills (BIS) is currently (Summer 2013) carrying out a large stakeholder consultation resulting in an active policy debate. A case study can benefit from the arguments surfacing from such a public discussion and make use from the attention of stakeholders to gather information on innovation effects of the regulation looking back at the last 7 years since the UK law was implemented (2007).

## C.9.2. WEEE in the United Kingdom

Policy discussions on the European level on how to deal with the growing challenge of e-waste (or WEEE) started in the early '90s when the European Union designated e-waste a priority for future legislation, since existing regulation was not considered adequate for a number of reasons<sup>129</sup>:

- A rapid growth of the quantity of WEE flowing into the municipal waste stream combined with high disposal costs posed a significant challenge for municipal authorities;
- Given the complex mixture of materials present in WEEE, contemporary practice of landfill and incineration posed a threat for the realisation of toxins into soil, water and air;
- WEEE contains a number of valuable resources such as gold, silver, palladium, indium, tellurium, but also iron, copper and aluminium.

Together with the Directive on Restriction of Hazardous Substances (RoHS<sup>130</sup>), the WEEE Directive was introduced in 2002 to address this challenge. The WEE Directive came into force on 27 January 2003, and covers a set of 10 broad categories of appliances which fall under the directive:

1. Large household appliances
2. Small household appliances
3. Information technology
4. Consumer equipment
5. Lighting equipment
6. Electric and Electronic tools
7. Toys, leisure and sports equipment
8. Medical devices
9. Monitoring and control instruments
10. Automatic Dispensers

The Directive stipulates that Member States must ensure that producers provide for free of charge collection mechanisms for consumers, and introduces a triple target for Member States:

- A collection target (4kg per capita per year from households)
- A reuse and recycling target (between 50%-75%, depending on product class)
- A recovery target (between 70%-80%, depending on product class)

The extension of producer's responsibilities for downstream waste was intended to have a dual effect on better waste collection and recycling on the one hand, and also an effect on product design and innovation on the other hand. The basic premise of this mechanism is that producers have a direct incentive to reduce to the use of materials when they have to pay for the costs of collection, recycling and recovery themselves.

Given the legal function of a Directive, these requirements are outcome-oriented and leave the methods of implementation up to the Member States. According to Savage et al. (2006), there are two typical methods of implementing the European Directive – the single national compliance scheme model and the clearing house model. In a single national compliance scheme model a national producer responsibility organisation takes on the collection, transportation and recycling of WEEE on behalf of all producers. This model is used in countries such as Belgium and Sweden. In a clearing house model, producers must report their products put on the market to a government managed or authorised organisation which assigns the financing and collection responsibilities based on market shares. The clearing house model is based on the idea that such a system is more market based and thereby provides better incentives for material efficiency in design. Most larger EU Member States, such as Germany, France and the United Kingdom use this approach.

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<sup>129</sup> Khetriwal (2011)

<sup>130</sup> EC Directive 2002/95

The implementation of the Directive in the United Kingdom took relatively long and was effective from 1 July 2007<sup>131</sup>. In the United Kingdom, producers of electronic and electrical equipment are required to join a producer compliance scheme (PCS). A PCS is responsible for financing the recycling and disposal of WEE, and has to be approved by the Environment Agency (EA). Recycling and disposal is handled by authorised treatment facilities (ATF) and approved exporters (AE). Additionally, distributors have to join a Distributor Take back Scheme or provide in-store take back in order to fulfil their responsibilities for collection and transport of WEEE. Local Authorities can play a role by volunteering their Household Waste Recycling Centres (HWRC) as Designated Collection Facilities (DCFs), thereby financially compensated by the PCS. Table 20 gives a summary of the groups affected by the WEEE regulations.

Table 20 Groups affected by WEEE-Directive

Group	Level of impact	Description
<b>Producers</b>	High	Producers are given the main responsibilities in the WEEE Directive for financing recycling and recovery, as well as offering free waste collection services
<b>Distributors</b>	Low	Distributors have to work together with producers to facilitate collection (e.g. through in-store take back)
<b>Consumers</b>	Low	Consumers will have to dispose of their EEE products in a different way (e.g. in-store) for some products.
<b>Local Authorities</b>	Medium	Local Household Waste Recycling Centres have to make new arrangements with producers and may need to offer extra collection services, although their financial burden is relieved.
<b>Treatment facilities</b>	High	High collection and recycling targets translate into a large secure demand, which allows for investment into capacity and effectiveness/efficiency

### C.9.3. Regulation

As discussed above, the Waste Electrical and Electronic Equipment Regulations 2006 is the transposition of the WEEE Directive into UK legislation. In the following sections the key objectives, the specific regulations, a characterisation and key effects and will be discussed in more detail:

#### Key objectives

The overall rationales of the WEEE regulations<sup>132</sup>, as stated by the UK Government, are market failures in terms of negative externalities.

The key objectives of the regulation are equivalent to the European Directive:

- To improve WEEE collection through a collection target (4kg per capita per year from households)
- To increase reuse and recycling through a target (between 50%-75%, depending on product class)
- To improve recovery rates through a recovery target (between 70%-80%, depending on product class)

The UK Government followed two important principles when designing the regulation:

- The financial and administrative burden on UK business should be minimised while complying with the EU Directive
- Producers should have as much flexibility as possible in using implementation methods while complying with the UK WEEE regulations.

<sup>131</sup>The official title is the Waste Electrical and Electronic Equipment Regulations 2006

<sup>132</sup>As discussed in the 2013 UK WEEE Impact Assessment

## Key regulations

The most important elements of the WEEE Regulations 2006 are discussed below.

### Financing WEEE from private households (Part 3)

Producers of EEE have to bear the cost of collection, treatment, recovery and environmentally sound disposal of WEEE from private households and that is deposited at a DCF or returned in-store. Producers pay for their mass share in the total mass share per 'relevant category'. These relevant categories are the 10 mentioned in 2.1. The financing and accounting mechanism is provided by a PCS, which acts as a clearing house service for each producer. Joining a PCS is mandatory (Art. 10). Other complementary measures are:

- Adequate record keeping of tonnes of EEE, and disclosure of information to PCS operators (Art. 11)
- Marking the EEE with a crossed out wheeled bin symbol (Art. 15)
- Marking the EEE with a producer identification mark and date mark (Art. 16)

### Functioning of a producer compliance scheme (Part 4)

Producer Compliance Scheme operators are responsible to set up a scheme for setting up systems that ensure recovery of WEEE and subsequent recovery/recycling by a treatment facility (Art. 26). This article also prescribes recovery and reuse/recycling targets for each product category. Producers are obliged to provide information to the PCS regarding the amounts of EEE in tonnes on the market (Art. 27 & Art. 28).

### Distributor obligations and rights (Part 5)

Distributors of EEE have to provide the ability for consumers to return any equivalent WEEE from private households free of charge (Art. 31, Art 32.). Distributors also have an active information duty to inform consumers (Art. 32), and have to keep records regarding sold EEE and recovered WEEE (Art. 33). Alternatively, distributors may join a distributor take back scheme (Art 34.)

### Miscellaneous provisions (Part 6, 7, 8)

- Users other than households have to all bear costs themselves (Art. 36)
- WEEE transporters have to optimise their systems to promote recyclability (Art. 37)
- Scheme operators are free to implement another collection mechanism which goals are consistent with the Directive (Art. 39)
- Producers are not allowed to show the incurred costs to the purchaser (Art. 40)
- PCSs have to be approved by the Environmental Agency<sup>133</sup> (Art. 45)
- Treatment facilities and exporters have to be approved by the Environmental Agency (Art. 47)

## C.9.4. Classification of regulation

### Blind Classification

When classifying the WEEE Directive and the UK implementing regulation using the Blind/OECD methodology, multiple aspects can be distinguished:

- Social
  - Environmental protection
  - Product and consumer safety
- Economic
  - Market entry regulation for compliance schemes, approved waste treatment facilities and exporters
- Institutional
  - Extended producer responsibility changes the institutional arrangements on product liability/environmental impact.

The WEEE regulations is clearly a relatively complex 'regulatory system' with institutional, economic and environmental aspects, given its focus across multiple parts of the life-cycle of a product through the extended producer responsibility principle.

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<sup>133</sup> The situation described applies to England and Wales, Scotland and Northern Ireland have their own environmental agencies.

## Stewart characteristics

The Stewart (2010) model assesses regulations on three dimensions: flexibility, transparency inducement and stringency. Regarding flexibility, the WEEE Directive and its UK version can be considered to be very flexible, since all requirements are outcome-oriented (collection, reuse and recycle targets). Producers are free to organise their own compliance schemes and may work with any (approved) waste treatment facility. One aspect of the regulation, which is less flexible, is the fact that the product categories to which the WEEE Directive applies are predetermined, the regulation therefore needs to be updated regularly when new product classes appear.

When assessing the extent to which the regulation promotes transparency, the WEEE Regulations in the UK do not score particularly high. Although the implementation requires good record keeping of introduced product mass into the markets, and induces the collection of information on processed WEEE, this information is not publicly accessible nor particularly useful. Since producers cannot trace their individual products through the entire product cycle (unless they have an individual PCS), they only receive the average cross-brand recycling figures.

Regarding stringency, it is clear that the regulation was designed to work together to the RoHS Directive<sup>134</sup>, which places restrictions on the use of certain hazardous materials in electronic and electrical equipment. There is no direct evidence of compliance issues with other regulations, so the regulation can be considered relatively stringent.

### C.9.5. Key outcomes

In terms of main outcomes of the regulation, the UK Impact Assessment Report showed that by 2011:

- 5957 businesses were registered as either B2C (Business to Consumer) or B2B (Business to Business) EEE producer;
- 37 producer compliance schemes had been approved.
- Over 200 authorized treatment facilities were approved
- 74 companies were on the Approved Exporter Register
- The number of designated collection facilities was 1874
- 2850 distributors joined the official Valpak Distributor take back scheme.

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<sup>134</sup> EU Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment

Table 21 shows the total amount of WEEE collected in the United Kingdom and a few other European countries. Clearly, all countries show substantial growth, with the UK more than doubling its collection of WEEE between 2007 and 2008. After that date, figures grew only slightly. The 2010 figures of ±480 tonnes of WEEE collected with a total population of ±62 million translates to 7.8 kg per head, comfortably reaching the EU target of 4 kg per person.

Table 21 WEEE collection in tonnes

	2005	2006	2007	2008	2009	2010	2010 (tonnes/head)
Belgium	68,150	76,187.3	81,828.6	89,109.3	102,977.2	105,556.4	9.6
Germany	:	753,900	586,966	693,775	832,236.3	777,034.7	9.5
France	:	15,160	174,777	300,988	393,273	433,959	6.6
Netherlands	89,827	94,484	98,190	103,319	108,457	128,119	7.7
Sweden	48,774	130,062	155,553	150,124.8	153,706	161,444	17.1
United Kingdom	:	:	193,993.5	448,009.5	471,449.3	479,356.4	7.7

Source: Eurostat

The total volume of WEEE which is re-used or recycled is shown in Table 22. Here we see a similar jump between 2007 and 2008 for the United Kingdom. Other countries show similar sharp increases related to the implementation of the WEEE directive in their respective countries, for instance France (between 2006 and 2007) and Sweden (between 2005 and 2006). The Netherlands and Belgium already had national WEEE-schemes in place before 2005.

Table 22 Re-use/recycle of WEEE in tonnes

	2005	2006	2007	2008	2009	2010
Belgium	50,325.4	58,465.1	65,369.7	68,635.9	80,371.3	84,647.2
Germany	:	600,062	474,436	558,907	668,593.8	643,079.1
France	:	4,081	125,122	228,394	290,526	335,991
Netherlands	67,898.6	73,475	77,617	83,756	85,515	102,325
Sweden	46,007	122,688	127,321	123,900	129,135	135,490
United Kingdom	:	:	150,548.4	340,611.9	366,218.4	:

Source: Eurostat

Table 23 shows the rate of recycling and re-use as a share of total collected WEEE volumes. The United Kingdom consistently scores over 75%, but performs worst of the selected countries except for France (although the UK does score better than some other EU countries not mentioned). In general, the figures have steadily converged to around 80%.

Table 23 Re-use/recycle as a share of collected WEEE

GEO/TIME	2005	2006	2007	2008	2009	2010
Belgium	73.85%	76.74%	79.89%	77.02%	78.05%	80.19%
Germany	NA	79.59%	80.83%	80.56%	80.34%	82.76%
France	NA	26.92%	71.59%	75.88%	73.87%	77.42%
Netherlands	75.59%	77.76%	79.05%	81.07%	78.85%	79.87%
Sweden	94.33%	94.33%	81.85%	82.53%	84.01%	83.92%
United Kingdom	NA	NA	77.60%	76.03%	77.68%	NA

Source: Eurostat



The figures show that the WEEE regulation was successfully implemented. However, it is important to note that the figures show collected and registered WEEE. Some experts indicate that the UK was already reaching similar targets before 2006, but was not registering WEEE separately. Although the WEEE regulations of 2006 definitely changed the way WEEE collection, recycling and re-use is administrated and financed, it is more difficult to say whether it has had a very large effect on actual improved WEEE collection and recycling. However, the interviewed experts agree that the implementation has had at least some positive effect on collection and recycling rates.

One of the **main drawbacks** of the WEEE Directive and its UK implementation regarding material use is **its generalisation of 'kg mass' across all products**. This has led to a focus on the collection and recovery of bulk metals (steel, copper etc.) of large and heavy appliances (such as washing machines, tumble dryers, fridges etc.) instead of increased efforts in collecting critical earth minerals and metals in relatively lightweight appliances (such as mobile phones).

#### C.9.6. Innovation effects and associated barriers and drivers

The innovation effects of the WEEE Directive can arguably take place in the following lifecycle stages of a product, given the affected actors as presented in Table 20:

- Product innovation by producers in product design aimed at improved material efficiency
- Process/organisational innovation by producers and distributors in collection mechanisms
- Process/organisational innovation by waste treatment facilities and recycling companies aimed at improved recovery, recycling and re-use.

The expected and realised innovation effects will be discussed for these three types, including an analysis of the drivers and barriers interacting with these effects.

#### C.9.7. Innovation by producers in product design

We already discussed earlier that the WEEE Directive and its UK implementation is especially interesting from an innovation perspective since, unlike most other regulations, it actually has an explicit innovation goal. By extending producer responsibility, the WEEE Directive not only aims to implement the 'polluter pays' principle, but also seeks to incentivise innovation in material efficiency of products, or 'waste prevention'.

Table 24 shows the R&D expenditure by product groups of UK manufacturers, which could provide us with an initial insight in innovation activities in the electrical and electronic equipment industry. The evidence here is mixed, some categories show sharp growth (computers and peripheral equipment), some grow slightly (electrical equipment and precision instruments), whereas consumer electronics and communication equipment R&D-spending decreased substantially. However, given the challenging economic conditions of the past five years and the substantial market changes in some consumer good categories (mainly mobile phones and portable computers), it is very difficult to attribute any of these changes directly to the WEEE regulations.

Table 24 Expenditure in R&D by product groups, in million of pounds

	2006	2007	2008	2009	2010	2011	Percentage (2011)
TOTAL	14144	15676	15814	15532	16053	17408	100
Computers and peripheral equipment	67	83	123	151	157	180	1.0
Electrical equipment	458	547	577	577	513	509	2.9
Consumer electronics and communication equipment	748	667	700	547	476	510	2.9
Precision instruments and optical products; photographic equipment	462	544	591	498	490	595	3.4

Source: Office of National Statistics

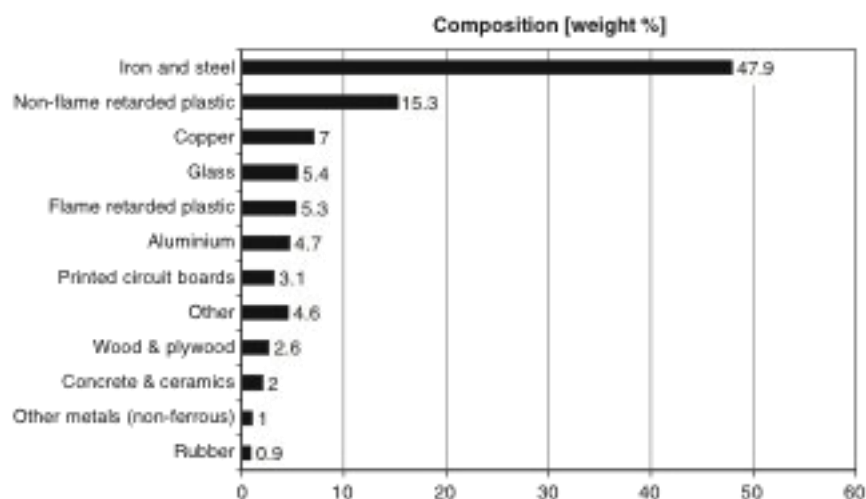
However, all interviewed experts agree that by and large there has been **no change in producer innovation behaviour** and therefore innovation outcomes oriented **towards improved material efficiency**, although there are a few exceptions<sup>135</sup>.

The following barriers were identified as most important in limiting producer behaviour change:

- The Producer Compliance Schemes generally operate on a collective basis. Since waste cannot be traced across the entire chain, producers pay a more or less average contribution per product put on the market. There is no large incentive to invest in reducing the materials in your own products, since little of the returns will flow back to your own company and as a producer you will end up subsidising your competitors.
- The costs associated with a PCS are not large enough for producers to provide incentives to reduce their material consumption for products. Since the current focus of the WEEE scheme in the UK is on the recovery of bulk metals (Figure 37), the sale of this recovered material is quite lucrative and offsets a substantial share of the collection and recovery costs.
- There is no real consumer demand for products with a better material efficiency. Although the importance of energy use during actual use has increased (with for instance the labelling of large household appliances), consumers generally do not choose on the basis of material efficiency.
- Most electrical and electronic products are not designed for the United Kingdom only, and are designed for worldwide use. Since recycling methods and regulations differ across the world and there is a need for standardised production methods, producers may not find it attractive to 'design for recycling in the UK'.
- Producer compliance schemes are generally viewed as a burdensome cost only rather than an opportunity to differentiate with competitors or an incentive to secure access to recovered raw materials.

Most experts agree that the **main problem holding back innovative design** for improved material efficiency or the implementation of integrated life-cycle thinking is **the lack of individual producer responsibility**. A huge potential driver for increasing innovation in this sector would therefore be to implement individual producer responsibility. The main challenge herein is organisational and administrative, not technical, since it would require a cheap, reliable way of tracking and measuring material (and waste) flows across the entire life cycle.

Figure 37 Composition of WEEE



Source: Widmer et al (2005)

<sup>135</sup> Experts mention Dell as a positive example, which operates its own take-back scheme and has an explicit 'design for recycling strategy', although this policy cannot be entirely attributed to the WEEE regulatory developments. . See <http://www.dell.com/learn/uk/en/ukcorp1/dell-environment?c=uk&l=en&s=corp&cs=ukcorp1> for more information.

### C.9.8. Innovation in collection by producers and distributors

Another potential innovation effect of the WEEE regulations could be expected around collection and distributor take-back schemes for WEEE. The UK implementation leaves a lot of flexibility for producers and distributors to organise collection in their own preferred manner, as long as they comply with the WEEE regulations. In the previous section, we have seen that separated collection of WEEE has increased, although parts of this effect are due to better registration of WEEE. Interviewed stakeholders note that there are some good examples of effective collection mechanisms<sup>136</sup>, but the majority of WEEE is collected via regular municipal waste treatment facilities. Although current collection mechanisms are effective in reaching the WEEE targets, there is limited evidence of particular innovative service models (e.g. leasing contracts, financial incentives for returning appliances) aimed at improving collection. Barriers for more innovation in this area have been, according to experts:

- Limited incentive to further improve collection rates, since targets were already met comfortably.
- Very little incentive for consumers to bring back appliances to stores, except for offered collection service during delivery of a new appliance
- The UK has a limited culture of 'consumer responsibility' for waste, such as container deposits for bottles.

### C.9.9. Innovation in recycling, re-use and recovery

Finally, innovation effects could in principle be expected in waste treatment, recycling and recovery. Since the regulation provides a secure supply of WEEE to waste processors and may lead to expectations regarding future higher recycling targets, the WEEE regulations could induce innovation at the waste processing side as well.

Figure 38 shows the recent development of the investments in research and development in the sewerage, recycling and remediation activities. Between 2006 and 2010, the level of investment increased more than tenfold to around 11 million pounds (still less than 0.1% of total R&D expenditure). Although this growth coincides with the adoption of the WEEE regulations, it is not immediately obvious whether this increase is directly related to the implementation of the WEEE Directive or whether it reflects broader economic, social and scientific developments. While it is difficult to present conclusive figures, interviewed experts and stakeholders agree that WEEE has contributed to some extent to encouraging innovation behaviour, but that the overall effects have been limited. One process innovation that did occur in this period is the introduction of near-infrared technology to recognise and separate circuit boards, which are relatively valuable<sup>137</sup>.

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<sup>136</sup> The Dixons/Currys chain, which has a large market share in consumer appliances, has a particularly good in-store take back scheme for collection of appliances. See for instance <http://www.currys.co.uk/gbuk/recycle-1042-theme.html>. Dell, mentioned earlier, also has a dedicated take-back system.

<sup>137</sup> Two technologies were introduced: the Belgian Visys laser sorter and the German TITECH Near infrared Polysort. For more information see WRAP (2009). 'Separation of Mixed WEEE Plastics',

Figure 38 R&D expenditure in millions of pounds



Source: Office of National Statistics

The main barriers for innovation have been:

- A focus on recovery of ferrous bulk metals, due to the generic kg mass requirement, has led to little attention for the recovery of critical rare earth metals and minerals. Very little of these low-volume high-value materials are currently actively recovered or exported, either to low-wage countries or specialist firms (most collected mobile phones are exported to Umicore, a global Belgium-based materials firm).
- Since producer compliance schemes can contract their recycling to any of the Designated Treatment Facilities, there is a market, which is mainly based on a competition on cost (while still delivering the minimum requirements), rather than on quality, high recovery rates or innovative services.
- Material prices for non-ferrous materials, such as plastics and critical earth minerals/metals are too low or too volatile to warrant substantial investment in recovery technology.
- There are environmental and regulatory risks with more complex recovery of plastics and critical earth metals/minerals.
- Waste treatment facilities work with spot markets for their recovered materials, further decreasing the willingness and possibilities to invest in new technology.
- Large parts of the waste treatment industry are relatively conservative. Also, since the UK was relatively late with implementation of the Directive, the next recast was never far away and many companies adopted a 'wait and see' attitude. It might be that, depending on the regulatory change, investments may go up after regulatory certainty is improved once the updated regulation is implemented.

#### C.9.10. Conclusions on innovation effects and drivers and barriers

Overall, we can conclude from the above that the implementation of the WEEE Directive has had slight positive effects on innovation, but did not achieve its explicit aim of fostering and inducing innovation by producers of electronic and electrical equipment. Similarly, few new collection methods were implemented, and although research in waste related industries increased slightly in nominal terms, only a minority of companies adopted new processes in their waste treatment procedures. Furthermore, many of these examples of innovation found in the case study originated elsewhere and were only 'new to market' in the UK. Real disruptive innovations, such as 'product as service' or leasing models which define extended producer responsibility in a new way did not materialise. On the positive side, WEEE has contributed to improving the acceptance of the 'polluter pays' principle, increased recognition of WEEE as a public and – to some extent – private challenge, and it has provided some leading innovative companies to design their own Producer Compliance Schemes. Since there is no evidence that WEEE has actually substantially decreased research and development due to higher costs, this leads to the conclusion that **WEEE has had a slightly positive effect on mainly incremental innovation**, but that the potential

innovation effects could have been much higher if the regulation was better designed (design aspects) or if raw materials markets had functioned differently (structural aspects).

The most important drivers and barriers are listed in Table 25 below. Arguably, the dominant barriers are economic and market factors, which would need to change in order to turn them into drivers. A stringent implementation of extended individual producer responsibility, or the introduction of material-specific targets could greatly increase the incentives for innovation, but also has much larger (negative) side-aspects such as a potential loss of competitiveness for UK industry.

Table 25 WEEE: Drivers and barriers

Factor	Driver	Barrier
<b>Economic and market factors</b>		
• <b>Current industry structure</b>	+ competition between companies stimulates innovation and cost reduction.	--- most product design is globally oriented, while recycling (WEEE) regulation is national
• <b>Pricing</b>	+ there are markets for most recovered materials	--- but the prices are often too low and volatile to provide real incentives of collection materials beyond ferrous metal
• <b>Market demand</b>	+ there is market demand for most raw materials + increasing attention/value given to rare earth metals/minerals	--- but most supply chains are not oriented towards recovered materials such as plastics
• <b>Consumer market demand</b>	+ growing awareness of energy use of appliances	-- but there is no real consumer 'pull' for resource efficient products or 'product-as-a-service' concepts'.
• <b>International competitiveness</b>		--- Recovery market is competing with low-labour disassembly in non-EU countries
• <b>Trade</b>		--- Most EEE sold in the UK was not designed nor manufactured in the UK.
<b>R&amp;D capabilities</b>		
<b>Research organisation structure</b>	+ waste research in the UK is increasing	-- But there is not large technology institute 'pushing' new technologies
<b>Risk aversity</b>		-- Waste treatment facilities are relatively risk averse towards long-term investments and innovation behaviour
<b>Socio-cultural</b>		
<b>Environmental awareness</b>	+ WEEE fits into and support a growing environmental awareness among consumers, although there is a threat of 'environment fatigue'.	- there is no tradition of consumers being responsible for waste collection beyond separation at home

<b>Policy</b>		
<b>Governance structures</b>	+ the existing WEEE regulations offers flexibility to producers	--- but the lack of individual producer responsibility leads to a lack of individual incentives.
<b>Demand-side innovation policy</b>	+ Existence of the SBRI innovation funding	-- No use of the municipal authorities often responsible for these waste collection facilities of the SBRI.
<b>Harmonisation</b>	+ WEEE uses the same principles across the EU	-- But producer compliance schemes operate mainly nationally and have to be approved in each Member State separately.

## C.10. Recycling certificates

Author: Michaela Gigli

### C.10.1. Introduction: Innovation needs

The present case study on 'Promoting the use of recycled content in new products: Recycling certificates and Tax refunds' deals with the non-technology policy pillar of the Strategic Implementation Plan (SIP), referring to the priority area aiming to improve Europe's product and waste management regulatory framework conditions and excellence. In detail, in order to evoke innovations with regards to raw material efficiency, the action is targeted on improving the EU regulatory framework for products. Several policy measures for waste management are already in place for recycling or collection of certain waste streams (e.g., packaging, tyres, end-of-life vehicles, batteries or WEEE) but specific policy measures to promote the overall use of recycled materials in the production of new products are still lagging behind.

The EU's legal framework for products is an area of utmost importance, since the regulations for the design of products so far in place do not yet cover all objectives regarding recycling efficiency and raw material use. Besides the recognition that the Eco-design directive should be further improved in that regard (see separate case study), this is especially true in light of achieving minimum recycling rates for certain specific materials used in certain products.

The European Commission in its Roadmap to a Resource Efficient Europe (COM/2011/571) tackles the existing deficits by planning to:

- “Stimulate the secondary materials market and demand for recycled materials through economic incentives and developing end-of-waste criteria (in 2013/2014);
- Assess the introduction of minimum recycled material rates, durability and reusability criteria and extensions of producer responsibility for key products (in 2012)”

The European Commission thus considers introducing minimum recycled material rates for key products, amongst others, as an action that is able to stimulate the secondary materials market and demand for recycled materials. It is stated furthermore that economic incentives and developing end-of-waste criteria would also support these markets.

Moreover, in its Raw Materials Initiative strategy document (2011), the European Commission proposed a number of measures aimed at improving how the recycling market works and proposed to develop new initiatives to improve the competitiveness of EU recycling industries notably by introducing new market based instruments favouring secondary raw materials (and promote the use of secondary raw materials in products, notably in the context of the Eco-design Directive). This is advanced through the ongoing development of “End-of-waste”<sup>138</sup> criteria, which is a major policy issue because legal clarity needs to be established for defining when certain waste ceases to be waste and obtains a status of a product (or a secondary raw material). The Commission under the Waste Framework Directive is developing 'End-of-Waste' criteria for specific waste streams. The criteria have been laid down for iron, steel and aluminium scrap and work is advancing on rules for recovered paper, copper, plastics, biodegradable materials and glass.

The following section reviews existing instruments and programmes to foster recycled content rates of products before going over to a more in-depth comparative analysis of recycling certificates and tax refunds as specific instruments.

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<sup>138</sup> See <http://susproc.jrc.ec.europa.eu/activities/waste/> 03/07/2013

### C.10.2. From innovation to regulation: policies promoting recycled content of products

Several possibilities can be thought of that are capable of introducing legal or voluntary requirements for the use of recycled content.

A report on the implementation of the packaging and packaging waste directive (94/62/EC) (Ecologic & IEEP, 2009) assessed the measures taken at EU level to encourage the use of recycled material (in reference to Article 6.4 of the directive: "Member States shall, where appropriate, encourage the use of materials obtained from recycled packaging waste for the manufacturing of packaging and other products by: (a) improving market conditions for such materials; (b) reviewing existing regulations preventing the use of those materials"). The study examines the transposition of the directive to different Member States and concludes, "that the majority of Member States have taken measures to encourage the use of materials obtained from recycled packaging waste for the manufacturing of packaging and other products" (p.22). The most common measures are described below.

### C.10.3. Minimum recycled content standards

This measure serves to increase demand for recycled material directly by forcing manufacturers to include recycling in their operations. Content mandates issued by governments specify that a certain percentage of a new product must consist of recycled material. No standard of this sort seem to be in place within the EU.

Hoogmartens et al (2013) mention the United States as an example where such command and control-regulation exists in several States. For instance California requires newspapers to have a recycled paper content of 40% in at least half of the amount of paper that is used by one publisher. These standards also exist for other products, eg phone books, packaging, plastic bottles and glass. The legislation is said to be controversial given its very static target (and the fact that not reaching it will be fined, whereas outperforming bears no additional benefits). A further step could try to identify evaluations of this policy instrument the USA to learn more about its effectiveness.

There are however voluntary standards to be found within the EU that came into existence as a reaction to the Packaging and Packaging Waste Directive (94/62/EC) and its amendment in 2004 where recycling targets for certain materials were defined (Hoogmartens et al 2013, p. 14).

There is for instance the UK with its standards on construction and demolition waste (see below). Also in Germany some minimum recycled material content standards are found in the voluntary eco-label standards ("Der Blaue Engel"). In these cases producers and distributors must prioritise recycled content in manufacturing products (ETC/SCP 2010).

Hoogmartens et al (2013, pp. 21) describe in more detail why standards are less advantageous. Many of these arguments are described in more detail below since they also for other instruments. One problem is the definition of recycled content, which has been mentioned in other parts of this paper. As it is the case with other instruments, procedures would have to be put in place for each product/waste stream separately. There is furthermore the risk of standards being too high or too low and have as a consequence no or not enough impact. Standards are not offering any motivation to perform better than the target. There are observations that governments increasingly tend to make use of voluntary initiatives or procurement standards instead of command-and-control measures.

### C.10.4. Promotion of recycled content through public procurement

Procurement policies are introduced by governments, following the logic that their own power of purchasing subsequently increases the demand of products with recycled content. Procurement standards set minimum limits for the amount of recovered material a specific product must contain (or that total purchases must contain). They can be expressed relative to the amount of virgin material used in production, or relative to total output.



The DG Environment's Green Procurement Handbook (2011) encourages contracting authorities to "insist that the product you are purchasing be made from a specific material, or contain a certain percentage of recycled or reused content" (p. 28). Typical examples in place in many member states include requiring a certain percentage of post-consumer recycled content in copying paper.

For instance, in Finland and Italy the public authorities are encouraged to use as much recycled materials as possible. The Danish public procurement policy requires municipalities to use recycled paper (ETC/SCP 2010). In Cyprus, measures to encourage the use of recycled materials have been implemented through 'Green Public Procurement' (Ecologic & IEEP 2009) and in the UK a procurement guide is available for delivering higher recycled content in construction projects (WRAP & Cyril Sweett 2009).

The following is an example for a procurement scheme from the United States. The Resource Conservation and Recovery Act (RCRA) requires procuring agencies to buy recycled-content products designated by the US Environment Protection Agency (EPA) in the Comprehensive Procurement Guidelines (CPG). A key component of the CPG program is EPA's list of designated products<sup>139</sup> which are grouped into eight categories, and the accompanying recycled-content recommendations. Again, the analysis of programme evaluations could also in this case help to draw conclusions about innovation effects of public procurement measures.

#### C.10.5. Financing of projects or research into the promotion of recycled materials

Ecologic & IEEP (2009) refer to the example of France where ADEME, the national environment protection agency, and the return system "Eco-Emballages" support research and development programmes to develop applications for the use of secondary materials. Also Eco-Emballages publishes an online catalogue of products made from recycled materials destined for public purchasers (p.20).

##### Information and awareness-raising activities



A further policy measure to promote increased demand of recycled materials are information campaigns and programmes, e.g. recycled product labelling (such as the Möbius loop) or online catalogues of recycled products.

For instance in Spain, manifold awareness-raising activities to promote the use of recycled packaging waste were undertaken (Ecologic & IEEP 2009). The labelling of packaging with the amount of recycled material in the product (including the packaging), enables consumers to make educated choices, thus prompting producers to increase the amount of recycled material in their product.

A revised method for the calculation of the recycled content is presented in JRC Report No 3 (2012). Looking at non-EU markets, a voluntary industry initiative has been implemented at the U.S. market in which companies can obtain certificates of their products that contain recycled material. The recycled content is also expressed quantitatively as a percentage in form of a label. Total proportion of recycled materials is considered by mass for the product and/or product packaging. There are several accredited certifying bodies in the U.S.<sup>140</sup>.

Ecologic & IEEP (2009) furthermore mention that there are measures specifically related to drinks packaging, which can be added as an extra category to the above mentioned measures.

<sup>139</sup> See <http://www.epa.gov/epawaste/consERVE/tools/cpg/products/index.htm> (01/07/13).

<sup>140</sup> See for example <http://www.verus-co2.com/RecycledContentCert.htm> or <http://www.scsglobalservices.com/recycled-content-certification> (01/07/2013).

Moreover, an ETC/SCP working paper (2010) focuses on policy instruments used in the member countries of the European Environmental Agency (EEA) and investigates those with regards to seven selected waste streams: Packaging and packaging waste, batteries and accumulators, waste electrical and electronic equipment (WEEE), end-of-life vehicles (ELV), construction and demolition waste (C&D), biodegradable municipal waste (WMW) and municipal solid waste (MSW). Amongst other the paper reviews how measures may directly enhance the use of recycled materials. It concludes that on EU-level, minimum recycled materials content standards are not identified among legislative measures; yet they are along with the inclusion in the eco-labelling criteria an interesting way to encourage the creation and growth of a market for recyclables and contribute to resource efficiency.

The report furthermore mentions that government rather prefer the “softer” measure of procurement policies over mandating the use of recycled materials (as seen above). Table 26 presents a summary of the policy instruments identified with capacity to promote the use of recycled materials within the packaging and packaging waste area.

Table 26 Extract of recycling policy instruments for packaging and packaging waste in EEA countries

Policy instrument	Type of instrument	Level of coerciveness	Level of government introducing the instrument	EEA countries using the instrument
<b>Minimum recycled materials content standards</b>	Administrative			Some are found in the Ecolabel standards in Germany
<b>Taxes on virgin materials</b>	Economic	Mandatory		-
<b>Tax exemption/ reduction</b>	Economic	Mandatory	National/ Regional, Local	CZ (Products made of recycled paper)
<b>Tradable recycling credits</b>	Economic	Mandatory	National	UK (packaging waste recovery note)
<b>Ecolabels</b>	Informative	Voluntary	National	DE (packaging, paper, plastics, use of waste paper, etc.)

Source: ETC/SCP, 2010, pp. 8

With regards to other waste streams with relevance to the case study at hand, some results of the ETC/SCP working paper (2010) are provided.

Table 27 Instruments targeting recycled materials content within other waste streams

Waste stream	EEA countries using the instrument
<b>WEEE - Waste electrical and electronic equipment</b>	No existence of: minimum recycled materials content standards, taxes on virgin materials and tradable recycling credits. Tax reduction/exemption was found as mandatory in Belgium for source separated waste
<b>ELV - End-of-life vehicles</b>	Increased use of recycled material (mandatory in some countries via verification or mandatory information to the public; unclear level of coerciveness in other countries. Taxes on virgin materials, tax reductions/exemptions or tradable recycling credits were not found.
<b>C&amp;D - Construction and demolition waste</b>	Minimum recycled content standards existed in Finland (replacement of 5% of the natural gravel and crushed rocks used in construction or other activities, with industrial and mining waste) and in The Netherlands (use of recycled granulate by road-traffic department of the government. Furthermore, taxes on virgin materials (all on pure aggregates) are found in Belgium, Denmark, Italy, Sweden and the UK. Mandatory tax reduction/exemption is found at the regional level in Belgium (on reduction, source separated).

Source: ETC/SCP, 2010, pp. 12

The report concludes that overall, fiscal measures (e.g. taxes on raw materials) were not among the 25 instruments identified by the study. The study lists the use of minimum recycled materials content standards as limited to one case for construction and demolition waste in Finland (see however above mentioning of the UK in that regard<sup>0</sup>, with the exception of those found in some eco-label standards. It is also stated that product taxes/fees/charges are increasingly used mainly for waste prevention purpose. In Poland, a reduced rate of taxation exists for plastic products made from recycled plastic packaging waste.

A further policy option could be the introduction of market-based instruments to promote minimum quantities of recycled material in products, which shall be reflected on in more detail in the following chapter.

#### C.10.6. Recycling certificates and tax refunds

The Waste Agency of Flanders (OVAM) drafted at the beginning of 2013 a policy paper on tradable recycling certificates linked to promoting recycled content (OVAM 2013). It was drafted in connection to the EIP on Raw Materials and has so far not been published. Another conference paper from KU Leuven together with other Flemish research institutes (Dubois et al 2013) compares certificates with other policy instruments, among other tax refunds which are found to be a potentially better mean to foster the use of recycled content. The background of these papers was, along with EU efforts, the interest of Flanders to study a potential implementation of recycling certificates (however with a broader aim for waste management and not only focused on recycled content in the case of Dubois et al<sup>141</sup>). So far, a policy discussion on innovation effects of both certificates as well as tax refunds has not taken place. The economic effects are discussed mainly with view to directly affected groups whereas social effects are not regarded at this stage. Given that the overall aim of implementing both instruments would be to enhance product and waste management in terms of greening the economy, they are strongly linked to other regulation in the field of waste and recycling in general, and to directives concerning specific product categories in particular.

The following section presents first the most important findings regarding the characteristics of recycling certificates and then compares them to taxes on raw material and their refund in function of recycled material used.

#### C.10.7. Which kind of certificates for promoting the use of recycled material within new products?

Certificates of the tradable kind are in focus (the most famous example of those would be the EU Emissions Trading System), which should not be confused with the certification of processes or the award of labels (OVAM, 2013) that are being described in similar terms in the literature. The following points try to pinpoint the major characteristics and opportunities of recycling certificates as defined by OVAM (2013) and Dubois et al et al (2013).

- Type of regulation: Trading schemes are a market-based instrument and with this they bring about the opportunity that industries are free to choose how they will achieve the environmental target. The established environmental objectives can thus be met in the most cost-efficient manner given that companies will choose the least expensive way to comply with them (OVAM, 2013). In this sense tradable certificates would offer greatest possible flexibility in achieving the targets and do not impose technological choices that hamper innovation.
- Type of certificate: Credit scheme, which determines the emission level for a unit of industrial activity, as opposed to Cap & Trade schemes that determine the maximum yearly emission level. The targeted emissions per unit produced are fixed, but within the sector emissions can fluctuate depending on yearly changes of quantities produced (Dubois et al 2013).
- Definition of targets: an obligatory target is imposed on manufacturers that fixes a certain percentage of recycled materials that have to be used in the production of new items. The objective can pertain either to material streams (eg. Different metals, plastic etc) or products (cars, furniture etc).

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<sup>141</sup> Dubois et al not only look at the policy objective "Raise recycled content in new products", but also at the two following policy ambitions: "Improve recycling rate of waste treatment firms" and "Raise the End-of-life recycling rate of materials or products"

- Who generates certificates: Possibly, the company that recovers material and then recycles to reusable secondary raw material would generate certificates and pass them on to manufacturers when they purchase this material (per tonne of material recovered) (OVAM, 2013). It would be the producer that generates the certificate per ton of recyclate used in production (Dubois et al 2013) in case recycler and producer are the same company.
- Who purchases certificates: producers of goods either purchase recycled material from a recovering facility and the certificates are passed along (but not sold; trade may only be possible among manufacturers); or they buy them from other manufacturers divesting their certificates. The incentives for the recycling industry in this is that demand for recycled material will increase (OVAM 2013).
- Encouragement to perform better than the norm: One characteristic of tradable schemes is they encourage companies to raise the amount of recycled content as long as this activity it is cheaper than the price of a certificate. In this manner they are able to sell freed-up certificates on the market (OVAM, 2013)
- Import and export of products: When products are imported, the same standards must be applied for their recycled content, and the burden of proof might be imposed to the importer. Further research into the cost disadvantage of imported products and if this imposes too great obstacles for international trade would have to be conducted. It is furthermore mentioned recyclers that export to countries where no such certificates exist should not be granted certificates (OVAM, 2013).
- Geographical level: In the studies for the Flemish region (OVAM 2013; Dubois et al 2013) it was concluded that such a scheme could only be introduced at EU-level given that the regional or Member State level would be too small (regarding the number of manufacturers and recyclers and their technological possibilities) for the introduction of a system with tradable certificates. A second argument for implementing a certificate scheme at EU-level, is that only in this way the price of the certificates can be determined by the market and no government intervention is needed.
- Bearing in mind the already advantageous characteristics of the market-based instrument 'recycling certificates' as described above, there are two distinctive advantages of recycling certificates over other policy instruments (for instance disposal taxes):
- Both winners and losers: Compared to environmental taxes, that extract finances from the waste sector, recycling certificates create not only losers, but also incentives to strengthen continued environmental performances which in turn lead to increased revenues by companies selling the certificates.
- International competitiveness: Since trade-offs between revenues and expenses from certificates are neutral within one sector, they do not create a competitive disadvantage of companies located in the region where the certificates are applied to and therefore have no inclination to move their business abroad.

#### C.10.8. Drawbacks of recycling certificates and comparison with tax refunds

As it is generally the case for all existing tradable permit schemes, it would be quite a complex endeavour to establish a system of tradable recycling certificates across a defined region, in this case Europe. The following section points out barriers to recycling certificates aiming to improve recycled content. It concludes with a depiction of the advantages that tax refunds might bear.

The following drawbacks of recycling certificates can be found in the literature:

- The recycling market is too diverse: A general instrument across all material streams seems not possible. Recycling certificates cannot be issued across the whole recycling market but have to be adapted to each material stream. This is derived from the observation that the recycling market is very diverse and different for every material stream, also with regards to size and number of market players and the level that the market is established for a certain material (a common market, like the one for trading of carbon emission permits, is therefore not possible) (OVAM 2013).
- Sensitivity to market power: Given that a separate trading scheme seems necessary for each specific product or waste stream, the respective markets would be too small and fragmented and thus victim to market power when certain very strong market actors prevail (Dubois et al 2013). The authors provide the extreme example of monopolies of waste recyclers or manufacturers, which leads to the situation of no incentives (the producer would have to trade with himself or get all taxes refunded). In general, when market power is not evenly provided then strategic behaviour would annihilate the gains in efficiency from market based-instruments (Dubois et al 2013).

- High administration costs: As it seems to be the case with other tradable permit schemes, it is very likely that the overhead costs of a recycling certificate for the governing party (e.g. monitoring, control and administration) and as such the transaction costs can run very high (OVAM 2013).
- Definition of the imposed recycled target: The percentage of recycled content rates needs to be fixed which can be an arbitrary process. Moreover, target setting is prone to be influenced by lobbying activities and once these targets are fixed, they remain typically quite static due to advocacy of different stakeholder (Dubois et al 2013). After all, if the target is set is too high, few if any additional certificates will circulate on the market, so that their price will be very high. In this way, companies that, because of their product and/or production process, cannot use any recycled material are punished more severely. The target also cannot be set too low, because then the certificates will have no value, so that there will be no incentive to make more than the statutorily provided use of recycled material (OVAM 2013). Much attention is needed that fraud will be avoided.
- Quality of the recycled material: This could be affected when certificates are generated as a function of weight unit of recycled material. Linking certificates to a system of minimum quality requirements requires thorough knowledge of the market (OVAM 2013) as well as further administrative costs. According to experts however it is of outmost importance that a high quality of the recycled material will be ensured and control, since this might otherwise be object to fraud.
- Definition of recycling and recyclers (Dubois et al 2013): This is in line with the above mentioned attempts to define End-of-waste criteria, which clarifies when a material loses the status of being waste. It will be difficult to determine who will generate certificates if certain material is not considered as waste. To bear in mind are also the definitions of pre- and post-consumer recycled content and production vs. consumption recycled content (Hoogmarens et al 2013).
- Coherence with other policy instruments: There will not necessarily be negative impacts from the regulatory landscape on recycling certificates. However, a very good market knowledge is required to successfully implement the trading scheme and monitor its interaction with other policies. An example has been given by Dubois et al (2013), describing that the UK LATS scheme for tradable certificates aimed to reduce landfilling of biodegradable waste became redundant with the continuously rising landfill tax that had stronger impact on the demand for landfill. The authors conclude that recycling certificates should only be used where they complement existing instruments. Interview partners furthermore imply that compatibility with the REACH Directive before implementing recycling certificates should be assured.
- Reduced incentives for waste prevention: Recycling certificates have the opportunity to increase recycling rates and recycled content, however the mechanism doesn't encourage the prevention of waste given that the cost for waste treatment is overall reduced. Therefore the certificates do not internalize the full cost of waste management, since they do not take into account the environmental externality of disposing of waste (Dubois et al 2013). It is not discussed whether there might be rebound effects in the sense of even higher levels of waste produced; the author in an expert interview expresses the view of neutral effects (especially in view to recyclability of cars because their dismantling could potentially be hampered by recycled material use. When metals are used this problem diminishes almost completely).
- Price transparency (uncertainty of costs): The costs and benefits of tradable certificates are a-priori unknown since their price are created through demand and supply and thus price volatility can be high over time. This fact is described as bearing high potential of strengthening the resistance of market players against recycling certificates (Dubois et al 2013).
- Market transparency: Certificates as well as tax refunds do not necessarily promote higher levels of market transparency. The problem of company secrets will not be solved, but it could be helpful to develop robust indicators in order to implement informational measures, for instance public benchmarking (eg in the car branch, comparing different car models) as an accompanying measure. This would significantly contribute to transparency about the composition of materials in new products.

- Dubois et al (2013) have identified tax refunds as in general more efficient and effective means to bring about changes towards using higher recycling rates in material production. Especially since they do not lead to high transaction costs linked to additional policy intervention through trading. The authors present the example of tax refunds that were introduced in Sweden for NO<sub>x</sub> emissions from large energy producers. Energy producers that lowered more NO<sub>x</sub> per unity of electricity produced were granted higher tax refunds. In order to encourage the uptake of more recycled material by manufacturers, such a tax was proposed by Dubois et al (2013) that has to be paid per weight unit of primary raw material used in a certain product, for instance a car. The tax refund would then happen on the basis of the amount of recycled material used in that product. The following overview compares tradable recycling certificates with refunded tax.

Table 28 Comparison of tax refund and tradable recycling certificates

<ul style="list-style-type: none"> <li>• <b>Tax refunds: +++</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Tax refunds: ---</b></li> </ul>
<ul style="list-style-type: none"> <li>• Support: winners &amp; losers</li> <li>• International competitiveness</li> </ul>	<ul style="list-style-type: none"> <li>• No full internalisation of externalities</li> <li>• Sensitive to market power</li> </ul>
<ul style="list-style-type: none"> <li>• <b>Tradable recycling certificates +++</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Tradable recycling certificates: ---</b></li> </ul>
<ul style="list-style-type: none"> <li>• EU target for amount of recycled material used for benchmarking</li> </ul>	<ul style="list-style-type: none"> <li>• Complicated and complex scheme</li> <li>• Uncertainty of costs</li> <li>• Definition of static target</li> </ul>

Source: Adapted from Dubois et al 2013

- As shown above, both instruments have the advantage of providing rising benefits related to advances in using recycled content in products, and do not only impose charges on concerned market players. Also, they both do not create competitive disadvantages. With regards to common negative properties, equally tax refunds do not account for waste prevention in the marketplace, neither are they sensitive to market power (a monopolist would get all of his taxes refunded). Recycling certificates are more complicated and demand higher administrative control and thus transaction costs. Uncertainty is partly also the case for tax refunds, but less so than for certificates (for further details see Dubois et al 2013). And finally, since tax refunds are to be seen in connection with a tax on virgin material used per product, no target needs to be set (only the tax rate). Dubois et al (2013) in their study demonstrate that recycling certificates might not necessarily be the best way to trigger higher rates of recycled content in manufacturing; particularly because tax refunds seem to achieve the policy objective with less transaction costs and definition needs. Further research is needed in order to draw precise conclusions on this matter.

#### C.10.9. Innovation effects

The case study at hand looks into the possible effects that regulation may have on innovation activity in the waste and recycling industries. More precisely, we are focussing on policy instruments that bring about the shift to use higher quantities of recycled content in new products. Two instruments have been identified to bear the most advantages in bringing about this change and leading to the creation of a market for recycled materials: recycling certificates and tax refunds. An attempt shall furthermore be made to learn more about the complex and dynamic relationship between regulations (their design, implementation and enforcement) and the way that the waste and recycling businesses may innovate. As neither of the above-mentioned regulatory measures exists so far, this chapter serves to present some preliminary insights that have been developed in this ex-ante qualitative assessment. The following sections are therefore drafted on the basis of expert interviews and one expert workshop.

The following actors or stakeholders might be affected by introducing a certificate scheme or tax refunds: Recycling companies; manufacturers of goods; national and international import and export partners; government stakeholders introducing and overseeing the measure; furthermore various stakeholders in the waste and recycling sector responsible for waste sorting, collection, separating, transporting and pre-treatment; and finally the consumers of the goods and in turn their ability of influencing the price system through acceptance, willingness to pay or the demand for recycled products.

It is expected that recycling certificates or tax will bring about product innovations (i.e. the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics (OECD 2005)). At the same time, those are strongly connected to process innovations (i.e. the implementation of a new or significantly improved production or delivery method, which includes significant changes in techniques, equipment and/or software. (OECD 2005)). To sum up, mainly the final product itself as well as the production process will be affected by regulation with the aim to achieve minimum recycling rates for specific materials used in defined products.

The above mentioned product or process innovations are expected to occur along the entire product chain, with the ones generating and the ones trading the recycling certificates (or pay taxes on raw material use) being most affected. Also product designers would need to make sure that the use of recycled material is compatible with the products' properties, and furthermore provide for disassembly and recyclability of those products.

According to the paper by Dubois et al (2013), the aim of raising recycled content in products is inextricably connected to achieving two more policy objectives:

- Improve recycling rate of waste treatment firms
- Raise the EoL-RR of materials of products

Recycling Certificates would lead to higher collection and recycling rates of waste treatment companies. The instrument would support achieving a certain product End-of-Life recycling rate (EoL-RR), defined as the fraction of discarded product or material that is recycled, in the most cost efficient way (Dubois et al 2013). This is due to the higher demand for recycled material that recycling certificates would elicit in the market. Therefore the recycling rate of waste treatment firms would rise, which is seen as another policy target. Implications that the introduction of recycling certificates would have on the other potential areas of innovation thus need to be taken into account.

Innovation effects would be mainly incremental since the certificates or tax refunds lead to a rise in the use of recycled material in products. The question is, whether taking up recycling material in products that formerly were produced using exclusively raw materials, would be classified as a disruptive or radical innovation (Christensen 1997); this seems rather not the case for several reasons. The need of developing new knowledge and resources in general is limited to bring about this change; existing competence will not lose its value but needs to be enhanced; and finally the changes in performance, in this case the use of recycled content, are rather incremental given that certain products already contain recycled material and their percentage simply needs to be raised.

The recycling certificates or refunded taxes would affect mostly the implementation phase of the innovation process, i.e., when processes aiming to raise recycled content in products are still quite new and the change in composition of materials within products as well. Innovation effects are assumed to occur across the whole product/recycling chain and affecting all above-mentioned stakeholders.

An important question is how to measure the innovation effects that took place. Intuitively the most obvious indicator is the amount of recycled material used in specific products after the new policy instrument has been introduced. Furthermore, the substitution effect (virgin raw materials replaced by recycled materials) should be assessed; according to experts a methodology for this is not in place yet. According to an interview partner, it is essential for recycling certificates as well as tax refunds to verify that the recycled content claimed is true since proneness to fraud is an issue. Since none of the measures have been implemented yet, we can merely rely on the use of indicators for innovation with the aim to illustrate innovative performance. A good starting point might be the indicators that are included in the Eco-Innovation Scoreboard (since the wider objectives of the measure are to contribute to a circular economy) or in general in the literature dealing with the measurement of innovation.

In order to make assumptions about the R&D capabilities of companies, it is necessary to further investigate into the structure of the waste management sector as well as into the manufacturing sector where most of the innovations will occur. Especially interesting will be prevailing company sizes that permit to draw further conclusions about R&D capabilities on the basis of financial resources, skills etc., as well as published studies and interviews.

#### C.10.10. Drivers and barriers to innovation

First of all, all the drivers and barriers mentioned above with regards to recycling certificates are to a large extent true for both recycling certificates as well as tax refunds. Those market-based instruments are expected to foster innovation to a greater extent than similar potential measures (standards, disposal taxes, voluntary labels etc.). Factors that hamper their functioning will equally negatively affect their innovation impacts. On top of the insights derived in prior chapters on the success and hampering factors associated with those regulatory instruments, further anticipations from experts as obtained in interviews are provided with regards to different categories in the drivers and barriers list below.

#### C.10.11. Conclusions

In order to evoke higher levels of recycled content used in manufacturing of products, within the EU-27 several initiatives are already in place. They apply to different product- and/or waste-streams and include mostly voluntary and procurement initiatives. Strict standards are not a preferred measure.

In order to make a transition to a better functioning market for recycled materials, several research institutions and the European Innovation Partnership (EIP) on Raw Materials have done investigations into the functioning of market-based instruments to encourage the use of recycled content. This kind of instrument seems to be able to tackle innovation needs more effectively than command-and-control regulation. Most convincing at the current stage seem **Recycling Certificates** and **Tax Refunds**. Both instruments bear major advantages over existing regulation that have the same objectives, at the same time they are more cost-efficient. Especially with regards to the effects they will potentially have on innovation, these two instruments seem worth to looking into in the future since they bear certain positive effects:

- They encourage companies to perform better than the norm.
- They offer greatest possible flexibility and creativity in achieving the (technological) targets and do not impose technological choices that hamper innovation.
- They do not create competitive disadvantages compared with companies or sectors that are not affected by the regulation.
- When taken into account in the design phase, these instruments are compatible with other regulation. Especially the combination with internal and benchmarking activities for selected products containing recycled material can stimulate further innovation.

To make use of market-based policy instruments to tackle the innovation gaps seems worthwhile. There are however, at this stage, risks associated with recycling certificates or tax refunds. The main identified limiting factors are as follows:

- Efficient functioning of recycling certificates would require a sufficiently large market like the European market.
- Recycling certificates and tax refunds would have to be implemented for each material stream. The resulting small markets would furthermore be sensitive to market power.
- Recycling certificates are complicated instrument and would impose quite high transaction costs.
- Both instruments do not fully internalize externalities such as disposing of waste, and as such provide no incentives for waste prevention.
- Price and market transparency issues need to be taken into account for recycling certificates.
- Defining the static target for certificates and tax refunds can become an arbitrary process.
- These risks and drawbacks associated with recycling certificates or tax refunds could not have been solved yet in this theoretical state of development of instruments. Therefore further research and importantly, stakeholder consultations, will be necessary to draw detailed conclusions about the most promising market-based instruments.



Table 29 Recycling certificates: Drivers and barriers

Factors	Barrier	Driver	Neutral	Specific regulation/Type
<b>Policy, regulation, governance</b>				
Governance structures (e.g., monopolies, ownership structures...)	X			Distortion of the recycled market when ownership structure is too high (for certain materials/waste streams). Monopolies hamper the effectiveness completely
Coherence with other existing regulation		X		May negatively interact with other policy measures, such as disposal taxes or technology standards. Positive interactions when designed to complement or strengthen existing policy. Interaction between national, regional and EU instruments possible.
Trade agreements	X			Trade agreements might be too restrictive for the trade with recycling certificates
<b>National/international (demand-side) policies:</b>				
- Innovation procurement		X		Encourages use of recycled content as stand-alone measure or in combination with other, preferably market-based approaches
- Taxes	X			Disposal taxes or levies may create incentives but create losers only in the financial sense, and have poor effects compared to tax refunds
- Standardisation	X			Standards may create incentives but can also have no or negative impacts when set too low or too high. Voluntary schemes are preferred across the regulatory landscape.
- Labeling		X		Encourages use of recycled content as stand-alone measure or in combination with other, preferably market-based approaches
- Information campaigns		X		Voluntary labeling (see above) serves as an information instrument
<b>Economic and market</b>				
Lack of market demand	X			Currently there is still a lack of market demand for recycled materials imposing a barrier to the use of recycled content
Market power of competing products		X		Benchmarking of products with recycled content would be publicly communicated through recycling certificates or tax refunds
Rebound effect	X			Focus on recycled content could potentially lead to a neglect of waste prevention. Recycled material might complicate also dismantling of cars.
Lack of transparency	X			Company secrets concerning innovative solutions will not become more transparent through certificates
<b>R&amp;D capabilities</b>				
Companies' financial resources		X		Further research is needed for this category
Lack of access to finance	X			
High innovation costs	X			
Shortage of qualified internal technological skills	X			
Shortage of skills related to innovation management	X			
Limited abilities to spot market opportunities – lack of information on markets (EU and global)	X			
Risk aversity	X			
Limited abilities to test market readiness	X			
<b>Socio-cultural</b>				
Environmental concerns		X		Consumer demand for products containing recycled content drives market development
Geopolitics and world conflicts		X		Stronger efforts to become independent of raw material imports
Acceptance of stakeholders	X			Industry: Need to counteract resistance to change, create legitimacy of the policy instruments Consumers: need of assurance about the quality of the products that have recycled content

## C.10.12. References

Christensen, C., (1997): *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Cambridge, MA: Harvard Business Review Press.

Dubois, M., R. Hoogmartens, S. Van Passel, I. Vanderreydt (2013). Opportunities and drawbacks of tradable recycling certificates. Paper to be presented at the "Sardinia\_2013: International Waste Management and Landfill Symposium", Sept. 30 – Okt 4 2013.

Ecologic & IEEP (2009). *A Report on the Implementation of the Packaging and Packaging Waste Directive 94/62/EC*. Berlin: Ecologic Institute.

<http://ec.europa.eu/environment/waste/reporting/pdf/Packaging%20Directive%20Report.pdf>, 03/07/2013.

ETC/SCP (2010). *Europe as a Recycling Society. Recycling policies for selected waste streams in EEA member countries*. Working Paper prepared by N. Tojo. Copenhagen: European Topic Centre on Sustainable Consumption and Production. [http://scp.eionet.europa.eu/publications/WP2010\\_6/wp/WP2010\\_6](http://scp.eionet.europa.eu/publications/WP2010_6/wp/WP2010_6), 03/07/2013.

European Commission (2011) *Roadmap to a Resource Efficient Europe (COM/2011/571)*

[http://ec.europa.eu/environment/resource\\_efficiency/pdf/com2011\\_571.pdf](http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf), 30/06/2013

European Commission (2011). *Tackling the challenges in commodity markets and on raw materials*:

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0025:FIN:EN:PDF>, 30/07/2013.

European Commission, DG Env (2011). *Buying Green! – A Handbook on green public procurement*.

[http://ec.europa.eu/environment/gpp/buying\\_handbook\\_en.htm](http://ec.europa.eu/environment/gpp/buying_handbook_en.htm), 02/07/2013

European Commission, DG Health & Consumer Protection (2000). *Guidelines for making and assessing environmental claims*. Report No. 67/94/22/1/00281. Barcelona: ECA S.A.

[http://ec.europa.eu/consumers/cons\\_safe/news/green/guidelines\\_en.pdf](http://ec.europa.eu/consumers/cons_safe/news/green/guidelines_en.pdf), 02/07/2013

Hoogmartens R., Dubois, M., Van Passel, S. (2013). *Recycled content als beleidsinstrument: Internationale wetgevingsvoorbeelden en verdere ontwikkeling (Recycled content as a policy instrument; in Dutch)*. Policy Research Centre for Sustainable Materials, Leuven. <http://steunpuntsumma.be/nl/publicaties/recycled-content-als-beleidsinstrument>, 04/07/13.

JRC Technical Reports No 3 (2012). *Integration of resource efficiency and waste management criteria in European product policies – Second phase. Report Nr 3*. <http://lct.jrc.ec.europa.eu/pdf-directory/Report%203-%20%20Methodologies%20and%20guidance%20documents%20-final%20draft.pdf>, 02/07/2013.

OECD (2005). *Oslo Manual*. <http://www.oecd.org/sti/inno/2367580.pdf>, 04/07/2013.

OVAM (2013). *Vision Note: Recycling Certificates at the European Level*. Mechelen: Public Waste Agency of Flanders (OVAM).

WRAP & Cyril Sweett (2009). *Construction procurement guidance. Delivering higher recycled content in construction projects*. UK: Waste & Resource Action Programme.

<http://www.wrap.org.uk/sites/files/wrap/Delivering%20higher%20recycled%20content%20in%20construction%20projects.pdf>

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## C.11. Screening of regulatory framework for secondary raw material recovery and re-use and its impact on innovation

Author: Martin Brocklehurst

### Summary:

The Regulatory Screening Framework has been applied to review the impact of regulation on innovation in the field of raw materials and in particular its effects on the quality of recycled secondary raw materials collected and treated by the waste industry and made available for designers to use in new products.

The process clearly shows the value of this approach in highlighting the disruptive innovation that the legislation has triggered in many EU countries. The prime waste legislative drivers have laid down prescriptive command and control legislation to redirect key waste streams away from landfill and towards recovery and reuse. In many cases the early phases of change have triggered incremental innovation, building on existing knowledge, resources and technologies. The legislation in place has been effective in driving this innovation as more efficient waste to energy programmes have evolved in countries such as Sweden, Denmark, Holland and Germany. It has been less effective at driving disruptive innovation that is capable of delivering quality secondary raw materials that can compete with primary raw materials. It is also at best ambivalent in supporting the creation of a circular economy in which “up-cycling”<sup>142</sup> rather than “down-cycling”<sup>143</sup> becomes the norm. Neither does it help overcoming the financial barriers that early movers face in establishing these new markets. Fiscal support for these changes has so far been left to EU Member States.

The prescriptive nature of the waste legislation is currently holding back disruptive “up-cycling” innovation as leading companies seek to take the full potential economic value the circular economy can offer. These problems are compounded by the lack of simple effective decision making processes across regulatory actors that can be applied to deal with rapidly emerging technologies that open up EU and Global markets for these materials and demand consistent decisions across the EU.

The legislation does not deliver good quality data and information on the flows of secondary raw materials particularly for commercial and industrial waste that can inform designers of the opportunities available to them to use these materials. Such data is crucial to secure the investment required in infrastructure, both to collect and secure quality secondary raw materials.

The complex interaction between waste legislation and primary product legislation places further technical and commercial barriers in the way of recovering secondary raw materials. The legislation does not tackle the problems of secondary raw material markets. With a few exceptions they remain complex, often lack transparency and have problems with standards and specifications that affect both EU and International Trade. They lack clearly laid out dispute resolution processes and are indicative of immature markets. Legislation is still dealing with waste as a local issue when in fact the legislation is driving secondary raw materials back into EU and global markets.

The recent IMF study makes it clear that to support a fully working circular economy in which high quality secondary raw materials are produced and where each step of the chain adds value a series of regulatory changes are needed to deal with barriers in both product and waste legislation.

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<sup>142</sup> “Up-cycling” is the process of converting waste materials into new materials of products of better quality or for better environmental value.

<sup>143</sup> “Down-cycling” is the process of converting waste materials into new materials of lesser quality and reduced functionality.

The European Union, Member States and others such as the Ellen McArthur Foundation, WRAP and OVAM have highlighted the current market failure to exploit secondary raw materials. The cost to the EU economy is estimated at 600,000 lost jobs, a lost opportunity worth €49 billion growth in the waste and resource management sector and €90 billion overall through a failure to implement the environmental acquis<sup>144</sup>. Overall the EU is losing between 3-3.9% of 2010 EU GDP as a result of this market failure<sup>145</sup>.

The key to improving quality standards for recycled materials, to improving process standards for collecting, sorting and processing waste and to driving change in design is to recognise and remove the barriers behind that market failure.

By using the Regulatory Screening process the case study has been able to identify a series of changes in the way current legislation is implemented that could unlock more of these secondary raw materials

Changes are possible now in the way we gather data and information on secondary raw materials contained in waste. Simple ways to put in place regulatory structures that would support common decision-making processes amongst EU waste regulators when dealing with disruptive innovation are outlined. Suggestions are also made as to how the Commission can support the emergence of agreed quality standards, and transparent open market structures with agreed dispute resolution procedures and clear market prices that will support the emergence of a mature market for secondary raw materials. Examples are given to show that when these critical factors come together market transformation can be rapid.

Lastly, two further suggestions are made as to how European funding mechanisms can be changed to support emerging solutions to the recovery of secondary raw materials. Firstly by fast tracking solutions from research, to demonstration, innovation and final market delivery. Secondly by providing financial support to existing European platforms, organisations and mechanisms to capture that best practice and drive common solution across the EU.

#### C.11.1. Scoping of the area in focus, innovation needs and EU policy objectives.

The present case study applies the methodology for screening of regulatory frameworks to explore three related topic areas:

- Improving the recycling rates and the quality of recycled materials;
- Process standards for collecting, sorting and processing waste; and
- The eco-design directive and how to encourage the use and recovery of secondary raw materials.

They are three inter-related issues that form an important part of the non-technology policy pillar of the Strategic Implementation Plan (SIP) for the European Innovation Partnership (EIP) on Raw Materials (first draft version dated 27/03/2013). In detail, in order to evoke innovations with regards to the use of secondary raw materials, the EIP is targeted on improving the EU regulatory product and waste frameworks to foster industrial excellence and ensure an innovative-friendly framework is created.

Regulations have been crucial to driving change in the waste industry and to encourage a transition from safe disposal to resource recovery. Modern waste legislation is aimed at turning waste into a resource. ISWA make the point that the waste management industry in Europe is on a journey from waste management to resource management moving from disposal (landfill and thermal recovery) to recycling and resource recovery. They plot Member States activities between percentages waste to landfill, incineration and recycling. Even those EU states who have largely moved away from landfill still have some distance to travel to reach optimal waste management. That is where all metal and mineral resources are fully recovered and reused and where biodegradable materials are fully utilised with minimum waste used for its thermal value. If we are to see a 70% improvement in resource efficiency as envisaged in EU policy this becomes the ultimate goal. ISWA again see the major challenge to “integrate modern waste management as an integral aspect of material and energy flows management”.

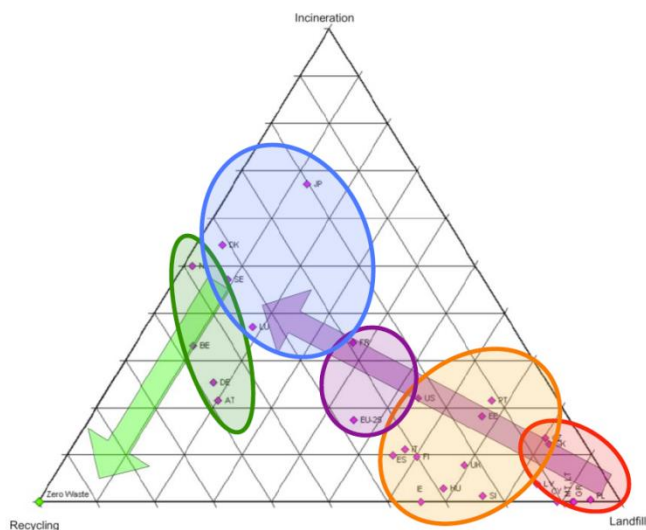
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<sup>144</sup> EU DG Environment (2011). The costs of not implementing the environmental acquis. Final Report ENV.G.1/FRA/2006/0073. Cowi A/s Denmark.

<sup>145</sup> Ellen Macarthur Foundation, (2012) Towards the circular economy, Economic and business rationale for an accelerated transition.

The current review mechanism has been allied in this assessment to understand if the current regulations are driving the EU towards this goal and if not what further changes are needed to attain it.

Figure 39 Evolution of waste management towards recycling<sup>146</sup>



Source: Technopolis

### C.11.2. The Current Situation

The EEA<sup>147</sup> report that in total in 2009 some 7.3 billion tonnes of raw materials were used in domestic material consumption (DMC) during 2009 of which some 3.65 billion are minerals, 1.75 billion tonnes are fossil fuels, 1.68 billion tonnes are biomass and 219 million tonnes are metals.

Waste streams in 2008 by comparison were some 2.6 billion tonnes of which 1.59 billion tonnes was mineral waste, 104 million tonnes metal waste, 52 million tonnes paper and card, 78 million tonnes wood waste, 104 million tonnes animal and vegetable waste, 208 million tonnes mixed household and similar wastes, 182 million tonnes combustion waste and 286 million tonnes other wastes.

Current EU policies set specific recycling targets for about 50% of the waste or secondary raw materials we generate, some 1.329 billion tonnes (2006/7 data). Currently we recycle or reuse 675 million tonnes or some 51%. The EU has already estimated that 6-12% of all material consumption including fossil fuels is currently saved or avoided due to recycling, waste prevention and eco-design. The same study estimated a maximum contribution of between 10-17% with a monetary value of €5 billion and a carbon saving of 148 million tonnes.

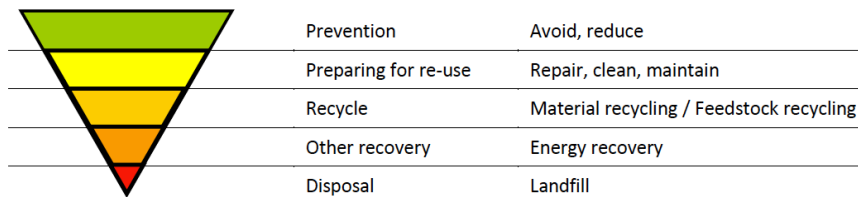
Several policy measures are already in place to increase the availability of secondary raw materials, by increasing the quality and amount of materials for recycling being collected and then recycled.

<sup>146</sup> ISWA (2011) . Working Group Recycling and Waste Minimisation. Key Issue Paper on Waste Prevention, Waste Minimisation and Resource Management. Lead Authors Maarten Goorhuis and Andreas Bartl. Vienna, Austria.

<sup>147</sup> Material Resources and Waste -2012 Update (2012) The European Environment State and Outlook 2010. Copenhagen, Denmark.

Article 11 of the Waste Framework Directive sets obligations on Member States to collect paper, metals, plastics and glass separately from each other by 2015 and to achieve a minimum re-use and recycling of overall 50% by weight by 2020 from households and possibly from other origins as far as these waste streams are similar to waste from households. The Directive also sets out priorities under the waste hierarchy as follows:

Figure 40 Waste hierarchy according to the EU Directive 2008/98/EC



Source: Technopolis

ISWA make clear that although this hierarchy seems quite clear “in practice several uncertainties exist” – “the term recycling stands for a great variety of processes and methods which significantly differ in terms of environmental and economic benefit”. No distinction is made in the legislation between methods that lead to materials with the same or better quality than the original (up-cycling) than those that lead to materials of lower quality (down-cycling). The former generally have a better environmental performance than the later. Quality recycling is crucial to resource recovery but also will make a significant impact on reducing green house gas emissions. ISWA calculate that the industry has already between 1990-2003 reduced total GHG emissions from the sector by 14-19% from the 36 industrialised countries and economies in transition (EIT) listed in annex 1 of the UN Framework Convention on Climate Change (UNFCCC) due to increased landfill methane recovery. In the EU they calculate that municipal waste management activities could account for 18% of the 2012 Kyoto GHG reduction target set for the original 15 Member States and that the industry is well on the way to becoming a net reducer of GHG emissions as increased material recovery and energy recovery outweigh direct emissions<sup>148</sup>. This study is about understanding if the legislative framework is coherent enough to drive life cycle assessment thinking into resource recovery and encourage up cycling of material.

The European Thematic Strategy on the Prevention and recycling of Waste, the revised Waste Framework Directive and the 2011 “Roadmap to a resource-efficient Europe” all call for the virtual elimination of landfilling and limited energy recovery for non recyclable-waste. Several EU Directives have set hard targets for the reduction or elimination of wastes from landfill and Producer Responsibility legislation has been introduced for electrical and electronic waste (WEEE), end of life vehicles (ELV), packaging and batteries and accumulators.

The EU has mainly used regulatory instruments to promote recycling and recovery leaving economic instruments largely to Member States. These regulatory targets, which have both provided a framework for waste regulation and specific targets for waste streams, along with fiscal measures have driven a diversion away from landfill across the EU. Eurostat and EEA data confirm that for municipal waste in 2011 some 40% was recycled or composted up from 27% in 2001. Packaging is at 59%, End of Life Vehicles at 82%, Waste electrical and electronic equipment at 23%, Construction and demolition waste at 53% and overall some 51% of the 3 billion tonnes of waste the EU produced in 2006/7 is targeted with EU recycling targets.

It has been left to Member States to use economic instruments such as taxes on landfill or waste incineration, product charges or trade of recycling quota to support these targets with price signals and accelerate diversion of waste from landfill and incineration.

<sup>148</sup> ISWA (2009) Waste and Climate Change ISWA White Paper, Vienna Austria

### C.11.3. Improving recycling rates

#### **Geographical Issues**

##### Member States

Data on recycling and recovery demonstrate large variations in performance both across and within member States. Overall 49% of waste is still disposed to landfill with 46% being recovered and 5% incinerated. In volume terms Germany, France, the UK and Romania account for over 50% of all waste treated in the EU. 8 countries produce 75% of the waste in the EU, namely Germany, France, UK, Romania, Italy, Bulgaria, Poland and Spain. Add in the Netherlands and 80% of all waste and 81% of household waste in the EU is captured.

With Germany and the Netherlands reporting 1% to landfill, concentrating recycling efforts in just 6 EU countries would deliver large increases in recovered secondary raw materials. To achieve the 50% recycling rate for municipal waste by 2020 will require annual improvements of 5% by Romania and Bulgaria, a rate not achieved by any EU country between 2001-2010 or 2006-2010. Poland, France and Spain will also need to accelerate current improvement rates for recycling. The cost of not implementing the waste legislation denies Europe €49 billion additional waste (and recycling) industry turnover and 600,000 jobs. The costs of not fully implementing the environmental acquis for waste across the EU is estimated at circa €90 billion.

##### The Problem of Cities

More detailed analysis of the recycling rates reveals wide variation across socio economic groups and major challenges in our cities. High recycling rates are common in the UK for instance within high to middle income, affluent, low density housing areas where rates often reach 70%. In densely populated inner city urban areas rates fall to near a third of that level. In the Netherlands where recycling rates of 61% are reported, rates fall to nearer 30% in major cities and as low as 15% in Amsterdam and Rotterdam. With population densities rising and over 80% of our population expected to live in cities by 2020 this will present a growing challenge to maintaining and improving recycling rates and the quality of materials we recover. Recent work by the EEA<sup>149</sup> highlights that since 2008 the total amount of municipal waste recycled has slightly declined illustrating the challenge that still lies ahead.

### C.11.4. Fiscal Instruments

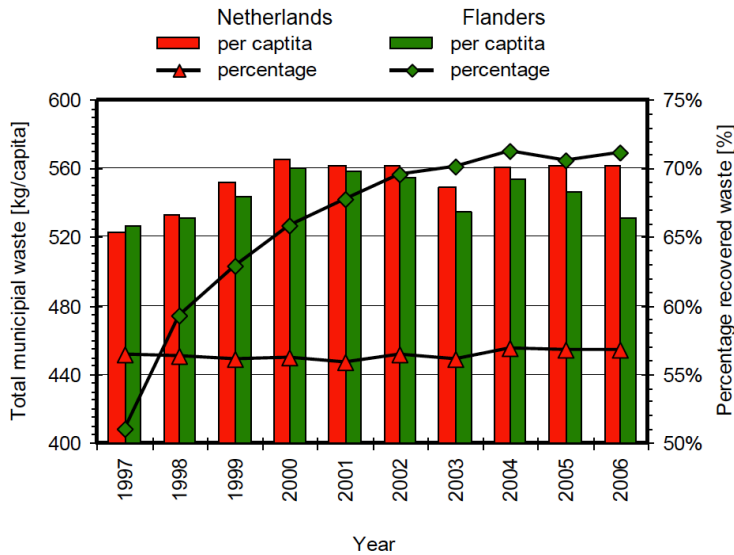
The value of fiscal instruments to drive change in the behaviours of waste producers has been shown both in Flanders with the introduction of pay-as-you throw schemes and in the UK with the Landfill Tax escalator. ISWA<sup>150</sup> provide an example of the power of these fiscal instruments comparing Flanders to the Netherlands. Both produce similar amounts of waste but there has been a large-scale divergence in the amounts of recovered materials with pay-as-you throw schemes proving to be very effective at driving up the percentage of recovered materials.

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<sup>149</sup> EEA (2013) Managing municipal solid waste – a review of achievements in 32 EU countries. Copenhagen Denmark.

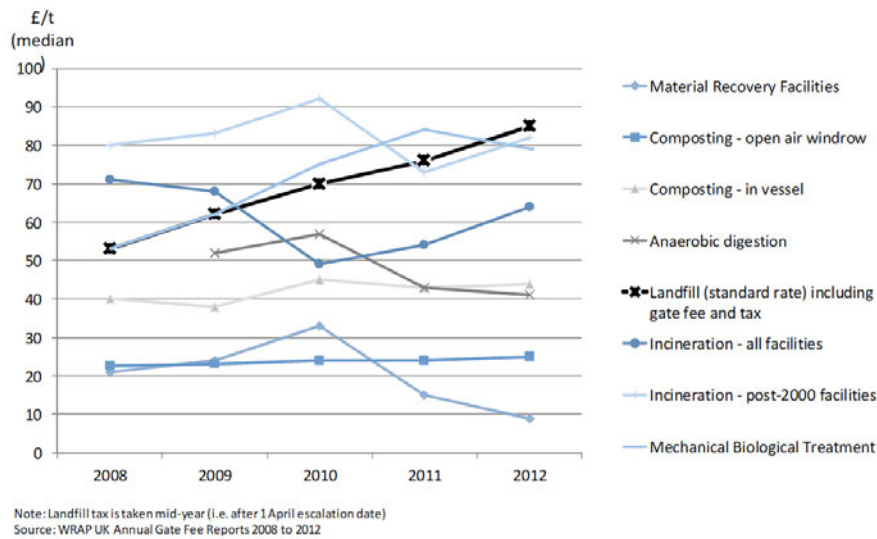
<sup>150</sup> ISWA (2011) . Working Group Recycling and Waste Minimisation. Key Issue Paper on Waste Prevention, Waste Minimisation and Resource Management. Lead Authors Maarten Goorhuis and Andreas Bartl. Vienna, Austria.

Figure 41 Effect of “Pay-as-you-throw” schemes



Source: Technopolis

Figure 42 UK Waste Disposal Costs



Within the UK the landfill tax escalator was introduced to assist the UK to achieve its obligations under the European Commission Landfill Directive. Its impact on business has been dramatic with circa a 50% fall in manufacturing waste and a 60% fall in waste to landfill. It has also unlocked the potential of other treatment technologies. From 2012 landfill is now the most expensive treatment system in the UK and a rapid growth has taken place in aerobic composting systems and more latterly anaerobic systems. The UK example is doubly of interest in view of the rapid pace of change and the role regulation has played. The EU Landfill Directive set reduction targets for municipal organic waste from landfill, the UK set the landfill tax escalator that affects all wastes, and the Environment Agency with WRAP support established “End of Waste” standards for organic materials from both aerobic and anaerobic systems. The evidence from the market place on these combined effects is compelling. It is a good example where legislation has supported disruptive innovation.

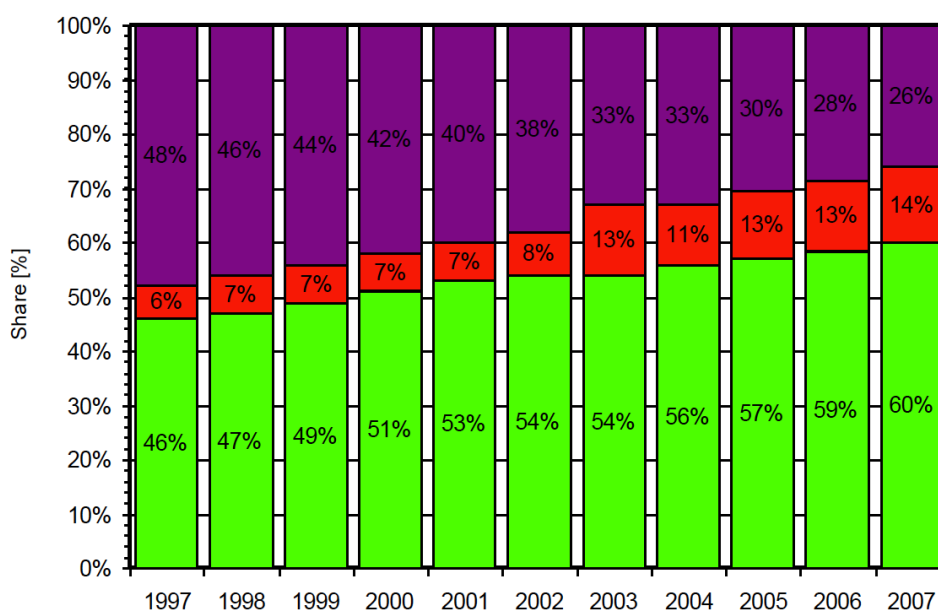


The UK organics market<sup>151</sup> has grown to over 7.2 million tonnes from 1994 to 2010. It received a major boost with the adoption of the End of Waste Protocol in March 2007. Growth in organics collected and treated rose between 2007-08 and 2008-09 some 36% and employment some 26%. The market was underpinned by effective quality standards, quality assurance systems and regulatory certainty. By 2008-09 the market was worth €260 million. Similar growth is now evident in the Anaerobic Digestion market where the number of companies grew by 182% between 2009 and 2010.

### C.11.5. Producer Responsibility

The impact of producer responsibility schemes can also be seen in the figure below for packaging. Similar schemes exist in the EU for waste electrical and electronic waste (WEE), end of life vehicles, packaging and batteries and accumulators.

Figure 43 Treatment of Packaging Waste 1997-2007



Note: Green – Recycling; Red – Energy Recovery; Purple – Disposal. Source : EEA

Considerable variation is evident across companies however. The IFM quote improvements from companies such as Toyota and Atlas Copco of reductions in business to business (B2B) and business to consumers (B2C) packaging of 5% per years for 5 years. This compares to the historical average of 0.9% per year. Leading companies are going beyond recycling and achieving real reductions in some cases up to 30% in B2C packaging through light weighting of products. This is important because although the legislation in the UK case has driven up recycling of packaging from 38% to 67% between 1999 to 2010 end of life packaging has still continued to increase by about 1.5% p.a. for the last decade.

The IFM calculate that further optimization of packaging is worth £450 million p.a. in cost savings in the UK alone, mostly in B2B packaging and greenhouse reductio0ns of 0.55 MtCO<sub>2</sub> e per annum.

<sup>151</sup> WRAP(August 2012) A survey of the UK Organics recycling industry in 2012. Banbury . UK

### C.11.6. Improving the quality of recycled materials.

The current waste legislation sets waste reduction and recycling targets but sets no quality standards. Many targets are weight based and drive public sector bodies to collect materials regardless of value to achieve these weight -based targets. With no clear economic drivers much of the recovered material is often down-cycled or used for energy generation. Evidence is emerging from the UK and Ireland that this trend is continuing with the export of RDF and SRF.

Until clear economic drivers or legal requirement are in place to drive up process standards for the collection, sorting and processing of waste, the next lowest cost disposal route with the minimum of separation will continue to dominate the market.

By way of example discussions with brokers<sup>152</sup> suggest that for some EU countries quality of recycled paper is falling. As a consequence EU exports are vulnerable in a “soft” or declining international market and may suffer as higher quality recyclates are produced from other major economic global centres. This trend is now evident as China implements its “Operation Green Fence”. Launched in February 2013 it is designed to prevent materials entering China with more that 1.5% prohibitive, or allowable contaminant, in each bale. It nicely illustrated the international nature of secondary raw material flows and calls into question the declining standards that can come from co-mingled or single stream collections evident in some EU countries and the US.

Where countries have achieved 1% to landfill circa 30-40% of the diverted waste is incinerated. Denmark and Sweden incinerate over 50%<sup>153</sup> of their municipal waste, Belgium 42%, Luxembourg and the Netherlands 38%, Germany 37%, France and Austria 35%. In total some 0.12 billion tonnes of waste were incinerated across the EU in 2010.

This route for the use of recovered materials, particularly plastics, is now being challenged in Sweden and Denmark where work is underway to reduce waste to incineration. In Copenhagen for instance the drive to make the city carbon neutral by 2025 has led to planned reductions in waste to incineration and new programmes to improve recycling efficiency. Programmes are in place to improve recycling efficiency rates as follows<sup>154</sup>

Table 30 Copenhagen’s rRecycling efficiency goals by 2025

Fraction	Recycling efficiency	
<b>Cardboard</b>	41%	63%
<b>Paper</b>	60%	75%
<b>Glass</b>	62%	86%
<b>Hard plastic</b>	1%	23%
<b>Biowaste</b>	0%	33%
<b>Metal</b>	20%	30%
<b>WEEE</b>	32%	70%

Source: Technopolis

<sup>152</sup> Personal communication

<sup>153</sup> 2011 Figues

<sup>154</sup> Presentation by Bjorn Appleqvist, Chairman ISWA Working Group on Recycling and Waste Minimisation and Project Leader Technical & Environmental Administration City of Copenhagen, LARAC/CIWM Meeting Telford July 2013

A key issue for this programme is to identify new markets for recovered plastics and a major LIFE+ study "Plastic Zero" is underway to identify how to recover and re-use plastic. In Sweden aspirational targets have been set to move to zero waste by 2020 and materials are being diverted from incineration for recovery. Again in both cases the work is not led by demands from manufacturers for recovered materials and thus again recycled materials are potentially searching for new markets. Again the legislative framework is not supporting the development of markets for these recovered materials.

These changes, along with the economic down turn have impacts on the collection and treatment systems and the emerging infrastructure of other EU countries that are now moving away from landfill. Without a clear understanding of the material specifications required by markets, high quality recyclate will not be produced to match market need and materials will continue to seek low cost / low quality outlets. Without market certainty it is difficult to secure public or private investment funds to drive the collection of, or production of, high quality recyclate. Surplus capacity that is now emerging in NW Europe incineration infrastructure is instead drawing in low quality recyclate to back fill surplus capacity. CIWM/AMEC (2013) have quantified the impact this is having on the quality of recovered materials and the export of Refuse Derived Fuels (RDF) and Solid Recovered Fuels (SRF) from the UK and Ireland to Europe. They estimate the trade has grown from little or none in 2010 to almost 868,000 tonnes in 2012. The potential RDF/SRF resource in the UK and Ireland is estimated at 26.09 million tonnes, some 28% of current municipal and municipal like C&I waste. Exports of RDF where mainly to Norway, Denmark, Netherlands, Sweden, and Germany with higher quality SRF to cement kilns in Estonia and Latvia. 85% of exports were from England and only 15% came from commercial and industrial waste. Household waste was the main source. The report concludes that with Landfill Tax making the export of RDF the cheapest waste management option it will continue to grow. Markets for SRF are also opening up with cement kilns in India. Current exports have an estimated energy content of almost 5TWh (electrical) or 10TWh (heat) with a potential to increase to 7.7 and 15.4 TWh respectively, some 5% of the UK's and Ireland's renewable energy. The cost of these exports is estimated at £43 million. This does not take account of the lost energy potential for the UK and Ireland.

The challenge is to ensure that emerging markets for secondary raw materials are not undermined by surplus incineration capacity and that materials are recovered to maximize their carbon reduction potential and value added. If countries with incineration capacity follow the Danish and Swedish lead it will impact the quality of recovered materials from those countries moving away from landfill. The CIWM report highlights the problems of developing UK and Irish infrastructure when competitors can offer lower gate fees either due to having already paid back their initial investment or due to the level of revenue they can receive from electricity, heat and steam sales.

Further difficulties emerge with commercial and industrial (C&I) wastes. Unless clear markets are defined for materials recovered from landfill, waste in this market will continue to seek out the next lowest cost disposal route and investment in infrastructure to create a circular economy will be undermined. C&I markets by their very nature are volatile and do not provide secure quantities of waste. It is a market dominated in volume terms by a few large players and a myriad of SME's. With poor quality data on what is produced, where it is produced and little guidance on the quality of materials that need to be recovered, investment risk remains high. Where initiatives have been taken such as the recovery of secondary plastics to produce food grade materials they have been underpinned by public funds. Although the economic value of the circular economy is clear, how to mainstream the activity is not. Leading companies have research in place but the risk remains that the EU will export more and more of its C&I waste rather than develop the infrastructure to recover it into manufacturing activity in the EU.

### C.11.7. Emergence of secondary raw materials markets

Despite the impressive growth of recycling and recovery the raw materials are not necessarily benefiting EU manufacturing activities. The growth of exports of recovered waste raw materials has matched the growth of recycling and recovery. In 2011 €10 billion by value of secondary raw materials were exported from the EU. The exports were mainly metals, paper, cardboard and plastics. Evidence is growing that the EU is moving towards a single market for recovered secondary raw materials. This is not surprising as smaller EU countries may lack the necessary scale for an efficient recycling and remanufacturing industry. At the international scale global markets have developed, building on the successful metals markets for ferrous and non-ferrous metals to include paper, card, plastics and textiles and evidence is growing for new markets in waste organics, refuse derived fuels (RDF) and solid recovered fuels (SRF). Estimates in 2004 placed the size of this market at over 600 million tonnes and value it at \$100 billion<sup>155</sup>.

The emerging secondary raw material markets are complex. Insufficient data and information, lack of transparency, manipulation of markets and trade barriers, problems with standards and specifications (often in great numbers) and regulatory uncertainty, lack of clear dispute resolution processes all illustrate the immature nature of these markets.

The growth in recycling and recovery and emerging international markets has also been matched by a growth in illegal trade, particularly in electrical goods. The EEA estimate that up to 70% of reported cases relate to transactions from the Netherlands, Belgium, the UK and Austria. Whilst tonnages are difficult to estimate for electrical goods, it is estimated that up to 38% of all e-waste collected could be involved or nearly 1.3 million tonnes.

These trends are not surprising as tackling resource efficiency through driving recycling rates to agreed targets or through driving up the cost of disposal to landfill or incineration creates materials looking for markets. ISWA again comment “even if legislation dictates recycling quotas, waste can be directed to illegal routes if no economically viable procedures for recycling and recovery are available”. A critical question in this study is therefore whether or not legislative objectives are sufficiently coherent to remove the barriers in the way of the creation of markets for recovered raw materials. Replacing primary raw materials with secondary raw materials is a disruptive process likely to be resisted by established markets, as it demands a major rethink in the way business is undertaken in the EU.

It is this coherence, which is crucial to driving up standards in the recovery of raw materials. Various studies have identified the economic advantage of exploiting these materials as secondary raw materials but few attempts have been made to create open transparent markets for their recovery and little agreement has yet been reached on the overall standards that are required. The Institute for Manufacturing make the point that we are dealing with the “next manufacturing revolution” in their report on Non Labour Resource Productivity and its potential for UK manufacturing.<sup>156</sup> They site 7 features of this developing paradigm shift (see Annex A3) including the evolving economic crisis with rising raw material prices and externalities such as water, carbon and waste disposal being priced into manufacturing costs. The environmental crisis driven by population growth and rise in living standards is taking us beyond the sustainable carrying capacity of the planet and major social change including escalating unemployment is challenging conventional business thinking. The crisis leads to a return to first principles in how companies do business, leading to a rethink on what they make and how they provide it to customers. Market leaders deliver radical change and increased profitability through adopting a resource efficient approach whilst resistance to change remains in many companies. Within sectors others follow as the economic, environmental and social benefits become clear, to maintain market share, making the change irreversible. As in any revolution the new approach is poorly described, unstructured and poorly understood.

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<sup>155</sup> *Economica - From Waste to resource 2006 World Waste Survey* Elisabeth Lacoste & Philippe Chalmen. Paris, France.

<sup>156</sup> Institute for Manufacturing (IFM) (2013). Dr Greg Lavey et al, *The Next Manufacturing Revolution – Non labour resource productivity and its potential for UK manufacturing*. Cambridge United Kingdom.

For the UK this report suggest the benefit to the UK economy of this revolution in non-labour resource productivity could be worth: -

- £10 billion p.a. – a 12% increase in average annual profits;
- 314,000 new jobs in manufacturing – a 12% growth in manufacturing employment;
- 27 million tonnes CO2 equivalent p.a greenhouse gas reductions.

Across the EU the benefits are also clear and have been spelt out in the Resource Efficiency Roadmap.

#### C.11.8. Securing EU Markets for secondary raw materials

The current markets for secondary raw materials present a not dissimilar picture to the early years of the 19<sup>th</sup> Century when primary raw materials were extracted from the developing world to fuel the economies of NW Europe. This time round the risk is that we export secondary raw materials to fuel the developing economies of the far east and China rather than sustain and develop manufacturing industries in the EU. This is despite the fact that a third of all profit warnings issued by FTSE-350 companies in the UK in 2011 related to rising resource prices.

Numerous studies have highlighted current market failure to capture and use secondary raw materials in the EU to add economic value to our economy. The export of second hand goods stripping out critical raw materials was highlighted by Hagelucken et al (2005) who estimated 30% of the platinum needed in German manufacturing industry was lost in the catalytic converters exported in second hand cars with over 100,000 annually shipped to Africa and the Middle East where it is likely these materials will be lost. Mobile phones are another example where gold is in small concentrations but is five times more concentrated than in most primary ores<sup>157</sup>. WRAP<sup>158</sup> estimate that by 2020 the UK will have 12 million tonnes of electronic waste that will contain on current market prices precious raw materials worth over €8 billion. Currently only 30% of this material reaches recovery facilities where most is crushed, sorted and exported.

When efforts to reuse and recover these materials are made it becomes clear the infrastructure is not available and the standards for recovery are not clear. Work by ISWA<sup>159</sup> on recycling denim for jeans highlighted the lack of infrastructure for spinning recovered denim fabric within the EU. Work by Jaguar/Landrover<sup>160</sup> into sources of aluminium for its next generation vehicles identified 40,500 tonnes of UK aluminium landfilled in 2009 and a lack of infrastructure to recover dirty aluminium. It also highlighted uncertainty on the metal alloy standards required to ensure that recovered aluminium was fit for use in new car manufacturing. Research was needed to establish the contamination levels that were tolerable in the metal alloys recovered.

What is clear is that not enough dialogue takes place between manufacturers and the waste industry, designers and academics to work through what standards are required in recovered materials, what market demand exists, how that market demand can be satisfied and where the investment in infrastructure is required.

Work by the RSA<sup>161</sup> highlights that the third industrial revolution has arrived and at its core will be “new digital and rapid bespoke manufacturing, and efficient resource use through a circular economic model”. Globally a scramble for primary raw materials is underway yet we fail to recognize the value of and secure the secondary resources we already have.

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<sup>157</sup> Hywel Jones, Sheffield Hallam University – Whats in my stuff lecture, RSC 2011.

<sup>158</sup> WRAP Facts & Figures - <http://www.wrap.org.uk/content/facts-and-figures>

<sup>159</sup> Saxion University of Applied Science (April 2013) Marijn Heerink et al, Experiences and bottlenecks with recycling of jeans, ISWA/NVRD Project Chain Management Jeans. Denmark.

<sup>160</sup> Adrian Tautscher, (2012) Jaguar/Landrover. Real Car Project Leader – Presentation at the CIWM Midlands Region AGM 2012

<sup>161</sup> The Royal Society for the encouragement of Arts Manufactures and Commerce (RSA), Investigating the role of design in the circular economy (June 2013) The Great Recovery Project. London UK.

## C.11.9. Innovative effects and associated barriers and drivers with regards to the use of secondary raw materials

### **Innovation Types**

There is no doubt that EU Directives have driven innovation in the way waste is recovered and managed across the EU. The waste legislation has disrupted existing markets for waste disposal, as it was intended to do, but has not been clear on the alternate outcomes desired. The legislation has largely left these decisions to market forces. Recycling has been seen as an “environmental good” in that it reduces waste to landfill but the legislation has not been clear on the environmental and economic benefits to be achieved with the recovered raw materials. It has left secondary raw materials looking for markets that 10 years ago did not exist.

Subsequent developments have shown a mix of disruptive innovation and incremental innovation. In those countries where incineration has been seen as an acceptable alternative an incremental approach has been possible, building on existing competences and driving up changes in performance as the technology adopts with better systems for recovery of energy for electricity, and combined heat and power systems delivering hot water and steam.

Where this has not been possible due to public resistance to incineration a more disruptive innovation is evident. Here the search has been to find new ways to secure value from waste. Research has been commissioned into a range of technologies that include mechanical biological treatment (MBT), composting, anaerobic digestion, autoclaving, gasification, pyrolysis, and mechanical recovery facilities. Virtually none of these approaches has been designed to provide a secondary raw material to market based on market need.

The escalating costs for primary raw materials have however encouraged the search for new markets for secondary raw materials. Cheap export routes in empty returning containers to offshore manufacturing centres has encouraged a rapid growth in recyclates. Throughout this process the market has been a largely a “push” market where secondary raw materials are seeking outlets. “Pull” markets where industry is seeking secondary raw materials has been slow to emerge except for scrap metal and recycled paper. In such markets it is not surprising to see illegal exports to developing countries in Africa and Asia.

As with most disruptive innovation the initial secondary materials that have emerged initially have provided inferior performance, as they adopt to a market which is currently underserved and they have a steep improvement trajectory to make before they develop market confidence in what is being produced and overcome in built prejudice to the use of secondary raw materials.

### **Innovation Phases**

The waste industry over the last 10 years has arguably seen the biggest disruptive upheaval and change in the last 50 years, driven by legislation. To operate in this changing market requires new skills and existing competencies are losing their value. An experienced waste operator with the technical competency to operate a landfill site needs to reskill as the industry moves away from this solution to treatment options that involve complex process plant operating at high temperature and pressure. In the UK this change is providing new challenges as Health & Safety issues and concerns grow for the workforce and the industry now has one of the highest death and accident rates in the UK.

Changes have been most rapid in EU Member States that have set additional drivers in place that include bans on combustible and degradable materials to landfill or fiscal measure that drive up costs of disposal to landfill. Within Germany, operators were forced to find new ways to deal with waste as a result of landfill bans. In the UK, the ever-escalating cost of landfill meant facing year on year price rises. Largely for the first time waste ceased to be a minor cost and no action became the most costly choice of all. Put in place to help the UK meet its diversion targets for municipal organic waste, it has been responsible for innovation in the diversion of all wastes from landfill. With this change there has been a rapid decline in the number of landfill sites in the UK.

A string of unintended consequences have followed as the waste industry has attempted to deal with the consequences and contain costs. All across the major EU Member States, new processes and products have been emerging that have challenged the industry and regulators alike. In many respects we are still at the early stage of this innovation. Only since the EU Resource Efficiency Roadmap emerged has the policy framework started to clear on how Europe should use the secondary raw materials recovered from waste. Innovators and market leaders in industry are now seeking to do more than move waste from landfill to the next cheapest alternative disposal route. It is leading to a change in those countries that incinerate large volumes of waste as they seek to extract greater value from materials like plastics than can be achieved from waste to energy. ISWA has indicated that a convergence to a more disruptive innovation is now underway in a number of EU Member States which led the initial drive away from landfill. The EU is being joined by countries that have thought to minimise incineration as part of their post landfill solutions.

We now find that waste legislation which has driven secondary materials away from landfill is now acting as a barrier to the recovery and re-use of secondary raw materials.

New products and processes face barriers at every step of their development as they are “out of the technical norm”. Uncertainty exists as to their environmental and health effects and many of the controls that apply to primary raw materials are not appropriate. Innovators are frustrated that efforts to organise adequate legislation is a major burden and they find that legislation designed for primary raw materials such as REACH (EU Regulation, Evaluation, Authorisation and Restriction of Chemicals) creates new challenges and problems for secondary raw materials that block their entry into the market place.

The **approval process** for end of waste definitions remains a **major blockage** in this emerging scenario. New technology also emerges in this phase and again innovators are frustrated by attempts to develop legislation that address the key issues. Micro-gasification is a good example where existing legislation has effectively prevented its development in the EU and the technology is exported first to international markets.

#### C.11.10. Supporting Future Innovation

The EU has mainly used regulatory instruments to promote recycling and recovery leaving economic instruments largely to Member States. Tackling resource efficiency through driving recycling rates to agreed targets or through driving up the cost of disposal to landfill or incineration creates materials looking for markets. Unless we change this model and develop effective markets for recovered materials that can be used in European manufacturing activity we will:

- See countries move to next lowest cost disposal route and stifle new technology in waste management;
- export ever growing volumes of variable grade recyclate;
- achieve patchy success to recover quality materials and add value;
- continue to operate to minimum standards where they are set by regulation;
- continue to see enforcement as a critical problem as we try to deal with free loaders;
- fail to attract and retain a skilled workforce in emerging technologies required to reprocess secondary raw materials;
- fail to attract investment for infrastructure, long term research and development; and
- fail to meet our aspirations to become the global leader in waste and resource management technology.

We need a major change in our approach to the way we drive recycling. In particular we need regulatory intervention that builds understanding of the needs and requirements of the EU manufacturing sector. That builds knowledge about the secondary raw materials in our waste and resources supply chain and how we can recover and reuse them. By **creating clear demand led markets for secondary raw materials** we will be able to:

- seek out the highest quality secondary raw materials and stimulate innovation in new infrastructure to recover and use that material ;
- provide market incentives to recover materials and add value;
- reward quality standards and move away from “command and control” regulatory driven approaches to “softer” market-based approaches;
- reduce pressure on enforcement agencies as market demand removes the incentive to free load;
- attract and retain a growing skilled workforce to the waste and resource management industry
- establish the economic case for investment in infrastructure long term research and development
- reduce exports of low quality recycle and secure added economic value from up-cycling secondary raw materials; and
- position the EU to be a market leader in the 3rd Industrial revolution.

Various studies have identified the economic advantage of a demand led secondary raw materials industry but few attempts have been made to create the open, transparent markets, such an economy will require. The Ellen McArthur Study (2012) concluded that 3-3.9% growth in GDP was possible if a circular economy was developed in Europe in which wasted raw materials were returned to productive use. Such changes will not happen without the creation of open and transparent commodity markets for secondary raw materials that are underpinned by **agreed quality standards**.

Doherty (2010) makes clear that the economic impact of **commodity markets** for primary raw materials cannot be overstated. Modern commodity markets emerged from the industrial revolution when agricultural products required an organised market to meet the needs of an expanding agricultural industry. Such markets have:

- quality standards;
- agreed sampling and testing protocols;
- dispute resolution and enforcement tools;
- significant numbers of buyers and sellers who operate in national and international markets;
- price transparency; and
- sophisticated data and information systems.

Our current markets for primary raw materials evolved over a 100 years to move from the early Victorian Markets where buyers and sellers met to agree trades, review the quality of the materials and where personal relationships and trust were key to successful trades to markets where participants :

- buy and sell materials sight un-seen;
- have price transparency;
- have low transactional costs;
- have built in systems to protect against price fluctuations and “futures” trading is common place;
- have regulatory certainty; and
- have computerised data and information systems to underpin that market.

The current market for secondary raw materials, with a few exceptions, remains immature. In many cases, it is still similar to the early Victorian agricultural markets. We need to mirror the evolution of commodity markets that emerged for primary raw materials in order to drive up recycling rates, improve process standards for collecting sorting and processing waste materials and encourage designers to use secondary raw materials. Current markets have little incentive to take on secondary raw materials as they undermine the demand for primary raw materials and challenge the status quo. Only when we have in place effective commodity markets for secondary raw materials will we move from a “push” (driven by regulation) to a “pull” (driven by commercial markets) model for secondary raw materials.



Currently progress in establishing commodity markets for secondary raw materials is most advanced for scrap metals, paper and cardboard but even here obstacles remain to their development. Dougherty (2010) highlighted the experience of the Chicago Board of Trade (CBOT) experience in seeking to create a commodity market in the US for secondary raw materials recovered from recycled materials in 1995.

The LIFE+ Project EPOW (2008-2012) has sought to learn from the CABOT experiment and to identify what we need to put in place to secure open effective commodity markets in the EU that will drive up recycle standards and encourage the development of infrastructure to supply market demands of EU manufacturing sectors.

What the above arguments suggest is, that we **need to refresh our current regulations and how they are delivered and interpreted** to find new ways to support innovation in the recovery of secondary raw materials. This refresh needs to **consider not only waste regulations but also product regulation, animal health regulations and economic regulations** to encourage the emergence of strong markets for secondary raw materials. Only when we do this and develop economic advantage from the recovery of quality secondary raw materials will we secure changes in collection and treatment infrastructure.

#### C.11.11. Screening regulatory landscape, impact on innovation and potential solutions

##### **The overall framework**

Waste and secondary raw materials are now affected by several sets of regulations that both drive and hinder innovation as it effects the quality and use of secondary raw materials. The BERR Study<sup>162</sup> has 6 main drivers that determine the impact of regulation on innovation. They are: prescriptive v outcome-based legislation; stringency (or technology forcing regulations); timing, compliance costs; regulatory uncertainty; and interactions with other government policies.

To secure the quality of recycle envisaged in the resource efficiency road map and drive up the quality of recovered raw materials and back into productive use these 6 drivers will need to be in place.

The first, which relates to the prescriptive versus outcome-based nature of regulation is important due to the changing nature of the challenge faced by the waste industry.

There is not doubt that historical waste regulation has been largely prescriptive in its nature. In many respects it is complex in nature and was originally designed to ensure the safe disposal of waste. As the regulation has moved away from disposal to resource management it is changing moving more to outcome-based regulation. Prescriptive regulation met the needs of society to ensure safe disposal of waste. By and large clear rules could be written for what was a very stable industry for the collection, treatment and disposal of waste. Such regulation did not have to deal with a dynamic changing market place where innovation is essential to find new outlets for recovered raw materials.

Waste legislation was also largely self-contained. Cross cutting health and safety issue could be dealt with in a stable environment where the skills of the workforce could be developed. Consultations on the impact of legislation could be easily targeted at the industry to ensure it was fit for purpose. Implementation was local, simple, and effective. The proximity principle meant that most waste was dealt with close to its source and where interest in common solutions existed. It was not crucial to business success and local interpretation could be the price of approval.

We are now living in a very different world where the prescriptive command and control waste regulation is not suited to solving the problems presented by the recovery and re-use of secondary raw materials. Worse still the fractured methods of implementation create barriers in an industry that now routinely moves recovered raw materials across EU and global markets. Innovators in the use of secondary raw materials and in the development of innovative treatment methods want local decisions that can be applied across EU markets.

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<sup>162</sup> BERR (2008) Economics Paper No 4 – Regulation and innovation: evidence and policy implications. London UK.

Decisions that affect recycle quality now have implications for EU trade, they impact primary raw material resource flows, they change the dynamics of markets and they have world trade implications. The recovery and re-use of secondary raw materials are also affected by decisions covering product regulations and economic regulations. In effect we have a poor regulatory framework to support the recovery of secondary raw materials, one that generally stifles innovation.

The IFM report referred to earlier highlights the issues. In the UK they identify that circular resource use (the circular economy) would in just three manufacturing sectors create £5.6 bn to £8bn p.a of value for manufacturers, support over 310,000 jobs and reduce green house emissions. The sectors cover:

- electrical, electronic and optical products;
- machinery and equipment; and
- transport equipment.

They identify the barriers to achieving these remanufacturing benefits as: senior executive leadership, information, skills, design, infrastructure, legal constraints and collaboration. The regulatory and legal constraints they identify now include a range of legislation that is well beyond waste regulation and demonstrates the complexity now faced by companies seeking to re-use secondary raw materials. The regulatory impediments include:

- Banning of remanufactured components in new goods
- The UK Sales of Goods Act (SoGA) which discourages retailers from retailing used goods
- Definitions of waste that hinder trade and transport of products for remanufacturing
- Classification of remanufactured products as 'used', which gives the impression of a second-rate or unsafe product
- Legislative focus on recycling which can preclude or at least make remanufacturing difficult e.g. incentivising of recycling of scrap rather than re-use or refurbishment for Waste Electrical and Electronic Equipment
- EU Regulation, Evaluation, Authorisation and Restriction of Chemical (REACH) rules, specifically Article 33 (1) which requires contract manufacturers and distributors who supply an article which contains more than 0.1% weight by weight of any Candidate List Substance of Very High Concern to provide their industrial customers with sufficient information to allow safe use of the article including, as a minimum, the name of that substance. Compliance can be difficult for remanufacturers, especially if they did not produce the product in the first place.
- Safety and environmental regulation that can limit the reuse of vehicle parts, even with design changes for modularisation.

Source IMF Report 2013.

Improving the quality of collected secondary raw materials, the processing standards to which it is treated and confidence in designers to use the recovered raw materials needs all the above regulatory issues to be tackled.

### C.11.12. Suggested solutions

The waste industry needs to be clear on the quality of secondary raw materials required by the remanufacturers. It then needs to have effective and efficient commodity markets through which it can sell those secondary raw materials. Such markets need to be underpinned by good data and information on those materials, and a clear dialogue between the manufacturers and the waste industry on what quality of materials are required and on how they can be produced. Only when these measures are in place will investment be allocated to create the infrastructure such a change demands. A series of clear changes are needed to bring about these outcomes as follows. We need a series of technology forcing regulations to achieve such change in the current market place.

The following five areas are identified where major change is needed and where EU intervention could make a major difference. In some instances regulatory change is needed, in others a change of approach and new ways of implementing existing regulations to support innovation is required and lastly in a number of areas better coordination of existing programmes to support innovation. The key five areas identified are explained in the next sub-sections.

#### **Review of commodity markets for secondary raw materials**

The EU Resource Efficiency Road Map has highlighted the need to establish functional markets for secondary raw materials. For such markets to work a series of changes need to take place in the way we view and regulate waste. Without these changes it remains a complex challenge to drive up recycling standards in a rapidly urbanizing Europe and to give confidence to designers to specify secondary raw materials.

Commodity markets for secondary raw materials are yet to fully emerge. Trials to establish such markets with the exception of secondary metals have by and large failed to achieve material size. Early trials in the USA between 1993-1995 with the Chicago Board of Trade (CBOT) were unsuccessful. Doherty (2010)<sup>163</sup> reported for the ERDF project “A pathway to zero waste” on the reasons for the failure of the CABOT pilot.

The lack of effective commodity markets for secondary raw materials remains a major blockage to driving up standards. The EU has the potential to develop global commodity markets for secondary raw materials building on the experience of the London Metals Market, CABOT and the work undertaken by the LIFE+ project EPOW.

A review is needed into the operation of existing markets for secondary raw materials across the EU. The review should establish the current position with emerging commodity markets for such materials, how they can be strengthened and underpinned and where gaps remain. Discussions should be undertaken on the fundamentals for the effective operation of such markets and how set up costs can be overcome. Issues that need to be addressed include whether the existing trading systems meet the growing European demands for trading in secondary commodities, whether adequate standards and testing protocols are in place and whether or not adequate dispute resolution processes have been put in place.

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<sup>163</sup> Doherty, D (2010) Developing a commodity market for recovered materials. A report for the ERDF project A pathway to zero waste. Reading, UK.

## **Data & Information systems**

Data and information on secondary raw materials needs radical improvement. Although data on waste flows has improved as a result of the Waste Statistics Regulation data on commercial and industrial waste is still inconsistent, often of poor quality and not timely. If we are to move to a recycling economy it is essential that we develop as close to real time data as possible for all major waste flows. As we recognise the value of recovered secondary raw materials, and seek to add value by moving materials back into productive use, such data is crucial for investment decisions.

Lessons learnt from primary supply chains need to be applied to waste flows. Just as energy and mining companies invest to obtain data on the location of primary raw materials we must do the same for secondary raw materials. This information is fundamental to our business success. We control secondary resources that are cheaper to exploit, have higher concentrations than can be found in virgin deposits and in most cases have a lower carbon footprint to bring to market.

Efficient data systems are at the heart of modern supply chains. Hypermarkets have built a business model with sophisticated stock control systems that enable them to track and manage all their primary resources through their linear supply chains to the point of sale. Such systems enable them to minimise stock, ensure they have the right quantities of raw materials in the right places to supply the demands of their customer at a lower price than their competitors. Such systems are required for secondary raw materials.

We still fail to recognise that secondary raw materials have more value for our economy than primary raw materials in a world where commodity prices continue to escalate as the effects of rising demand for finite resources are felt. We do not sufficiently invest in data management and so continue to struggle to make the case for effective investment. This is clearly seen in how we manage Commercial and Industrial waste where investment decisions cannot be presented with any certainty due to a lack of good clear data with which to make the investment case. The waste industry lacks consistent leadership in tackling this data deficit despite the efforts of a few.

To support innovation and the development of a circular economy we need to move the waste industry from one that manages discarded raw materials from use to point of disposal in the lowest cost manner, to a raw materials supply industry. The industry needs to be one that adds value to secondary raw materials, competes with primary suppliers and delivers raw materials to manufacturing industries who themselves increasingly need to secure raw material supply chains. As such the waste industry needs to learn and apply the lessons of the multinational energy, mining, manufacturing and retail companies who have invested heavily in modernising data systems.

To be effective the waste industry needs to learn the lessons from these major players and develop effective investment plans to modernise and share data on the location, movement and availability of critical raw materials in the secondary supply chains. To implement a clear plan that tackles the data deficit and remove the remaining gaps so that as an industry it can start to manage the resources they control in an effective manner.

Member States have several initiatives in place to modernise data and information on secondary raw materials. Within the UK the LIFE+ project EDOC (Electronic Duty of Care) is developing an online data base system that can receive data on electronic duty of care transfer notes. Within the EU the European Data Interchange for Waste Notification (EUDIN) has been set up to exchange data on shipments of waste. Similar systems are already in place in South Korea for all wastes and in Australia and New Zealand for specific waste streams. Without them the EU is at a competitive disadvantage as it seeks to develop a resource efficient economy.

It is becoming increasingly clear that the EU is operating in an international market where we are competing for secondary raw materials and that we will gain competitive advantage from having in place effective data systems that enable us to manage secondary resources effectively and identify where we can add greatest value. With this data we can identify how to reduce manufacturing costs in the EU providing a competitive edge in global markets for our industries. Without it we risk others using the EU as a supply point for their own industries exploiting the secondary resources we currently control and delivering little economic benefit to the EU.

The EEA has been active in developing global public information networks for creating and sharing information such as Eye-on-Earth. Eye-on-Earth applies the principles of a Shared Information System (SEIS) for Europe. SEIS aims to improve the collection, exchange and use of environmental data and information and is based on the principles of: managing information as close to its source; collecting information once, and sharing with others for many purposes; and using open software standards for sharing. This expertise needs to be exploited to develop the quality data management systems the EU needs to underpin the effective management of secondary raw materials. Particular attention should be given to high value materials, those that can be up-cycled such as precious metals, rare earths and other critical raw materials contained in waste. But even humble materials such as food or organic waste have market potential. Organic waste is rapidly moving from a problem raw material costing over €100 to dispose to landfill to become a source for power, fertilisers, organic materials to improve soil structures, feed stocks to the chemical industry and ultimately a source of hydrogen.

As European and global markets open up for secondary raw materials, sophisticated data and information systems are required to underpin those markets. The experience of the EEA in developing Eye-on-Earth and the relationships it now has with global systems providers places it in a unique position to develop a common waste data system in partnership with the EU waste industry. The EEA has the potential to build on best practice emerging from current EU LIFE+ demonstration programmes. Such a common system would underpin the emergence of commodity markets for secondary raw materials across the EU.

### **Quality standards**

Quality standards are fundamental to any commodity market. For secondary raw materials common standards are needed that work across the EU and answer both regulatory and market questions. No designer will use secondary raw materials unless the properties of those materials are understood, the quality is guaranteed and the supply chain is secure.

### **End of Waste Standards - Regulatory Certainty**

Uncertainty over the point at which waste has been fully recovered and ceases to be waste within the meaning of Article 1(1)(a) of the EU Waste Framework Directive (WFD) (2006/12/EC) has inhibited the development and marketing of materials produced from waste which could be used beneficially without damaging human health and the environment. This uncertainty has inhibited the recovery and recycling of waste and its diversion from landfill.

This problem was recognized in the European Roadmap to a Resource Efficient Future and end of waste regulations have been introduced for scrap iron, steel, aluminium and glass cullet. But this is not enough and the process is too slow, bureaucratic and inflexible.

Environmental regulators across the EU regularly take decisions on End of Waste. They are often business, product and site specific. Often it is a risk-based decision taken in the light of the scale and nature of the business. Where this is not the case and large volumes of materials are involved, where risks to the environment need to be carefully considered, detailed and painstaking work is commissioned before decisions are taken.

The Quality Protocol programme in the UK and now extended to the Netherlands is a good example. Decisions have been taken on end of waste for 11 materials including biodegradable waste – compost; biodegradable waste – anaerobic digestate; aggregates; plasterboard; plastics (non-packaging); poultry litter ash; pulverized fuel ash and furnace bottom ash; tyre derived rubber materials; lubricating oil, and cooking oil and rendered animal fat. Work continues on asphalt waste containing coal tar; biomethane; incinerator bottom ash; meat and bone meal ash; paper sludge ash; steel slag; tyres – tyre bales; and wood. The benefit to the UK economy of this work is releasing materials back into productive use is estimated to be £1 billion savings by 2020, 17 million tonnes of waste diverted from landfill, 14 million tonnes of raw materials preserved and a reduction of 2.1 million tonnes of carbon dioxide equivalent emissions<sup>164</sup>.

Current work by the Environment Agency (England) and its Life+ project partners in the UK and the Netherlands<sup>165</sup> and work by the Joint Research Centre in Seville<sup>166</sup> have shown how complicated this process can become. The EU needs to find a simple way to draw on and recognise the end of waste work undertaken by regulators across Member States to encourage the development of common standards and open markets for the recovered raw materials.

Currently no simple way exists for the work of individual regulators on end of waste standards to be recognised across the EU. Although all end of waste standards are submitted for consideration under the Standards Directive, until EU Regulations are adopted innovative companies still need to seek approval in each Member State for end of waste decisions to apply. Such requirements stifle innovation and need to end. Agreement is needed between Environmental Regulators, facilitated by the Commission to put in place simple systems that allow common solutions to be accepted across the EU. It should be for individual regulators to opt out of end of waste decisions and the default position should move to one where after careful and detailed work has been undertaken and consultations under the Standards Directive have been completed the end of waste specification de facto applies across the EU.

As international markets develop for secondary raw materials international agreement is required on standards for End of Waste in order that reprocessing industries can be developed that deliver quality products and “sham recovery<sup>167</sup>” is avoided.

### **End of Waste Standards – The Current Regulatory Framework**

The current regulatory framework for End of Waste decisions has stood the test of several judicial challenges and there has been little consensus to change that framework. Unfortunately each legal challenge seems to have made it more difficult to recover materials as each decision has taken the point of recovery closer to the point at which a former waste material is used. This stifles market innovation.

Article 6 states that:

“Certain specified waste shall cease to be waste within the meaning of point (1) of Article 3 when it has undergone a recovery, including recycling, operation and complies with specific criteria to be developed in accordance with the following conditions:

- (a) the substance or object is commonly used for specific purposes;
- (b) a market or demand exists for such a substance or object;
- (c) the substance or object fulfills the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and
- (d) the use of the substance or object will not lead to overall adverse environmental or human health impacts.

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<sup>164</sup> These figures originate from analysis of financial impact assessments, prepared by the Environment Agency (England) Waste Protocols Project for the first 12 materials studied and form part of reporting to DEFRA on the Landfill Tax funding provided for this project. These figures were independently audited. They are contained in the successful LIFE+ Equal Project Bid (2011).

Also see: <http://www.wrap.org.uk/content/waste-protocols-project-wins-national-business-award>

<sup>165</sup> See EQual Project - <http://www.environment-agency.gov.uk/aboutus/wfo/134219.aspx>

<sup>166</sup> JCR End of Waste Criteria – Final Report, Luis Delgado, Ana Sofia Catarino, Peter Eder, Don Litten, Zheng Luo, Alejandro Villanueva, European Communities, 2009. ISBN 978-92-79-134227

<sup>167</sup> “Sham Recovery” – This term is used to describe processes that purport to produce secondary raw materials that are of highly variable and inconsistent quality that will ultimately fail “End of Waste” tests.

The criteria shall include limit values for pollutants where necessary and shall take into account any possible adverse environmental effects of the substance or object”.

This approach was challenged in the UK. The OSS test [the case of R (on the application of OSS Group Ltd) v Environment Agency and others ([2007] EWCA Civ 611) (“OSS”) where Lord Justice Carnwath established a test to determine when waste lubricating oil ceased to be waste, having been subject to a waste recovery operation].

The Environment Agency now takes the view that the test set out in the OSS case is directly applicable to any waste-derived fuels, not just waste lubricating oil, and indeed to any waste-derived product which meets the ‘test’. Then test they have now put in place in the UK is that:

- the waste has been converted into a distinct and marketable product;
- the processed substance can be used in exactly the same way as a non-waste, and
- the processed substance can be stored and used with no worse environmental effects when compared to the raw material it is intended to replace.

As more and more uses for secondary raw materials are devised, this is a logical step forward and one that supports innovation and is worthy of wider adoption across the EU.

Adopting a modification to Article 6 of the Waste Framework Directive (as suggested by the OSS judgement) at the earliest opportunity would release further innovation in the recovery of secondary raw materials across the EU. In the interim, as with other interpretations by regulators a simple system is required where such case law can be adopted by all Environmental Regulators across the EU through IMPEL (European Union Network for the Implementation and Enforcement of Environmental Law) or the Heads of the Environmental Regulators. Such an approach would accelerate the development of open EU markets for secondary raw materials.

### **End of Waste Decision – An innovators decision-making process**

Whilst the End of Waste work by regulators works well for bulk materials it does not support innovative companies bringing new thinking to market on how to exploit secondary raw materials contained in waste streams. Regulators across the EU increasingly have to take decisions on End of Waste and do so using risk based decision-making tools that take account of the scale and likely impact of the recovered material. They are normally product, site and scale limited. No agreed decision-making process exists and regulators continue to make ad-hoc decisions. No mechanism exists for these decisions to be more widely adopted leaving the SME’s looking for EU wide markets to repeat the arguments to every regulator with which they work across EU markets

Such an approach does not stimulate innovation in recycling and recovery for individual materials nor does it support SME’s developing new materials from waste. Regulators also tend to be risk averse due to concerns about setting precedent for markets that may subsequently grow in size and geographic area.

The LIFE+ project Equal – “Ensuring Quality of waste-derived products to achieve resource efficiency”, has set out to demonstrate a new method by which these decisions can be taken within an agreed framework and release innovation in the recovery and reuse of raw materials. With the support of Environmental Regulators in England, Netherlands, and Northern Ireland it aspires to empower industry to make their own decisions about whether their product has ceased to be waste, offering the opportunity for the material to be re-used or sold without waste regulatory control. The project is in the process of demonstrating a successful methodology for making end-of-waste decisions by developing an End of Waste e-tool, and implementation guide designed to enable businesses to make their own end of waste decisions and create their own bespoke end of waste Quality Protocols, by August 2014. By following this tool industry should then be able to apply to a regulator with confidence that they have undertaken a rigorous process on which decision can be made about end of waste status.

As with the work on large-scale End of Waste standards a simple means is needed to see such tools adopted and implemented by regulators across the EU. It will then become possible to open up European markets for innovative businesses that develop new ways to recover and reuse secondary raw materials. Innovation is stifled if companies cannot find a way to gain approvals once across the EU and have to argue their case with every waste regulator in every EU country where they seek to operate.

Equally important as international markets develop for secondary raw materials, international agreement is required on decisions taken under these processes.

## Commodity Market - Product Standards

End of Waste standards remove regulatory uncertainty but do not necessarily meet market demands. Commodity markets for primary raw materials set and regulate standards that ensure price mechanisms are tied to agreed standards. Similar standards are required for large volume secondary raw materials that need to be used in EU manufacturing industries. Without these standards materials cannot be traded unseen.

Standards are also needed to match secondary raw materials to manufacturers demands for primary raw material. Research is needed into the standards manufacturing industry requires from secondary raw materials and the changes that need to be made in primary design to facilitate their delivery. Only in this way can the problem of “down-cycling” be avoided. The waste industry needs clear price signals on the quality of recovered materials required. Opportunities exist to match secondary raw material supply to industry demand but this needs sector-by-sector agreements. Such agreements become crucial across the EU if sufficient market demand is to be created that will justify funding for new treatment and collection infrastructure.

Experience from the CABOT pilot suggests that such standards cost in the order of €50,000 to €60,000 to produce for each material under consideration. Each standard must be measurable and consultation between the major parties is an essential aspect of agreeing the final standards.

The EU has a number of funding programmes that could be used to stimulate this work including Horizon 2020, the LIFE+ programme, Eco-innovation, Risk Sharing Finance Facilities as well as Regional and National Cohesion programmes such as INTERREG & ERDF. These funding sources offer a potential route to test such standards, the changes to collection infrastructures that are required to bulk up recovered materials and the infrastructure needed to refine the final secondary raw materials.

The EU should include coherent guidance as part of future funding calls to encourage the emergence of standards for secondary raw materials that will provide EU manufacturing industries with an estimated €5 billion monetary saving in material consumption that will flow from displacing primary raw materials. The EU should also bring together key players in the waste industry and manufacturing sectors to negotiate sector-by-sector agreements that provide market certainty to underpin investment decisions that will change collection and treatment systems for secondary raw materials

### C.11.13. Best Practice and skills build up

The European Waste industry is evolving at a widely different pace between the market leaders, early followers and those who are seeking to catch up. The industry faces significant challenges in building up the skills needed to move from a waste industry to a resource management industry and to attract the qualified engineers that will be required to operate complex plant required to recover secondary raw materials. Exchange of best practice is slow to evolve and until last year<sup>168</sup> for example the industry had completely failed to take advantage of the Leonardo Mobility Programme to exchange skills and knowledge across the EU.

It is clear that solutions exist to the challenges faced by countries that have been slow to move to a recycling economy, but the rate of change to meet EU targets and objectives will need to be at a pace not achieved by the early pioneers. Support is needed to organisations that can affect transfer of skills, best practice and to share innovative ideas.

Organisations either exist or are in embryonic form to support the exchange of best practice, skills and experience across the EU but lack the secure operational funding to fully discharge this role. An opportunity exists for the EU to support these organisations in a similar way to that adopted for IMPEL and to agree common annual objectives and funding arrangements.

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<sup>168</sup> See The Renewable Energy Association (REA) 2012 at:-  
<http://www.r-e-a.net/news/advanced-biogas-learning-in-europe-able-eu-leonardo-project>



Organisations such as:

- ACR+ The Association of Cities and Regions for Recycling and Sustainable Resource Management;
- The VDI-ZRE/ WRAP led Network of Agencies seeking to support SME's to identify and improve their resource efficiency and sustainable use of raw materials;
- The International Solid Waste Association (ISWA) European Group set up to promote professional solid waste management;
- EUROCITIES Environment Forum -supporting cities achieve sustainable development and share knowledge and expertise
- EIONET – European Topic Centre on the Sustainable Consumption (SCP) and Production of Natural Resources, set up to provide reliable and comparable data and information on SCP, resource and waste management in Europe to decision-makers and the public.

These organisations could over a five-year period provide effective support and guidance to public and private sector organisations and become the source of best practice advice across the EU.

The EU should invite bids from appropriate organisations to support the exchange of best practice across the EU in recycling activities, process standards for the collection, sorting and processing of waste and the use and recovery of secondary resources in eco-design.

Recognition is also needed of the fundamental shift in skills and expertise that moving to a recycling economy demands of the existing waste and resource management industry. It is critical that provisions are made to build up skills for the resource management industry. Initiatives such as those put in place to build skills for the building sector to deliver energy and climate change objectives under the Intelligent Energy Europe programme, are needed for the waste industry.

#### C.11.14. Funding for Innovation

The EU offers both industry and public sector bodies a range of funding opportunities to take ideas from research, to demonstration programmes, and then onto market development and implementation. As ideas evolve many of these programme identify the top projects, but the EU has no process to nurture the most innovative ideas to full EU wide implantation. Different skills are needed at each stage in this process and fast track methods are needed if the EU is to achieve the objectives set out in its "Road map to a resource efficient future".

Innovators who develop new ways to recover and reuse secondary raw materials are stifled by the lack of common EU wide systems to interpret waste legislation. A simple agreed system for a lead regulator is required, where by once a decision is taken it is adopted by all regulators across the EU. IMPEL would make an excellent body to set up and monitor this type of solution. Without it innovators are left to argue their case with 27 Members States and the regulators within those states. Such processes stifle innovation and drive market development overseas.

The EU should consider a package of measures that captures best of the best programmes for waste and resource management and provides continuing financial support to ensure they reach market and are widely disseminated. Where such ideas challenge regulatory thinking and require new risk based solutions from Member States, the EU through IMPEL should ensure those decisions are accepted across the EU. This is crucial to SME's developing new ideas in the recovery and re-use of materials.

### C.11.15. Conclusions

The case study looked at how to:

- improve the recycling rates and the quality of recycled materials;
- improve process standards for collecting, sorting and processing waste; and
- improve the eco-design directive through encouragement to use and recover secondary raw materials.

The study has applied the Methodology – Screening of regulatory framework to outline the area for the assessment, the exact area in focus, identified barriers and drivers for innovation in the target sector, reviewed the regulatory landscape, analysed links between regulation and innovation and identified areas for further work that would if delivered accelerate the pace of change in the recovery and reuse of quality secondary raw materials.

The case study recognises that the EU has mainly used regulatory instruments to promote recycling and recovery leaving economic instruments largely to Member States. It highlights that tackling resource efficiency through driving recycling rates to agreed targets or through driving up the cost of disposal to landfill or incineration creates materials looking for markets. It concludes that the next stage is to drive through to recognise the needs of manufacturers and remove regulatory barriers in the way of re-use.

The study recognizes that the EU Resource Efficiency Road Map has highlighted the need to establish functional markets for secondary raw materials. For such markets to work a series of changes need to take place in the way we view and regulate waste. Without these changes it remains a complex challenge to drive up recycling standards in a rapidly urbanizing Europe and to give confidence to designers to specify secondary raw materials.

The above case study provides an outline how these issues can be tackled in support of the European Innovation Partnership (EIP) on Raw Materials in its attempts to improve Europe's waste management regulatory framework conditions and excellence (WP4).

### C.11.16. References

Bio Intelligence Service (2011), Implementing EU waste legislation for green growth.

Bio Intelligence Service. (April 2012) Report for EU DG ENV Unit G.4 Sustainable Production & Consumption. Use of Economic Instruments & Waste Management Performance, Final Report, Paris, France.

BiPRO (2012), Screening of waste management performance of EU Member States, European Commission. Brussels.

CIWM/AMEC Environment & Infrastructure UK Ltd (July 2013), Research into SRF/RDF Exports to other EU Countries. Final Technical Report, Northampton,UK.

Dougherty, David (2010), Developing a Commodity Market for Recovered Materials, Pathway to Zero Waste, ERDF Project.

Ellen Macarthur Foundation, (2012) Towards the circular economy, Economic and business rationale for an accelerated transition.

ENTEC UK Limited (2011), Commodity Market Feasibility Study, European Pathway to Zero Waste, LIFE08 ENV/UK000208, Environment Agency, Reading, UK.

Ernst & Young (2011), Analysis of profit warnings issued by UK quoted companies.

EU (July 2013) BUILD UP Skills – Qualification and training schemes – Pillar II Intelligent Energy Europe Programme – Guide for Proposers.

European Commission (2011) CCMI/091 Commodity Markets and Raw Materials- Opinion of the European Economic and Social Committee. COM92011) 25 Final.

European Commission (2011) Commission staff working paper, Analysis associated with the Roadmap to a Resource Efficient Europe Part II (SEC/2011/1067 Final.

European Commission (2011) Roadmap to a Resource Efficient Europe (COM/2011/571),

European Environment Agency (2012) Material Resources and Waste – 2012 Update. The European Environment State and Outlook 2012, Copenhagen Denmark.

European Environment Agency, (2012) Materials Resources and Waste – 2012 Update

European Environment Agency, (2013) Managing municipal solid waste – a review of achievements in 32 European countries, EEA Copenhagen, 2013 ISBN 978-92-9213-335-9

European Environment Agency, (2013) Movements of waste across the EU's internal and external borders, EEA Report No 7/2012, EEA Copenhagen, 2012 ISBN 978-92-9213-337-5.

[http://ec.europa.eu/environment/resource\\_efficiency/pdf/com2011\\_571.pdf](http://ec.europa.eu/environment/resource_efficiency/pdf/com2011_571.pdf), 30/06/2013

ISWA (2011). Working Group Recycling and Waste Minimisation. Key Issue Paper on Waste Prevention, Waste Minimisation and Resource Management. Lead Authors Maarten Goorhuis and Andreas Bartl. Vienna, Austria.

JCR End of Waste Criteria – Final Report, Luis Delgado, Ana Sofia Catarino, Peter Eder, Don Litten, Zheng Luo, Alejandro Villanueva, European Communities, 2009. ISBN 978-92-79-134227

Lacosts, E.; Chalmin, Ph. (2007) From Waste to Resource 2006 World Waste Survey, Economica Paris France.

LIFE08 ENV\_UK\_000208, European Pathway to Zero Waste: demonstrating the route to zero waste to landfill via end of waste protocols and building a recycling society (EPOW), Environment Agency, Bristol UK. 2009 <http://www.environment-agency.gov.uk/aboutus/wfo/epow/123624.aspx>

LIFE09 ENV\_UK\_000023, Electronic Duty of Care (EDOC), Environment Agency, Bristol. UK 2010 <http://www.environment-agency.gov.uk/aboutus/wfo/128930.aspx>

LIFE10 ENV\_DK\_000098 Plastic ZERO - Public Private Cooperation's for avoiding plastic as a waste (Plastic zero) City of Copenhagen, Denmark. 2011 <http://www.plastic-zero.com/news/new-website.aspx>

LIFE10 ENV/UK/000176, Ensuring Quality of waste-derived products to achieve resource efficiency (EQual), Bristol. UK 2011 <http://www.environment-agency.gov.uk/aboutus/wfo/134219.aspx>

LIFE11 ENV\_UK\_000389 Urban Participation and Focus on Reusing Waste and Recycling Development of Communications (UP&FORWARD COMS) Greater Manchester Waste Disposal Authority Manchester UK. 2012 <http://upandforward.recycleforgreatermanchester.com>

LIFE12 ENV/UK/000608, Developing Resource Efficient Business Models (REBus), Waste & Resource Action Programme (WRAP), Banbury. UK 2013 <http://www.wrap.org.uk/>

LIFE12 NAT/BE/000459, European Week for Waste Reduction (EWWR+) Association of Cities and Regions for Recycling and Sustainable Resource Management (ACR+), Brussels. Belgium. 2013 <http://www.acrplus.org>

The European Environment, State and Outlook 2010, EEA Copenhagen 2012, ISBN 978-92-9213-314-6.

The RSA, (June 2013), The Great Recovery - Redesigning the Future, Investigating the role of design in the circular economy, London. UK.

WRAP (August 2012). A survey of the UK Organics Recycling Industry in 2010. A report on the structure of the UK Organics processing / recycling sector and the market outputs. Banbury, UK.

Table 31 List of drivers and barriers for recycle material use

<b>Factors</b>	<b>Barrier</b>	<b>Driver</b>	<b>Neutral</b>	
<b>Policy, regulation, governance</b>				
Governance structures (e.g., monopolies, ownership structures...)	X			Monopolies are a barrier to the operation of open commodity markets and constrain innovation
Lack of multi-stakeholders approach in governance	X			Lack of multi-stakeholder ownership and governance is major block to the development of value added recycle markets.
Lack of coherence with other existing regulation	X			Waste legislation is mainly designed to control safe disposal and is not suited to recovery and re-use. REACH and other raw material legislation was not drafted with secondary raw materials in mind and can be over complex. End of waste decisions throw up complex legal arguments between very different strands of legislation including Animal By-Products Regulations, REACH and the Waste Framework Directive.
Risk assessment approach for harmonized EU regulation	X			No common framework exists for risk-based decisions taken by one EU Environmental Regulator to apply across the EU. This becomes a barrier to innovation and trade and slows down the development of the recycling economy.
National/international (demand-side) policies:				
- Innovation procurement	X			Despite the rhetoric procurement decisions are risk averse mitigating against using recovered raw materials
- Regulation	X			Regulation continue to block recover and reuse of raw materials. No simple systems exist to adopt Member State decisions on end of waste across the EU or with international trading partners.
- Standardization	X			Lack of transparent tradable standards is a major blockage to the development of infrastructure to reprocess secondary raw materials obtained from waste.
- Demonstration projects		X		Demonstration programmes are an excellent way of demonstrating how to promote high quality recycling and recovery of secondary raw materials from waste. Better dissemination and sharing of best practice is still a challenge from these programmes.
- Prototyping		X		Excellent way to prove new technologies for use in the recovery of secondary raw materials from waste. Lack of simple systems to adopt the decisions of one Member State regulator across the EU remains a barrier to innovation and to trade.
- Tax incentives		X		Major driver of change and take up of recycling initiatives to recover secondary raw materials. Without markets it can lead to materials seeking an end use and the next cheapest disposal route.
- Labelling			X	Current stigma to the use of secondary raw materials in new products means this cannot be used as a promotional opportunity
- Information campaigns		X		Critical driver in changing people's behavior to promote recycling and recovery but it takes time and persistence to work.
Competition law (incl. State Aid rules)			X	
Trade agreements		X		With the development of global trade in secondary raw materials recovered from waste this can be a major driver to the development of quality materials and a deterrent to sham recovery.
Dedicated sectoral (supply-side) policies		X		This will become a driver if we can achieve dialogue between the waste industry and major manufacturers on the materials available from the waste streams ass secondary raw materials. The lack of long-term business relationships for Commercial and Industrial waste remains a barrier to the development of treatment infrastructure that would be overcome with sectoral agreements.
<b>Economic and market</b>				
Pricing		X		Price remains the major driver of the waste and resource management industry and is critical to the emergence of secondary raw materials into EU manufacturing.
Lack of market demand	X			Market demand is crucial to the emergence of a high quality recycle industry capable of creating the right secondary raw materials at the right price.
Current industry structure with high share of larger incumbents	X			The limited number of large companies in the waste and resources market is a barrier to innovation along with large public sector bodies

				on mainland Europe that control the waste industry.
Market power of competing products / substitution potential of these products		X		Secondary raw materials have the potential to displaced primary raw materials at yesterday's prices if the quality is right but they disrupt primary supply chains and are resisted by established players in the market place.
Rebound effect; fragmented responsibility for investment in innovation that would lower resources burden of overall system (5)	X			The circular economy that could drive high quality recycling and recovery of secondary raw materials is currently fragmented and designers, manufacturers and the waste industry rarely meet and do not understand one another issues.
Lack of transparency	X			The lack of transparent commodity markets for secondary raw materials obtained from waste remains a major barrier
Industrialization	X			Lack of infrastructure to recover secondary raw materials remains a major barrier. Secondary raw materials offer the EU raw materials at yesterdays prices that could be used to re-industrialize parts of the EU in the same way that primary raw materials were critical to the first industrial revolution
Deindustrialization	X			Loss of manufacturing industry removes demand for recovered secondary raw materials and leaves the EU as a cheap supplier for China and other.
Facility of transportation		X		Cheap transport has fuelled the export of low quality recycled materials and RDF for incineration.
Technological challenges (use and integration of spillover)	X			The waste and resource management industry has a low skilled workforce and problems attracting and retaining the skilled engineers needed to move from a landfill based to a process based industry.
Enabling infrastructures	X			This remains a major barrier to the recovery and provision of high quality secondary raw materials
<b>R&amp;D capabilities</b>				
Inadequate own financial resources	X			Low profitability in the waste and resource management industry and a large number of SME companies restricts spend on R&D.
Lack of access to finance	X			A major issue in the development of new infrastructure across the EU for recycling and the recovery of secondary raw materials. Where environmental taxation is put in place to drive behavior change the lack of hypothecation and the use of the funding raised to help drive change in the waste and resource management industry is a major opportunity lost.
High innovation costs	X			The waste and resource management industry remains risk averse and resistant to change. High innovation costs is a major barrier.
Shortage of qualified internal technological skills	X			As above the industry has a major reskilling problem both for its existing workforce and a major problem attracting the engineers to develop and operate process plant required to provide secondary raw materials from high quality recycle.
Shortage of skills related to innovation management	X			The waste and resource management industry does not attract the brightest and the best graduate and has a major image problem of a dangerous industry in which to work. As the industry changes to become a supplier of secondary raw materials a major effort to rebrand will be required if this problem is to be addressed.
Limited abilities to spot market opportunities – lack of information on markets (EU and global)	X			Poor quality data on industrial and commercial waste, where it is, what is in it and in what quantities makes investment decisions a guessing game.
Risk adversity	X			The waste and resource management industry remains risk averse
Limited abilities to test market readiness	X			Lack of innovative thinkers, risk adverse cultures, low pay and profitability all mitigate against testing market readiness.
<b>Socio-cultural</b>				
Population growth		X		In a resource constrained world population growth should be a driver of innovation to recover and re-use secondary raw materials.
Population decline	X			Population decline could breed complacency and reduce pressure to secure better use of secondary raw materials
Ageing of the population			X	
Environmental concerns		X		Environmental concerns are the major driver for change in the waste and resource management industry.
Geopolitics and world conflicts		X		The growing scramble for primary raw materials is a major driver to the recovery of secondary raw materials from waste.
Quality of life		X		This remains a driver to the move away from incineration and landfill to a productive use of recovered raw materials from waste.
Urbanisation		X		Urbanisation should concentrate secondary raw materials and offer

				economies of scale in their exploitation and reuse .
User sophistication level		X		As the benefits of using secondary raw materials become clear this could be helpful in promoting their uptake and reuse in new products.
Personalisation			X	

Table 32 Evidence of a Paradigm Shift in Manufacturing

Features of a Paradigm Shift	Evidence from the Manufacturing Sector
1. Crisis	<p>Economic: Manufacturers are facing substantial price increases driven by constraints on resources including oil, commodities and skilled labour. Externalities such as carbon, water and waste disposal are being priced into the economy causing disruption to conventional production costings.</p> <p>Environmental: Environmentalists believe that rising population, wealth and living standards combined with current manufacturing and disposal approaches mean that we are now living beyond the sustainable carrying capacity of the planet<sup>353</sup>.</p> <p>Social: Changing supplier, customer and consumer needs, including corporate social responsibility. Unemployment.</p>
2. Return to first principles	In response to these challenges, leading companies are rethinking what they make, how they make it, and how they provide it to clients (with solutions across the four areas of Incremental change, Process and System change, Structural change and Core Redesign). The emergence of new business models demonstrates the fresh thinking that is occurring.
3. Better solution of the problems	The analysis in this paper indicates the extent of the benefits of the new resource efficient approach, as does the profitability and growth of pioneering companies like Unilever and Toyota.
4. Resistance	Many companies have preferred to maintain the historical linear production model, despite benefits from changing and the successes of their pioneering peers.
5. Gradual growth of support	Company performance data for most of the seven topics examined show increasing numbers of companies making significant improvements in recent years.
6. A new perspective that is an irreversible step change	Resource productivity including circular resource use and the new business models that facilitate it create economic, environmental and social benefits. Historically, when one leading company embraces a more efficient approach, similar peers within the sub-sector have followed to maintain market share. This has occurred, for example, in carpet tiles and photocopiers.
7. Incomplete definition of the new approach	The change described has no standard definition or common taxonomy. Interface's Ray Anderson called it "a better way" of doing business <sup>354</sup> , Patagonia's Yvon Chouinard calls it "responsible business" <sup>355</sup> . Amory Lovins refers to it as "Factor 4" <sup>356</sup> . None of these are well established terms or have become accepted labels for the change. This report refers to the change as the next manufacturing revolution.

Source: Institute for Manufacturing Cambridge United Kingdom.

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The regulatory environment is an important factor influencing the innovation activities of companies and the wider economic system within which they operate. The study provides a methodology for assessing the impact of regulation on innovation and applies it to two sectors: Water and Raw Materials.

As expected, the analysis shows that regulations can both foster and hamper innovation depending on how they are designed and implemented. Implementing one of the commitments of the Innovation Union, this methodology can now be used to screen the innovation impacts of existing regulatory frameworks in different areas with a view to identifying their effectiveness as catalysts of innovative behaviours.

*Studies and reports*

