Meso-level eco-efficiency indicators to assess technologies and their uptake in water use sectors

Collaborative project, Grant Agreement No: 282882

Deliverable 5.11

Policy recommendation for technology uptake

February 2015

DOCUMENT INFORMATION

Project	
Project acronym:	EcoWater
Project full title:	Meso-level eco-efficiency indicators to assess technologies and their uptake in water use sectors
Grant agreement no.:	282882
Funding scheme:	Collaborative Project
Project start date:	01/11/2011
Project duration:	36 months
Call topic:	ENV.2011.3.1.9-2: Development of eco-efficiency meso-level indicators for technology assessment
Project web-site:	http://environ.chemeng.ntua.gr/ecowater
Document	
Deliverable number:	5.11
Deliverable title:	Policy recommendations for technology uptake
Due date of deliverable:	30/09/2014
Actual submission date:	4/02/2015
Editor(s):	NTUA
Author(s):	Anna Giannikopoulou, Les Levidow
Reviewer(s):	Michiel Blind
Work Package no.:	5
Work Package title:	Integration and Synthesis
Work Package Leader:	NTUA
Dissemination level:	Public
Version:	1
Draft/Final:	Final
No of pages (including cover):	41
Keywords:	Policy recommendations, Resource efficiency, Pollution prevention, PESTLE analysis

Executive summary

The Deliverable 5.11 “Policy recommendations for technology uptake” summarises the current barriers and policy efforts that should be considered for the adoption of technology for eco-efficiency improvement in each Case Study individually in the EcoWater Project.

Policy recommendations are based on the eco-efficiency analysis undertaken (to reveal the weaknesses of the system’s operation), the PESTLE analysis of the external environment, and the review of available instruments / tools at the EU level. The recommendations incorporate a wide range of available policy tools such as technical and other instruments to overcome current barriers examined at each Case Study. It should be noted that the recommended policies or instruments are provided per sector, in line with the classification of the Case Studies, i.e. agricultural, urban and industrial water management settings.

The Deliverable 5.11 will be useful for adoption of innovative technologies to each Case Study while addressing local specificities and potential constraints through policy recommendations.

The main results from the review of relevant policies to enhance eco-efficiency are:

- In the Agricultural sector, the eco-efficiency could be promoted by the greening criteria for the CAP subsides;
- In the Urban water use sector, the phosphorus recovery policy will promote significant the improvement of eco-efficiency. Therefore, the modernisation of the waste water treatment infrastructure is necessary; and
- In the Industrial sector, the focus should be on: (i) the appropriate economic mechanisms to support investments for innovative practices, and (ii) development of a market to promote the new eco-products. It should be also highlighted that the EU 2012 Energy Efficiency Directive will have a significant role for eco-efficiency improvement.

Contents

Contents of Figures and Tables

1 The Europe 2020 Strategy

The Europe 2020 strategy promotes resource efficiency in several ways, e.g. by increasing the share of renewables in the EU's energy mix. The strategy also promotes a ‘Resource efficient Europe’ to help decouple economic growth from the use of resources, alongside ‘resource efficient technologies’ ([14]: 4). According to the flagship document on *A Resource-Efficient Europe*, ‘*By reducing reliance on increasingly scarce fuels and materials, boosting resource efficiency can also improve the security of Europe's supply of raw materials…*’ [11]. Also, the shift towards a resource-efficient and low-carbon economy ‘*will help us to boost economic performance while reducing resource use*’. For example, ‘*stricter environmental targets and standards which establish challenging objectives and ensure long-term predictability provide a major boost for eco-innovation*’ ([16]: 2, 6).

Eco-efficiency can boost businesses’ productivity and competitiveness in the global market. It can help the public sector to improve its finances. It can bring significant gains for European citizens, ranging from jobs to health benefits. It can stimulate interest in the European project of the Strategy 2020. And it can help to deepen the internal market, which is Europe’s main driver of competitiveness, security of supply and sustainability. Eco-efficiency has the potential to become the next European success story, helping to deliver the ‘Europe 2020’ strategy’s objectives of driving smart, sustainable and inclusive growth.

1.1 Resource Efficiency

Resource efficiency refers to the production or supply-side/demand measures that tackle inefficiencies across supply chains, i.e. overuse of resources and waste when products and services are produced. Being more resource efficient means using less material to produce the same level of output ([50]). It should be highlighted that resources should be used in ways providing the highest possible value for the final products.

The European Union recognizes resource efficiency as a high priority, as this is the first target in the 2020 Strategy. The 7th Environment Action Program focuses on measures to '*further improve the environmental performance of goods and services on the EU market over their whole life-cycle*' ([36]; [38]).

Greater resource-efficiency ‘*will ease pressure on the environment and bring increased competitiveness and new sources of growth and jobs through cost savings from improved efficiency, the commercialization of innovations and better management of resources over their whole life cycle ([38]: 8). Implementation ‘shall be informed by the European Environment Agency’s indicators on the state of the environment as well as indicators used to monitor progress….*’([40]). The report puts emphasis on the need for indicators to monitor change[1].

---

[1] Several key concepts, including green economy, resource efficiency, sustainable consumption and production and circular economy, are increasingly being discussed and used in Europe, and imply considerable changes in the way production and consumption are

Resource-efficient innovation has numerous drivers and barriers, which have been identified on a general industry-wide basis ([25]; [41]). The EcoWater case studies identify drivers and barriers in specific meso-level contexts, for better understanding what changes would be helpful taking into account the water value chain.

Resource efficiency, investment in greener products and services, new business models, more efficient city planning and transportation systems, using new and existing technologies, and developing internal and external markets for eco-efficiency can bring enormous benefits.

1.2 Pollution Prevention

Pollution prevention is another important issue incorporated in the policy objectives of the EU. At the EU level, a significant number of Directives describe the pollution threats for several sectors and propose set of instruments to limit the phenomenon, such as the Urban Waste Water Treatment Directive (UWWTD). Pollution prevention as a concept is linked almost directly with resource efficiency. Hence, a number of measures related to waste management incorporate definitely the aspect of pollution.

Source reduction means lessening the amount of material entering a waste stream. It allows for the greatest improvements in environmental protection by avoiding the generation of waste and harmful emissions. Source reduction makes the regulatory system more efficient by reducing the need for end-of-pipe environmental control by the government. It should be also highlighted that pollution prevention could be technically achieved through a number of actions to enhance resource efficiency (e.g. the usage of renewable energy reduces the use of conventional resources and final emissions of CO_2). Pollution prevention practices and techniques often benefit industry by lowering a company's operational and environmental compliance costs [64].

The European pollution policies are developed to address individual types of plant or activities (e.g. combustion plants, incinerators). The Industrial Emissions Directive ([32];[33]) however uses a more comprehensive approach to environmental management to cover a wide range of industrial activities.

1.3 Circular Economy

The European Commission has elaborated the 'circular economy' concept, primarily for revising EU waste legislation. The waste policy review builds on the idea that waste-as-resource and resource efficiency must become part of the fundamental structure of EU economic strategy.

According to the Environment Commissioner Janez Potocnik, '*resource efficiency is about getting more added value and wellbeing from each unit of resource: each ton of materials, each hectare of land, each joule of energy, and each cubic meter of water'*. The concept of the circular economy goes to the core of this. It is 'about

organised. Indicators have a crucial role in tracking progress towards the implementation of these policy concepts ([40]: 21) getting rid of the very concept of waste'. Therefore the waste strategy promotes reuse, recycling and the minimization of residual waste [65].

Going beyond waste management, the Commission's overall policy is more ambitious, proposing systemic changes in production-consumption value chains[2]:

In addition, the concept of 'circular economy' has been widely elaborated with diverse definitions, as given in Table 1. While the EC emphasizes value chains, Forum for the Future (2014) emphasizes a shift to value networks for greater flexibility.

Table 1. Alternative definitions for a circular economy

Definitions	Source
A circular economy seeks to rebuild capital, whether this is financial, manufactured, human, social or natural. This ensures enhanced flows of goods and services. The system diagram illustrates the continuous flow of technical and biological materials through the 'value circle'	Ellen Macarthur Foundation, US, [66]
A circular economy is an alternative – to a traditional linear economy (make, use, dispose) – in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life	WRAP, UK, [67]
Circular economy is the one which captures materials so that today's goods are remanufactured or reused to become tomorrow's goods, rather than landfill. To make this work, we need to understand how circular business models can be developed in a way that keeps companies profitable, and how the policy landscape can better help to foster a circular, resource-secure economy,	Green Alliance, UK, [62]
Developing a circular economy product or service means creating a new value network. This means forming a web of new relationships to access a greater variety of assets and capabilities. In doing this, it will be possible to develop circular business models that rely on new physical (materials or components) and value flows	Forum for the Future, UK, [68]
Taking inspiration from natural ecosystems, the circular economy already shows that efficiency in resource usage simultaneously creates economic, social and environmental value [translation],	L'Institut de l'Economie Circulaire, France, [63]

[2] Circular economy systems keep the added value in products for as long as possible and eliminate waste. They keep resources within the economy when a product has reached the end of its life, so that they can be productively used again and again and hence create further value. Transition to a more circular economy requires changes throughout value chains, from product design to new business and market models, from new ways of turning waste into a resource to new modes of consumer behaviour. This implies full systemic change, and innovation not only in technologies, but also in organisation, society, finance methods and policies ([23]).

2 Policy recommendations using PESTLE analysis

Policy formulation and further recommendations towards the adoption of innovative technologies require a deep understanding of sociotechnical dynamics. In fact, there are two major phases to this process: (a) the analysis of factors that influence the technology uptake, and (b) the identification of a suitable set of measures to strengthen the technology adoption taking into account the opinion of the respective policy makers. It should be highlighted also that the contemporary socio-economic conditions crucially affect the ability to develop the appropriate policy recommendations for several sectors presented in the EcoWater Project.

Figure 1 illustrates the process followed in the Project.

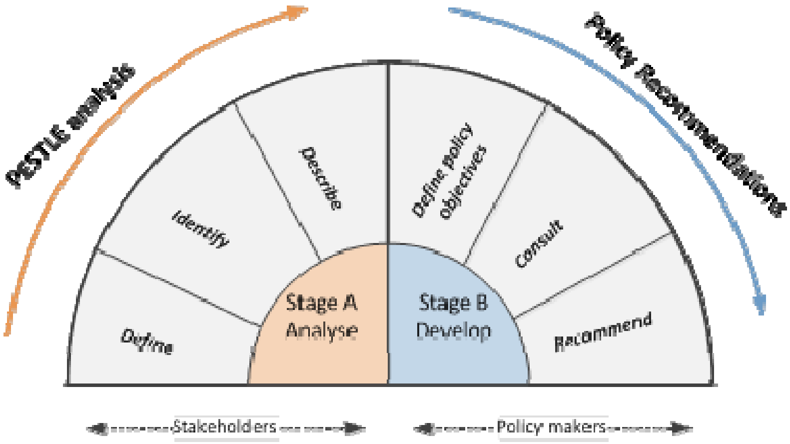

Figure 1. The policy formulation process

PESTLE analysis (Stage A in **Error! Reference source not found.**) includes several sub-steps as the following:

- Identification of PESTLE factors and their meaning; and
- Detailed description of their influence and their role in each Case Study (e.g. drivers or barriers).

For Policy Recommendations, Stage B part in **Error! Reference source not found.**, two sub-steps are required prior to their formulation:

- Definition of policy objectives (e.g. resource efficiency or circular economy etc.); and
- Review of instruments and mechanisms providing the implementation of innovative technologies taking into account the barriers retrieved from PESTLE analysis.

PESTLE analysis is a tool that supports the identification of factors or aspects using the taxonomy of them that affect a focal issue in order to depict a potential future trends related to this issue. The following paragraphs present the PESTLE analysis and the findings retrieved from the Case Studies. The identification of socio-economic forces that are either negative or positive for adopting innovative technologies will be useful information for the policy makers. Policy makers should define the policy objectives and consider the socio-economic conditions identified through the PESTLE exercises in order to propose a set of measures suitable for the needs of each Case Study.

2.1 Introduction to the PESTLE analysis

The process of identification and further categorization of factors that influence the technology uptake includes several steps:

- Identification of socio-technical factors through Workshop Events, in which stakeholders and relevant actors identify the external pressures that affect the adoption of innovative technology in the entire water value chain;
- Classification of the identified factors according to the PESTLE taxonomy and characterization as drivers or barriers corresponding to their role (positive or negative influence on technology adoption);
- Aggregation of the classified factors from each Case Study and development of “groups” of factors (i.e. Political driver: EU Climate Change Strategy). The grouping was based on individual factors, identified though Workshops, which seemed to be similar and formed a specific group took place;
- Literature review on additional factors and connection with policy objectives; and
- Distinction of these “groups” of factors into external or internal. The internal factors are inner strengths or weaknesses of the value chain system (i.e. company strategies) and external factors represent the conditions of the external environment that influence the uptake of innovative technologies (i.e. government measures).

By and large, PESTLE analysis focuses on a number of aspects (Political, Economic, Social, Technological, Legal and Environmental), which are likely to influence the future of technology adoption. In particular, according to literature review ([59]; [45]):

Political factors refer to policy instruments and the institutional and administrative framework that may affect positively (driver) and negatively (barrier) the technology uptake. A list of political factors may include: (1) International, European and National policy, (2) National and local organizations’ requirements, (3) Trading policies, (4) Funding, grants and initiatives, and (5) Inter-country relationships.

Economic factors refer to the economic aspects, which may influence the technology adoption in the value chain. Economic factors could be: (1) Funding mechanisms, (2) Internal funding models, (3) Budgetary restrictions (4) Income generation targets, (5) Taxation/Inflation/Interest, (6) Economy trends, (7) Industry growth, and (8) Import/export issues.

Social factors refer to the cultural aspects, general lifestyle changes and the trends in social elements/attributes (i.e. population, distribution, different mixes of culture) that affect the adoption of eco-innovative practices/technologies. The group of social factors may incorporate: (1) Demographics**,** (2) Work ethic**,** (3) Brand, company, technology image**,** (4) Lifestyle trends**,** (5) Consumer attitudes and opinions, and (6) Consumer buying patterns.

Technological factors focus on the technological aspects, innovations, barriers and incentives, which impact the decision making for the adoption of a new technology. This list may include: (1) Emerging technologies, (2) Maturity of technology, (3) Technology legislation, (3) Research and Innovation, (4) Information and communications, (5) Competitor technology development, and (6) Intellectual property issues.

Legal factors include laws and regulations that will affect the way the meso-level value chain operates. A list of legal factors may consist of: (1) Current legislation, (2) Future legislation, (3) International legislation, (4) Regulatory bodies and processes, (5) Consumer protection, (6) Health and safety regulations, (7) Tax regulations, and (8) Competitive regulations.

Environmental factors refer to the ecological and environmental aspects that will affect the technology uptake and can consider the reduction of: (1) carbon footprint and (2) water footprint.

2.2 Exploring the PESTLE factors in the EcoWater Project

The PESTLE exercises were held in the 1st and 2nd Round of Workshop Events, where a number of actors and stakeholders participated in. The identified factors, classified following the PESTLE taxonomy ([47]), were retrieved from the presentations given in the corresponding events as well as from Deliverables 1.7 ([47]) and 6.1 ([55]).

The final lists of PESTLE factors that influence technology uptake are presented in the following sections. For each factor, the following information is provided:

- The type (i.e. internal or external factor);
- The policy objectives that could be linked with the factors as this has arisen from the experience gained through the Project or from the literature review.
- The relevant economic sectors, following the classification scheme of the Case Studies (Annex I) examined in the EcoWater Project (i.e. Agricultural, Urban and Industrial Case Studies);

The Tables are filled in with the following symbols:

- (+) is used to indicate the drivers;
- (-) is used for the barriers;
- (x) is used in case there is no specific policy objective linked with the factor; and
- (✓) is used to indicate whether the factor is internal or external.

2.2.1 Political Factors

Table 2 shows the identified political factors that influence technology uptake linked with several policy objectives. It should be noted that the factors presented in Table 2 may describe priorities for each individual sector.

The issues that are important for the agricultural sector relate to national policies towards water saving and pollution prevention through energy efficiency measures (P.1 & P.5). The urban Case Studies are oriented to EU Directives (WFD) for addressing water scarcity and Climate Change, as the technologies to be selected are relevant to the water supply network (P.1 & P.2).

It is important to note that the political factors are mainly linked to the policy objectives of “resource efficiency” and “pollution prevention”. For instance, in the case of urban CS3 the National policies on water saving/scarcity (P.1) indicates that there is a number of instruments for enhancing the promotion of water reuse appliances, which are considered as a strong driver for adopting this group of technologies.

Table 2. Political factors for the Case Studies

Political Factors	**E**[3]	**I**[4]	**Policy Objectives**	**EcoWater Case Studies**							
				Agricultural		**Urban**		**Industrial**			
				CS1	**CS2**	**CS3**	**CS4**	**CS5**	**CS6**	**CS7**	**CS8**
P.1. National /regional policy compliant with Water Framework Directive(WFD) focused on water scarcity ([58]; slide 27) [4],[5]	✓		Resource Efficiency	+		+					
P.2. National/regional policy compliant with Water Framework Directive focused on climate change ([44];slide 17) ([58]; slide 27) ([60];slide 28) [4], [5]	✓		Pollution Prevention			+					
P.3. Promotion of Green growth and innovation ([55]; p. 45) [57]	✓		X								+
P.4. National/regional policy harmonized with Hazardous Waste Directive ([55]; p. 47) [7]	✓		Pollution Prevention								+
P.5. National strategy on Sustainable Development (focus on	✓		Pollution Prevention	+		+			+		

[3] E: External factors

[4] I : Internal factors

Political Factors	E[3]	I[4]	Policy Objectives	EcoWater Case Studies							
				Agricultural		Urban		Industrial			
				CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8
RES) ([44]; slide 17) ([58]; slide 27) ([60] 2; slide 8) [2], [27]											
P.6. National policies aiming at decoupling waste growth from economic growth ([60]; slide 8)	✓		• Pollution Prevention • Circular Economy • Resource Efficiency	+							
P.7. Stable and cohesive governance /Trust among parties ([44]; slide 17) ([47]; p. 18)	✓		X						+	+	
P.8. Environmental policies and strategies based on several Directives (e.g. EIA & SEA Directives) ([48]; slide 4) [2]	✓		Pollution Prevention							+	
P.9. Product labelling/ eco-labelling ([2]; slide 19,20) ([47]; p. 18) [39]	✓		X					+		+	
P.10. Company policy and strategy (e.g. decrease water and energy use) to improve their environmental profile ([48]; slide 4) ([55]; p. 46)		✓	Resource Efficiency							+	+
P.11. Bureaucratic issues ([2]; slide 18)	✓		X					-			
P.12. National policy harmonized with Drinking Water Directive (1980, 1998) ([58]; slide 27) [8]	✓		Pollution Prevention			+					
P.13. BAT under the Industrial Emissions Directive (IED) ([55]; p. 47) ([47]; p. 18; [48]; slide 4) [10]	✓		Pollution Prevention							+	+
P.14. National/regional policy compliant with Marine Water Directive ([55]; p. 47) [9]	✓		Pollution Prevention								+
P.15. Promotion of industrial symbiosis/circular economy ([44]; slide 17) ([48]; p. 19)[6]	✓		Circular Economy					+	+		

2.2.2 Economic Factors

Table 3 lists the economic factors that affect, either positively or negatively, the adoption of technologies by the three sectors.

According to Table 3, two drivers are important for all sectors: (a) high cost of water supply/use and of wastewater treatment and disposal (Ec.3), and (b) high cost of energy supply/use (Ec.4). With regards to the barriers in Table 3, the majority of Case Studies identifies as critical issues: (a) the high investment cost (Ec.6) and (b) the risk from an immature innovative technology (Ec.9).

Concretely, the industrial Case Studies are oriented to the green/ environmental taxation (Ec.2), which seems reasonable, as the industrial sector has a great share in environmental pollution load. The globalization factor (Ec.10) is highlighted by stakeholders who participated in the Workshops regarding the industrial sector, since its economic benefits are directly linked with export opportunities. Main barriers for CS3 and CS8 are considered the lack of financing mechanisms for innovation (Ec.11), as the technologies analysed and proposed in these Case Studies have a high investment cost.

The majority of economic factors connect with the economic capacity of actors to invest in an innovative technology for the upgrading of the water value chain. Therefore, the feasibility of a proposed technology/practice might depend on the economic factors tied with the distributional effects among the actors. Most of the economic factors are not linked to policy objectives apart from green taxes (Ec.2) and cost of energy and water services (Ec.3 & Ec.4).

Table 3. Economic factors for the Case Studies

Economic Factors	E	I	Policy Objectives	Agricultural		Urban		Industrial			
				CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8
Ec.1. Stable economic growth (e.g. competitive advantage or potential export opportunities) ([55]; p. 46) ([49]; slide 22)		✓	X		+						+
Ec.2. Environmental/Green taxes ([55] ; p. 46) ([48] ; slide 5)	✓		Pollution Prevention							+	+
Ec.3. High cost of water supply/use and of wastewater treatment and disposal ([49]; slide 22) ([58]; slide 27) ([48]; slide 5)	✓		Resource Efficiency		+	+				+	
Ec.4. High cost of energy supply/use ([58]; slide 27) ([55]; p. 46) ([48]; slide 5)	✓		Resource Efficiency			+				+	+
Ec.5. High O&M costs (resources, personnel) ([58]; slide 27) ([48]; slide 5)		✓	X			+				+	

Economic Factors	E	I	Policy Objectives	Agricultural		Urban		Industrial			
				CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8
Ec.6. High investment cost of innovative technologies ([60]; slide 8) ([2]; slide 18, 21) ([58], 2013; slide 27) ([55]; p. 46) ([48] 2013; slide 5)	✓		X	-		-		-			-
Ec.7. Highly competitive market (e.g. cheaper/environmental friendly competitive products) ([2]; slide 19)	✓		X					-			
Ec.8. Limited access to bank loans/other financing means (due to economic recession and system complexity) ([49]; slide 22) ([2]; slide 18)	✓		X		-			-			
Ec.9. Economic risk for an immature technology (e.g. payback period) ([60]; slide 8) ([44]; slide 17) ([58]; slide 27) ([55]; p. 46)	✓		X	-		-			-		-
Ec.10. Low economic efficiency at the higher level in a corporation (e.g. "Local" cost vs. "global" profit for the multinational enterprise) ([55]; p. 46) ([48]; p. 18)		✓	X							-	-
Ec.11. Funding mechanisms supporting innovation for SMEs and other political/administrative incentives ([2]; slide 18) ([58]; slide 27) ([44]; slide 17) ([55]; p. 46)	✓		X			-		+	+		-

2.2.3 Social Factors

The social factors discussed in the Case Study Workshops of the EcoWater Project are presented In Table 4. The social factors seem to be critical mainly for the Case Study of Sofia, which belongs to the urban group. The urban sector is linked directly to the public due to the nature of services provided to citizens.

The main social factor for all the Case Studies is the Corporate Social Responsibility (CSR) (S.1). In addition, CS1 and CS5 put an emphasis on the resilience to change as a main social barrier. The majority of social factors either as drivers or barriers seem to be tied with the acceptance of an innovative technology from the external or internal environment. Most of the industrial Case Studies are oriented to specialized personnel (S.B.6). Finally, some of the factors could either encourage or discourage several policy objectives, depending on the specific context.

Table 4. Social factors for the Case Studies in EcoWater Project

Social Factors	E	I	Policy Objectives	Agricultural		Urban		Industrial			
				CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8
S.1. Corporate Social Responsibility (CSR) ([60]; slide 8) ([55]; p. 46) ([48]; slide 6) [24]	✓		X	+						+	+
S.2. Lack of public awareness of water & energy saving /environmental issues ([58]; slide 27)	✓		Resource Efficiency			-					
S.3. Lack of public awareness of impacts on health by using products with poor quality and renewably energy systems aesthetic ([2]; slide 19) ([58]; slide 27)	✓		Pollution Prevention			-		-			
S.4. Lack of cooperation among actors ([2]; slide 21) ([58]; slide 27)	✓		X			-		-			
S.5. Lack of public participation in energy planning ([58]; slide 27)	✓		Resource Efficiency			-					
S.6. Lack of professional training/specialized personnel ([2]; slide 18) ([55]; p. 46) ([48]; p. 18)		✓	X					-		-	-
S.7. Resilience of citizen's or companies to change (e.g. use of traditional/"standardized" processes) ([60]; slide 8) ([2]; slide 21)	✓		X	-				-			

2.2.4 Technological Factors

Table 5 presents the technological factors proposed in the Case Studies. According to Table 5, it is apparent that the technological issues are a main concern for the industrial and urban sectors. The factors selected by the Case Studies on the urban sector relate to the infrastructure of networks (T.1, T.2 & T.3). Finally, agricultural Case Studies seem not to be affected by technological factors.

It should be noted that a great number of technological factors can be linked to the applicability of the proposed technologies/practices to the Case Studies and not with policies (directly).

Table 5. Technological factors for the Case Studies

Technological Factors	E	I	Policy Objectives	Agricultural		Urban		Industrial			
				CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8
T.1. Simplified operation (automated systems) ([58]; slide 27) ([55]; p. 46)		✓	x			+					+
T.2. Modernization of the water supplying system ([58]; slide 27)		✓	x			+					
T.3. Existing infrastructure or networks supporting the implementation of an innovative technology ([58]; slide 27)	✓		x			+					
T.4. Size of equipment for innovative technologies ([58]; slide 27) ([55]; p. 46)		✓	x			-					-
T.5. No verification of product quality ([55]; p. 46)	✓		x								-
T.6. Complex/differentiated networks with multiple resources ([44]; slide 17)		✓	x						-		

2.2.5 Legal Factors

Table 6 includes the legal factors that were pinpointed in the Workshops during to PESTLE exercises. Regulations and directives have high importance for the technology adoption to each Case Study, as they are oriented to several policy objectives. It should be highlighted that the lack of regulation in several cases can be a strong barrier to upgrading the examined systems.

Table 6. Legal factors for the Case Studies

Legal Factors	E	I	Policy Objectives	Agricultural		Urban		Industrial			
				CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8
L.1. New national legislation on the energy use ([58]; slide 27) ([61]; p. 8,9)	✓		Resource Efficiency			+					
L.2. Lack of regulation for product traceability (e.g. country/region of origin) and High Quality Excellence ([2]; slide 19, 21)	✓		X					-			
L.3. Inadequate/obsolete regulation for innovation (licensing and new installations) ([55]; p. 47)	✓		X			-					-
L.4. Not clear allocation of jurisdictions (e.g. between the National Water Regulator and Sofia Municipality) ([58] ; slide 27)([61] ; p. 8,9)	✓		X			-					
L.5. Food safety and hygiene regulations ([48] ; slide 4)	✓		X							-	
L.6. Stringent EU regulations for water quality ([60]; slide 8)	✓		Pollution Prevention	+							
L.7. National regulation-Water Framework Directive (WFD)([58]; slide 27) ([55]; p. 47) ([48]; slide 4)	✓		Resource Efficiency			+				+	+

2.2.6 Environmental Factors

Table 7 shows the environmental drivers and barriers for technology adoption in the Case Studies. The majority of factors are important for the industrial sector, as it has a high share in the environmental problems. A representative driver for the Case Studies seems to be the current environmental load (En.3), which may lead to the technology uptake focused on the pollution prevention.

Environmental, political and legal factors could encourage or discourage the uptake of a number of technologies, depending on their links to policy objectives.

Table 7. Environmental factors for the Case Studies

Environmental Factors	E	I	Policy Objectives	Agricultural		Urban		Industrial			
				CS1	CS2	CS3	CS4	CS5	CS6	CS7	CS8
En.1. Low water quality status ([55] ; p. 47) ([47]; p. 19) ([48]; slide 9)	✓		Pollution Prevention							+	+
En.2. Use of groundwater and water shortage risk ([2]; slide 18) ([49]; slide 22)		✓	Resource Efficiency		+			+			
En.3. Current high environmental load (e.g. high concentration of heavy metals) ([2]; slide 18) ([58]; slide 27) ([61] p. 8,9) ([55]; p. 47)		✓	Pollution Prevention			+		+			+

3 Policy recommendations per sector

Chapter 3 concerns the formulation of policy recommendations per sector, based on PESTLE findings and stakeholder opinions, related to hotspots in each Case Study identified through the eco-efficiency analysis. Hotspots are considered the weaknesses (i.e. high eutrophication) of the system in the eco-efficiency analysis. Policy makers are responsible to consider the aspects generated through the discussion with actors and stakeholders in order to suggest the suitable set of instruments to promote innovative practices to foster eco-efficiency.

Policy recommendations for each examined sector are based on relevant policies promoted by the European Commission through a number of Directives and other scientific reports and studies. The applicability of certain measures or actions included in these documents is influenced by the specific socio-economic conditions in the Case Studies. Possible filters for the procedure to formulate of recommendations are the PESTLE factors and relationships among the actors. Under this spectrum, in some cases policy gaps are identified that should be covered by the responsible authority/entity to foster technology uptake promoting the substantial targets of European Union (e.g. policy objectives presented in Chapter 1).

3.1 Agricultural sector

3.1.1 Relevant policies

In general, EU policies relevant to the agricultural sector promote improvements which reduce pollution or increase resource efficiency, or do both at once.

Water Framework Directive & irrigation technology: As required by the WFD ([30]), full-cost recovery may deter inefficient water-use and cultivation of water-intensive crops, e.g. maize and cotton. But higher water prices per se do not result in more resource-efficient practices ([51]; [52]), and nor does technological improvement. EU policy documents assume or imply that modern irrigation technology inherently increases water-use efficiency, so that the main task is to increase uptake ([10]; [20]; [42]).

According to the Environment Action Programme, '*an estimated 20-40% of Europe's available water is still being wasted, for instance, through leakages in the distribution system or inadequate uptake of water efficiency technologies*' ([38]: 41), likewise focusing on technology adoption as the main task. Yet evidence suggests that poorly managed high-tech systems waste water and other resources ([3]); enhancing farmers' knowledge is essential.

The CAP could establish stronger incentives to reduce environmental impacts, according to the Environment Action Programme (EAP)[5]. The CAP can provide economic incentives for resource-efficient practices by adapting the EU framework. Under the first pillar of the CAP, the Green Direct Payments must comprise at least 30% of the national budget for direct farm payments. 'Greening' criteria reward farmers for three obligatory practices – maintenance of permanent grassland, ecological focus areas and crop diversification ([26]). For each farm larger than 15 hectares of arable land, 5% of the arable land must be covered by ecological focus areas, which bring benefits for the environment, improve biodiversity and maintain attractive landscapes. Member States can specify various measures which include: diversifying crops through rotation, preserving permanent pastures, improving soil fertility, improving biodiversity and avoiding agrochemicals ([37]). Each member state has flexibility in deciding which criteria to favour.

Issues to focus on:

Nutrient cycle (nitrogen and phosphorus): According to the 7th Environment Action Program, '*Further efforts to manage the nutrient cycle in a more cost-effective,*

[5] The CAP still lacks an overarching strategy addressing agriculture's resource efficiency and its impact on carbon, water and nutrient cycles. Production-based interventions, such as agricultural subsidies, could be better geared towards practices with lower environmental impacts, for example organic farming, with increases in overall resource efficiency in terms of external chemical inputs, water and energy use, land use and waste generation ([38]: 31)

sustainable and resource-efficient way, and to improve efficiency in the use of fertilisers are also required' ([38]: 29).

Bio-fertiliser: The EAP overlaps with the CAP in promoting soil organic matter for agronomic benefits and carbon sinks[6]. Soil organic matter has been degraded by prevalent agricultural practices, especially agrochemical treatment of some crops such as maize, which also have high demands for water, according to the EU's Joint Research Centre (2009). As a substitute, bio-fertiliser avoids the nitrous oxide emissions from chemical fertiliser, as well as reducing methane emissions from bio waste. Bio-fertilizer also builds up soil organic matter, generating other resource benefits and thus resource efficiencies. This helps to retain moisture and maintain fertility, thus potentially minimizing water demand.

Climate protection via GHG reduction: For the agricultural sector the EU's low-carbon policy emphasises emissions other than CO_2, especially nitrous oxide and methane, which have relatively greater effects on climate change. This harm from agriculture could be reduced by various measures[7].

Manure management, including biofertiliser usage, is necessary to minimise GHG emissions when replacing chemical fertiliser.

Farmers need a systematic means to gain the necessary knowledge and skills for practices which enhance resource-efficiency and reduce pollution. Under the 2003 CAP reform, member states were required to establish a Farm Advisory System (FAS) to support the implementation of the CAP's cross-compliance standards for environmental protection. The role for an FAS has been elaborated over the past decade ([70]).

According to the Commission's guidance document, FAS advisors will not be able to reply to all questions but should be well informed and able to act as a 'general practitioner', directing farmers if necessary to specialist advisors ([15]: 8).

3.1.2 Recommendations for the agricultural sector

As a general problem in the examined Case Studies, many farmers (and their organisations) have invested in modern technology for greater water-effiency, yet

---

[6] Greening of the CAP will promote environmentally beneficial agricultural and forestry practices such as crop diversification, the protection of permanent grassland and grazing land, and sustainable agroforestry, and will also promote the establishment and maintenance of ecologically valuable farmland and forest areas, including through extensive and traditional practices. It will also increase the land use, land-use change and forestry sector's capacity to act as a carbon sink ([38]: 25).

[7] The Commission's analysis shows that by 2050 the agriculture sector can reduce non-CO2 emissions by between 42 and 49% compared to 1990. The sector has already achieved a significant reduction. More reductions are feasible in the next two decades. Agricultural policies should focus on options such as further sustainable efficiency gains, efficient fertilizer use, bio-gasification of organic manure, improved manure management, better fodder, local diversification and commercialisation of production and improved livestock productivity, as well as maximising the benefits of extensive farming ([19]: 9).

they do not gain the full potential benefits. Farmers lack means to know their actual irrigation efficiency, to see the link between resource-efficient practices and income and to make improvements with currently installed technology. These knowledge gaps leave weak incentives for further investment in irrigation technology or other improvement methods.

More specifically (the following problems were described) in the two Case Studies:

- **Case Study 1 - Sinistro Ofanto:** Occasional water shortages have led farmers to withdraw groundwater from unauthorised wells, thus potentially depleting or degrading acquifers. Many farmers apply greater amounts of chemical fertiliser than the crops need; the excess increases leaching and eutrophication. More precise application depends on better farmer awareness.
- **Case Study 2 - Monte Novo**: The law mandates an increase in water prices towards full-cost recovery by 2017. This may deter maize, as a water-intensive (and agrochemical-intensive) crop, but a price rise alone cannot stimulate more water-efficient practices. A shift to RDI offers resource benefits and eco-efficiency benefits for some indicators, but the investment imposes a high cost on farmers.

Amongst various innovative options for future improvements, the greatest eco-efficiency increase would come from replacing chemical with organic fertiliser, especially if combined with other environmentally favourable techniques such as low-till. Conversion to organic pastures and agriculture would offer even greater environmental benefits. The full economic benefit would depend on higher food prices through organic certification. All these improvements depend on enhancing farmer knowledge and skills.

Issues to focus on

CAP subsidies: In both case study areas, farmers' incomes are highly dependent on the provisions of the CAP, whose criteria would therefore be an effective way to promote more resource-efficient practices. Under the CAP 1st pillar [1], national and regional authorities can incentivize organic fertilizers; ecological focus areas could emphasize criteria such as improving soil fertility, improving biodiversity and avoiding agrochemicals.

Farm Advisory Service: For addressing all those issues, farmers need a knowledge-exchange system to realise the full benefits of current or future improvements, as well as to inform farmers about the potential benefits. A Farm Advisory Service would not achieve those aims simply by referring farmers to specialist advisors ([14]: 8). In the Sinistra Ofanto case, the water users' organisation has been serving as a farm advisory service, especially for water availability, weather monitoring, water-demand estimation and water-application rates. But the advice has no external validation and there is no systematic means for knowledge-exchange. In the nearby Foggia province, farmers established small unions for sharing their knowledge and experience. A farmers' knowledge-exchange system, using water-sensory equipment, has been recently developed in Emilia Romagna in Italy ([3]). To achieve these aims, a FAS needs to facilitate a farmers' knowledge-exchange system ([46]). Regional authorities should take responsibility to build on and expand current initiatives, with support from DG Agriculture's programme for a Farm Advisory Service.

Apart from the afforementioned policies, the following proposals could be also considered:

- The adoption of combinations of different technologies is a necessity. Therefore, technical assistance is needed to meet large scale water delivery issues and farm-specific situations to overcome the exploitation of groundwater resources (identified barrier).
- Design of an effective information and education program on adoption of eco-efficient technological solutions at various scales. Sponsored targeted workshops and roundtables are needed to promote technology demonstrations (identified social barrier).
- Increasing the flexibility for participants in commodity programs to respond to market signals and adopt environmentally sound production practices and systems, thereby increasing profitability and enhancing environmental quality in compliance with EU regulation (identified driver).
- Creating incentives for the farmers to adopt the best (environmentally friendly) management practices at farm level. A solution should be sought in water-energy saving technologies combined with organic types of fertilizers and adoption of zero-tillage where possible (identified economic barrier).
- Developing financial programs to improve access to capital for those willing to invest in eco-efficient practices. Securing sufficient access to capital is crucial for eco-innovations to grow in scope, especially for innovations with long development times (identified economic barrier).

3.2 Urban sector

3.2.1 Relevant policies

Policies relelated to water quality and pollution reduction

The Urban Waste Water Treatment Directive (**UWWTD**) has focused on conventional wastewater indicators and sum parameters. This has been important for raising all urban areas to minimum common standards.

The Water Framework Directive (**WFD**) requires Member States to maintain or achieve a ‘good ecological status’ for surface water by 2015. It introduced a single-substance approach defining a list of priority substances, listed in Annexes. Their removal has two different rationales: to lower health hazards, and to facilitate water re-use. The Directive on environmental quality standards required a ‘good chemical status’ in drinking water through removal of priority substances ([33]).

Micro-pollutants have been a contentious case, because their hazards have some uncertainty. Conventional WWTPs miss micro-pollutants, which are still found in drinking water in trace amounts. A focus of concern is the carcinogen NDMA, produced when water containing precursors is treated, especially during disinfection or advanced oxidation. Recycled water contains a significant amount of precursors, so greater water recycling may bring extra hazards without an effective means to eliminate NDMA. Effective removal of micro-pollutants would facilitate safe reuse of water.

As a generic category, micro-pollutants are not listed as such in EU law. Some Member States (such as Germany) have discussed whether to restrict pharmaceutical production methods to avoid generating micro-pollutants, and whether to require their removal from water.

Micropollutants: trade-offs in pollution reduction

Under Switzerland’s new Water Protection Ordinance, around 100 out of its more than 700 WWTPs will have to be upgraded to halve the currently discharged micro-pollutants. Their removal poses judgements about resource burdens and health hazards. The EcoWater assessments are instructive for such a requirement in Switzerland or elsewhere.

Techniques such as activated carbon and ozonation have been adopted by some water agencies (e.g. [27]). Many other techniques are still in the research or pilot phase. Activated-carbon technology depends on operating materials and energy inputs which are regularly consumed, incurring significant resource burdens. These vary according to the precise type of materials in activated-carbon. The resource burdens occur outside the water system but should be attributed to it through a broader Life Cycle Impact Assessment (LCIA).

Micropollutants pose health hazards which are known qualitatively. But diverse substances vary in their effects, which are difficult to quantify, thus complicating a translation into mid-point environmental indicators. For all those reasons, micropollutants removal entails uncertain trade-offs between extra resource burdens and health benefits. To clarify these trade-offs, a policy needs to assess linkages between technology design, its resource burdens, environmental standards and health-hazard reduction.

Policies related to phosphorus recovery

To avoid eutrophication, the **UWWTD** requires removal of phosphorus ([17]; [29]) but not necessarily in a useable form. As phosphorus becomes scarcer, there have been initiatives for its recovery and reuse, alongside proposals for legislative requirements. The European Commission has taken initial steps towards a policy on the sustainable use of phosphorus. Amongst the numerous questions-comments posed in the Communication Document, it should be noted that there is a need to make sewage sludge and biodegradable waste available to agricultural sector[8].

Even before the EU develops a policy, some countries have been setting requirements, and some water companies have been investing in phosphorus recovery processes.

At plant level, a key driver is the cost of *not* recovering phosphorus. After the anaerobic digestion of sewage sludge, the process leaves a struivite incrustation, thus incurring extra costs of chemicals (e.g. ferric chloride) for its removal and of plant maintenance. This problem occurs in two places – after the digester within the sludge matrix and after dewatering in the process water. In the P-recovery process at both places, the dissolved ortho-phosphate is recovered as struivite after pH adjustment and addition of Mg salts. Immediate benefits are improved sludge dewatering and lower chemicals demand for dewatering, thus saving costs. Partly for those immediate benefits, commercial struvite-process plants have been established in several places, e.g. in Germany, the UK and Canada.

3.2.2 Recommendation for the urban sector

The two urban Case Studies of the Ecowater project are: (i) the Sofia system, which is characterized by its old infrastructure, and (ii) the system of Zurich that operates in compliance with the modern Standards promoted by the EU.

More specifically in the two cases:

- **Case Study 3 - Sofia:** The eco-efficiency analysis for Sofia revealed that the system has a slightly poorer performance than the Zurich system in all environmental indicators (with the freshwater resource depletion being the most important among them, due to the leakages in water distribution). Given, also, that the TVA is 3 times higher for the Zurich Case study, the difference in the eco-efficiency performance of the two Case Studies is even higher. This may be due to the fact that the Sofia system is a larger urban water supply system with aged infrastructure. However, additional causes may be sought, mainly due to

---

[8] Should some form of recovery of phosphorus from waste water treatment be made mandatory or encouraged? What could be done to make sewage sludge and biodegradable waste more available and acceptable to arable farming? ([22][22]: 18).

the definition of system boundaries and the difference in the background processes.

- **Case Study 4 - Zurich:** Switzerland's new waste directive will require the recycling of phosphorus-rich wastes. Partly in response to that, in Zurich a decentralized WWT system is being replaced with a more resource-efficient mono-incineration plant. The centralized sludge incinerator is now in place, and a process to recover phosphorus from the ash produced is being tested ([54];[53]). The recovery technology is still in an evaluation stage; it is planned to store the ash until an economically viable technology can be found.

Issues to focus on

Phosphorus recovery policy: The EcoWater study evaluated the Ash-Dec method, for which there is more information available in the literature than alternative methods. According to the results the recovery costs seem to be higher than the financial return to the water company. The already-stringent water standards, P-removal does not improve water quality. Resource burdens of removing phosphorus, as well as the environmental benefits of P-reuse, occur outside the water system. Any benefits are spatially remote.

Therefore a phosphorus recovery policy needs attention to the wider environmental effects, as a basis to justify technology standards and their costs.

Renewable energy recovery policy: Two options were discussed in the Sofia workshop for renewable-energy recovery from the water system. For both options, the water operator actor is responsible; it would either substitute the energy for external sources or else sell it to the energy company. But there is a legally uncertain basis for allocating the economic benefits, which remain a potential conflict between the water and energy companies. According to the multi-stakeholder workshop discussion, a main barrier is the absence of legislation about planning, exploitation and maintenance. Statutory clarification would overcome this barrier.

Household-water resource burdens: EU has general targets to reduce energy use and GHG emissions, but such targets have no urban-specific policies. In the EcoWater urban case studies, household water use is the most environmentally weak stage, especially as regards energy and water use. Eco-efficient solutions are available in various resource-efficient domestic appliances. But their adoption would reduce the income of the water company, which therefore has no incentive to encourage householders to make the investment. Resource-efficient domestic appliances have no institutional basis for stakeholder discussions, nor an obvious EU policy framework.

3.3 Industrial sector

3.3.1 Relevant policies

In the EcoWater Case Studies, some process improvements address achieving lower pollution and enhancing resource efficiency; these improvements would be facilitated by clearer policies. In this section a number of policies are presented that are oriented towards the industrial sector.

"Best Available Techniques" BAT Standards

The EU Industrial Emissions Directive ([34]) regulates emissions related to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure, including production and processing of metals, chemicals and plastics and surface treatment processes[9].

BAT standards for each sector are outlined in a Reference Document on Best Available Techniques (BREF). For instance, the European Union has prepared an extended document related to textile industries which incorporated a series of practices applied to the specific type of industry ([69]).

Encouraging SMEs (through the corresponding EU Communication Reports) to reduce pollution and waste

The upgrading of the water value chain for the industrial sector by innovative eco-efficient practices requires financial support to small and medium sized enterprises to adopt more environmental practices. It should be also mentioned that this upgrading could be enhanced by the involvement of the appropriate consulting through research and innovation partnerships on waste[10].

The Small Business Act for Europe proposes actions to enable SMEs to turn environmental challenges into opportunities[11].

Encouraging resource efficiency through District Heating

Resource-efficient cogeneration, also known as combined heat and power (CHP), depends on using the waste heat through district heating. Since the 1990s the EU

---

[9] The uptake by industry of the 'Best Available Techniques' under the Industrial Emissions Directive will deliver improved resource-use patterns and reduced emissions for over 50,000 major industrial installations in the Union, thus making a significant contribution to stimulating the development of innovative techniques, greening the economy and reducing costs for industry in the longer term ([38]: 36).

[10] In order to improve their environmental performance, small and medium-sized enterprises (SMEs), in particular, require specific assistance with the uptake of new technologies, including through research and innovation partnerships on waste ([38]: 33).

[11] The EU and Member States should enable SMEs to turn environmental challenges into opportunities. They should provide more information, expertise and financial incentives for full exploitation of the opportunities for new 'green' markets and increased energy efficiency, partly through the implementation of environmental management systems in SMEs ([13]: 16).

has had a policy to promote district heating, as formalised in Directive ([31]), but this has been little implemented. As a major exception, Denmark has had strong support from civil society organisations successfully promoting district heating. When planning a subsequent directive on energy efficiency, the European Commission acknowledged that the Cogeneration Directive '*failed to fully tap the energy-saving potential*' of CHP ([18]; [32]), but hardly analysed reasons. The 2012 Energy Efficiency Directive elaborated the 2004 commitment related to potential for saving primary energy by district heating and cooling[12].

3.3.2 Recommendations for the industrial sector

The industrial Case Studies represent four different types of industries across Europe: (a) the textile industry in Italy, (b) the energy production in The Netherlands, (c) the dairy industry in Denmark and (d) the automobile industry in Sweden. The hotspots from the eco-efficiency analysis show that resource efficiency and pollution prevention are crucial to improve the overall eco-efficiency. The technologies selected in the examined Case Studies are the result of baseline eco-efficiency analysis and stakeholder's or actor's opinions. The policy recommendations are focused on the potential interventions and the identified barriers revealed in PESTLE analysis.

The next paragraphs briefly demonstrate the recommendations per Case Study.

Case Study 5 - Italy: The textile industry has been a focus of an EEA report on resource efficiency[13]:

All the above policies are relevant to the textile-dyeing process in Biella SMEs. Most use synthetic dyes, which generate resource burdens for wastewater treatment and have allergenic effects on consumers. One company (Quaregna) has revived the traditional use of herbal dyes, which cost four times as much. This process offers

---

[12] High-efficiency cogeneration and district heating and cooling has significant potential for saving primary energy, which is largely untapped in the Union. Member States should carry out a comprehensive assessment of the potential for high-efficiency cogeneration and district heating and cooling. These assessments should be updated, at the request of the Commission, to provide investors with information concerning national development plans and contribute to a stable and supportive investment environment..
New electricity generation installations and existing installations which are substantially refurbished or whose permit or licence is updated should, subject to a cost-benefit analysis showing a cost-benefit surplus, be equipped with high-efficiency cogeneration units to recover waste heat stemming from the production of electricity. This waste heat could then be transported where it is needed through district heating networks ([35]: 6).

[13] Growing European consumption has augmented resource demands and pressures across the life-cycle. Such pressures include water consumption and pesticide release when cultivating natural fibres, pollution from production and transportation, water and energy use for washing and drying, and emissions from waste. Growing implementation of new business models based on fewer and more sustainable materials and other resources, on sharing and leasing, reuse and recycling, likewise point the way towards greater sustainability.
European governments, businesses and citizens have a range of tools available to influence different stages of the product life-cycle. These include: strengthening environmental and social labelling of clothes supported by value-chain traceability systems ([40]: 105, 120).

consumers a higher-quality product under its *Naturale* brand, whose commercial viability depends on a higher price in distant specialty markets. It uses plant dyes in only 1/5 of its production, partly because it has low capacity to reach or create such markets.

Quaregna applied to the EC's Eco-Innovation programme for a grant to shorten the supply chain for its *Naturale* brand, but its proposal did not succeed. Evaluators said that the production process was insufficiently innovative. Such criticism expresses a narrow view of innovation as capital-intensive technology, while missing the crucial role of institutional innovation in supporting resource-efficient production.

Other difficulties relate to the overall decline of the Biella textile industry. Some European companies have been outsourcing production to Asian plants using allergenic chemicals and then importing the cheaper fabrics back to Europe. European quality fabrics face ever-stronger competition, potentially in a race to the bottom.

Case Study 6 - Netherlands: From a meso-level perspective, the cogeneration case study illuminates some obstacles and possible ways forward. The energy company plans to expand heat supply to district heating, alongside heat-storage facilities to provide peak-shaving amidst intermittent demand[14].

The Amsterdam municipality has made a commitment to increase district heating ([43]), though specific support measures remain unclear. District heating systems have been installed in newly built neighbourhoods in the Netherlands. But there was little residential building activity near the Diemen case-study plant supplying Amsterdam. So this solution would replace and/or jeopardize previous investment in heat supply.

As discussed at the Case Study workshop, the energy company's commitment to district heating would need political confidence in future favourable conditions, especially through 'consistent governance for a 30-50 year period'. As a way to achieve such conditions, a thermal network could be a public-service utility like electricity or roads, connecting various sources and many users. '*Here the government has a strong role in organizing the network, providing opportunities to its users, and exploiting and maintaining it*' (according to the workshop report). But such a scenario seems elusive; under foreseeable circumstances, the cogeneration plant will not make a priority of establishing a district heating network.

This case illustrates the need for extra support, perhaps through a public-service utility, in order to implement the EC's policy on district heating, while also supporting policies towards circular economy.

---

[14] Expanding further in district heating projects also provides valuable opportunities to expand further in renewable energy, as district heating provides a significant reduction of CO2 emissions in comparison with conventional gas-heated boilers. District heating fits well with Nuon's strategy, since it offers a 50% to 80% reduction of CO2 emissions compared to conventional gas-heated boilers, depending on the source of the heat ([56]).

Case Study 7 - Denmark: The Arla dairy case study investigated several improvement options. Some would reuse water from within the plant process, e.g. by condensing water vapor and sterilizing excess water from milk. Those options would greatly reduce the dairy's water intake, greatly increase eco-efficiency of the freshwater-depletion indicator and somewhat reduce the climate-change indicator.

Such replacement depends on food authorities accepting that the water in milk does not cause any risks to the products' consumers. Industry has had difficulty to gain such acceptance in some EU member states such as Denmark. Authorities refer to the EU requirement to use drinking water, as in the dairy-sector Bref document ([11]*).*

Its current ongoing revision should clarify that, under appropriate conditions, the water in milk can be safely used to a high degree and so replace freshwater intake. Several internal water streams in the dairy plant have low levels of contamination and thus could also be used outside the dairy, e.g. for irrigating agriculture, replenishing groundwater, etc. The dairy industry should be considered a sector with a large potential to reuse water safely for these purposes. The quality criteria and control mechanisms are being discussed for implementing the *Blueprint to Safeguard Europe's Water Resources*, whose objectives include 'maximization of water reuse' ([21]).

Case Study 8 - Sweden: For process improvements at Volvo, an important driver is the prospect of more stringent pollution standards, especially regarding the use of persistent chemicals and of scarce metals. The truck-body corrosion-protection process would reduce their use by replacing the current phosphating technique with the silane-based technique; this would increase resource efficiency as well as reduce pollution. It would likewise increase eco-efficiency because the silane process needs only a change in materials, not extra investment in technology.

As regards BAT standards for corrosion protection, the relevant BREF document compares the older chromate technique with phosphating. It briefly mentions silane-based alternatives, without evaluating them ([12]); it has not been updated for many years. Consequently, the company remains uncertain about whether the authorities will accept the silane-based alternative as 'best available' technology. The future uncertainty may deter such investment. Clearer, updated EU standards would help to guide national regulators and reassure manufacturing companies.

4 Concluding remarks

Policy recommendations in this document can support a discussion towards the necessity of measures and their effectiveness. The crucial target is the improvement of the system's eco-efficiency using a package of innovative practices promoted by several policies.

The aforementioned analysis is based on three basic stages: (a) the eco-efficiency analysis for baseline scenarios, (b) the assessment of innovative technological solutions from both the economic and environmental dimension and (c) the assessment of socio-economic conditions that affect the innovative proposals and possible policy recommendations to enhance the potential solutions. To that point, it is extremely crucial to note that the external conditions may drive towards an innovation or disrupt any progress towards this concept. The target of eco-efficiency improvement for each system can be attained through several economic, legal and other instruments.

The analysis applied in the Case Studies of EcoWater Project revealed that economic mechanisms should acquire the capacity to force the efforts towards the eco-efficiency. At the same time, European Directives include a number of instruments to enhance the eco-efficiency through the objectives set out in Strategy 2020 (resource efficiency, circular economy). But, it should be also highlighted that there are policy gaps or misconceptions in certain sectors (e.g. the water reuse in Dairy Industry).

To sum up on the recommendations proposed in this document, there is still considerable room to improve the socio-economic conditions towards accepting eco-efficiency innovation. Concerning the industrial sector, co-operative activities associated with trade agreements should be assured (e.g. in the Textile Industry). As for the urban sector, the authorities should either strengthen the legal regulations or enhance funding mechanisms in order to modernize the water supply systems in compliance with EU Directives. Finally, in the agriculture sector, the farmer's resilience to accept changes is an obstacle that authorities should take under consideration and overcome with EU proposals included in the CAP.

References

[1]. ARC 2020, (2013), CAP and Rural Development Policy Reform Deal for 2014-2020, https://docs.google.com/file/d/0B0aA8VrCTsRAcHdkdlINYnU5ZG8/edit

[2]. Balzarini, A., (November 2013), Case Study 5-Textile industry in Biella- Italy, 2nd Annual Meeting, Amsterdam

[3]. Battilani, A. 2012.http://ec.europa.eu/environment/greenweek2012/adriano-battilani.html

[4]. CEC, (2000), A framework for Community action in the field of water policy (DIRECTIVE 2000/60/EC), http://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF

[5]. CEC, (2011), Third follow up report to the Communication on water scarcity and droughts in the European Union, (COM /2007/414 final)

[6]. CEC, (2014), Towards a circular economy: A zero waste programme for Europe, (COM/2014/398 final)

[7]. CEC, (2008), On waste and repealing certain Directives, (DIRECTIVE 2008/98/EC), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

[8]. CEC, (1998), On the quality of water intended for human consumption, (DIRECTIVE 1998/83/EC), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31998L0083&from=EN

[9]. CEC, (2008), Establishing a framework for community action in the field of marine environmental policy, (DIRECTIVE 2008/56/EC) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN

[10]. CEC, (2008), Concerning integrated pollution prevention and control, (DIRECTIVE 2008/1/EC), http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0001&from=EN

[11]. CEC, (2005), Reference Document on Best Available Techniques in the Food, Drink and Milk Industries. Brussels: Commission of the European Communities

[12]. CEC, (2006), Integrated Pollution Prevention and Control Reference Document [Bref] on Best Available Techniques for the Surface Treatment of Metals and Plastics

[13]. CEC Staff, (2008), Commission Staff Working Document accompanying the Follow up Communication on water scarcity and droughts in the European Union

[14]. CEC, (2010a), Europe 2020: A strategy for smart, sustainable and inclusive growth

[15]. CEC, (2010b), Report from the Commission to The European Parliament and the Council on the application of the Farm Advisory System as defined in Article 12 and 13 of Council Regulation (EC) No 73/2009, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0665:FIN:en:PDF

[16]. CEC, (2011a), A Resource-Efficient Europe: Flagship initiative under the Europe 2020 Strategy, http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf
[17]. CEC, (2011e), 6th Commission Summary on the Implementation of the Urban Waste Water Treatment Directive. Commission staff working paper, SEC(2011) 1561 final, http://ec.europa.eu/environment/water/water-urbanwaste/implementation/pdf/SEC_2011_1561_F_EN.pdf
[18]. CEC, (2011f), Renewable Energy: Progressing towards the 2020 target {COM (2011) 31 final}
[19]. CEC, (2011g), A Roadmap for Moving to a Competitive Low Carbon Economy in 2050, COM/2011/0112 final.
[20]. CEC, (2012a), Water Scarcity & Droughts – 2012 Policy Review – Building blocks.
[21]. CEC, (2012b), A Blueprint to Safeguard Europe's Water Resources, COM(2012) 673 final http://ec.europa.eu/environment/consultations/blueprint_en.htm
[22]. CEC, (2013), Consultative Communication on the Sustainable Use of Phosphorus, http://ec.europa.eu/environment/consultations/pdf/phosphorus/EN.pdf
[23]. CEC, (2014), Towards a circular economy: A zero waste programme for Europe, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014DC0398
[24]. Corporate Social Responsibility National Public Policies in the European Union - Compendium 2014 , http://ec.europa.eu/digital-agenda/en/news/corporate-social-responsibility-national-public-policies-european-union-compendium-2014
[25]. DG Communication, (2011), Attitudes of European Entrepreneurs towards Eco-Innovation: Analytical Report [requested by DG Environment], Flash Eurobarometer 315
[26]. DG Agriculture, (2013), CAP Reform – an explanation of the main elements, file:///C:/Users/ll5/Downloads/MEMO-13-937_EN%20(1).pdf
[27]. EAWAG, (2009), Advanced treatment processes for micropollutant removal: full-scale ozonation and PAC addition, http://www.eu-neptune.org/Workshop/11_-_Hansruedi_Siegrist_Neptune_Koblenz_April_2009.pdf
[28]. EC, (2009), On the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC Renewable Energy Directive, (DIRECTIVE 2009/28/EC) O.J. L 140: 16-62, 5 June
[29]. EC, (1991), Council Directive 91/271/EEC concerning urban waste-water treatment, OJ L135, 30 May
[30]. EC, (2000), Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy
[31]. EC, (2004), Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC, Official Journal of the European Union, 21.2.2004

[32]. EC, (2006), Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration
[33]. EC, (2008), Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, OJ L 348/84-97
[34]. EC, (2010), Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), OJ L 334/17–119, 17.12.2010
[35]. EC, (2012), Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, OJ L 315/1-56
[36]. EC, (2013a), Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 Living well, within the limits of our planet, OJ L 354/171-200, 20.12.2013
[37]. EC, (2013b), Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy, OJ L 347/608: 608-70
[38]. EC, (2014), Environment Action Programme to 2020: Living well, within the limits of our planet [same as EC, 2013a]
[39]. EC, Eco-label, http://ec.europa.eu/environment/ecolabel/index_en.htm
[40]. EEA, (2014), Environmental Indicator Report 2014: Environmental Impacts of Production-Consumption Systems In Europe. Copenhagen: EEA
[41]. EIO, (2012), Closing the Eco-Innovation Gap: An economic opportunity for business
[42]. EP, (2008), Addressing the challenge of water scarcity and droughts in the European Union. European Parliament resolution of 9 October 2008 on addressing the challenge of water scarcity and droughts in the European Union (2008/2074(INI)
[43]. Gemeente Amsterdam, (2013), Kennisnemen van de voorgenomen uitbreiding van het Amsterdamse stadswarmtenet naar de bestaande bouw [Proposed expansion of Amsterdam's district heating to existing buildings], 2 July, http://zoeken.amsterdam.raadsinformatie.nl/cgi-bin/showdoc.cgi/action=view/id=206750/type=pdf/raadsbesluit.189.663.3a.13.pdf
[44]. Goossens, H., (November 2013), Case Study 6-Cogeneration of Heat and Power, 2nd Annual Meeting, Amsterdam
[45]. İhsan Yüksel, (2012), Developing a Multi-Criteria Decision Making Model for PESTEL Analysis, International Journal of Business and Management
[46]. Levidow, L., Zaccaria, D., Maia, R., Vivas, E., Todorovic, M., Scardigno, A., (2014), Improving water-efficient irrigation: prospects and difficulties of innovative practices, Agricultural Water Management, Elsevier, doi:10.1016/j.agwat.2014.07.012, http://www.sciencedirect.com/science/article/pii/S037837741400211X

[47]. Lindgaard-Jørgensen, P., & Levidow, L. (2012), *Methodology and Scenario Frameworks for elaboration in the EcoWater Case Studies.* Deliverable of the EcoWater Project, 7th Framework Programme, Grant Agreement No: 282882
[48]. Lindgaard-Jørgensen, P., (November 2013), Drivers and barriers for introducing new technologies-Mapping with PESTLE, , 2nd Annual Meeting, Amsterdam
[49]. Maia, R., (April 2012), The EcoWater Case Study in Portugal-Premises and context, 1st Case Study Workshop, Porter/Evora
[50]. Material Change for a Better Environment (Wrap), (2010), Securing the future-The role of resource efficiency, Final Report
[51]. Molle, F. and Berkoff, J., (2007), Water pricing in irrigation: the lifetime of an idea, in F. Molle and J. Berkoff, eds, Irrigation Water Pricing: The gap between theory and practice, pp.1-20, Wallingford: CABI
[52]. Molle F., (2008), Can water pricing policies regulate irrigation use?, 13th World Water Congress, September, Montpellier, France
[53]. Morf L., (2012), Phosphorus from sewage sludge: the strategy of the Canton of Zurich, Essner Tagung Wasserund Abfallwirtschaft, 14-16 März 2012 in Essen
[54]. Morf L., (2013b), P-Strategie der Schweiz: Umsetzung am Beispiel des Kantons Zürich, http://www.umweltbundesamt.de/sites/default/files/medien/378/dokumente/p-strategie_der_schweiz-umsetzung_am_beispiel_des_kantons_zuerich.pdf
[55]. Nilsson, Å., Skenhall, S., Gad, F., Kourentzis, V., (2013), Synthesis report from the 1st Round of Case Study events Deliverable 6.1 of the EcoWater Project, 7th Framework Programme, Grant Agreement No: 282882
[56]. Nuon, (2014), N.V. Nuon Energy Annual Report 2013: Continued positioning for tomorrow's energy market, http://www.nuon.com/Global/Nederlands/Financials/Jaarverslagen/Nuon%20Jaarverslag%202013.pdf
[57]. OECD, (2010), Eco-Innovation in Industry: Enabling Green Growth http://www.oecd.org/sti/ind/eco-innovationinindustryenablinggreengrowth.htm
[58]. Ribarova, I., (November 2013), Case Study 3-Sofia urban water system, 2nd Annual Meeting, Amsterdam
[59]. Team FME, (2013), PESTLE Analysis-Strategy Skills, ISBN 978-1-62620-998-5
[60]. Todorovic, M., (October 2012), Vision (desired future)-New technologies and alternative scenarios (possible/plausible future), EcoWater Sinistra Ofanto Workshop, Valenzano (BA)
[61]. UACEG, (2014), Report Case Study Sofia Workshop-Outcomes and discussions of the Sofia Case Study Workshop, Sofia
[62]. Green Alliance, http://www.green-alliance.org.uk/
[63]. Institut de l'economie circulaire, http://www.institut-economie-circulaire.fr/
[64]. National Pollution Prevention Roundtable, http://www.p2.org/about/what-is-pollution-prevention/)
[65]. Environment Eco-Innovation ACTION Plan, http://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/eu/20140602-waste-legislation-overhaul_en.htm

[66]. Ellen Macarthur Foundation, Rethink the future, http://www.ellenmacarthurfoundation.org/circular-economy/circular-economy/interactive-system-diagram,
[67]. Wrap, Wrap and the circular economy, http://www.wrap.org.uk/content/wrap-and-circular-economy
[68]. Circular Futures, Accelerating a new economy, https://www.forumforthefuture.org/sites/default/files/Circular-Futures-Report.pdf
[69]. Joint Research Centre, Institute for Prospective Technological Studies (IPTS) http://eippcb.jrc.ec.europa.eu/reference/
[70]. Agriculture and Rural Development, http://ec.europa.eu/agriculture/direct-support/cross-compliance/farm-advisory-system/index_en.htm

Annex I: Case Studies of EcoWater Project

Agricultural Water Use Systems

Case Study #1. Sinistra Ofanto Irrigation Scheme, Italy

Important agricultural district and irrigation system, located within Ofanto River Basin, in the Apulia region.

Water is supplied to the farmers through three different water supply chains:

- Gravity-fed conveyance and distribution by pumping
- Gravity-fed water conveyance and distribution
- Conveyance by lifting and distribution by gravity

The main directly involved actors of the system are :

- Consortium per la Bonifica dela Capitanata
- Farmers' Association
- Regional River Basin Authority

Annual Water Abstracted: 45.2 Mm^3 surface water, 42.4 Mm^3 groundwater

Main Product: 372,850 tn grapes, 40,800 tn olives, 27,000 tn wheat, 60,000 tn vegetables

Case Study #2. Monte Novo Irrigation Scheme, Portugal

Newly developed agricultural district (operation started in 2010), built as part of the Alqueva's infrastructure project, located within Guadiana's River Basin, in the Alentejo region.

The water supply chain consists of a primary and a secondary distribution network (with both low and high pressure irrigation heads) that delivers water to farmers.

The main directly involved actors of the system are :

- Alqueva's Development and Infrastructures Company
- Association of Monte Novo Irrigation Scheme Users
- Farmers

Annual Water Abstracted: 21.3 Mm^3 surface water

Main Product: 20,000 tn maize, 18,300 tn olives, 5,000 tn vegetables

Urban Water Supply Systems

The supply chain of both case studies consists of the following stages:

- Water Abstraction
- Water Treatment
- Water Distribution
- Domestic and Non-Domestic Water Use
- Waste Water Collection
- Wastewater Treatment

Case Study #3. The city of Sofia, Bulgaria

A system of ageing infrastructure (more than 100 years old), serving the capital and largest city of Bulgaria. The main directly involved actors of the system are :

- Water and Sewage Utility ("Sofiyska voda");
- Domestic water users;
- Non-domestic water users.

Annual Water Abstracted: 176.8 Mm^3 surface water

Satisfied Customers: 560,000 households

Case Study #4. The municipality of Waedenswil, Switzerland

Lake Zurich plays an important role as provider of raw water and the quality of water should be maintained in high level. Thus, the drinking water treatment plant has been rebuilt in 2012 and is equipped with modern membrane filtration technology, and the applied waste water treatment process is technologically on an advanced standard.

The main directly involved actors of the system are :

- Association of municipalities for water treatment
- Municipality Waedenswil responsible for water supply
- Domestic water users
- Non-domestic water users

Annual Water Abstracted: 1.1 Mm^3 surface water, 0.65 Mm^3 groundwater

Satisfied Customers: 9,100 households

Industrial Water Use Systems

Case Study #5. Textile Industry, Biella, Italy

Two representative units of the textile industry are considered:

- A unit with in-house wastewater treatment plant, where the dyeing process is done by using standard chemical methods;
- A unit which uses both standard chemical dyes and natural herbal dyes and is connected to the municipal wastewater network.

Annual Water Abstracted: 0.95 Mm^3 surface water, 0.75 Mm^3 Groundwater

Product: 890 t chemically dyed wool and 100 t naturally dyed wool

Case Study #6. Cogeneration Plant, Amsterdam, Netherlands

The case study examines a river water system, which provides cooling water for two cogeneration plants (Diemen 33 and Diemen 34). The studied system also includes the heat storage and distribution network and the domestic consumers of heat & electricity.

Annual Water Abstracted: 229 Mm^3 surface water (for cooling)

Product: 3,280 GJ Heat, 10,412 GJ Electriciity

Case Study #7. Dairy Industry, Holstebro, Denmark

The case study examines the production chian of the Arla dairy in Holstebro (HOCO), one of the company's milk powder plants, receiving milk from farmers and produces caseinates, hydrolisates and milk minerals.

Annual Water Abstracted: 0.59 Mm^3 groundwater

Product: 17 t milk powder

Case Study #8. Automotive Industry, Umea & Tuve, Sweden

Two separate water value chains are examined, linked together by the industrial actor Volvo Trucks, having production sites both in Umeå and Tuve. Additional actors in the system are the municipal water providers (UMEVA and Kretslopp & Vatten) and the wastewater treatment company (Stena Recycling).

Annual Water Abstracted: 0.41 Mm^3 surface water

Product: 30 000 truck cabins