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EcoWater report

Report from the 3rd targeted event - Policy links

IVL Swedish Environmental Research Institute

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This report is a deliverable or other report from the EU project EcoWater.

At project closure it is was also published in IVL's C-series, available from the IVL web-site.

The EcoWater project was conducted by an international consortium coordinated by NTUA (National Technical University of Athens). IVL participated in the R & D work, in addition to leading one of the industrial case studies (Volvo Trucks), represented by Volvo Technology.

EcoWater ran 2011-2014. The project is presented in more detail on http://environ.chemeng.ntua.gr/ecoWater/
The project website holds a complete repository of all public deliverables from the EcoWater project.

Persons from IVL involved in EcoWater were:

Åsa Nilsson
Sara Skenhall
Magnus Klingspor
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For Deliverables, please see additional information on this specific report on the subsequent Document Information page.

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

Collaborative project, Grant Agreement No: 282882

Deliverable 6.5

Report from the 3rd targeted event - Policy links

Roundtable on policy development towards increased eco-efficiency and industrial symbiosis

10th December 2014, "Bouche à Oreille", Brussels

December 2014

DOCUMENT INFORMATION

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Contents

1 Event Agenda

09:30	Registration - Coffee	Åsa Nilsson and Sara Skenhall
10:00	Welcome	Michiel Blind Luisa Prista Dionysis Assimacopoulos
Session 1: Experiences and Challenges		**Chair:** Michiel Blind
10:10	EcoWater: systemic eco-efficiency assessment towards innovation uptake	Dionysis Assimacopoulos
10:30	Experiences and Challenges in Systemic Eco-efficiency Assessment: - Agricultural Sector - Urban Sector - Industrial Sector	Mladen Todorovic Christoph Hugi Palle Lindgaard-Jørgensen
Session 2: Policy Implications of EcoWater Results		**Moderator:** Tomas Rydberg
11:45	Roundtable discussion on eco-efficient technology options and scenarios for water use systems and their policy implications	**Panel:** Maria Giovanna Zamburlini, Robbert Droop, Enrique Playán
12:50	Conclusions	Dionysis Assimacopoulos
13:00	Lunch - End of Event	

2 Event Minutes

2.1 Welcome

Michiel Blind (DELTARES) opened the meeting with a welcome to all participants and then gave the floor to Dr. Luisa Prista, head of Eco-Innovation unit at DG RTDI.

Dr. Prista spoke about the transition from a sectorial research focus into today's broader research approach, looking at impacts also on a societal level. She stressed that sectors need to be linked together and that DG RTDI has started this work by promoting systemic eco-innovation. In the future, the work of DG RTDI will become even more systemic and cross-sectorial. Dr. Prista pointed out that this thinking is already applied in the EcoWater project, where a shift is made from environmental technologies to eco-innovations. Technology projects are very useful and can indeed support and design future policies.

Three DG RTDI priorities for the future were mentioned; to set the orientation of research, to look at what the best investments of research are and to identify what research funds can be used. Circular economy will be taken into account and there should be a clear link with demonstration projects.

Dr. Prista pointed out to the audience that in Horizon 2020, Water will no longer be its own focus area but it will be a relevant part of another focus area (e.g. Industries and economy), and there may also be a separate call on Water. Furthermore Dr. Prista spoke of a call for ideas for large scale demonstration projects that will be launched by RTDI before Christmas. She encouraged everyone to participate with ideas on partnerships for demonstration projects.

Dr. Prista's concluding remark was that the present event, bringing people together to discuss, is a good approach for sharing results and experiences.

Professor Dionysis Assimacopoulos (NTUA), the co-ordinator of EcoWater, thanked Luisa Prista and also gave a warm welcome to all participants.

2.2 Session 1 - Experiences and Challenges

2.2.1 EcoWater: systemic eco-efficiency assessment towards innovation uptake (Dionysis Assimacopoulos)

Presentation slides are included in Annex II.

Questions:

Dr. Prista enquired about the exceptionally high values of eco-efficiency for the industrial Volvo case (CS#8).

Prof. Assimacopoulos explained that for the industrial case studies it is not relevant to compare across cases due to the different products in the systems. High value products will result in high baseline eco-efficiency to be compared with the results on technology eco-efficiency assessments for that particular case study.

2.2.2 Experiences and Challenges in Systemic Eco-efficiency Assessment

2.2.2.1 Agricultural Sector (Mladen Todorovic; CIHEAM-IAMB)

Presentation slides are included in Annex II.

No questions were posed.

2.2.2.2 Urban Sector (Christoph Hugi; FHNW)

Presentation slides are included in Annex II.

Questions:

Michiel Blind: There is new legislation for micro pollutants in Switzerland. Would it have been different if they used EcoWater approach before introducing that?

Christoph Hugi: The legislation is a precautionary measure and is not based on a full environmental assessment. For example, the environmental footprint of activated carbon which will be used to meet the new requirements is rather high. The legislator should be aware of the other effects and trade-offs.

2.2.2.3 Industrial Sector (Palle Lindgaard-Jørgensen; DHI)

Presentation slides are included in Annex II.

Questions:

Durk Krol (WssTP): How does the eco-efficiency indicator combine the economic and environmental impacts? We have to go behind the numbers and see, what is the reason for change. For uptake it is necessary to establish economic viability. What do you mean in your models by this?

Palle Lindgaard-Jørgensen: We should not look at the numbers as stand-alone. They give an indication and open the interest for knowing more about the details behind the results. Details are embedded in the tools. They are included in the baseline data and can be studied further by using the tools developed in the project. The business case depends partly on the return on investment (ROI). Technologies enable a company to comply with [regulatory] standards, but that assumption is already in the baseline in the models. The important thing is that a user can compare different technological alternatives, to find out which one is more eco-efficient.

2.3 Session 2 - Policy Implications of EcoWater Results

Presentation slides are included in Annex II.

Moderator: Tomas Rydberg (IVL)
Panel: Maria Giovanna Zamburlini (CEFIC), Enrique Playan (CSIC), Robbert Droop (Netherlands Ministry of Infrastructure and the Environment)

Moderator Tomas Rydberg showed a slide summarizing water use in the EU across different sectors, to show scarcity and highlight inefficiencies.

Tomas Rydberg (moderator): Question to panel - what do you see as the main challenges in the short and long term?

Maria Giovanna Zamburlini: The industrial sector has to take into account the difference between water use and water consumption.
E4Water project is testing already existing technologies for preparing process water. The main challenge is how to make innovations happen (through investment), return on investment of water technologies can be short when compared to other types of investment. Water innovations are capital intensive; there is a global and competitive market. It is difficult to find financing for long-term investment and access to other sources like joint venture capital or capital assets. Investment and resources for investment are the biggest issue! [1]

Palle Lindgaard-Jørgensen: With the EcoWater approach one can use a systems perspective to find the largest benefit instead of looking only within one's own process or plant.

Palle Lindgaard-Jørgensen: Some industries have realised that they need to look beyond their own fences. Can you confirm this from the chemical industry?

Maria Giovanna Zamburlini: Yes, more integration is happening, e.g. Dow Chemical is looking at integration of urban waste streams to agriculture.

Robbert Droop: First a step back - the industrialised world is using resources above the capacity, ca 3 planets and increasing. We have to initiate an ambitious increase in resource efficiency. The world is changing and more want the same. Projects like

[1] Mention was made of a report by Business Europe, *Expectations from an EU Investment Plan*: http://www.businesseurope.eu/content/default.asp?PageID=568&DocID=33551

EcoWater that try to identify potentials for resource efficiency are good, but only look at the specific sector. Policy makers will have to look further, for example on dietary changes and effects on societal level.

Tomas Rydberg (moderator): Are investments a challenge for society?

Robbert Droop: Water utilities are paid for by taxes. Incentives to improve technologies are small. There is a barrier in the institutional arrangement: Who will take leadership. There is also an institutional barrier to change, e.a. to significant improvement in innovation.

Enrique Playán: I was in the Expert Advisory Board of EcoWater. The project has produced interesting results. I am ready to see the knowledge incorporated into the ideas of decision makers. It will be interesting to see how the individual sectors can integrate into systemic innovation. How do different trade-offs in the sectors integrate between each other?
(Commenting on slide showing Water use in the EU) Water for the Environment (e.g. environmental flows) should be explicitly shown in the picture presented, as the urban sector is the largest water user. There is a need to integrate the environmental water use into the policy cycle, and look at the transfer of water between economic sectors. A project in Chile reuses wastewater, raising issues of how to allocate costs. Apparently there is not the same focus in Europe, and international cooperation is necessary to view it differently. Desalination of sea water is not perceived as cost efficient in Europe, but is so in Chile's mining industry. The water users' perspectives are well incorporated in the EcoWater project, which also tries to integrate the social perspective. The challenge is to draw more connections between the different sectors.

Tomas Rydberg (moderator): EcoWater has a meso-level approach; to what extent does the European policy system take this into account? Can it promote or prevent the eco-innovation?

Maria Giovanna Zamburlini: Under the Industrial Emissions Directive, the emission limit values (ELV) are decided locally, based on European regulation, BREF and BAT documents. BREF for wastewater is based on concentrations (rather than total load), which is not productive and bad for recycling and closed loop operations.
Concerning the Waste Framework Directive: End-of-waste status is a challenge because it is generally established at the EU level, but sometimes also at the local level if there is no EU definition of a particular waste. There are different decisions in different countries on what is considered waste, causing difficulties in waste management and policy; wastewater reuse is a regulatory gap. CEFIC argues that standards should be set only for external reuse.

Tomas Rydberg (moderator): Is there an obstacle for reuse in the EU? (directed to Enrique Playán)

Enrique Playán: The problem with reuse is when it's taken directly (not going back to river). Drinking water from grey water can be done technically. But when they want to use it for urban supply, they still need to first inject in a reservoir. This is not efficient, and hindered by regulation, so we need a progress of policy.
This agrees with the concentration issue discussed by Maria Giovanna Zamburlini, and that this issue is disruptive for progress. We cannot base quality standards on concentration. In the US it is based on the Total Maximum Daily Load [TMDL under U.S. Clean Water Act]. The concentration can be misleading. Innovative technologies

that result in reduced water use may result in higher concentrations but lower total loads; hence such technologies are not attractive.
There is need to do something, before water becomes so economically scarce that we use it in ways contrary to user perception, e.g. like making drinking water from grey water.

Dionysis Assimacopoulos: Water is part of our life. EcoWater has shown that water is also part of the economy (elaborating on the textile case; less water and less environmentally expensive technology brings industry back to the front of the market). We should not look at one side only, just the environment, we need to include both economic costs and benefits and the environment.

Comments and questions from the audience

Frederic Clarens (Fundacio CTM Centre Tecnologic): I congratulate the project and see the results and method as a powerful tool. Engagement of citizens is the key for progress, Politics takes time. The project provides good tools to communicate and details are within to study further. There is need to broaden knowledge to people about water availability and scarcity, and need to create awareness! Municipalities can be the way to get information out. This project has provided a good tool to communicate and also to integrate better between research and industry.

Christos Karavitis (Agricultural University of Athens): I am happy for the project, which has both a systemic and *systematic* approach, with a step by step approach. The absence of water cannot easily be transferred into water rights, which is a challenge for policy. We need to go further towards circular economy, and also make existing technologies more available and implementable.

Panos Balabanis (EC DG RTDI): Three policy related scenarios were assessed. If we look at combinations of scenarios, will the results be the same? Can we apply the results if we go beyond the specific barriers?

Nikos Pantalos (EC ENTR B3): Industries are interested in clean tech and will be interested in these results since they show that cost-savings are also possible. How is it possible to reach industry and SME's with results, and make them aware of benefits from eco-innovation and clean tech? SMEs don't know how to apply and exploit these kinds of results. Is there room to develop a support service for SMEs to help them be interactive and aware of the tools? Some work needs to be done with industrial associations. Other technologies could be included in the assessments.

The question is, how to better use results by SMEs by developing services to support them?

Dionysis Assimacopoulos: Biella gives one answer. The companies are SMEs, one does something different, but others cannot follow due to investments. Can we develop associations for different SMEs to benefit more? In the urban sector, most technologies were for resource efficiency in water consumption; the net economic output (NEO) for suppliers went down. Is the solution to increase the price of water? The whole system needs to be looked at through a different approach.

Tomas Rydberg (moderator) (directed to Robbert Droop): Although there is conformity across the common market, on the other hand water scarcity is on a local level. You are somewhere in between, at the national level (middle level). How do you balance between the international and local levels on a national level, between reasonably simple EU legislation and implementation at the local level?

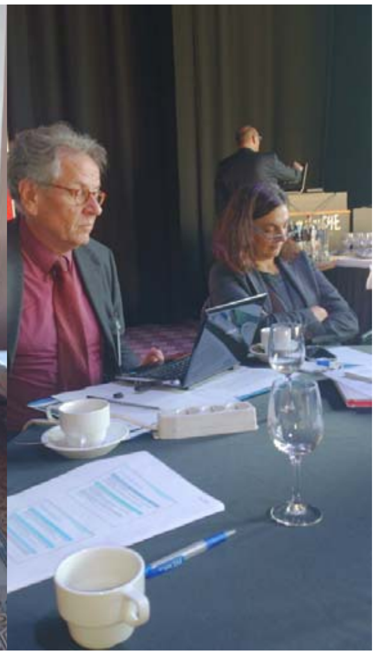
Robert Droop: It's a complex question. The general obstacle is the lack of internalisation of environmental costs, or the difference in internalisation between countries. It distorts market relations. Obstacles in policy: BAT is generally available technologies with a minimum performance standard, so frontrunners in eco-innovation do not need not go above the BAT, implying that going beyond BAT may even be an economic disadvantage. There's a need for a new mechanism for measures on EU level to promote frontrunners, favouring and incentivising introduction of ambitious environmental performance in technology. Another aspect is information and transparency, where we need an enormous step to help towards a circular economy, to close the loop within and across sectors.

Palle Lindgaard-Jørgensen: What is the water utilities' role? Who can play a role in bridging so that water utilities are not losers in optimised resource-efficient systems? Can they be winners in the long run? Who can organise it?

Robbert Droop: Not an easy question. Return on investment is the important thing, not whether they are selling more or less water. Water utilities can have an important role in water resources (these are often a public activity) if they are being valued for their societal function.

Maria Giovanna Zamburlini: We try to make companies more aware about their responsibilities, both on environmental and economic benefits. One must look at the local level.

Enrique Playán: The CAP is one of the most long-term conservative policies. But now we have funds to be used to create local networks for innovation. How to make a link between companies and help build innovation? How to build an agricultural extension system 2.0? Agricultural production with low chemical input and water efficiency are two important aspects.



Tomas Rydberg (moderator) invited final brief comments.

Maria Giovanna Zamburlini: A systematic view must look at innovation, trade-offs, winners and losers.

Robbert Droop: Research should move towards new functions in society, not on specific technologies, but with an integral and multi-stakeholder approach. Where is the leadership? How to develop such policies so that the leadership for innovation is growing in itself? We need public authorities to create the right conditions for actors to take that leadership.

Enrique Playán: We (researchers and EC) now have a change in job description. Policy on growth and jobs must be changed to serve society more directly.

2.4 Closing

The Project coordinator Prof. Assimacopoulos closed the meeting, and thanked everyone for participating in the meeting and discussions. The event ended with lunch at the venue.

Annex I: List of participants

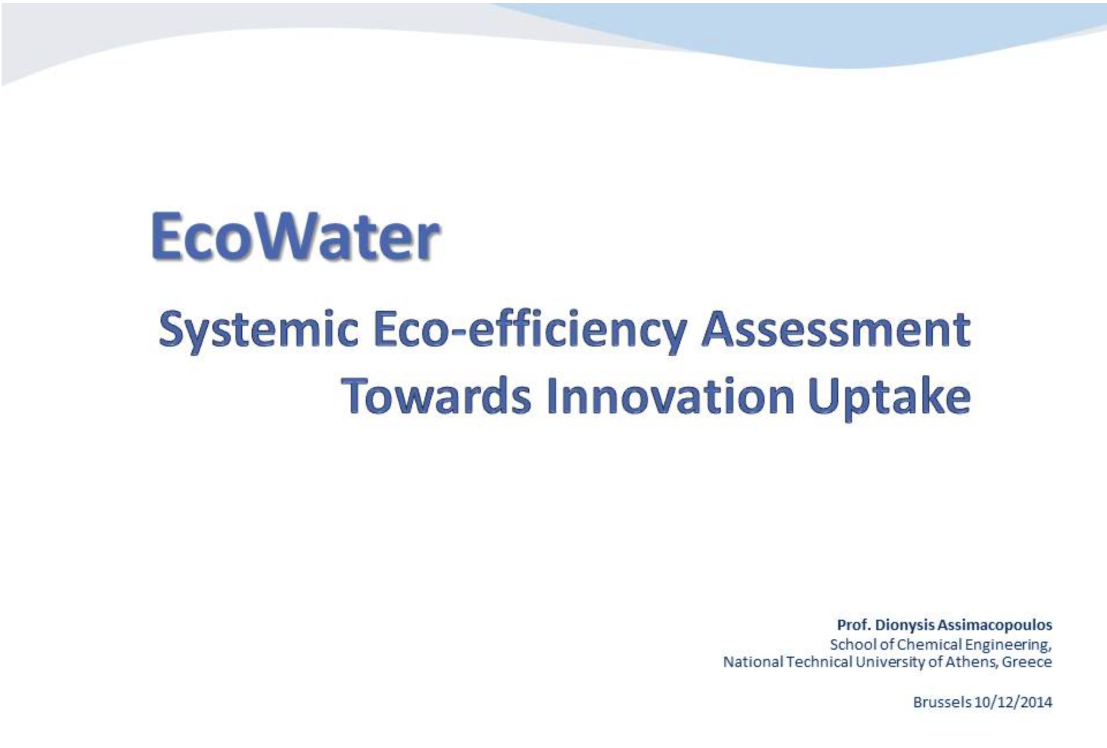
Name	Organisation	Job role
Asik, Anna-Natasa	DG RTDI	Research Programme Officer
Assimacopoulos, Dionysis	NTUA	EcoWater Co-ordinator; Professor
Balabanis, Panagiotis	DG RTDI	Deputy Head of Unit I2 Eco-Innovation
Balzarini, Anna	MITA S.A.S.	EcoWater partner; EU Consultant
Blind, Michiel	Deltares	EcoWater partner; Coordinator EuropeDesk
Clarens, Frederic	Fundacio CTM Centre Tecnologic	Head of Industrial Ecology
D' Ambrosio, Enrico	Regione Puglia Brussels Office	Officer
de Robertis, Claudia	Apulia Region	Officer
Droop, Robbert	Netherlands Ministry of Infrastructure and the Environment	Policy Coordinator
Esteban, Germán	EC	Programme Officer
Giannisi, Silvia	Veltha i.v.z.w.	President
Hugi, Christoph	FHNW - University of Applied Sciences and Arts Northwestern Switzerland	EcoWater partner; Professor
Karavitis, Christos	Department of Agricultural Engineering, Agricultural University of Athens	Ass. Professor
Krol, Durk	WssTP	Director
Levidow, Les	Open University	EcoWater partner; Senior Research Fellow
Lindgaard-Jörgensen, Palle	DHI	EcoWater partner; Senior consultant.
Maia, Rodrigo	UPORTO - FEUP	EcoWater partner; Associate Professor
Mena-Abela, Carmen	EC/EASME	Head of B.2.1 H2020 Eco-innovation
Nardella, Luigi	Consorzio per la Bonifica della Capitanata	Director Agronomic Sector
Nilsson, Åsa	IVL - Swedish Environmental Research Institute	EcoWater partner; Environmental Researcher
Pantalos, Nikos	ENTR B3	Policy Officer
Playan, Enrique	CSIC	Research Professor
Prista, Luisa	DG RTDI	Head of Unit Eco-Innovation
Ribarova, Irina	UACEG	EcoWater partner; Professor
Riggio, Rosseau	RTDI	Project/Process Assistant

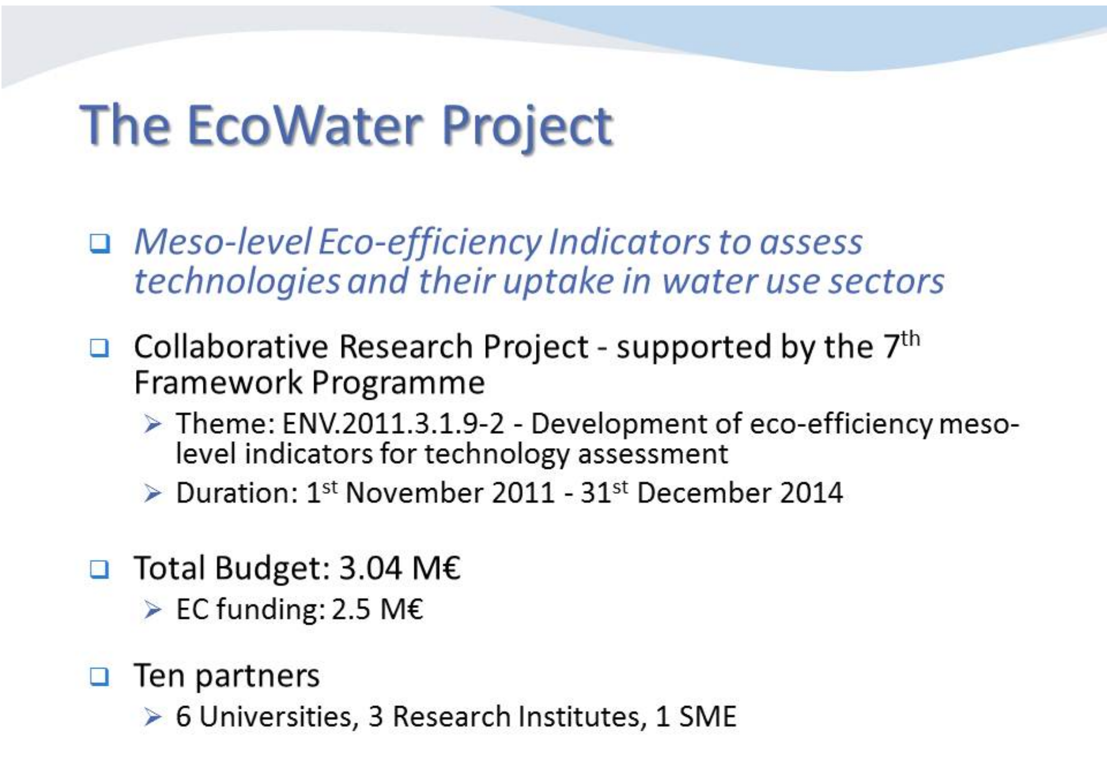
Name	Organisation	Job role
Rydberg, Tomas	IVL Swedish Environmental Research Institute	EcoWater partner; Senior LCA expert
Servant, Isabelle	Aqua Publica Europea	Communications officer (Executive Director)
Skenhall, Sara	IVL Swedish Environmental Research Institute	EcoWater partner; Consultant
Slob, Adriaan	TNO	Senior researcher
Todorovic, Mladen	CIHEAM - Mediterranean Agronomic Institute of Bari	EcoWater partner; Senior Scientific Officer
Zamburlini, Maria Giovanna	Cefic	Environmental Policy Counsellor

Annex II: Meeting presentations

1. EcoWater: systemic eco-efficiency assessment towards innovation uptake (*Dionysis Assimacopoulos*)
2. Experiences and Challenges in Systemic Eco-efficiency Assessment - *Agricultural Sector (Mladen Todorovic)*
3. Experiences and Challenges in Systemic Eco-efficiency Assessment - *Urban Sector (Christoph Hugi)*
4. Experiences and Challenges in Systemic Eco-efficiency Assessment - *Industrial Sector (Palle Lindgaard-Jørgensen)*
5. Water use in the EU across different sectors (*Tomas Rydberg*)

EcoWater: systemic eco-efficiency assessment towards innovation uptake (Dionysis Assimacopoulos)



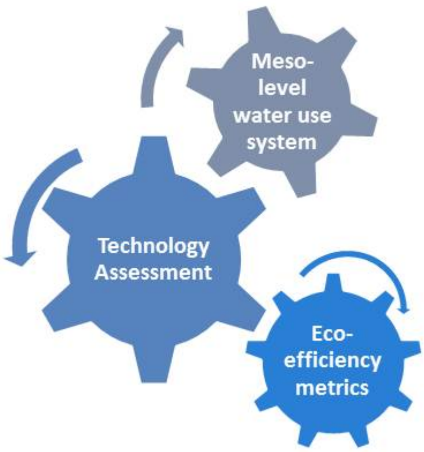


The EcoWater Consortium

1. National Technical University of Athens, GR
2. Centro Internazionale di Alti Studi Agronomici Mediterranei - Istituto Agronomico Mediterraneo di Bari, IT
3. Stichting Deltares, NL
4. University of Applied Sciences, Northwestern Switzerland, CH
5. Universidade do Porto, PT
6. University of Architecture, Civil Engineering and Geodesy, BG
7. The Open University, UK
8. DHI - Danish Hydraulic Institute, DK
9. IVL Swedish Environmental Research Institute, SE
10. MITA SAS, IT

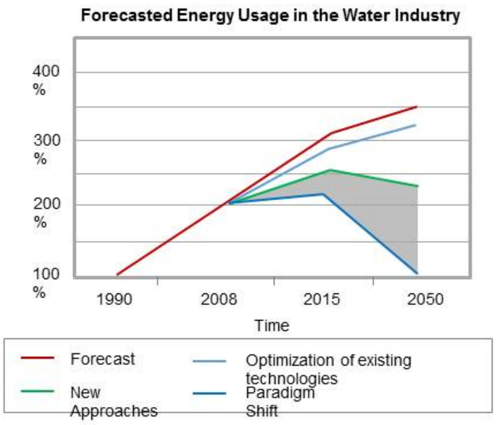
The Research Objectives

- Selection of **eco-efficiency indicators**, suitable for assessing the system-wide eco-efficiency
- A system-wide **environmental** and **economic assessment** of water-use systems
- Selection and testing of **innovative technologies** and practices for improving system-wide eco-efficiency of water-use systems
- Development and integration of assessment **methods** and **tools** into a coherent modeling environment



Water as a Common Denominator

- Water is an **input** to most production processes
- Water-use conveys an **added value** in products/services
- There is a significant **potential for water saving**
- There is a significant **environmental impact** and **cost** in making water suitable for different use purposes
- Uptake of water-related innovations remains **regulatory-driven** and existing standards offer limited incentives for further improvement



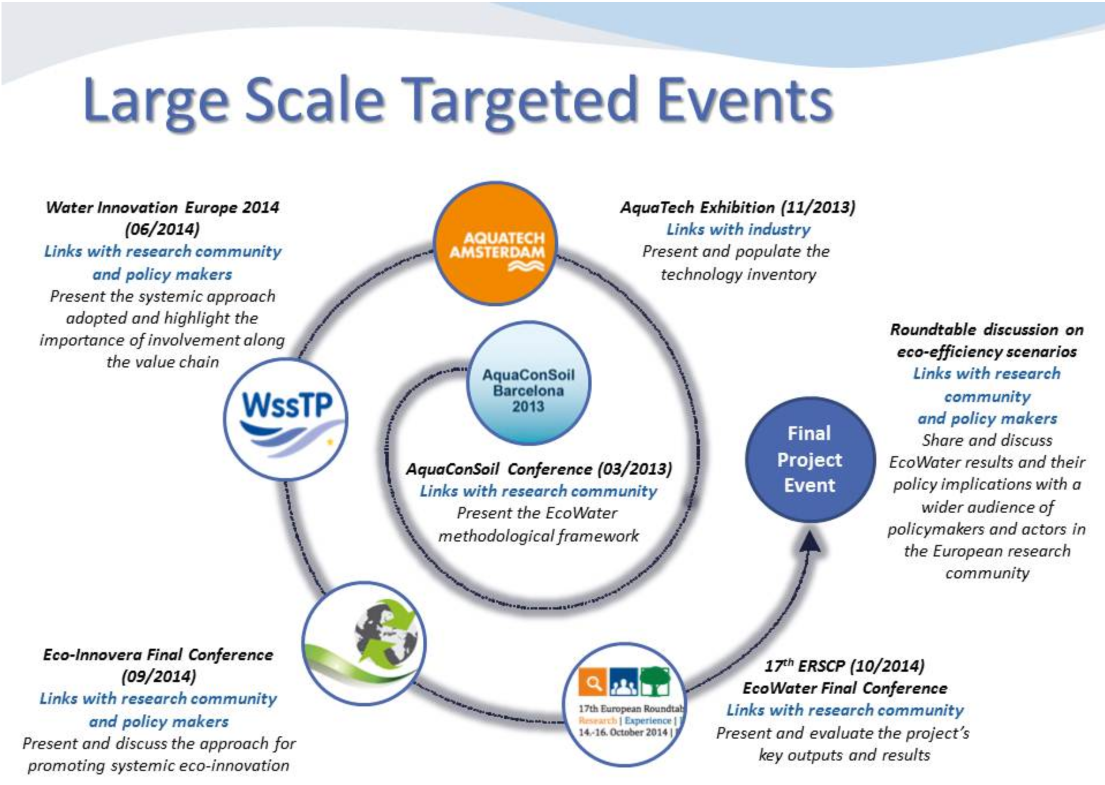
Source: UK Council for Science and Technology "Improving innovation in the water industry'" 2009

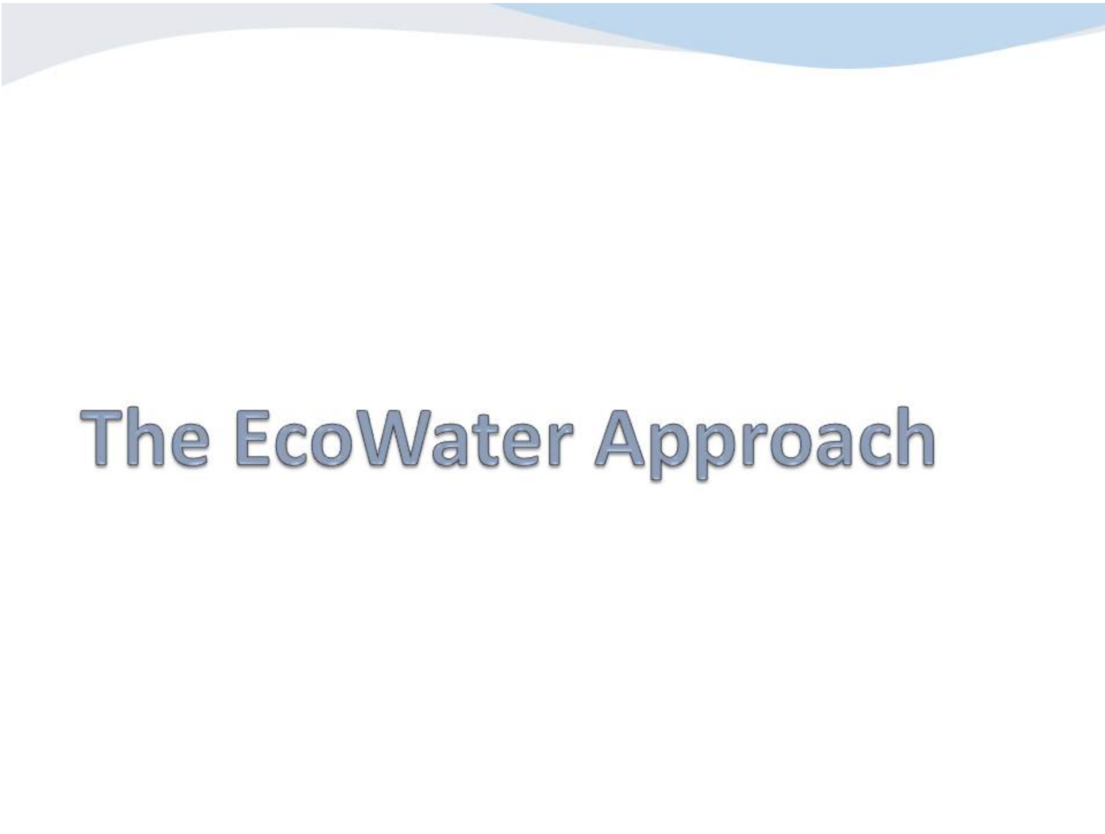
Dissemination Activities

A. Local Case Study Workshops
   - Discuss data requirements (*1st Year*)
   - Identify drivers and barriers for technology uptake (*1st & 2nd Year*)
   - Present the key outputs and results of EcoWater (*3rd Year*)

B. Large-scale Targeted Events
   - Present the methodology and results of the EcoWater
   - Develop links with key research and policy initiatives
   - Enhance the collaboration with stakeholder groups

C. EcoWater Final Conference
   - Present the key outputs and results
   - Discuss their applicability
   - Identify next steps, in terms of policy, industrial development and research


Large Scale Targeted Events
Water Innovation Europe 2014 (06/2014)
Links with research community and policy makers
Present the systemic approach adopted and highlight the importance of involvement along the value chain
AQUATECH AMSTERDAM
AquaTech Exhibition (11/2013)
Links with industry
Present and populate the technology inventory
AquaConSoil Barcelona 2013
AquaConSoil Conference (03/2013)
Links with research community
Present the EcoWater methodological framework
WssTP
Final Project Event
Roundtable discussion on eco-efficiency scenarios
Links with research community and policy makers
Share and discuss EcoWater results and their policy implications with a wider audience of policymakers and actors in the European research community
Eco-Innovera Final Conference (09/2014)
Links with research community and policy makers
Present and discuss the approach for promoting systemic eco-innovation
17th ERSCP (10/2014)
EcoWater Final Conference
Links with research community
Present and evaluate the project's key outputs and results


The EcoWater Approach

Eco-efficiency: Defining & Measuring

- Simultaneous improvement of both economic & ecological efficiency
- With respect to cleaner production concept "*it delivers products and processes that meet tomorrow's rather than yesterday's environmental expectations*"

Van Berkel R., 2008, "Eco-efficiency: concepts & rationale"

- **Eco-efficiency metrics**: Indicators to measure the most cost-effective way of reducing environmental pressures / impacts

$$\textit{Eco-efficiency indicator} = \frac{\textit{Economic output} \uparrow}{\textit{Environmental influence} \downarrow}$$

"more" welfare ↑

...from "less" nature ↓

The Challenge

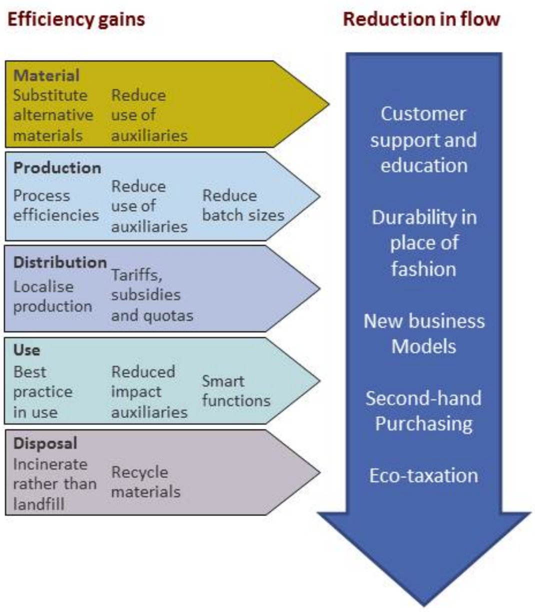
- ***Eco-Efficiency*** and ***Eco-innovation*** for water-use systems
- A ***systemic approach*** addressing both the physical and operational structure of the system
- A ***validated technology assessment framework*** recognizing
  - ***System-wide impacts*** from ***multiple interventions***
  - ***Heterogeneous actors*** with conflicting interests are involved

The Drivers

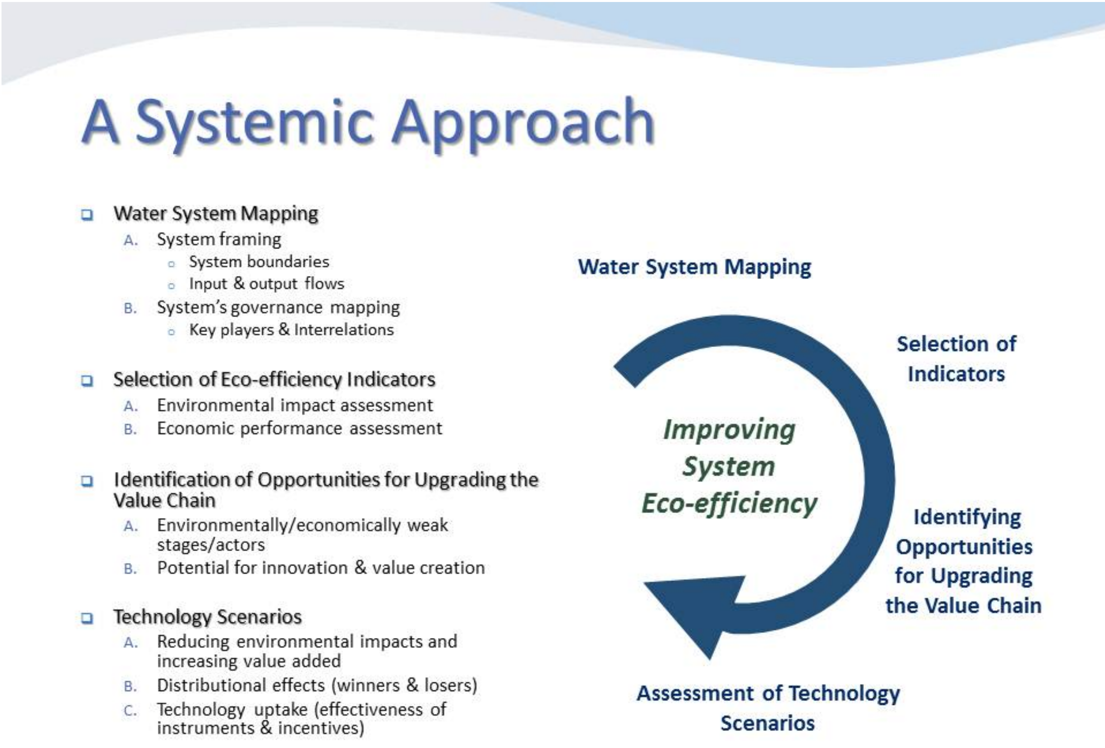
- EU and Member States
  - Towards a circular economy – 2014; Value chain focus and waste reduction targets
  - Building the Single Market for Green Products - Facilitating better information on the environmental performance of products and organisations - 2013
  - Roadmap for a resource-efficient Europe - 2011
  - Sustainable Consumption and Production Action Plan - 2008
  - Sector-specific policies, directives and regulations (WFD, IPPC – BATS, ...)
- Industry & SMEs
  - International standards – ISO 14045/2012
  - Eco-labelling of products & Eco-design
  - New business opportunities – Market for environmental technologies, innovations & secondary by-products (e.g. phosphorus)
  - New financing instruments to facilitate investment
- Society
  - New consumption drivers & preferences
  - Behavioural change
  - Increased concern over the footprint of products (Pilot phase for Product Environmental Footprint at EU level)

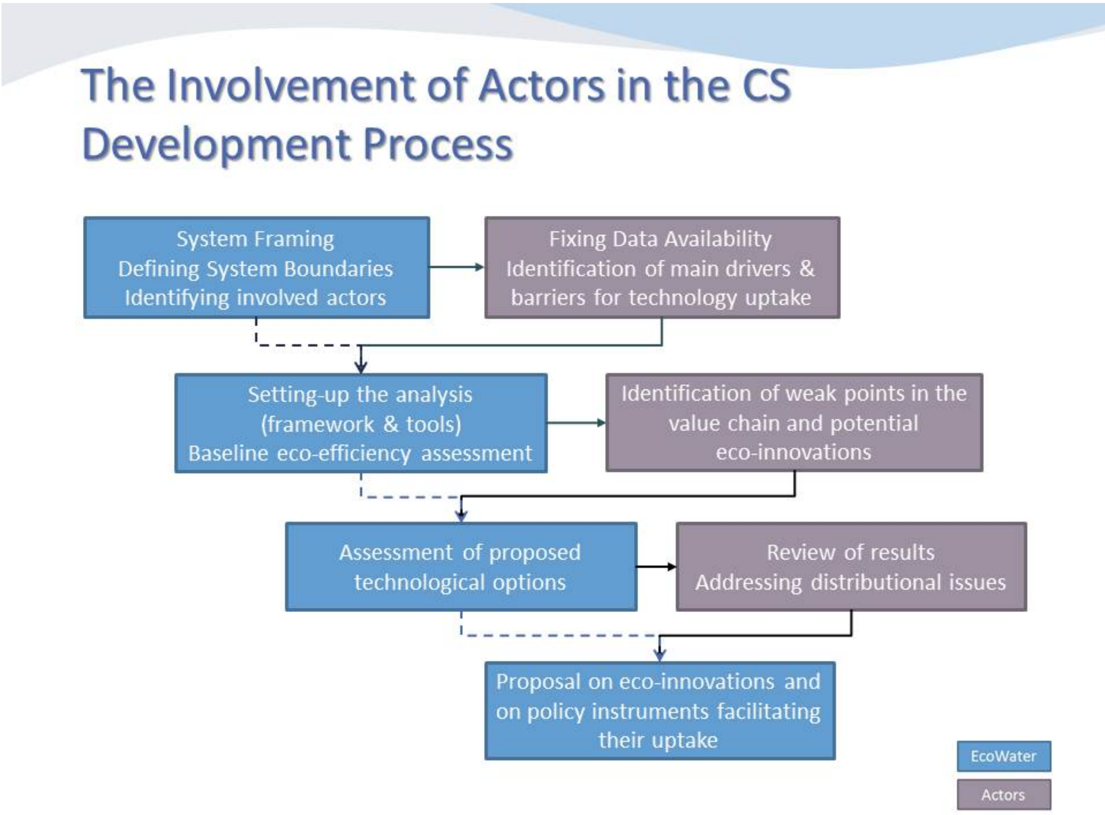
The Principles

- **Reduce**
  - Material intensity of goods & services - production with fewer inputs
  - Energy intensity of goods and services - production with less energy
  - Dispersion of any toxic substances - production with less harmful waste
- **Recycle**
  - Enhance the recyclability of materials - make recyclable products
- **Reuse**
- **Maximise**
  - Sustainable use of renewable resources - Make products from inputs that won't run out
  - Durability of products - Make products that last
  - The service intensity of goods & services - meet demand with services and not with products



***Source:** World Business Council for Sustainable Development*

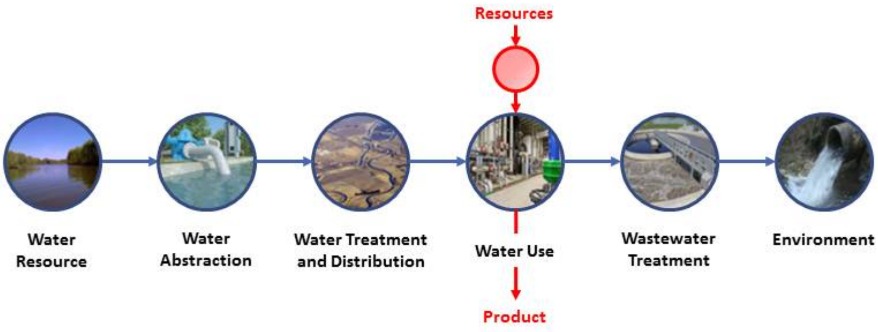

A Systemic Approach
Water System Mapping
A. System framing
System boundaries
Input & output flows
B. System's governance mapping
Key players & Interrelations
Selection of Eco-efficiency Indicators
A. Environmental impact assessment
B. Economic performance assessment
Identification of Opportunities for Upgrading the Value Chain
A. Environmentally/economically weak stages/actors
B. Potential for innovation & value creation
Technology Scenarios
A. Reducing environmental impacts and increasing value added
B. Distributional effects (winners & losers)
C. Technology uptake (effectiveness of instruments & incentives)
Water System Mapping
Selection of Indicators
Improving System Eco-efficiency
Identifying Opportunities for Upgrading the Value Chain
Assessment of Technology Scenarios

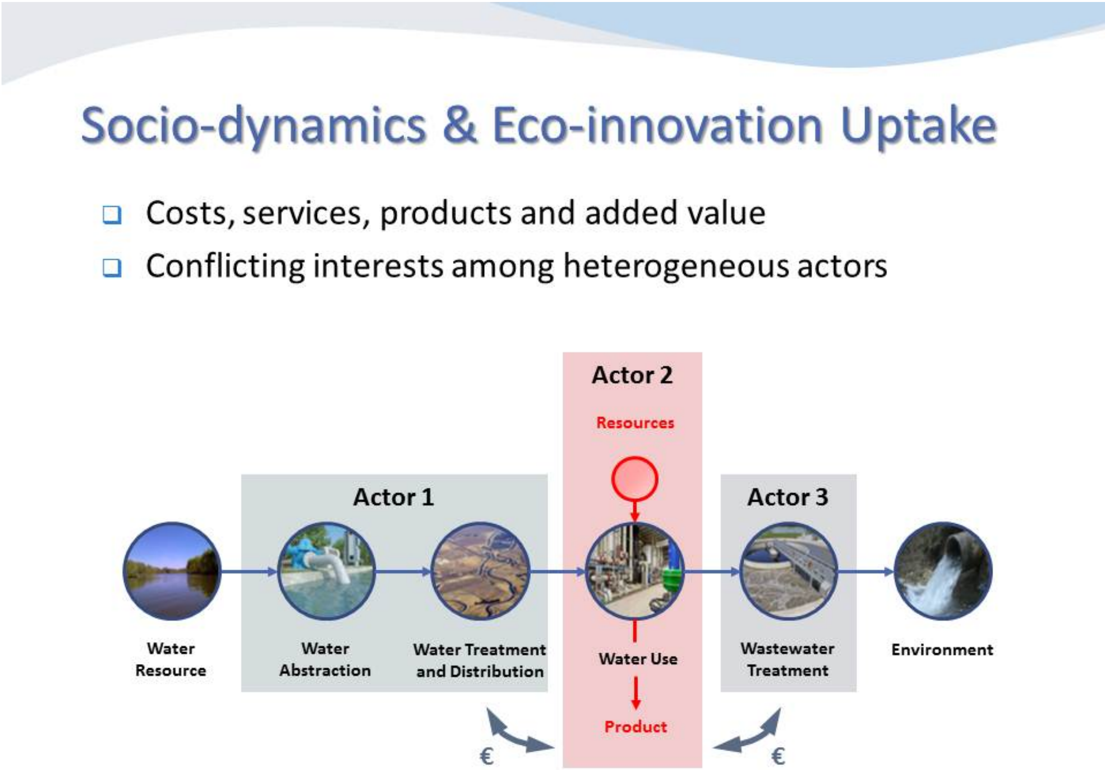

The Involvement of Actors in the CS Development Process
System Framing
Defining System Boundaries
Identifying involved actors
Fixing Data Availability
Identification of main drivers & barriers for technology uptake
Setting-up the analysis (framework & tools)
Baseline eco-efficiency assessment
Identification of weak points in the value chain and potential eco-innovations
Assessment of proposed technological options
Review of results
Addressing distributional issues
Proposal on eco-innovations and on policy instruments facilitating their uptake
EcoWater
Actors

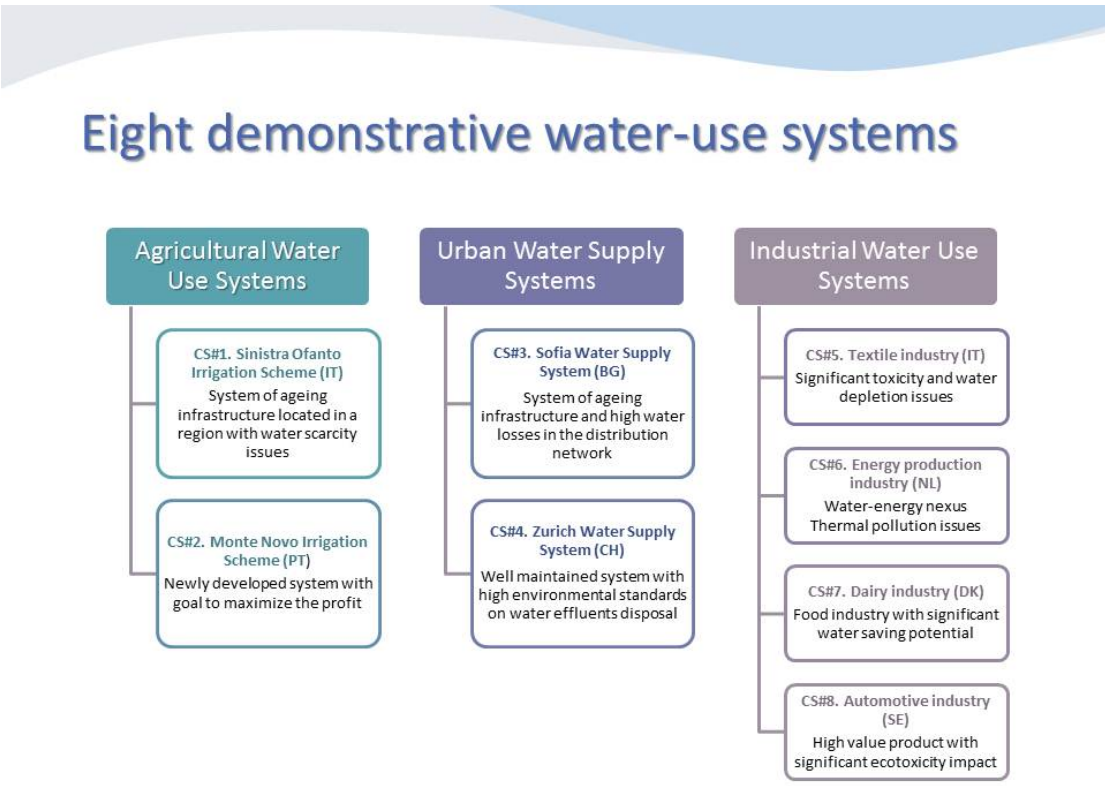
Implementing Eco-efficiency Analysis

The Water-Use System

- Stages (transformation - technologies) & Resource flows (water, energy, materials)
  1. Water supply/value chain
  2. Production chain




Socio-dynamics & Eco-innovation Uptake
Costs, services, products and added value
Conflicting interests among heterogeneous actors
Actor 1
Actor 2
Actor 3
Resources
Water Resource
Water Abstraction
Water Treatment and Distribution
Water Use
Wastewater Treatment
Environment
Product
€
€


Eight demonstrative water-use systems
Agricultural Water Use Systems
Urban Water Supply Systems
Industrial Water Use Systems
CS#1. Sinistra Ofanto Irrigation Scheme (IT)
System of ageing infrastructure located in a region with water scarcity issues
CS#2. Monte Novo Irrigation Scheme (PT)
Newly developed system with goal to maximize the profit
CS#3. Sofia Water Supply System (BG)
System of ageing infrastructure and high water losses in the distribution network
CS#4. Zurich Water Supply System (CH)
Well maintained system with high environmental standards on water effluents disposal
CS#5. Textile industry (IT)
Significant toxicity and water depletion issues
CS#6. Energy production industry (NL)
Water-energy nexus
Thermal pollution issues
CS#7. Dairy industry (DK)
Food industry with significant water saving potential
CS#8. Automotive industry (SE)
High value product with significant ecotoxicity impact

Environmental "Hotspots"

Agricultural Water Use Systems

- Identical hotspots
- Main common environmental issues are freshwater resource depletion, eutrophication due to fertilizers use and climate change due to fuel consumption

Urban Water Supply Systems

- Main hotspot is domestic water use, which leads to freshwater depletion
- Each system has its additional hotspots (sludge transportation for Sofia / micropollutants emissions for Zurich)

Industrial Water Use Systems

- Specific issues depending on the water use
- Main environmental hotspot: Ecotoxicity (Textiles), Eutrophication (Dairy), Thermal Pollution (Energy), Ecotoxicity and Abiotic Resource Depletion (Automotive)

Baseline Eco-efficiency Metrics

Indicators	Agricultural		Urban		Industrial			
	CS#1	CS#2	CS#3	CS#4	CS#5	CS#6	CS#7	CS#8
Climate Change (€/t$CO_{2,eq}$)	**1081**	**186**	**94**	**373**	1351	78.8	30.1	44000
Stratospheric Ozone Depletion (€/kgCFC-11$_{,eq}$)	*NR**	*NR*	>10^6	>10^6	*NR*	*NR*	*NR*	>10^6
Eutrophication (€/kg$PO_4^{-3}{}_{,eq}$)	109	15.4	41.7	4.9	1025	*NR*	**0.99**	42000
Acidification (€/kg$SO_2^{-}{}_{,eq}$)	82.6	21.8	4.4	215	366	104.5	3.1	15000
Human Toxicity (€/kg1,4-DB$_{,eq}$)	19.9	1.7	1.1	4.5	**6.8**	38.8	28.5	2000
Aquatic Ecotoxicity (€/kg1,4-DB$_{,eq}$)	74.5	10.9	13.3	15.6	**0.8**	10635	737.3	1800
Terrestrial Ecotoxicity (€/kg1,4-DB$_{,eq}$)	3866	106	513	6005	**9.5**	2907	630	>10^6
Photochemical Ozone Formation (€/kg$C_2H_{4,eq}$)	8417	519	111	8822	6959	808	3272	>10^6
Respiratory Inorganics (€/kg$PM_{10,eq}$)	*3007*	*NR*	22.5	1257	*NR*	21305	*NR*	*NR*
Abiotic Resource Depletion (€/kgSb$_{,eq}$)	*NR*	*NR*	*NR*	*NR*	*NR*	*NR*	*NR*	28660
Fossil Fuels Depletion (€/MJ)	4.9	0.01	0.01	0.03	*NR*	0.003	*NR*	*NR*
Freshwater Depletion (€/m^3)	7.0	0.6	1.1	31.6	122	6.1	203	17400

**NR: Not relevant to the Case Study*

Innovative Technologies

- Information for more than 50 different innovative technologies that potentially could improve the eco-efficiency has been retrieved
  - Best Available Techniques Reference Documents (BREFs)
  - Literature review
- All technologies are included in the online technology inventory, with detailed data on their environmental and economic performance
- Selection of technologies to be assessed has been based on
  A. Relevance
  B. Identification of the hotspots of environmental impacts
  C. Feedback from the local actors

Policy Scenarios

- Technologies have been classified in three classes according to the implementation objective
  - ***Resource Efficient technologies***, focusing on water, energy or material savings
  - ***Pollution Preventing technologies***, aiming to reduce the emissions to air, water and soil
  - ***Technologies enhancing Circular Economy***, such as reuse, recycle or recovery
- Based on that classification, three alternative scenarios have been formulated for each Case Study, each one including all the relevant eco-efficient technological options

Innovative Technologies

(a) Water Supply & Waste Treatment Chain

Technologies	Stage	Resource Efficiency	Pollution Prevention	Circular Economy
Variable Speed Pumps	Water Abstraction and Distribution	✓	✓	
Pressure reduction turbines		✓	✓	✓
Smart pumping		✓	✓	
Solar pumping		✓	✓	
Membrane distillation	Water Treatment		✓	
Micropollutants removal	Wastewater Treatment		✓	
Advanced phosphorus recovery			✓	✓
Solar drying of sludge			✓	✓
Anaerobic pre-treatment of wastewater			✓	
Advanced oxidation processes			✓	
Membrane bioreactor			✓	

Innovative Technologies

(b) Technologies in Production Chain

Sector	Resource Efficiency	Pollution Prevention	Circular Economy
Agricultural Water Use	Regulated deficit irrigation Drip & Sub-surface drip irrigation	Use of sludge Use of organic fertilizers	-
Urban Water Supply	Water saving appliances	Solar water heating Drain water heat recovery	Water reuse technologies
Textile Industry	Jet dyeing machines Automatic dye and Chemical dispensing systems	Use of natural dyes	-
Energy Production Industry	Heat only boilers Thermal energy buffer		Expansion of the Heat Distribution Network Preheating potable water
Dairy Industry	Product and water recovery from CIP Cleaning and reuse of condensate	Advanced oxidation and UV	Cleaning and Reuse of Condensate
Automotive Industry	Silane-based metal surface treatment Recycling of process water and chemicals		Recycling of process water and chemicals

Potential for Environmental Improvement

Case Study	Resource efficiency scenario		Pollution prevention scenario		Circular economy scenario	
	Water Use	Energy Use	Water Use	Energy Use	Water Use	Energy Use
CS1. Sinistra Ofanto (IT)	-6.3%	-5.9%	0%	-9%	-	-
CS2. Monte Novo (PT)	-8.7%	-8.3%	0%	-5%	-	-
CS3. Sofia (BG)	-9.0%	-8.0%	-9%	-14%	0%	-1%
CS4. Zurich (CH)	-13%	-6%	-1%	0%	-2%	0%
CS5. Textiles (IT)	-52%	-15%	0%	-0.8%	-	-
CS6. Amsterdam (NL)	-	-	-18%*	-11%	-30%*	+1%
CS7. Dairy (DK)	-47%	-	-133%	-	-316%	-
CS8. Automotive (SE)	-1.1%	-2.8%	-1.5%	+3.9%	-1.3%	+4.4%

** Case Study #6: In Water Use column the Thermal Pollution Reduction in the receiving water body is shown*

Distributional Issues

Net Economic Output change for the main involved actors

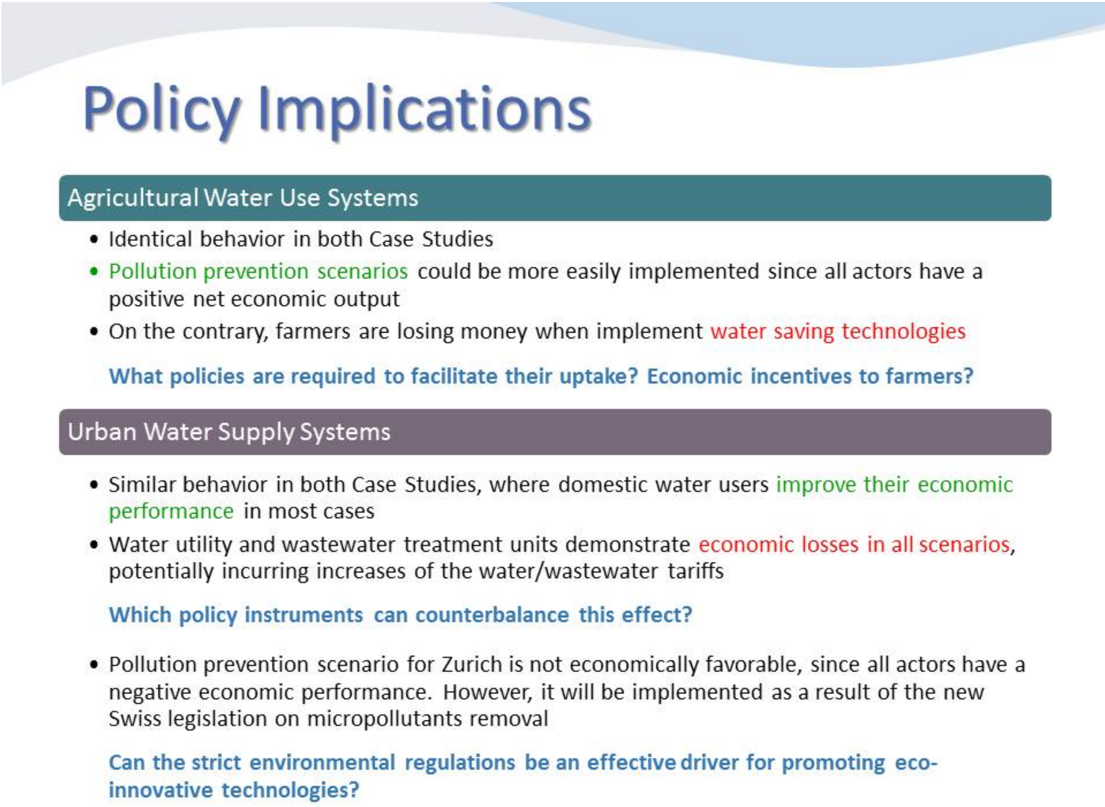
Drip irrigation

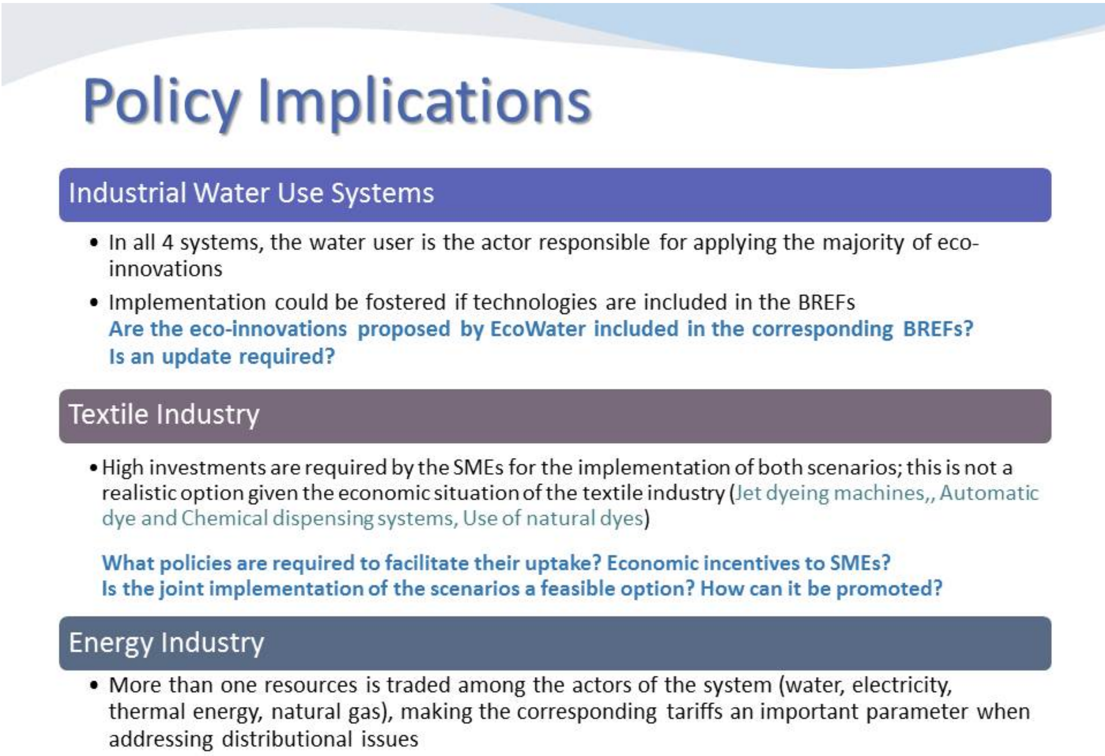
Smart pumping

Organic fertilizers

Case Study	Resource efficiency scenario			Pollution prevention scenario			Circular economy scenario		
	Water Utility	Water User	WW Utility	Water Utility	Water User	WW Utility	Water Utility	Water User	WW Utility
CS1. Sinistra Ofanto (IT)	0%	-3.1%*	N/A	0%	+1.2%	N/A	-	-	-
CS2. Monte Novo (PT)	+6%	-7.5%	N/A	0%	+11%	N/A	-	-	-
CS3. Sofia (BG)	-21%**	+13%	-21%	-20%	+10%	-20%	+9%	0%	+9%
CS4. Zurich (CH)	-1%	+19%	-17%	0%	-2%	-48%	0%	-3%	0%
CS5. Textiles (IT)	0%	+11%*	0%	0%	-6.8%	+6.7%	-	-	-
CS6. Amsterdam (NL)	-	-	-	0%	+11%	0%***	0%	+9%	-11%
CS7. Dairy (DK)	-55%	+10%	-42%	-26%	+10%	-6%	-75%	+10%	-41%
CS8. Automotive (SE)	0%	+0.3%	-57%	-12%	+0.3%	-57%	-12%	+0.2%	0%

** In CS#1 and CS#5 there is more than one water user. The worst economic performance is shown*
*** In Case Study #3, water utility and wastewater utility are managed by the same actor*
**** In Case Study #6, the users of electricity and thermal energy are shown in the 3rd column instead of WW Utility*


Policy Implications
Agricultural Water Use Systems
• Identical behavior in both Case Studies
• Pollution prevention scenarios could be more easily implemented since all actors have a positive net economic output
• On the contrary, farmers are losing money when implement water saving technologies
What policies are required to facilitate their uptake? Economic incentives to farmers?
Urban Water Supply Systems
• Similar behavior in both Case Studies, where domestic water users improve their economic performance in most cases
• Water utility and wastewater treatment units demonstrate economic losses in all scenarios, potentially incurring increases of the water/wastewater tariffs
Which policy instruments can counterbalance this effect?
• Pollution prevention scenario for Zurich is not economically favorable, since all actors have a negative economic performance. However, it will be implemented as a result of the new Swiss legislation on micropollutants removal
Can the strict environmental regulations be an effective driver for promoting eco-innovative technologies?


Policy Implications
Industrial Water Use Systems
• In all 4 systems, the water user is the actor responsible for applying the majority of eco-innovations
• Implementation could be fostered if technologies are included in the BREFs
Are the eco-innovations proposed by EcoWater included in the corresponding BREFs?
Is an update required?
Textile Industry
• High investments are required by the SMEs for the implementation of both scenarios; this is not a realistic option given the economic situation of the textile industry (Jet dyeing machines,, Automatic dye and Chemical dispensing systems, Use of natural dyes)
What policies are required to facilitate their uptake? Economic incentives to SMEs?
Is the joint implementation of the scenarios a feasible option? How can it be promoted?
Energy Industry
• More than one resources is traded among the actors of the system (water, electricity, thermal energy, natural gas), making the corresponding tariffs an important parameter when addressing distributional issues

Policy Implications

Dairy Industry

- All scenarios improve environmental indicators
- The dairy industry always has profit from their implementation (Product and water recovery from CIP, Cleaning and reuse of condensate, Advanced oxidation and UV)
- However, all scenarios assume the replacement of fresh water intake, currently used for dairy processes, with water extracted from milk
  Do national food authorities accept that using water extracted from milk is safe for the consumers? Is there a precedent in the EU legislation?

Automotive Industry

- The industrial actor has marginal economic profit from the implementation of eco-innovative technologies (Silane-based metal surface treatment, Recycling of process water and chemicals)
  What incentives are required to motivate an industry to invest in environmentally friendly technologies?

Wide Policy Implications

- For eco-innovations which offer greatest benefit, what are the main drivers and barriers?
- For adopting such eco-innovations, what policy changes would be helpful?
- For multi-stakeholder cooperation to identify optimal eco-innovations, what policy frameworks or changes would be helpful?
- What advantages does the adoption of a systemic approach offer?
- Which stages in the water value chains were the hotspots of environmental impacts and with the greatest potential for improvements?
- Which eco-innovations were proposed and for which technology scenarios?
- How was the environmental performance of a system affected by the implementation of technology scenarios?
- How was the economic performance of a system and its different actors affected by the implementation of technology scenarios?
- In the case that the assessment of technologies resulted in higher eco-efficiency, was this due to the economic or the environmental dimension mainly? Were there also win-win situations?

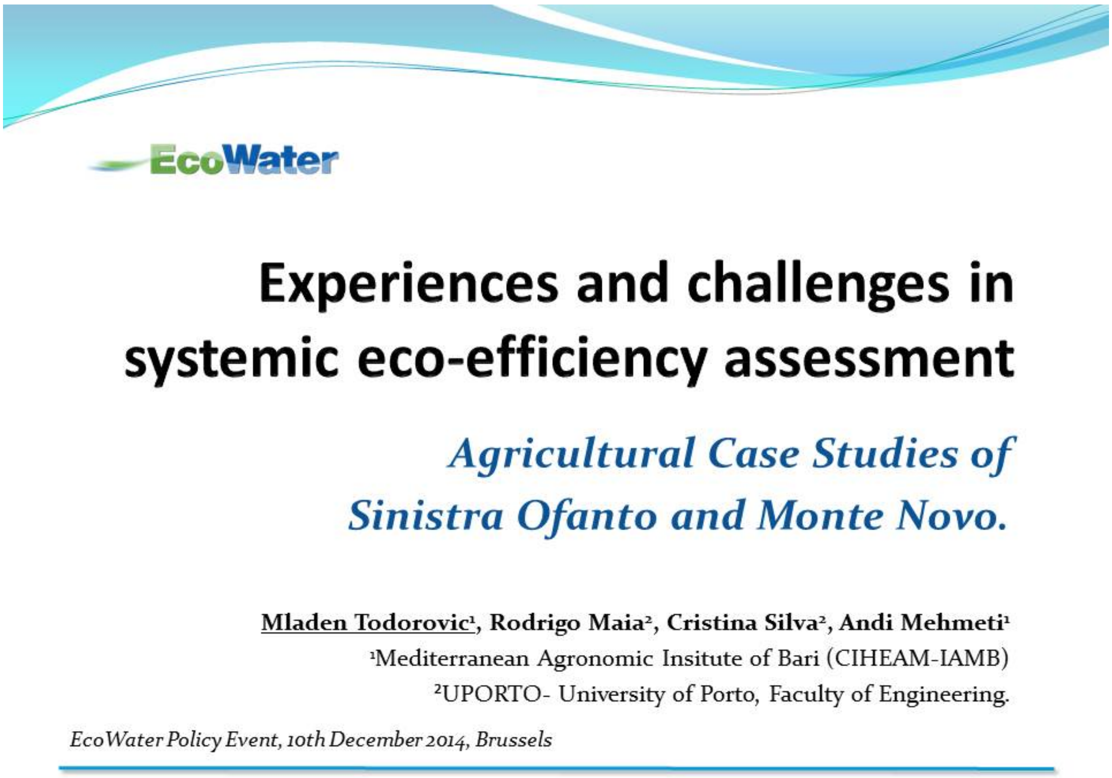
Thank you for your attention

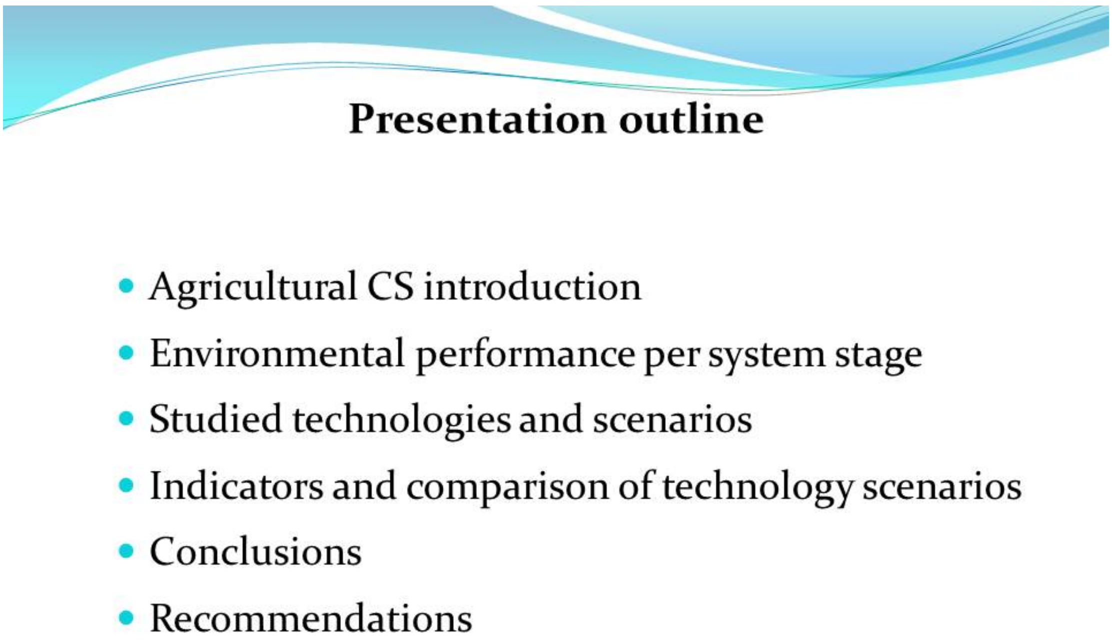
For more information, visit:

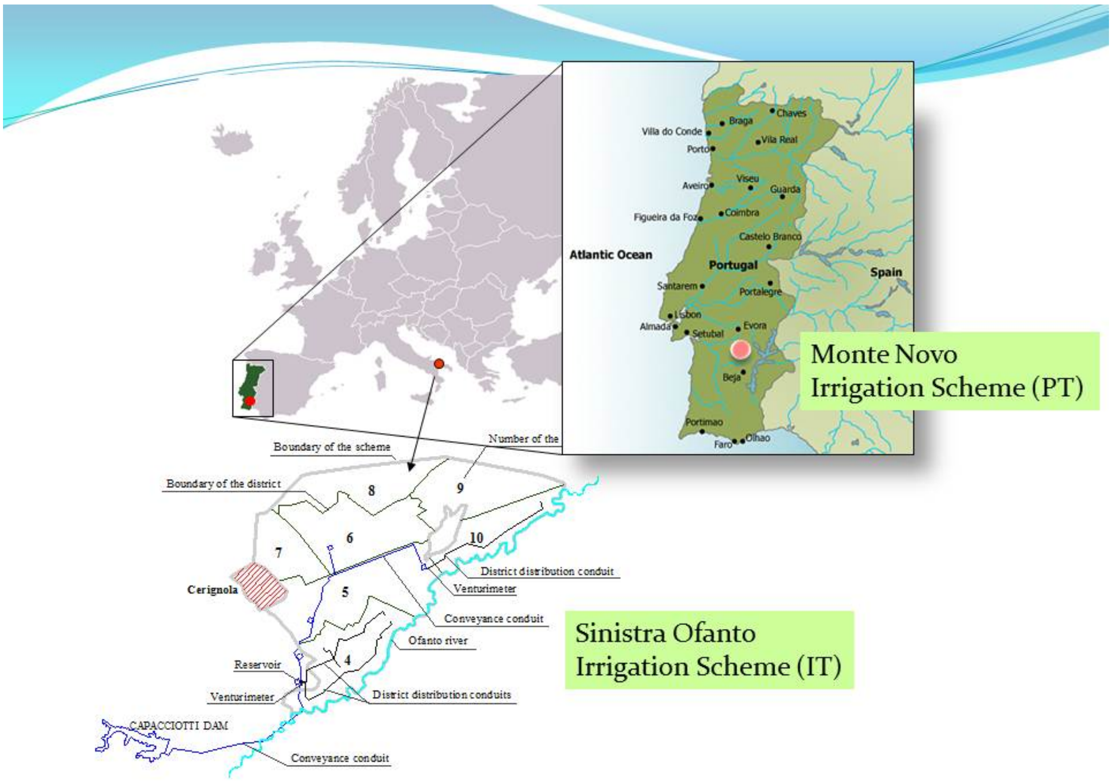
http://environ.chemeng.ntua.gr/ecowater/ (Project Site)

http://environ.chemeng.ntua.gr/ewtoolbox/ (EcoWater Toolbox)

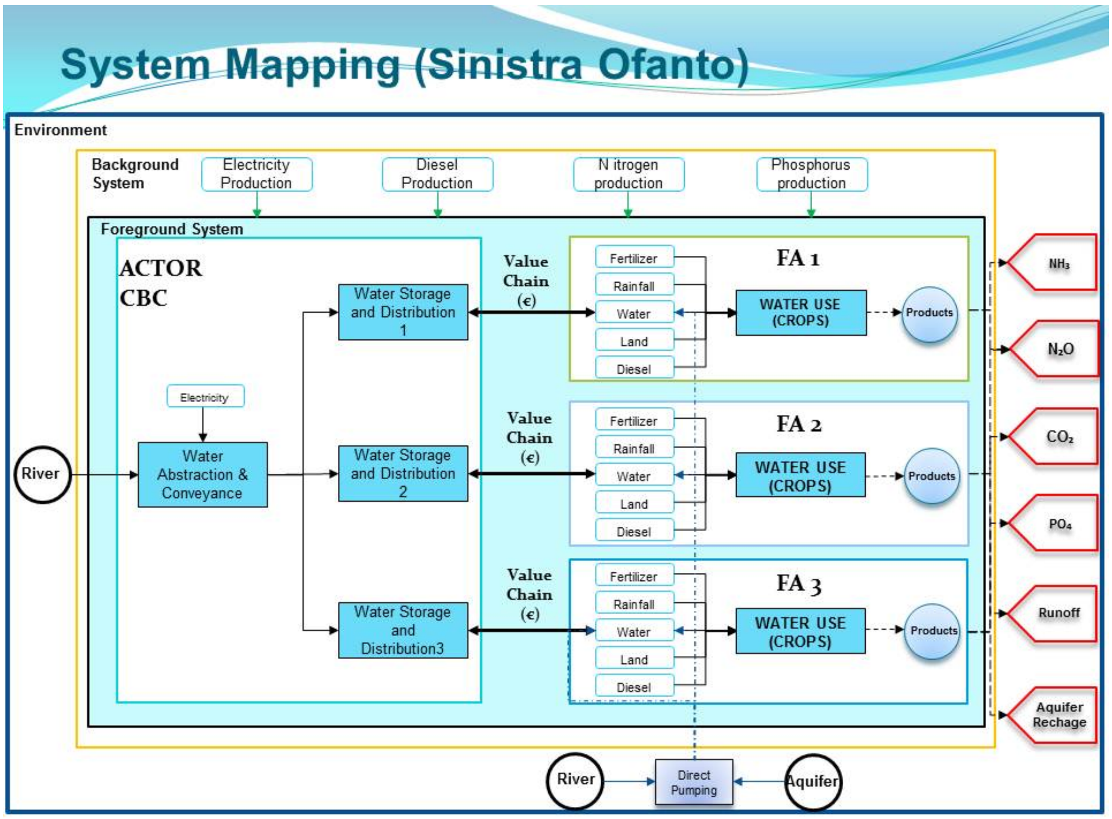
Experiences and Challenges in Systemic Eco-efficiency Assessment - Agricultural Sector (Mladen Todorovic)



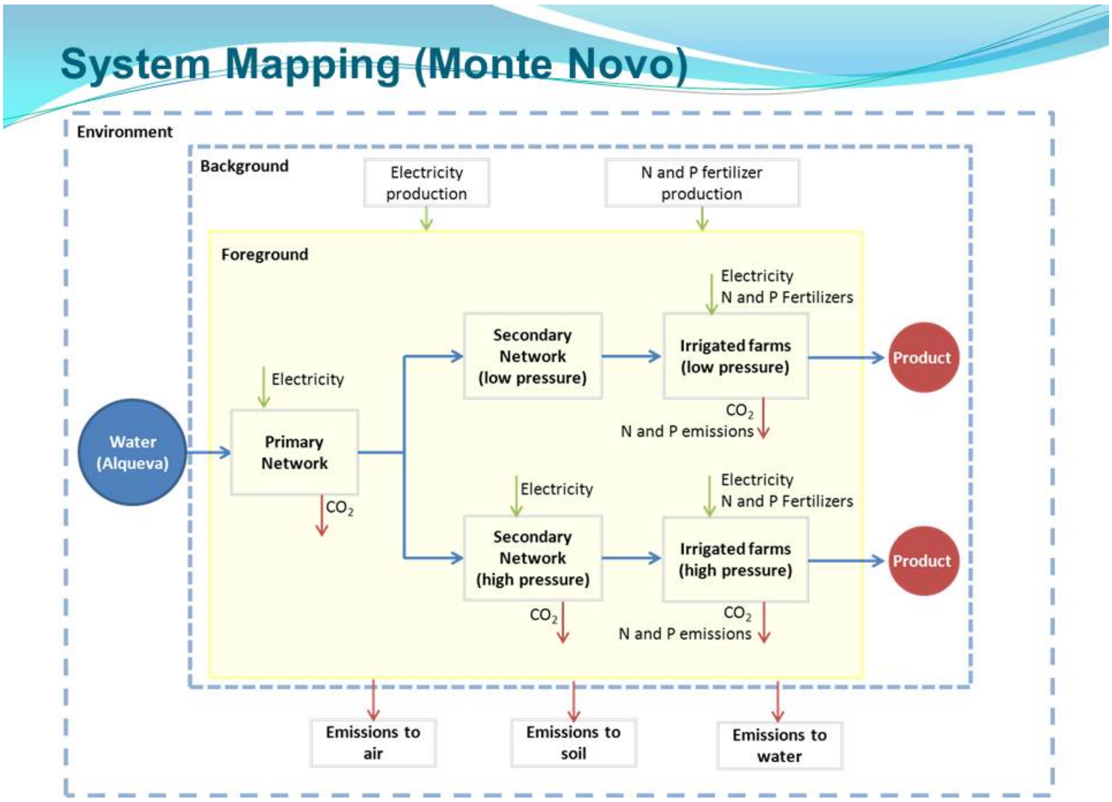


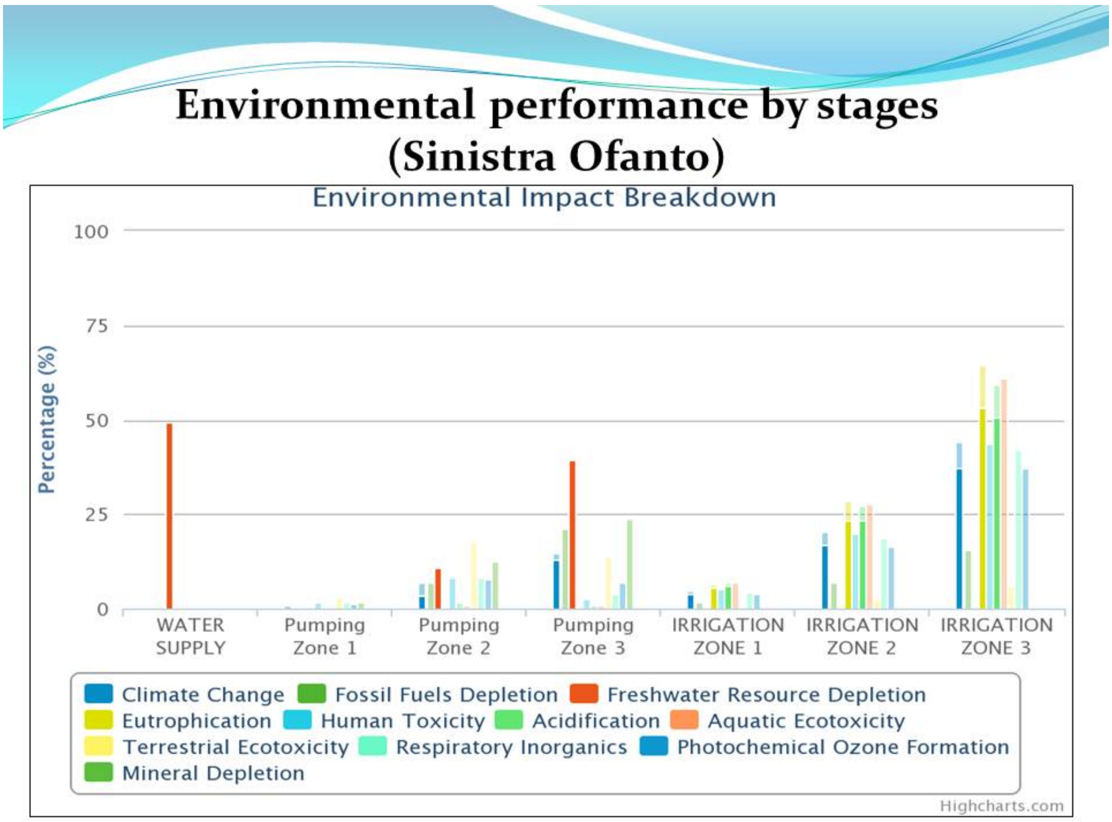


Monte Novo
Irrigation Scheme (PT)
Sinistra Ofanto
Irrigation Scheme (IT)
Atlantic Ocean
Portugal
Spain
Boundary of the scheme
Boundary of the district
Number of the
Cerignola
District distribution conduit
Venturimeter
Conveyance conduit
Ofanto river
Reservoir
District distribution conduits
CAPACCIOTTI DAM
Conveyance conduit

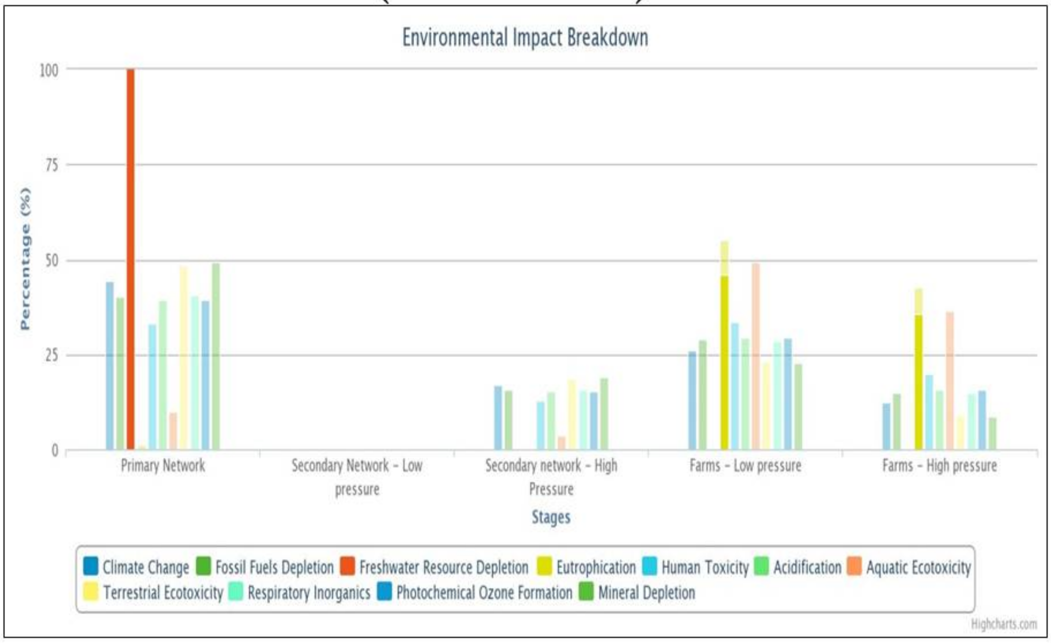


System Mapping (Sinistra Ofanto)
Environment
Background System
Electricity Production
Diesel Production
Nitrogen production
Phosphorus production
Foreground System
ACTOR CBC
Electricity
River
Water Abstraction & Conveyance
Water Storage and Distribution 1
Water Storage and Distribution 2
Water Storage and Distribution3
Value Chain (€)
FA 1
FA 2
FA 3
Fertilizer
Rainfall
Water
Land
Diesel
WATER USE (CROPS)
Products
NH₃
N₂O
CO₂
PO₄
Runoff
Aquifer Rechage
River
Direct Pumping
Aquifer


System Mapping (Monte Novo)
Environment
Background
Electricity production
N and P fertilizer production
Foreground
Electricity
N and P Fertilizers
Secondary Network (low pressure)
Irrigated farms (low pressure)
Product
Electricity
Water (Alqueva)
Primary Network
CO2
N and P emissions
Electricity
Electricity
N and P Fertilizers
Secondary Network (high pressure)
Irrigated farms (high pressure)
Product
CO2
CO2
N and P emissions
Emissions to air
Emissions to soil
Emissions to water


Environmental performance by stages (Sinistra Ofanto)
Environmental Impact Breakdown
Percentage (%)
100
75
50
25
0
WATER SUPPLY
Pumping Zone 1
Pumping Zone 2
Pumping Zone 3
IRRIGATION ZONE 1
IRRIGATION ZONE 2
IRRIGATION ZONE 3
Climate Change
Fossil Fuels Depletion
Freshwater Resource Depletion
Eutrophication
Human Toxicity
Acidification
Aquatic Ecotoxicity
Terrestrial Ecotoxicity
Respiratory Inorganics
Photochemical Ozone Formation
Mineral Depletion
Highcharts.com

Environmental performance by stages (Monte Novo)



Most relevant Eco-Efficiency Indicators (environmental weakness)

Sinistra Ofanto

- Freshwater Resources Depletion due to huge water supply and excessive pumping from aquifers;
- Climate change impact due to direct emissions from fertilizer and fuel consumption;
- Eutrophication of groundwater and surface water due to NO_3^- and PO_4^{3-} leaching.

Monte Novo

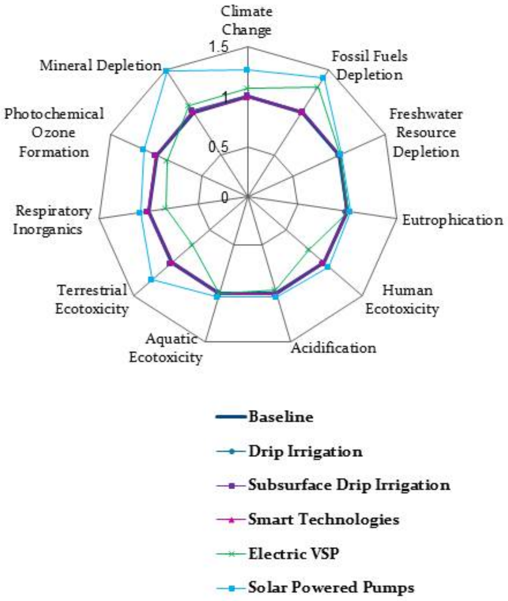
- Freshwater resource depletion, due to high amount of water abstracted for irrigation;
- Eutrophication, due to the use of fertilizers (N and P, foreground system);
- Aquatic eco-toxicity, due to the high characterization factor of nitrogen production in the background processes

Scenarios and corresponding technologies

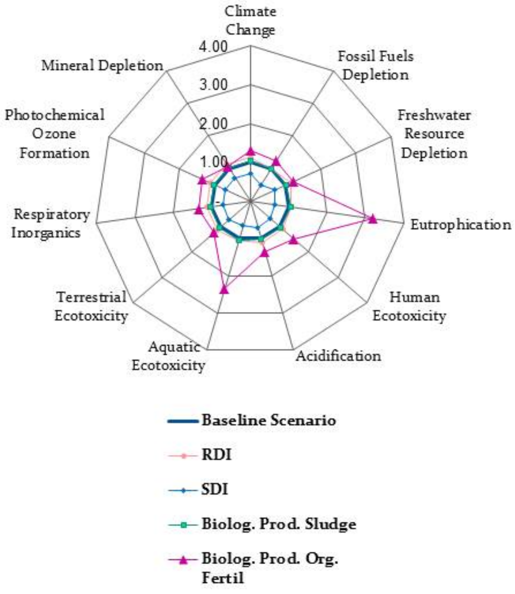
Scenarios	Technologies Sinistra Ofanto	Technologies Monte Novo
Scenarios ... towards Resource Efficiency	• Drip & Sub-surface drip Irrigation Technology • Smart Technologies for irrigation management	• Regulated Deficit Irrigation (RDI) • Sub-surface drip irrigation (SDI)
Scenarios ... towards Pollution Prevention	• Electric Pumps (On field) • Solar Pumps (On field)	• Use of Sludge • Use of Organic Fertilizer
Scenarios ... other	• New water tariffs	• New energy tariffs

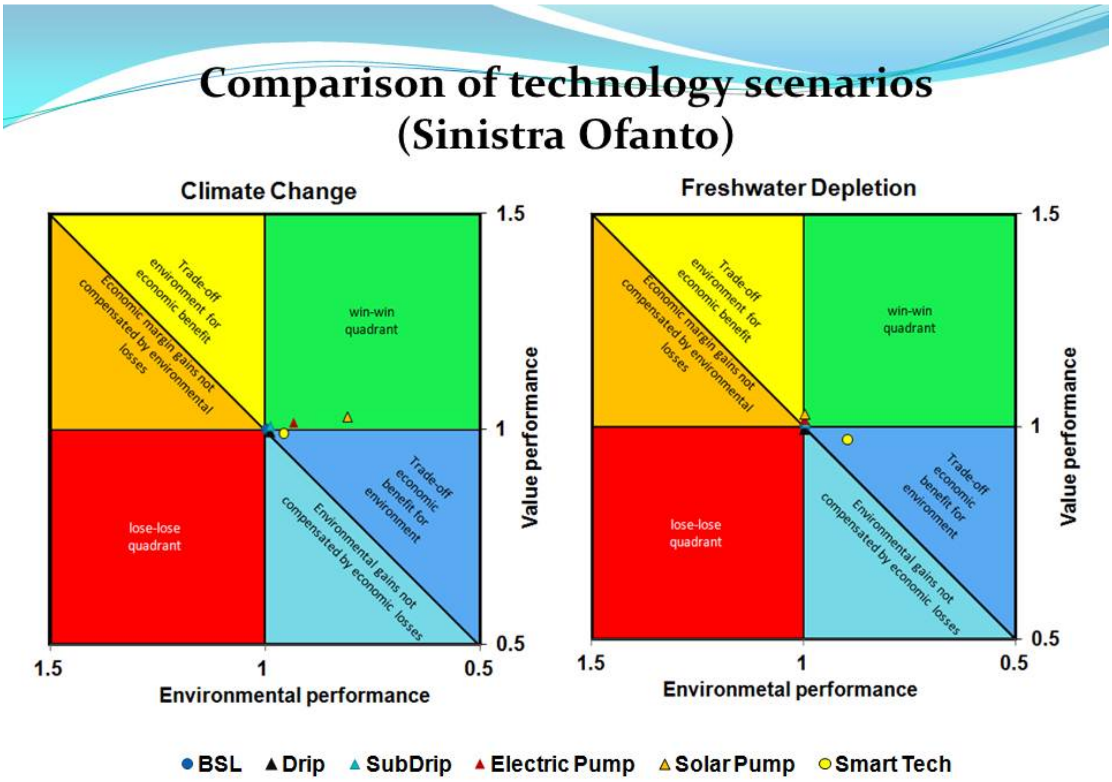
Eco-efficiency performance

Sinistra Ofanto

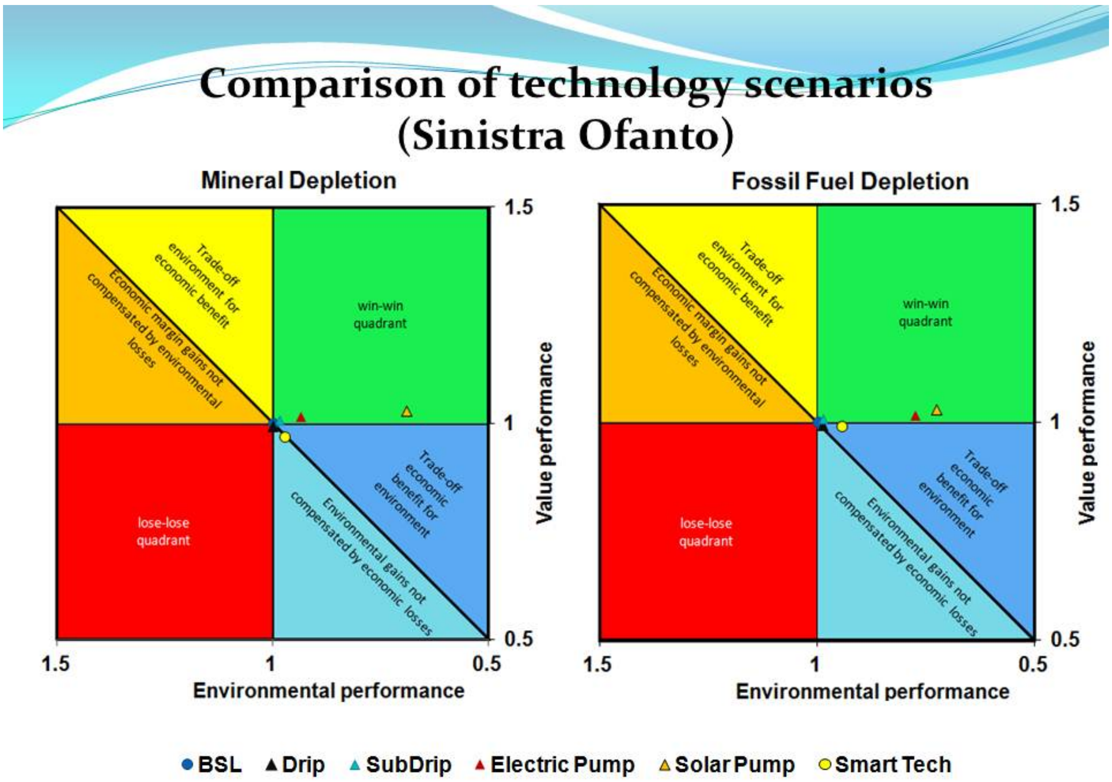


Monte Novo

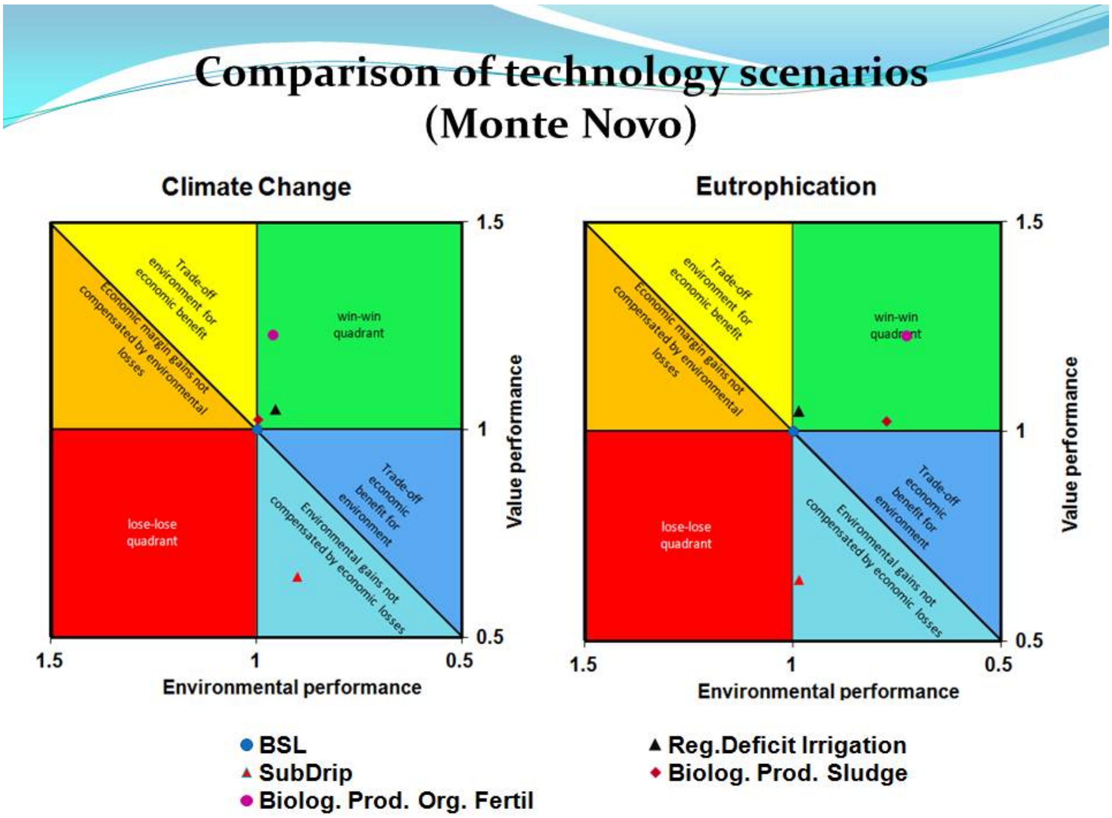


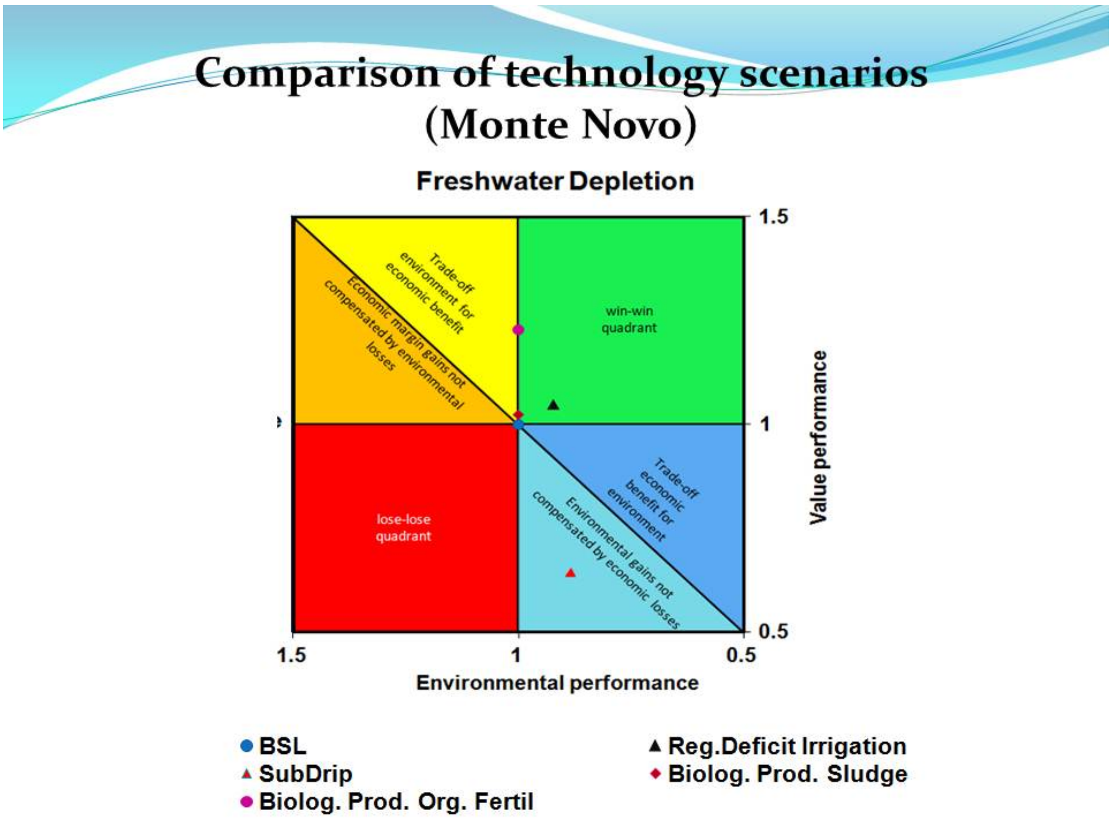


Comparison of technology scenarios
(Sinistra Ofanto)
Climate Change
Trade-off environment for economic benefit
Economic margin gains not compensated by environmental losses
win-win quadrant
lose-lose quadrant
Trade-off economic benefit for environment
Environmental gains not compensated by economic losses
1.5
1
0.5
Value performance
Environmental performance
Freshwater Depletion
Trade-off environment for economic benefit
Economic margin gains not compensated by environmental losses
win-win quadrant
lose-lose quadrant
Trade-off economic benefit for environment
Environmental gains not compensated by economic losses
1.5
1
0.5
Value performance
Environmetal performance
BSL
Drip
SubDrip
Electric Pump
Solar Pump
Smart Tech



Comparison of technology scenarios
(Sinistra Ofanto)
Mineral Depletion
Trade-off environment for economic benefit
Economic margin gains not compensated by environmental losses
win-win quadrant
lose-lose quadrant
Trade-off economic benefit for environment
Environmental gains not compensated by economic losses
1.5
1
0.5
Value performance
Environmental performance
Fossil Fuel Depletion
Trade-off environment for economic benefit
Economic margin gains not compensated by environmental losses
win-win quadrant
lose-lose quadrant
Trade-off economic benefit for environment
Environmental gains not compensated by economic losses
1.5
1
0.5
Value performance
Environmental performance
BSL
Drip
SubDrip
Electric Pump
Solar Pump
Smart Tech


Comparison of technology scenarios
(Monte Novo)
Climate Change
Eutrophication
Trade-off environment for economic benefit
Economic margin gains not compensated by environmental losses
win-win quadrant
lose-lose quadrant
Trade-off economic benefit for environment
Environmental gains not compensated by economic losses
Value performance
Environmental performance
1.5
1
0.5
BSL
SubDrip
Biolog. Prod. Org. Fertil
Reg.Deficit Irrigation
Biolog. Prod. Sludge


Comparison of technology scenarios
(Monte Novo)
Freshwater Depletion
Trade-off environment for economic benefit
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win-win quadrant
lose-lose quadrant
Trade-off economic benefit for environment
Environmental gains not compensated by economic losses
Value performance
Environmental performance
1.5
1
0.5
BSL
SubDrip
Biolog. Prod. Org. Fertil
Reg.Deficit Irrigation
Biolog. Prod. Sludge

Conclusions for Agricultural case studies
(Economic Performance)

- Economic benefits can change from year to year due to water input (main physical production risk) and market fluctuations (out of control of local stakeholders).
- Cropping pattern and cultivation should be focused more on qualitative aspects (i.e organic products which has higher market price and lower environmental impact).
- Costs of production and of investments and market variability are among the most important factors influencing innovation and technological uptake.
- No real and exact data about the quantities of by-products for proper assessment of TVA.
- Access to resources and support services may affect significantly components of economic performance.
- The application of new PAC can "motivate" farmers to adopt measures which are more efficient in the use of water in order to decrease the costs and increase the economic return.

Conclusions for Agricultural case studies
(Environmental Impacts)

- Environmental impacts change over time and space and depend on hydrological conditions (uncontrolled system, difficult to predict).
- Environmental impacts depend largely on cropping pattern, water availability and adopted management practices (water and fertilizer input).
- Farmer's behavior and capabilities affects substantially the component above.
- A composite set of meso-level EE indicators can help to understand and interpret complex agricultural water systems.
- Main environmental impacts are due to the background systems and the production of energy, fuel and agrochemicals.
- Four environmental impact indicators are particularly relevant: fresh water depletion, climate change, eutrophication, and fossil fuel depletion.
- Shifting to more clean technologies (e.g. smart irrigation technologies, electric/solar pumps, organic farming, sludge use) is a process which requires large societal, economic and political support.

Recommendations 1

- Adoption of combination of different technologies should be a must – requires a coordinated action and technical assistance to meet large scale water delivery issues and farm-specific situations.
- Promote the coordinated decision-making process based on stakeholder driven approach including all relevant actors (farmers and citizens, water user organizations, water authorities, policy and decision makers, investors, technology providers, etc.).
- Adoption of new policy instruments for a more equitable distribution of costs and benefits.
- Use of new measuring tools and models (like SEAT and EVAT with embedded life cycle approach) to generate, collect, and analyse data and compare scenarios of technology uptake within agricultural water systems.
- Benchmarking of "current situation" to identify weak stages and processes of the system and possible options for its enhancement including the quantification of the resource and cost saving options and the existence of eventual barriers for their implementation.

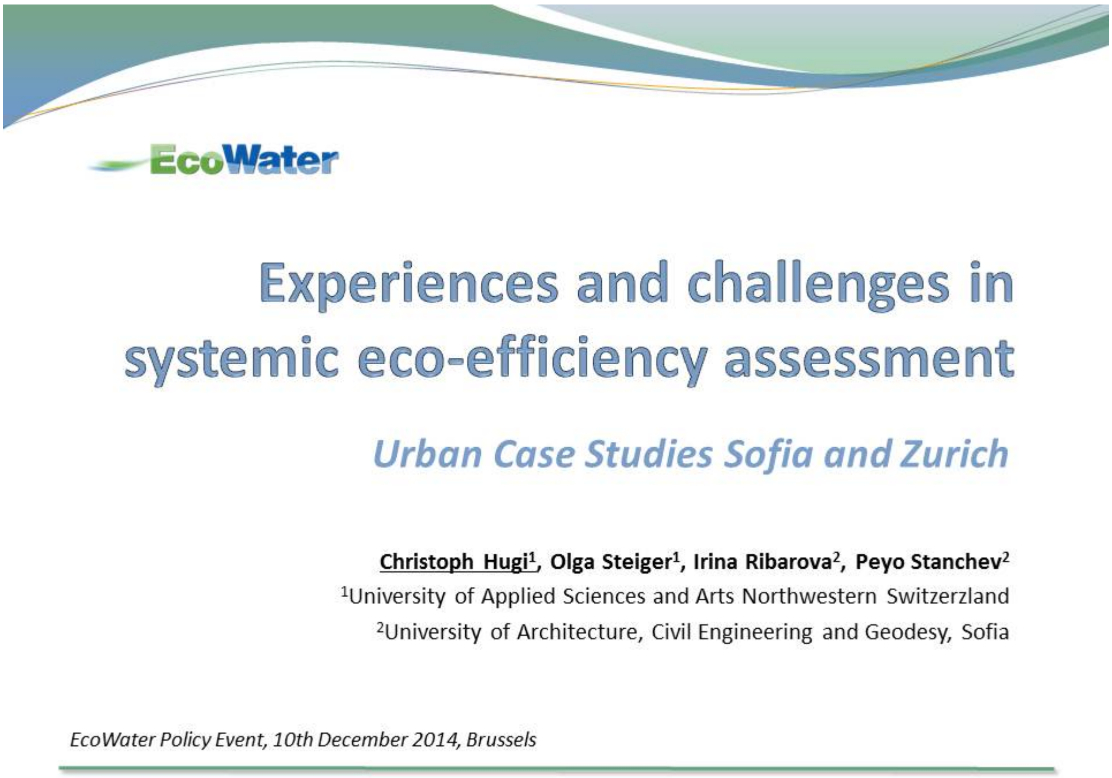
Recommendations 2

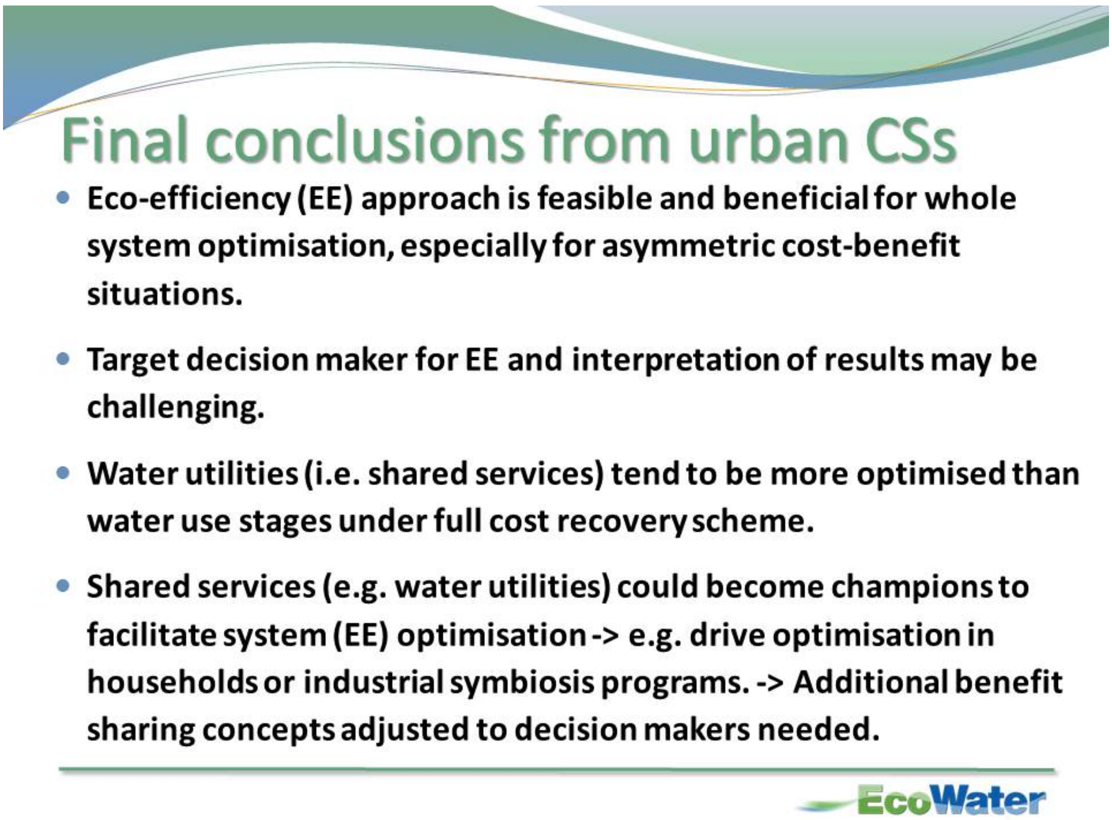
- Increase the flexibility for participations in commodity programs to respond to market signals and adopt environmentally sound production practices and systems, thereby increasing profitability and enhancing environmental quality in compliance with EU regulation.
- Create incentives for the farmers to adopt the best (environmentally friendly) management practices at farm level. Solution should be searched in water-energy saving technologies combined with organic types of fertilizers and adoption of zero-tillage where possible.
- 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.
- Design and promote the effective information and education programs on adoption of eco-efficient technological solutions at various scales. Sponsor demonstration activities, targeted workshops and roundtables to promote technology uptake.
- Use the knowledge systems and web platforms (as ECOWATER) to underpin the policy making process at the various levels of stakeholders and actors including regional environmental and water agencies, authorities and consultancy firms.

Thank you for your attention

For more information, see
http://environ.chemeng.ntua.gr/ecowater

Experiences and Challenges in Systemic Eco-efficiency Assessment - Urban Sector (Christoph Hugi)





Content

- Overview urban case studies
- Objectives and baseline
- Results for urban case studies
- Conclusions

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Overview urban case studies

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Urban case study Sofia, BG I

Case Study Area

General Characteristics

Location	Sofia, Bulgaria
Main Product	Water service
Annual Water abstracted	206,2 Mio m^3
Total Value Added	79 Mio €

Environmental characteristics

- Bigger freshwater intake due to high water losses in water distribution network
- Bigger freshwater intake due to inefficient water appliances
- Low energy efficiency

Economic characteristics

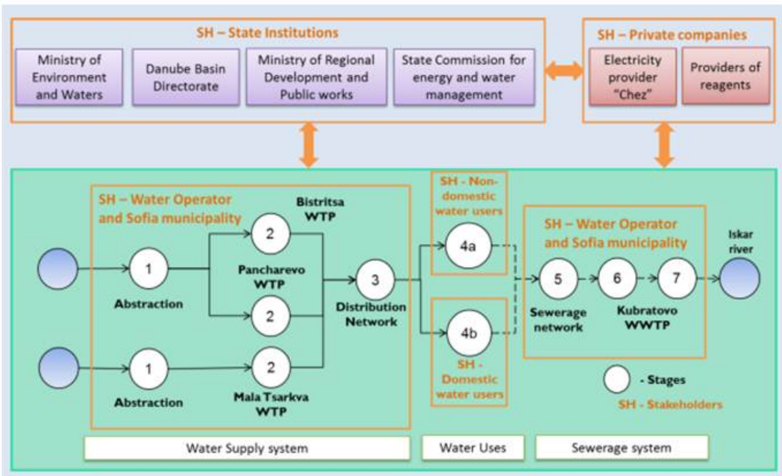
- Willingness to pay for water services
- Difficulties in estimation the TVA from non-domestic

Identified environmental weaknesses

- Freshwater Resource Depletion, due to water losses in the water distribution network and extensive amount of water used in households
- Climate change and fossil fuel depletion, due to sludge transportation
- Significant impact in most of the environmental categories, due to conventional energy production

Urban case study Sofia, BG II

Water services and use chain



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Urban case study in the Canton of Zurich, CH I

Case Study Area

General Characteristics	
Location	Waedenswil, Switzerland
Population	20,000 inhabitants
Annual Water Used	2.5 Mm^3 Surface and Groundwater
Total Value Added	2.5 Mio €/y 1.6 €/m^3 used

Environmental characteristics

- Water supply sources in the Canton of Zurich: mainly groundwater and lakes, partly spring water
- Lake Zurich as an important provider of raw water, especially for communities along the lakeside
- 62% of drinking water stems from the lake
- Applied waste water treatment in this area is technologically on an advanced standard

Economic characteristics

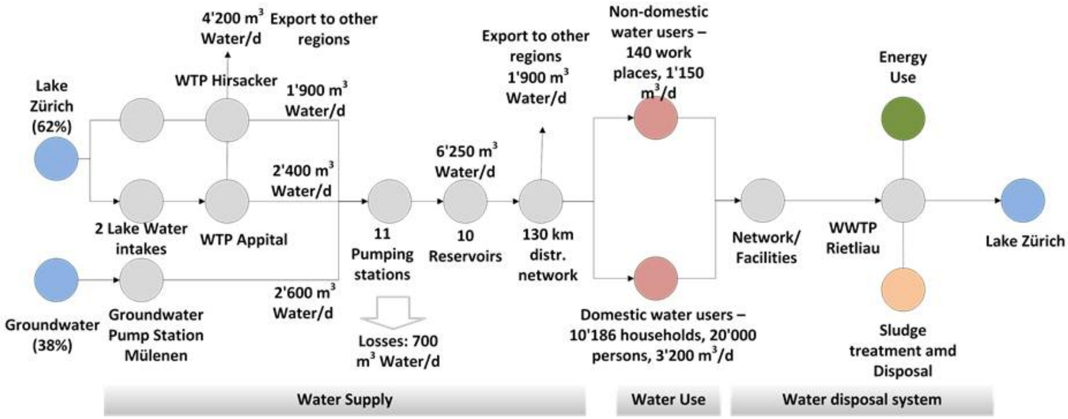
- Canton of Zurich is an economically important part of the country

Identified environmental weaknesses

- Climate change and fossil fuel depletion due to water heating with fossil resources such as gas and oil
- No measures to reduce micropollutants emissions
- Freshwater resource depletion, due to water use in households

Urban case study in the Canton of Zurich, CH II

Water services and use chain



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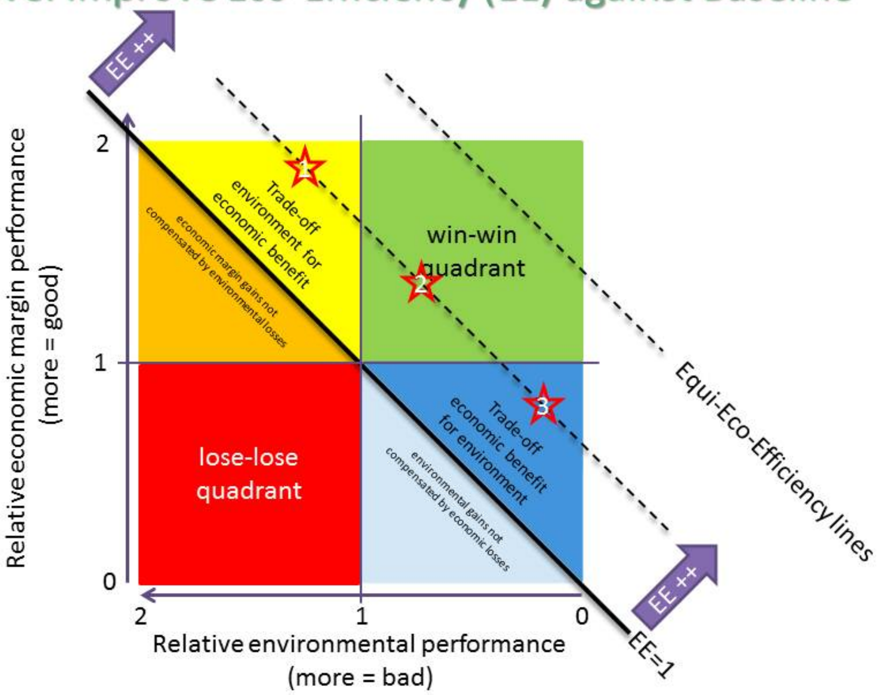
Objective and Baseline

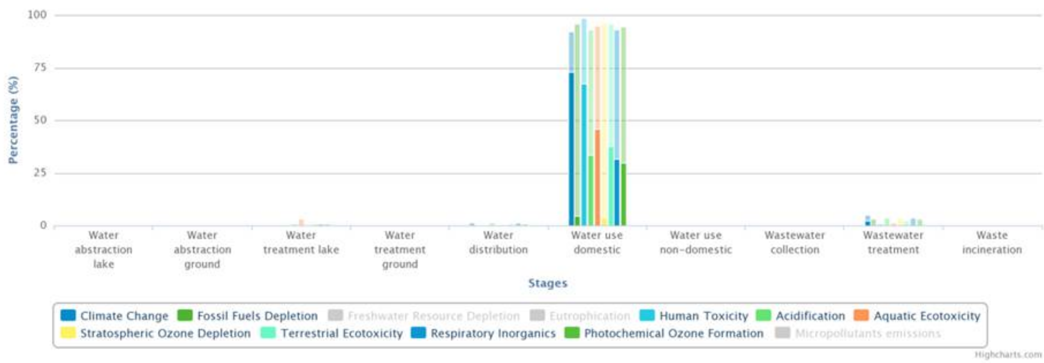
Objective: Improve Eco-Efficiency (EE) against Baseline



Environmental performance by stages

Main environmental impacts stem from water use stages ...

Example Zurich



... full cost recovery from fees has fostered optimisation in shared water services.

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Results for urban case studies

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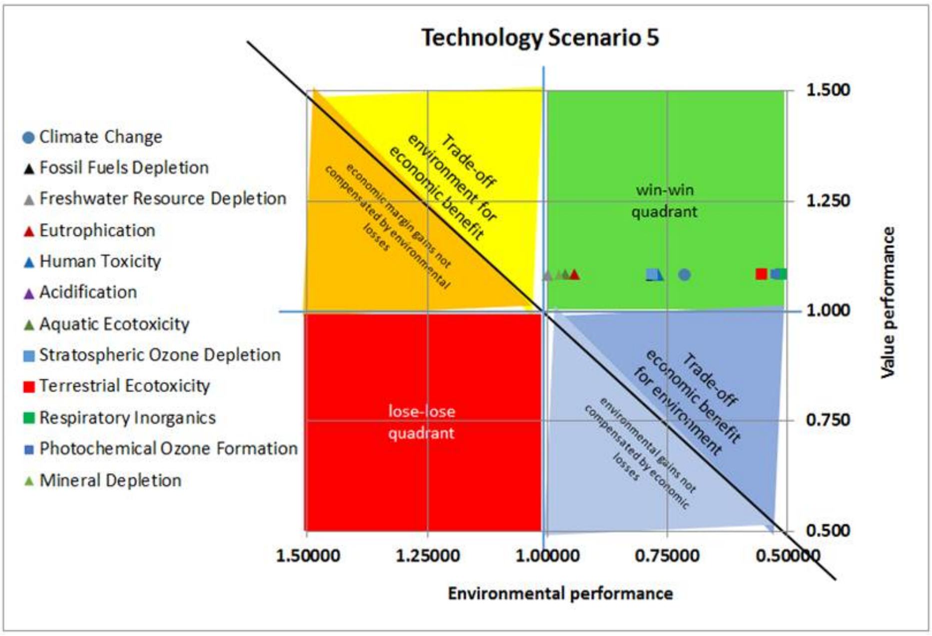
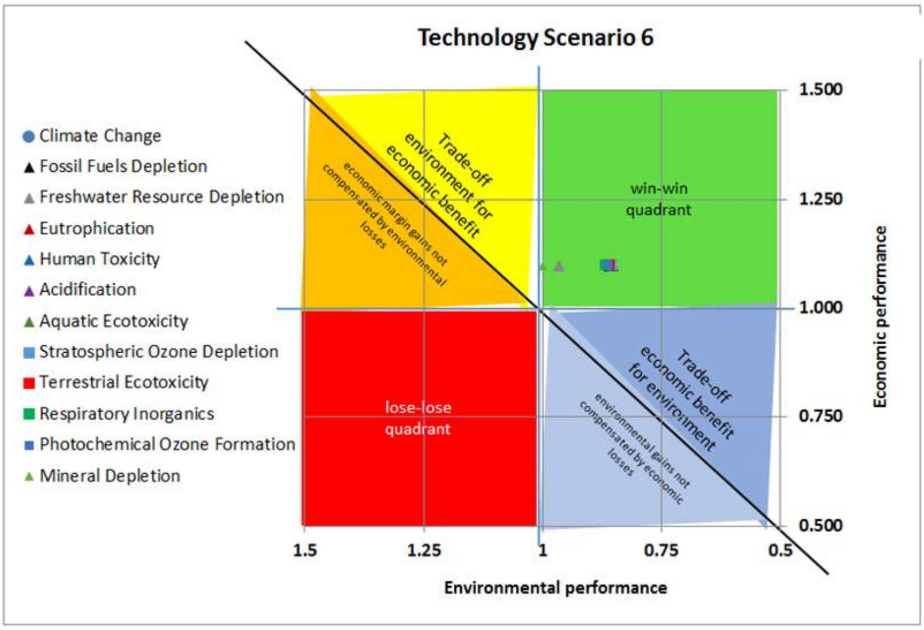
Studied innovative technologies in CS3 and CS4

Individual technologies	CS3 Sofia	CS4 Waedenswil
Stage: Water supply system		
Pressure reduction turbines	CS3 -T1	
Hydro power plant	CS3 -T2	
Smart pumping		CS4-T1
Stage: Water use		
Water saving appliances	CS3 -T4	CS4-T5, CS4-T6
Energy saving appliances	CS3 -T4	CS4-T6
Solar water heating	CS3 -T5	CS4-T7
Water reuse for domestic users		CS4-T4
Drain water heat recovery	CS3 -T6	
Stage: Sewerage system		
Solar sludge drying	CS3 -T3	
Advanced phosphorus recovery		CS4-T3
Micropollutants removal		CS4-T2

EE improvement of solar water heating in Sofia



EE improvements from water and energy saving appliances in Waedenswil



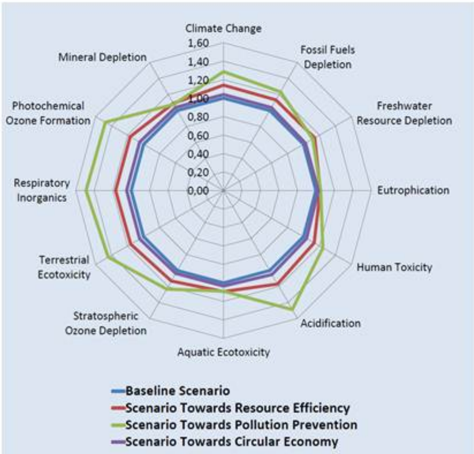
Scenarios and corresponding technologies

Scenario	Technologies CS3	Technologies CS4
Scenario 1: **… towards Resource Efficiency**	• Water saving appliances • Pressure reduction turbines	• Water saving appliances (cold water) • Water saving appliances (warm water) • Water reuse and recycling technologies
Scenario 2: **… towards Pollution Prevention**	• Water and energy saving appliances • Drain water heat recovery • Solar water heating • Pressure reduction turbines • Hydro power plant (before WTP)	• Water saving appliances (warm water) • Solar water heating • Micropollutants removal technologies • Smart pumping
Scenario 3: **… towards Circular economy**	• Solar sludge drying • Pressure reduction turbines • Hydro power plant (before WTP)	• Water reuse and recycling technologies • Advanced Phosphorus recovery

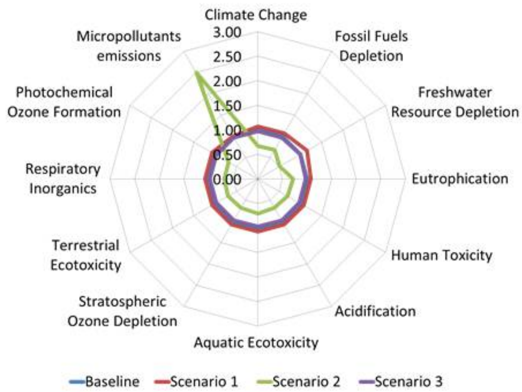
Eco-efficiency performance

Dominant technologies and scenarios preferred, …

Sofia



Zurich



… trade-offs and or non dominant solutions need additional decision criteria.

Conclusions for urban CS

Eco-Efficiency Indicator:

- Nominator - Economic benefit: Economic benefits can be difficult to estimate, but are important to guarantee long-term economic sustainability
- Nominator - Costs: To derive accurate costs is in general transparent for public but more difficult for private institutions
- Denominator - Environmental impact: Apply proven concepts: i.e. Life Cycle Assessment is the method to account for environmental impacts

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Conclusions for urban CS II

- **Aggregation of the different environmental impacts:** To support decisions in conflicting environmental impact results a weighting might be needed.
- **Interpretation challenges:** Eco-efficiency indicator depends on economic benefit minus cost margin changes and not on commonly applied costs per reduced impact metrics, i.e. not necessary least cost measures for reduction will be identified for different systems and measures might be eco-efficient in one system but not in another system that creates less margin.
- **A facilitator, or a price signal is needed to optimise the system:** The existing actors of the value chain will not make system-optimal decision on their own.

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Final conclusions from urban CSs

- **Eco-efficiency (EE) approach is feasible and beneficial for whole system optimisation, especially for asymmetric cost-benefit situations.**
- **Target decision maker for EE and interpretation of results may be challenging.**
- **Water utilities (i.e. shared services) tend to be more optimised than water use stages under full cost recovery scheme.**
- **Shared services (e.g. water utilities) could become champions to facilitate system (EE) optimisation -> e.g. drive optimisation in households or industrial symbiosis programs. -> Additional benefit sharing concepts adjusted to decision makers needed.**

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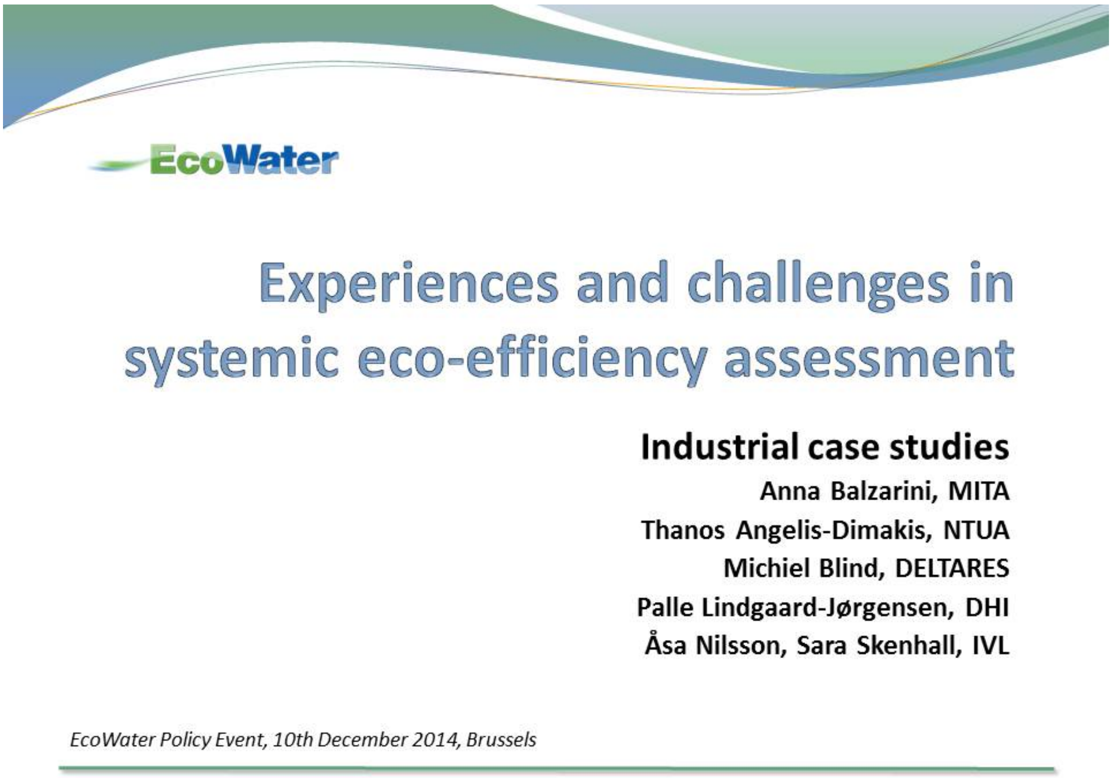
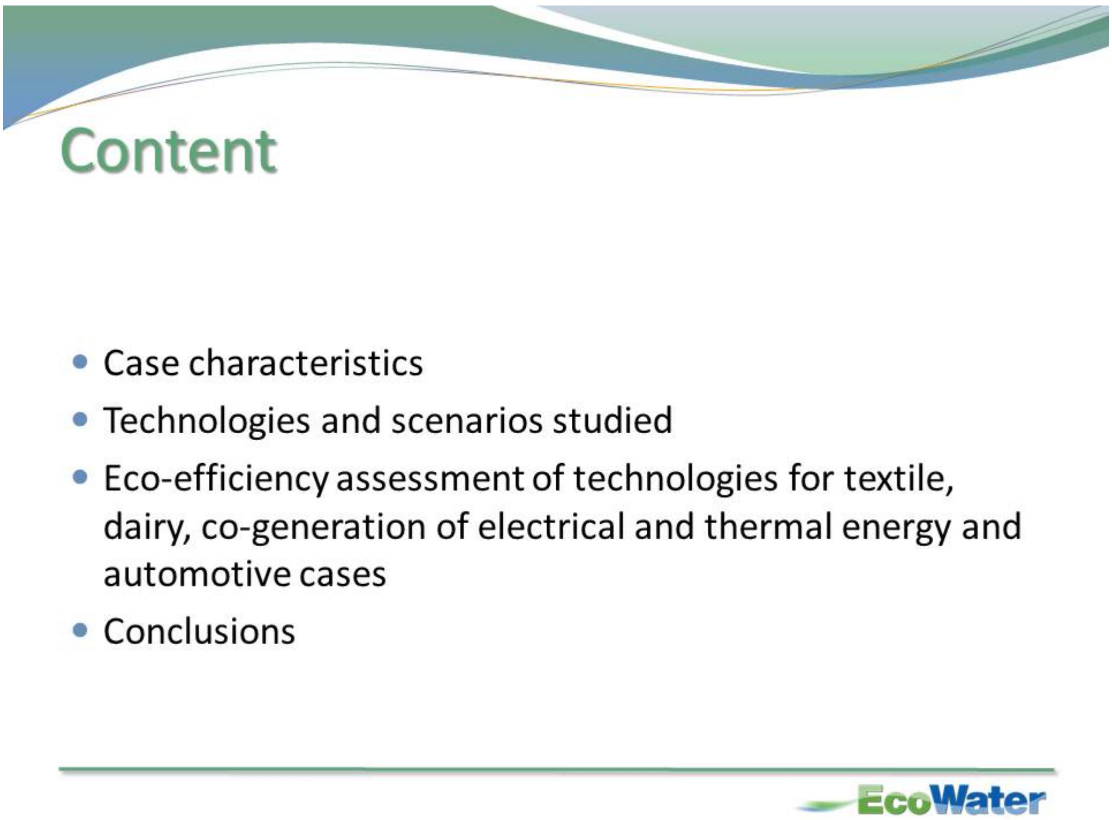
Thank you for your attention

For more information, see http://environ.chemeng.ntua.gr/ecowater

Experiences and Challenges in Systemic Eco-efficiency Assessment - Industrial Sector (Palle Lindgaard-Jørgensen)

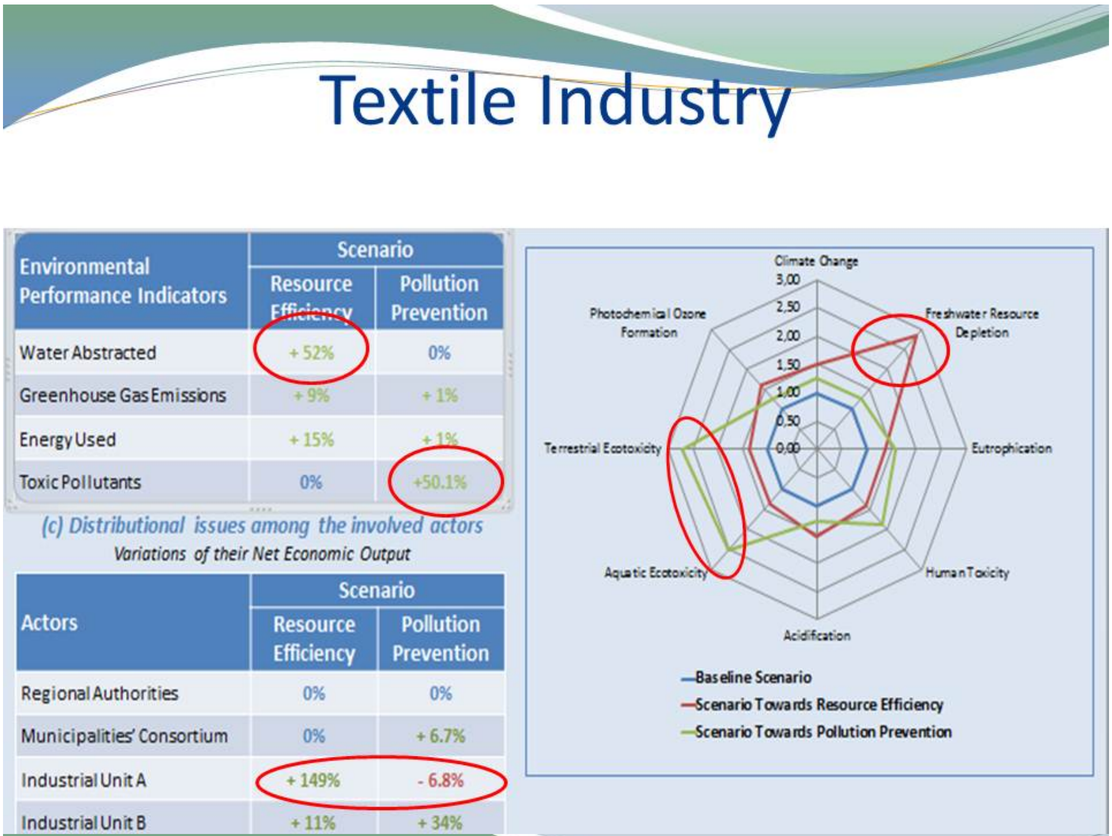




Charac-teristics	Textile	Co-generation of heat	Dairy	Automotive
Location	Italy, Biella	Nether-lands, Amsterdam	Denmark. Holstebro	Sweden, Umeå and Gothenburg
Main product	890 t /100 t chemically /naturally dyed wool	Thermal and electrical energy	17.000 ton Milk powder	30.000 Truck cabins
Main environ-mental issues	Water, toxic chemicals	Thermal pollution, air emissions, resource depletion, aquatic ecotoxicity	Water, climate gas emission	Water pollutants (phosphorus and heavy metals), energy use
Annual water used m3	1.700.000	65.000.000	531.000	405.000
value added €/m^3 used	18	1,35	57	71

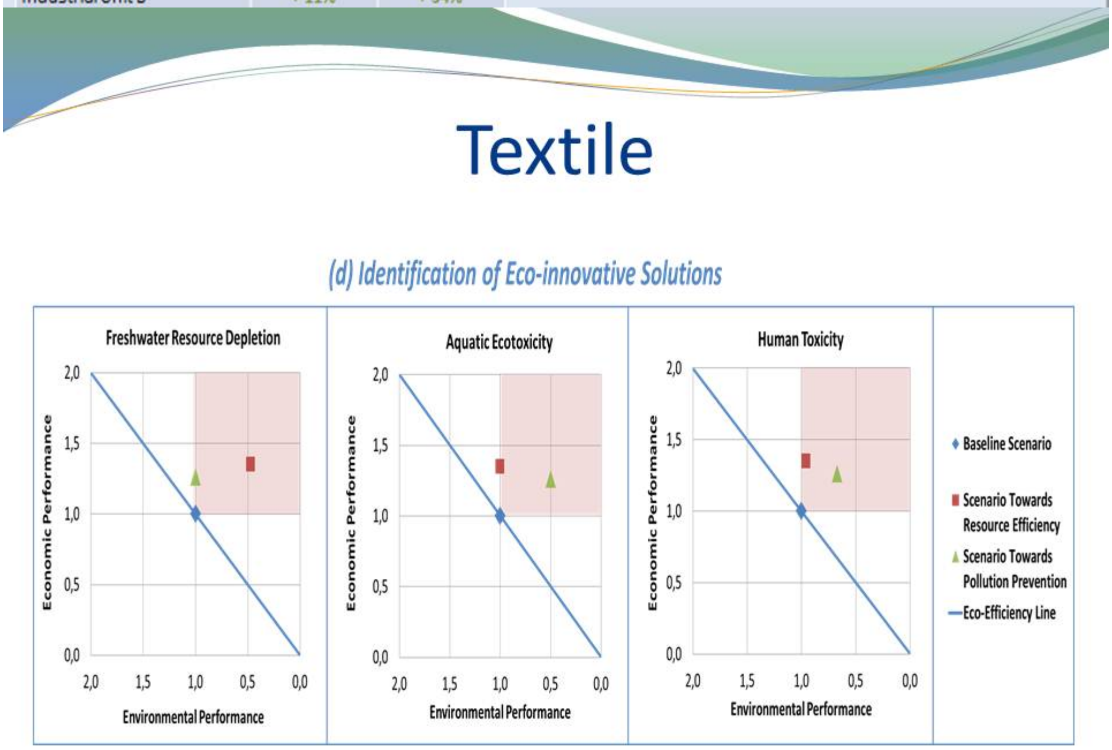
Industrial innovative technologies are sector specific

Textile	Co-generation	Dairy	Automotive
Smart Pumping Systems	Heat-only boilers	Product and water recovery from CIP	Silane-based corrosion protection
Automatic Dye and Chemical Dispensing	Thermal energy buffer	Cleaning and reuse of condensate	Recycling of process water and chemicals
Low-Liquor-Ratio Jet Dyeing Machines	Micro-Combined Heat-Power	Anaerobic digester	Membrane distillation
Use of Natural Dyes	Additional thermal energy users	Advanced oxidation and UV	
Advanced Oxidation Process	Potable water pre-heating		
Membrane Bioreactor			



Environmental Performance Indicators	Scenario	
	Resource Efficiency	Pollution Prevention
Water Abstracted	+ 52%	0%
Greenhouse Gas Emissions	+ 9%	+ 1%
Energy Used	+ 15%	+ 1%
Toxic Pollutants	0%	+50.1%

Actors	Scenario	
	Resource Efficiency	Pollution Prevention
Regional Authorities	0%	0%
Municipalities' Consortium	0%	+ 6.7%
Industrial Unit A	+ 149%	- 6.8%
Industrial Unit B	+ 11%	+ 34%

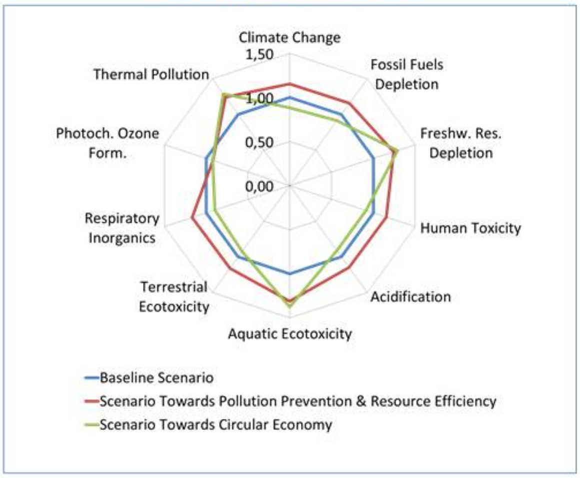


Co-generation of heat

(a) Environmental Performance Assessment

Environmental Performance Indicators	Scenario	
	Resource Efficiency & Pollution Prevention	Circular Economy
GHG Emissions	-11%	+3%
Natural Gas Use	-11%	0%
Thermal Pollution	-18%	-30%

(b) Eco-efficiency Assessment



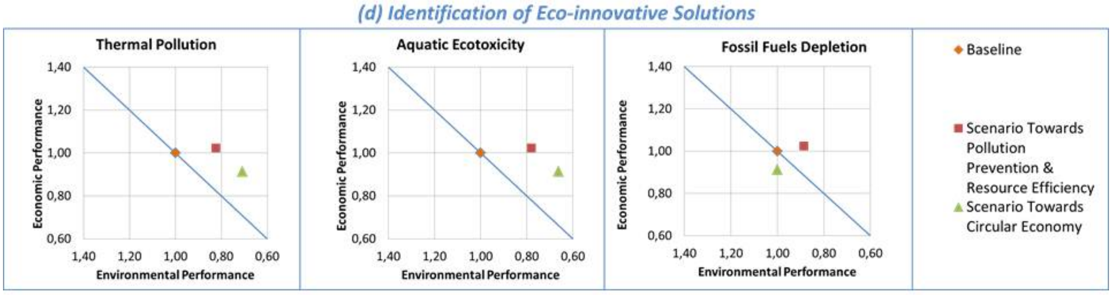
(c) Distributional issues among the involved actors

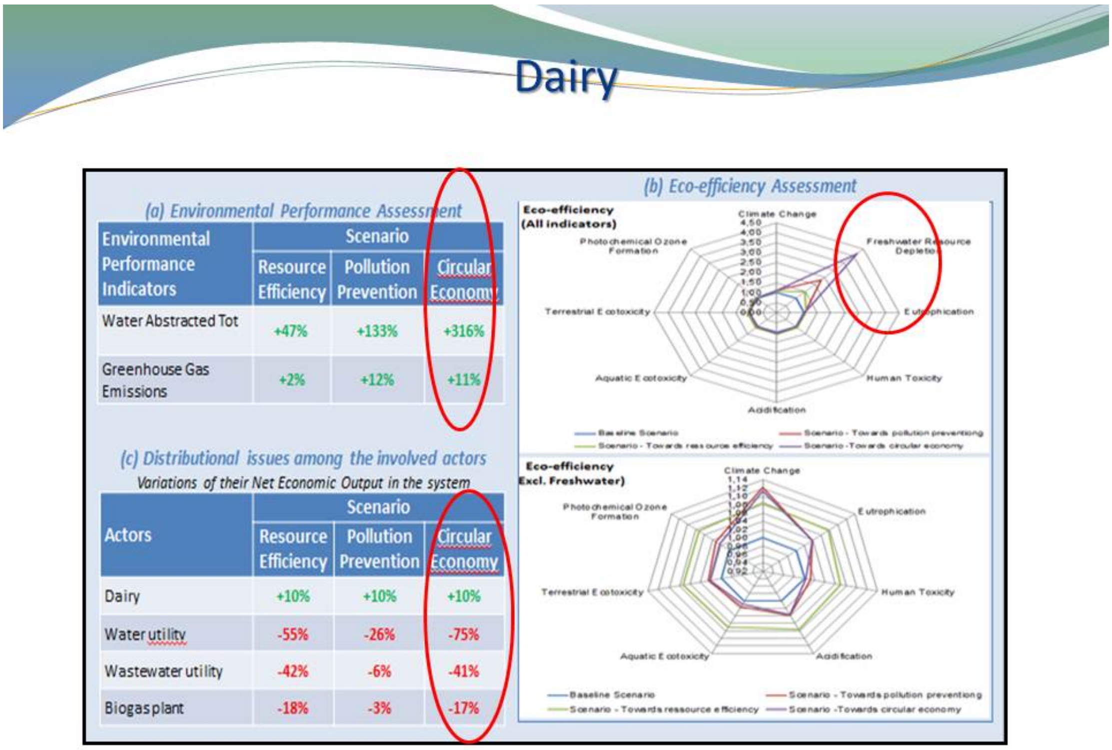
Variations of their Net Economic Output in the system

Actors	Scenario	
	Resource Efficiency & Pollution Prevention	Circular Economy
NUON Producer	+10%	-0,5%
NUON Retail	+2,3%	+6,2%
Consumers	0%	-11%

Co-generation of heat

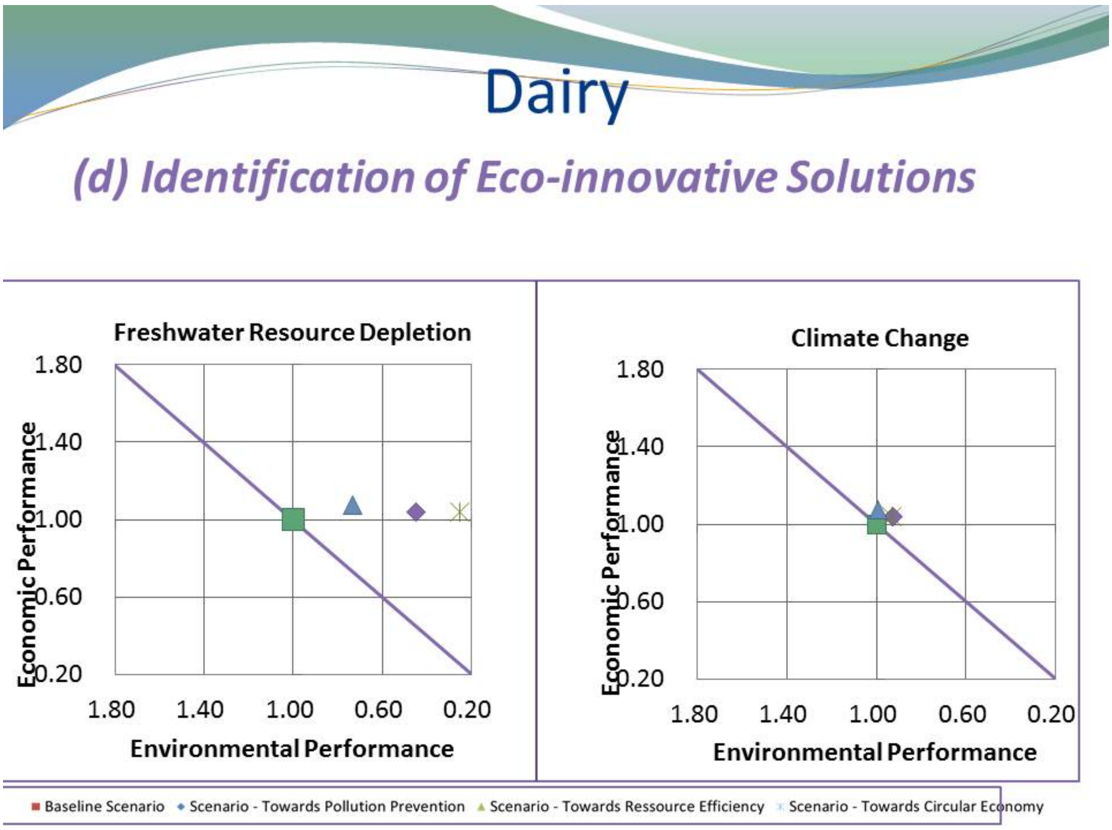
(d) Identification of Eco-innovative Solutions





Environmental Performance Indicators	Scenario		
	Resource Efficiency	Pollution Prevention	Circular Economy
Water Abstracted Tot	+47%	+133%	+316%
Greenhouse Gas Emissions	+2%	+12%	+11%

Actors	Scenario		
	Resource Efficiency	Pollution Prevention	Circular Economy
Dairy	+10%	+10%	+10%
Water utility	-55%	-26%	-75%
Wastewater utility	-42%	-6%	-41%
Biogas plant	-18%	-3%	-17%



Automotive

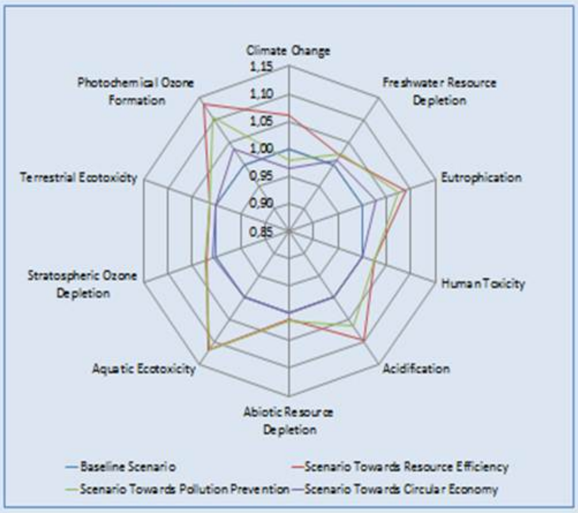
Table 1. Resource use	Scenario		
	RE	PP	CE
Water abstracted (process water)	-1.1% (- 16%)	-1.5% (- 22%)	-1.3% (- 19%)
Energy used	-2.8%	3.9%	4.4%
Phosphorus	-9.3%	-9.3%	0%
Ni and Zn	-11%	-11%	0%
Emissions	RE	PP	CE
Phosphorus	-4.7%	-4.7%	0%
Ni and Zn	-11%	-11%	0%
CO_2eq	-5.7%	2%	3.6%

(c) Distributional issues among the involved actors

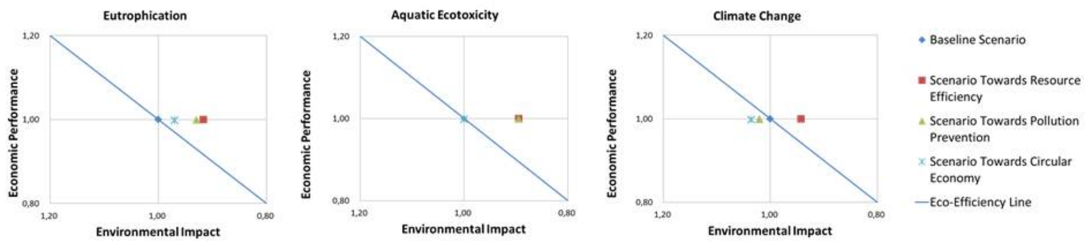
Variations of their Net Economic Output in the system

Actors	Scenario		
	Resource Efficiency	Pollution Prevention	Circular Economy
UMEVA	0%	- 12%	- 12%
Kretslopp & Vatten	- 57%	- 57%	0%
Volvo Trucks	+ 0.3%	+ 0.3%	+ 0.2%
Stena Recycling	- 57%	- 57%	0%

(b) Eco-efficiency Assessment



Automotive



Conclusions for industrial CS

- System boundaries- has been expanded in some case studies to include more stages and possibilities for technology scenarios (workshops with stakeholders were instrumental)
- The water use stages were the dominant contributors to both the total value added and the environmental impacts of the industrial water value chains studied
- The technologies which result in an increased Eco-efficiency in the water value chain are sector specific

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Conclusions for industrial CS II

- Combinations of technologies (scenarios) provide more eco-efficient solutions than single technologies
- Eco-innovative solutions were identified- with significant improvements in environmental performance and smaller improvements in economic performance.
- Economic performance was primarily improved for the industries- while suppliers of water and energy experienced losses.
- Industries understand «business cases and rate of return of investment» -need to be educated on the use of Eco-efficiency and total value added in decision making
- Eco-efficiency assessment may be particular relevant in analyses of circular economy like e.g. industrial symbiosis

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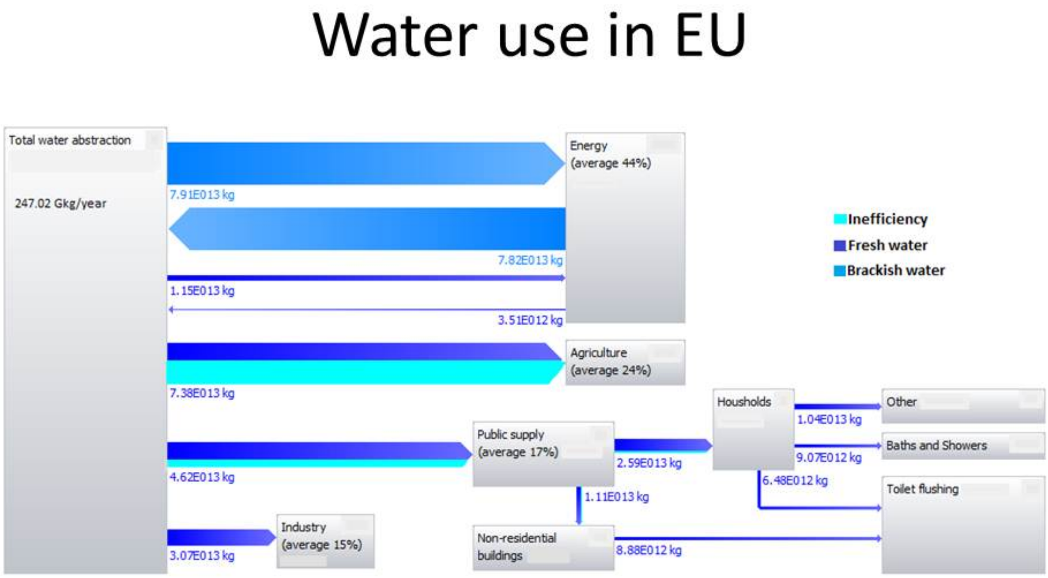
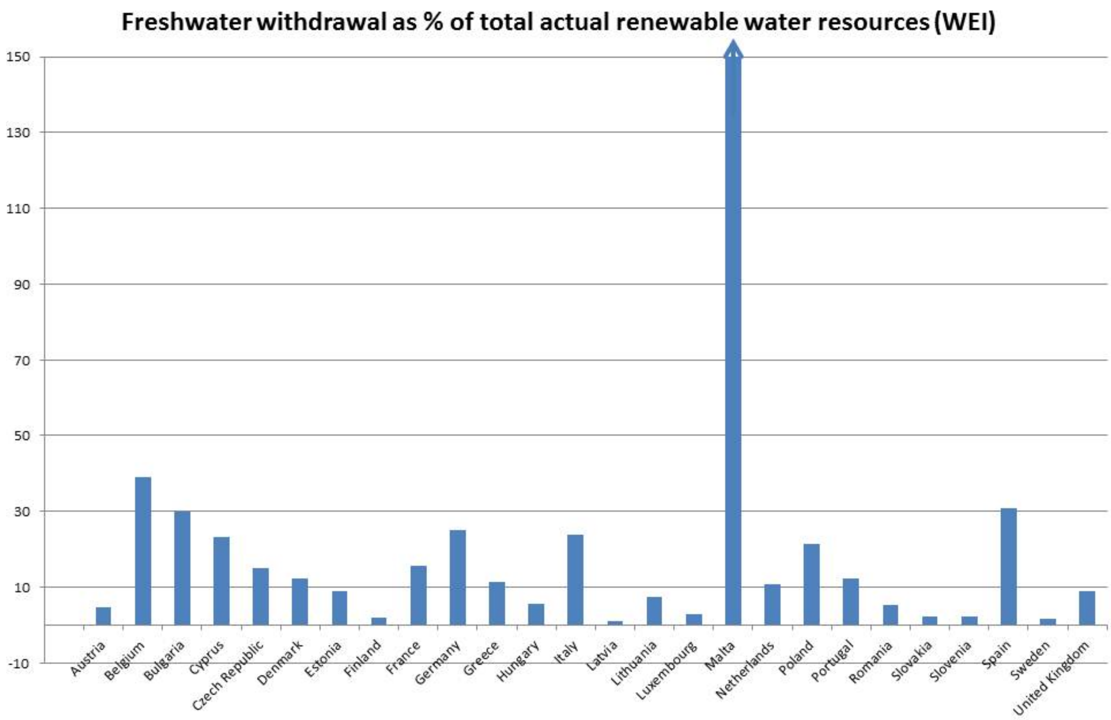
Thank you for your attention

For more information, see http://environ.chemeng.ntua.gr/ecowater

Water use in the EU across different sectors (Tomas Rydberg)





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