EcoWater

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

Science - Policy Brief No.1

Eco-efficiency in Agricultural Water Use Systems

The Project

EcoWater developed a methodology for the eco-efficiency assessment of meso-level water use systems and the assessment of the anticipated eco-efficiency improvements from the introduction of innovative technologies. The project methods and tools are applied in eight distinct water use systems for the agricultural, urban and industrial sectors.

EcoWater has fostered operational science - policy links with EU initiatives, policy actors and representatives from each sector interested in EcoWater results. Science Policy Briefs for each sector (agricultural, urban, and industrial) aim to link the available policy instruments in EU policies with eco-efficiency improvement through the adoption of innovative eco-efficient technologies.

EU Policy Framework

The Europe 2020 strategy promotes resource efficiency in several ways, setting objectives to be achieved in the near future, incorporated into the 7th Action Programme as priorities. One of the key priorities is the decoupling of economic growth from the use of resources. The objectives most relevant to the water use in agriculture are: (a) Resource efficiency, (b) Pollution prevention and (c) Circular economy. These can all be directly linked with eco-efficiency improvement, a key component of green growth and competiveness in several economic sectors.

Water Framework Directive

The WFD requires full-cost recovery, resulting in higher water prices which may deter the cultivation of water-intensive crops, e.g. maize and cotton. But more expensive water does not necessarily result in more resource-efficient farming practices, and nor does technological improvement per se. EU policy documents assume or imply that modern irrigation technology inherently increases water-use efficiency, so that the main task is to increase uptake of water-efficient technologies. If poorly managed, however, such technologies waste water and other resources; better farmers’ knowledge is essential.

The Common Agricultural Policy (CAP)

The CAP still lacks an overarching strategy addressing agriculture's resource efficiency and its impact on carbon, water and nutrient cycles; it should establish stronger incentives to reduce environmental impacts, according to the Environment Action Programme. At the national and regional levels, CAP criteria can provide economic incentives for resource-efficient practices. Green Direct Payments must comprise at least 30% of the national budget under the 1st pillar. 'Greening' criteria reward farmers for three obligatory practices – maintenance of permanent grassland, ecological focus areas, and crop diversification.

Nutrient cycles (nitrogen and phosphorus)

Agricultural improvement of the production requires *"further efforts to manage the nutrient cycle in a more cost-effective, sustainable and resource-efficient way, and to improve efficiency in the use of fertilisers"* (article 26 from 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'). Greening the CAP should make farmland ecologically more valuable. Biofertiliser can be used to avoid the nitrous oxide emissions from chemical fertiliser, reduce methane emissions from biowaste and build up soil organic matter. This helps to maintain fertility and retain moisture, thus potentially lowering water demand.

Experiences from Agricultural Case Studies

Given those EU policy aims, practical difficulties and ways forward are illustrated by the two EcoWater agricultural case studies, which have some common features. Many farmers (and their organisations) have invested in modern technology for greater water-efficiency, yet they do not gain the full potential benefits. Farmers lack the means to assess their actual irrigation efficiency, to see the link between resource-efficient practices and income, and to optimise the use of currently installed technology.

In Sinistro Ofanto, Italy

Many farmers apply greater amounts of chemical fertiliser than the crops need; the excess worsens leaching and eutrophication. Occasional water shortages have led farmers to withdraw groundwater from unauthorised wells, thus potentially depleting or degrading aquifers. 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 recommendations have no external validation and there are no systematic means for knowledge exchange.

In Monte Novo, Portugal

Irrigation services come from the expensive Alqueva Multipurpose Project, so the law has mandated a rise in water prices towards full-cost recovery by 2017. This may deter maize, as a water-intensive (and agrochemical-intensive) crop, but a price increase alone cannot stimulate more water-efficient practices. Although a network of meteorological stations exists in the area, relevant information is not available for irrigation planning and scheduling purposes; farmers' access to such information is still under development.

Innovative options were evaluated across the meso-level value chain, encompassing all resource loads from inputs and pollutants. The results indicated that the greatest eco-efficiency increase would come from replacing chemical with organic fertilisers, especially if combined with other environmentally favourable techniques such as low-till. Conversion to organic pastures and crops would offer even greater environmental benefits. The full economic benefit would depend on higher food prices through organic certification.

Policy Implications

Many policy measures could enhance farmers' capacities and provide incentives for the most eco-efficient management practices. In particular, farmer's education, Farm Advisory Service, CAP criteria etc.:

Farmers' education: Establish an effective education programme, e.g. through workshops and roundtables, to facilitate the uptake of better management practices. Give farmers information on more eco-efficient techniques and access to agro-meteorological data for daily water-use management. Learn from the experiences of similar services, e.g. in Emilia Romagna in Italy.

Farm Advisory Service: Strengthen such roles of field-level technical staff, farmers' associations, regional authorities and other public institutions, alongside DG Agriculture's programme for a Farm Advisory Service. Beyond specialist advisors, establish a knowledge-exchange system so that farmers can know their current water-use efficiency, can optimise the use of currently installed technologies and can realise their full potential benefits, thus incentivising further improvements.

CAP criteria: Remunerate practices such as building up soil fertility, substituting organic fertilisers, enhancing biodiversity and avoiding agrochemicals. Incentivise those practices through criteria for Green Direct Payments and Ecological Focus Areas, meant to improve biodiversity and maintain attractive landscapes.

Finance and markets: Improve access to loans for those willing to invest in eco-efficient practices. Increase loans' duration with lower rates, especially for innovations with long-term return on investment. Give farmers' associations easier access to organic fertilizers at a lower cost. Promote biological products to increase the demand and remunerate less resource-intensive cultivation methods.

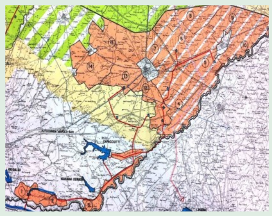
Whole-system cooperation: Facilitate discussions among all stakeholders in the water-system value chain. Carry out meso-level systemic assessments to identify better solutions and policy measures which can incentivise them.

Further Reading

This Science Policy Brief is drawn from the "Deliverable 5.11: Policy recommendations for technology uptake", which can be found at http://environ.chemeng.ntua.gr/ecoWater/.

Overview of Agricultural Case Studies

Sinistra Ofanto Irrigation Scheme, Italy



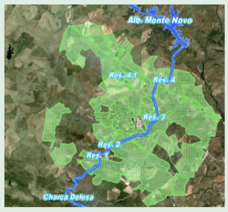
Important agricultural district and irrigation system, located within the Ofanto River Basin in the Apulia region. Irrigation demand in the Sinistra Ofanto area is increasing and the supply is no longer sufficient to meet demand under the conditions assumed at the design stage. Hence, the performance of the water delivery network is worsening, the system suffers from inadequate discharge and pressure, and irrigation pumps work out of their optimal efficiency range increasing energy consumption and the cost of agricultural products. Moreover, during peak periods, a restriction in water delivery is imposed. As a result, farmers abstract groundwater from the local wells, and surface water directly from the Ofanto River. The massive uncontrolled withdrawal of groundwater periodically causes excessive drops of the groundwater table, saltwater intrusion in the aquifers, and subsequently results in the use of salty water for irrigation with degradation of soil quality. Overall, the excessive exploitation of water resources causes reduction of water quantity and degradation of surface and groundwater quality, compromising ecosystem conditions. The application of conventional fertilizers and pesticides causes leaching of residues and degradation of soil and water quality. 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; and
- Conveyance by lifting and distribution by gravity.

The main directly involved actors of the system are:

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

Monte Novo Irrigation Scheme, Portugal



The Monte Novo Irrigation Scheme covers an area of 7,700 ha in the Évora and Portel municipalities of the Alentejo region, Southern Portugal. It forms part of the Alqueva Global Irrigation System, which has a total area of about 115,000 ha, and is still in the development phase.

Overall, the Irrigation Scheme forms part of the Alqueva Multi-Purpose Project (EFMA-Empreendimento de Fins Múltiplos de Alqueva), one of the largest investments ever made in Portugal, in order to support the economic development of one of the poorest regions of Europe. The EFMA is linked to the Alqueva reservoir (usable capacity of 3,150 hm^3), used to provide water to meet agricultural, urban, industrial and tourism demands. 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:

- The Alqueva Development and Infrastructures Company;
- The Association of Monte Novo Irrigation Scheme Users; and
- The local farmers.

Further information on the EcoWater Project

Collaborative

7th Framework Project

Project Duration:

01 November 2011 – 31 December 2014

Web-Link:

http://environ.chemeng.ntua.gr/ecowater

Consortium:

- ***National Technical University of Athens, Greece***
- ***Centro Internazionale di Alti Studi Agronomici Mediterranei - Istituto Agronomico Mediterraneo di Bari, Italy***
- ***Stichting Deltares, The Netherlands***
- ***Fachhochschule Nordwestschweiz, Switzerland***
- ***Universidade do Porto, Portugal***
- ***University of Architecture, Civil Engineering and Geodesy, Bulgaria***
- ***The Open University, United Kingdom***
- ***DHI, Denmark***
- ***IVL Svenska Miljoeinstitutet AB, Sweden***
- ***MITA Sas, Italy***

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

Science - Policy Brief No.2

Eco-efficiency in Urban Water Use Systems

The Project

EcoWater developed a methodology for the eco-efficiency assessment of meso-level water use systems and the assessment of the anticipated eco-efficiency improvements from the introduction of innovative technologies. The project methods and tools are applied in eight distinct water use systems for the agricultural, urban and industrial sectors.

EcoWater has fostered operational science - policy links with EU initiatives, policy actors and representatives from each sector interested in EcoWater results. Science Policy Briefs for each sector (agricultural, urban, and industrial) aim to link the available policy instruments in EU policies with eco-efficiency improvement through the adoption of innovative eco-efficient technologies.

EU Policy Framework

The Europe 2020 strategy promotes resource efficiency in several ways, setting objectives to be achieved in the near future, incorporated into the 7th Action Programme as priorities. One of the key priorities is the decoupling of economic growth from the use of resources. The objectives most relevant to the water use in urban systems are: (a) Resource efficiency, (b) Pollution prevention and (c) Circular economy. These can all be directly linked with eco-efficiency improvement, a key component of green growth and competiveness in several economic sectors.

In urban water systems, resource burdens and optimal improvements lie beyond the responsibility of any single actor in the value chain. A meso-level systemic assessment helps to identify eco-efficient solutions and policy measures which can incentivise those. An institutional facilitator may be necessary to stimulate multi-stakeholder discussions to find cooperative ways forward.

The quality standards policy is fundamental for increasing the eco-efficiency of urban water use systems. The formulation of water quality standards contributes significantly to the achievement of high eco-efficiency for water companies. The Waste Water Urban Treatment Directive (UWWTD), the Water Framework Directive (WFD) and the Environmental Quality Standards Directive address water quality issues in the European Union.

Water quality: trade-offs of micropollutants removal

The WFD requires Member States to maintain or achieve a "good ecological status" for surface water bodies by 2015 and introduced a single-substance approach defining a list of priority substances. Their removal has two different rationales: to lower health hazards, and to facilitate water reuse. A further Directive on environmental quality standards requires a "good chemical status" in drinking water through removal of priority substances.

Besides chemical substances, micropollutants removal is necessary as these pose uncertain hazards. Diverse substances vary in their effects, which are difficult to quantify. Conventional wastewater treatment plants do not remove micropollutants, 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. Conversely, as a benefit, effective removal of micropollutants would facilitate the safe reuse of water.

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

Under Switzerland's new Water Protection Ordinance, approximately 100 out of the country's more than 700 WWTPs must be upgraded to halve the currently discharged micropollutants. Any removal strategy depends on judgements about resource burdens and health hazards. Techniques such as activated carbon and ozonation have been adopted by some water agencies; many other techniques are still in the research or pilot phase.

According to the EcoWater assessments, activated carbon technology requires regularly operating materials and energy inputs, incurring significant resource burdens. These vary according to the specific type of materials and energy source. The resource burdens occur outside the water system, but should be attributed to it through a broader Life Cycle Impact Analysis (LCIA).

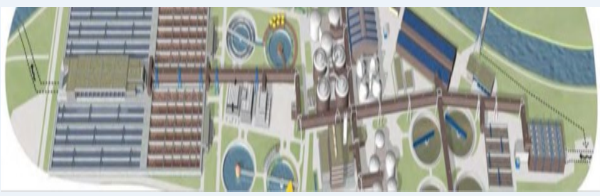
For all those reasons, micropollutants removal entails uncertain trade-offs between health benefits and resource burdens. To clarify these trade-offs, a policy needs to assess linkages between technology design, its resource burdens, environmental standards and health hazard reduction.

Phosphorus recovery: resource-efficiency benefits

To avoid eutrophication, the Urban Waste Water Treatment Directive (UWWTD) requires removal of phosphorus but not necessarily in a useable form. As phosphorus becomes more scarce, there have been initiatives for its recovery and reuse, alongside proposals for legislative requirements. The European Commission has held a public consultation on the sustainable use and recovery of phosphorus. Amongst the numerous questions posed:

"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?" (CEC, 2013, Consultative Communication on the Sustainable Use of Phosphorus).

Even prior to an EU policy, some countries have been setting requirements, and water companies have been investing in Phosphorus-recovery processes.



Zurich mono-incinerator plant for P-recovery, Morf, L. (2013) P-Strategie der Schweiz: Umsetzung am Beispiel des Kantons Zürich

Switzerland's new Waste Directive will require the recycling of phosphorus-rich wastes. Responding to the requirement, a decentralised wastewater treatment system is being replaced in Zurich with a more resource-efficient, larger-scale mono-incineration plant. The centralised sludge incinerator is now in place, and a process to recover phosphorus from the ash produced is being tested. The recovery technology is still in an evaluation stage; the ash will be stored until an economically viable technology can be found.

The EcoWater Case Study evaluated the Ash-Dec method, for which there is more extensive literature than for alternative methods. The results indicate that the recovery costs would be higher than the financial return to the water company. Given the country's already stringent water standards, phosphorus removal does not improve water quality. Resource burdens of removing phosphorous, as well as the environmental benefits of phosphorus reuse, occur outside the water system; any benefits are spatially remote. Therefore a phosphorus recovery policy should evaluate the wider environmental effects, involving stakeholders across the value chain, as a basis to justify specific technology standards, their benefits and costs.

Household water-use resource burdens

EU has general targets to reduce energy use and GHG emissions, which are not urban-specific. In the EcoWater urban case studies, household water use incurs the greatest resource burdens, especially from energy and water use, in the overall water-delivery system. Eco-efficient solutions are available in various water-efficient domestic appliances, which would be adopted on an individual household basis.

Their adoption, however, would reduce the income of the water company, which therefore has little incentive to encourage householders to make the investment. As a policy option, the water operator could introduce a differential tariff according to volume, thus providing incentives for households to adopt water-saving technologies. The water operator and users could jointly invest in technologies aiming at reducing water and energy burdens.

These issues should be discussed through stakeholder forums. No organisation represents householders' interests regarding improvement options, and there is no institutional forum for multi-stakeholder discussions. These representation gaps make finding ways to go forward more difficult; however, urban authorities could engage residents' organisations to participate in exploratory meetings.

Improving eco-efficiency

There is still considerable room to improve the eco-efficiency of urban water use systems through a number of (institutional or policy) actions, such as:

- Enforcement of synergies among involved actors;
- Enhancement of public participation in decision making;
- Integrated management for including infrastructure within urban spatial planning; and
- Financing strategic interventions.

Further Reading

This Science Policy Brief is drawn from the "Deliverable 5.11: Policy recommendations for technology uptake", which can be found at http://environ.chemeng.ntua.gr/ecoWater/.

Overview of Urban Case Studies

The City of Sofia, Bulgaria

A water system of ageing infrastructure (more than 100 years old), serving the capital and largest city of Bulgaria. The Case Study focus is on the wider Sofia metropolitan area (total area of 3,668 km^2), as delineated by the borders of the Upper Iskar river catchment.

The Iskar River is the longest river in the Bulgarian part of the Danube River Basin, with significant economic and environmental importance. The permanent population is 1,267,098 inhabitants (2008) but increases above 2,000,000 if non-permanent residents (students and workers) are included.

The average amount of water abstracted in the Upper Iskar basin is around 361 hm^3/yr. Only 6% of the water supply concerns groundwater, while the remaining 94% is abstracted from surface sources. Water resources are used for domestic water supply (54.6%), for industrial water supply (44.9%), for hydroelectricity production, for irrigation (0.5%) and for recreation. A series of water reservoirs have been built upstream, of which two are used for water supply: Iskar, the biggest water reservoir in the country (655.3 hm^3), and Beli Iskar (1.5 hm^3). The main directly involved actors of the system are:

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

The municipality of Waedenswil, Switzerland

The city of Zurich is a highly populated area in Switzerland with activities of substantial economic value. SMEs are an important part of this value creation and are financially affected by tightening legislation and water quality standards.

Drinking water in the area is provided by springs (20%), groundwater (40%) and lakes (40%). 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 was rebuilt in 2012 and is now equipped with modern membrane filtration technology, and the applied waste water treatment process is on an advanced technological standard.

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

Customers served: 9,100 households

The main directly involved actors of the system are:

- The Association of municipalities for water treatment;
- The Municipality of Waedenswil, responsible for water supply; and
- Domestic and non-domestic water users.

Further information on the EcoWater Project

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Science - Policy Brief No.3

Eco-efficiency in Industrial Water Use Systems

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EU Policy Framework

The Europe 2020 strategy promotes a shift towards a resource-efficient and low-carbon economy, which "will help us to boost economic performance while reducing resource use". In particular, "*stricter environmental targets and standards which establish challenging objectives and ensure long-term predictability, provide a major boost for eco-innovation*" (CEC, 2011, A Resource-Efficient Europe: Flagship initiative under the Europe 2020 Strategy).

The 7th Environment Action Programme centered on measures which can "*further improve the environmental performance of goods and services on the EU market over their whole life-cycle*" (EC, 2014, Environment Action Programme to 2020: Living well, within the limits of our planet).

Standards for Best Available Techniques (BAT)

The EU Industrial Emissions Directive provides a regulatory framework for enhancing resource efficiency as well as reducing pollution. "*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 EU, thus making a significant contribution to stimulating the development of innovative techniques, greening the economy and reducing costs for industry in the longer term*" (EC, 2014, Environment Action Programme to 2020: Living well, within the limits of our planet).

The BAT standards for each sector are outlined in a Reference Document on Best Available Techniques (BREF). The need to clarify standards is illustrated by the EcoWater case studies in two sectors.

Textile industry, Italy

"In order to improve their environmental performance, small and medium-sized enterprises (SMEs), in particular, require specific assistance with the uptake of new technologies…"(EC, 2014, Environment Action Programme to 2020: Living well, within the limits of our planet). The Small Business Act for Europe proposes actions to enable SMEs to turn environmental challenges into opportunities. The textile industry is a focus for less-polluting processes, supported by quality markets through environmental and social labelling.

All those policies are relevant to Biella SMEs which dye textiles. Some want to invest in more resource-efficient technology, but the sector has faced a major decline over the past decade. Many European companies have outsourced production to Asian plants using allergenic chemicals, and then import the cheaper fabrics to Europe. "Competitiveness" potentially means a race to quality deterioration .

Most Biella SMEs use synthetic dyes, which impose resource burdens on wastewater treatment. By contrast, Tintoria Quaregna has revived the traditional use of herbal dyes, which cost four times as much as synthetic ones. This process offers consumers a higher-quality product under its *Naturale* brand, the commercial viability of which depends on a higher price in distant specialty markets. These are limited, so the company uses herbal dyes in only a fifth of its production. The company applied to the EC's Eco-Innovation programme for a grant to strengthen markets for its *Naturale* brand, but evaluators commented that the production process was insufficiently innovative. This narrow focus on capital-intensive technology misses the company's institutional innovation in linking traditional techniques with novel markets.

Greater support is necessary for companies to adopt resource-efficient, less-pollution processes and to expand quality markets remunerating them.

Energy industry, The Netherlands

The "energy-water nexus" has become a perspective for identifying the mutual dependence of energy and water sectors. From a nexus perspective, reducing resource burdens "*requires full integration of policy objectives in the areas of sustainable water management, water policy and renewable energies*", argues the European Environmental Agency (EEA, 2012, Towards Efficient Use of Water Resources in Europe, Copenhagen: European Environmental Agency).

As for the energy industry, water saving is a priority and technically feasible. But it should be highlighted that a number of institutional or financial barriers hinder the implementation of water saving measures.

In energy production, saving water could be achieved if electricity & heat cogeneration is set at a higher-temperature condensing-point, then less water-pumping is needed for cooling and thus less energy input. But this benefit has a financial trade-off in generating less electricity, which has a higher price than heat. Also, different equipment would be necessary (new investment).

In summary, the "energy-water nexus" can be broadened to the energy-resource nexus in a water-service system, i.e. a system rendering water suitable and available for specific purposes. Energy-resource interactions can be mapped by a systemic analysis of resource burdens. The EcoWater project has developed a method to assess the systemic eco-efficiency of potential improvements through eco-innovation. The assessments have been the basis for multi-stakeholder discussion of options, trade-offs, incentives, benefits and decision-making responsibilities. Institutional support and national policy frameworks are needed to support productive synergies among water and energy systems.

Dairy industry, Denmark

The Arla dairy case study investigated several options; some would reuse water from within the plant process, e.g. by condensing water vapour and sterilizing excess water from milk. Those options would significantly 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 consumers. But the dairy 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.

Its current ongoing revision should clarify that, under appropriate conditions, the water in milk can be safely used to a high degree to replace freshwater intake. Several internal water streams in the dairy plant have low levels of contamination and so could be used outside the dairy, e.g. for irrigating, replenishing groundwater, etc. The dairy industry should be considered as 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 "maximisation of water reuse".

Motor vehicles industry, Sweden

For process improvements at Volvo Trucks, 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 a 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; the document has not been updated for many years. Consequently, the company remains uncertain about whether the authorities will accept the silane-based alternative as the 'best available' technology, and the future uncertainty may deter such investment. Clearer, updated EU standards would help to guide national regulators and reassure manufacturing companies.

Further Reading

This Science Policy Brief is drawn from:

- The "Deliverable 5.11: Policy recommendations for technology uptake", which can be found at http://environ.chemeng.ntua.gr/ecoWater/, and
- Levidow, L., 2014, Energy-Resource Synergies through Eco-innovation: Insights from a whole-system eco-efficiency analysis, 'Energy & Society', mid-term conference of ESA RN 12 (Environment), Krakow.

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Overview of Industrial Case Studies

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

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

Cogeneration Plant, Amsterdam, The Netherlands

The case study examines a river water system providing 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)

Production: 3,280 GJ Heat, 10,412 GJ Electricity

Dairy Industry, Holstebro, Denmark

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

Annual Water Abstracted: 0.59 Mm^3 groundwater

Production: 17 t milk powder

Automotive Industry, Umea & Tuve, Sweden

Two separate water value chains are examined, linked together by the industrial actor Volvo Trucks with 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

Further information on the EcoWater Project

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