REPORT
POST-CONFERENCE WORKSHOP @IWARR2019

VENICE (ITALY), SEPTEMBER 11, 2019
San Servolo, Room Theatre, h 14.00-18.15

"H2020 WATER INNOVATIONS FOR SUSTAINABLE IMPACTS IN INDUSTRIES AND UTILITIES"

SMART-Plant
nextGen Circular Water Solutions
European Commission
Project Ô
HYDROUSA

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Introduction

The workshop "H2020 Water Innovations for sustainable impacts in industries and utilities" was held within the 3rd IWA Resource Recovery Conference. The conference hosted over 300 water stakeholders and professionals from around the globe, who met in Venice to discuss and boost the impact of the latest scientific and engineering results, state-of-the-art technologies and eco-innovative solutions for sustainable treatment and recovery and reuse of renewable resources from the water cycle.

The "H2020 Water Innovations for sustainable impacts in industries and utilities" post-conference workshop was attended by over 70 delegates and invited stakeholders, representatives of water utilities, technology providers, policy makers, market segments and industries who agreed on potential impacts and results exploitability of large EU-funded innovation actions and discussed opportunities, barriers and challenges finally providing recommendations to be used as a vehicle for policy advice to competent EU authorities.

The main conclusions, collected in the final chapter of this report, include considerations on the importance and opportunity of digitalization of water solutions, demonstration of the water/energy/food and nutrients nexus, development of niche markets and overcoming legislative, regulatory and social acceptance barriers to deliver circular economy in water management sector.


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CONCEPT & AGENDA OF THE WORKSHOP

The post-conference workshop *"H2020 Water Innovations for sustainable impacts in industries and utilities" was* co-organised by EASME and H2020 innovation actions: projects **SMART-Plant, HYDROUSA, NextGen and Project-O**. The workshop intended to showcase the **concrete results and significant progress achieved by selected a**dvanced **Horizon 2020 water projects (IAs)** funded from the Societal Challenge "Climate Action, Environment, Resource Efficiency, and Raw Materials" (years 2015 to 2017).

The workshop was addressed to a target of utilities, researchers, water professionals, technology providers, policy makers, as well as market segments and industries outside of the water sector that can valorize the recovered resources.

Several platforms, key EU initiatives and water utilities and authorities' associations actively contributed to the event, as panellists of the pitching session and/or chairs and moderators of the breakout session.

The workshop was organized in 2 main sessions:

a. **pitching session**, where projects presented their water circular economy solutions to a panel of clients (utilities / industries) and stakeholders (e.g. regulators).

b. **breakout session,** to discuss the market uptake of the proposed circular economy solutions, seeking to address specific challenges but also to highlight opportunities, barriers and positive cases of exploitation.

The outcome of the event, in particular of the breakout session, is summarized in this report in as conclusions, which can be used for policy briefing.

AGENDA

Timing	Agenda item	Speaker
14:15-14:40	Welcome speech - Setting the scene	Evdokia Achilleos, EC-EASME
	Pitching session	
14.40-15.50	8 advanced projects to pitch their water circular economy solutions to utilities and stakeholders. A representative panel will ask questions and provide feedback at the end of each session Chair: Jos Frijns - nextGen	Projects ***INCOVER-*** https://incover-project.eu ***(Juan Antonio Alvarez - AIMEN)***

	Panel 1: Representatives from *EurEau (Bertrand Vallet), Water Alliance – NL (Hein Molenkamp) - CAP Holding (Davide Scaglione), VERITAS (Nicoletta Chiucchini), UTILITALIA/UTILITATIS (Valeria Garotta), SUEZ (Luca Pedrazzi), Severn Trent Water (Peter Vale),* ***Comments from panel 1*** Chair: Simos Malamis - HYDROUSA **Panel 2: Representatives from *WATER EUROPE (Andrea Rubini), Aqua Publica Europea (Margot Auvray), Alto Trevigiano Servizi (Matteo Tartini), SMAT (Gerardo Scibilia), Socamex (Natalia Alfaro) ESPP (Ludwig Hermann/ Chris Thornton)*** ***Comments from panel 2***	***SMART-PLANT*** - www.smart-plant.eu ***(Francesco Fatone - UNIVPM)*** ***HYDROUSA*** - https://www.hydrousa.org ***(Simos Malamis - NTUA)*** ***SALTGAE*** - saltgae.eu ***(Robert Reinhardt - ALGEN)*** ***nextGen-*** https://nextgenwater.eu ***(Jos Frijns - KWR)*** ***PROJECT-O*** - http://eu-project-o.eu/ ***(Ilaria Schiavi - IRIS)*** ***Water2Return*** - https://water2return.eu ***(Antonia Lorenzo, Bioazul)*** ***DWC*** https://www.digital-water.city/ ***(Pascale Raoult, KWB)***
15.50-16.00	Q&A	Audience
16.10-16.10	Introduction for breakout sessions	Evdokia Achilleos, EC-EASME
16.10-16.30	Coffee break	
	Breakout Session	Evdokia Achilleos, EC-EASME
16.30-17.40	Organised by thematically for discuss opportunities, barriers, challenges and policy recommendations in	All

	the market uptake of the proposed circular economy solutions. Proposed themes: 1) Water & Energy *(Moderators: SMART-PLANT - Francesco Fatone and EurEau – Bertrand Vallet)* 2) Water Reuse *(Moderators: Project O – Ilaria Schiavi and Water Europe -Andrea Rubini)* 3) Nutrient Recovery and Recycling (Moderators: *INCOVER – Juan Antonio Alvarez and ESPP – Chris Thornton*) 4) Bio-based Resource Recovery and Recycling *(Moderators: nextGen – Jos Frijns and Water Alliance- Hein Molenkamp)* *5)* Water-energy-food loops and their implications for water tariffs (*Moderators: HYDROUSA – Simos Malamis and Brunel University – Peyo Stanchev*) Discussions will be based on a story (preselected) from a project representative who will also moderate the table and collect main discussion points (2 rotations, about 35 min in each discussion group)	
17.40-18.05	Debriefing and points for policy and regulation brief (5 minutes per topic)	Group Moderators
18.05-18.30	Closing, voting and award for best pitch	Evdokia Achilleos, EC-EASME Francesco Fatone, SMART-Plant

PITCHING SESSION

Advanced projects pitched their water circular economy solutions to clients (utilities / industries) and stakeholders (e.g. regulators). A panel of representative clients /stakeholders has been selected. The panel asked questions and provided feedback to participants

PANEL 1

Chair: Jos Frijns – nextGen

Panelists: EurEau (Bertrand Vallet), Water Alliance – NL (Hein Molenkamp) - CAP Holding (Davide Scaglione), VERITAS (Nicoletta Chiucchini), UTILITALIA/UTILITATIS (Valeria Garotta), SUEZ (Luca Pedrazzi), Severn Trent Water (Peter Vale)

INCOVER (Juan Antonio Alvarez - AIMEN)

INCOVER has developed innovative and sustainable added-value technologies for a resource recovery-based treatment (TRL 7) using smart operation monitoring and control methodologies.

At demonstration scale, three added-value plants treating wastewater have been implemented and optimized to recover energy and added-value products.

INCOVER added-value plants will generate benefits from wastewater through the following three solutions:

1) Bio-production (bio-plastics and organic acids) via microalgae/bacteria and yeast biotechnology;

2) Near-zero-energy plant providing upgraded bio-methane via pre-treatment and anaerobic co-digestion systems;

3) Chemical recovery (N, P) and reclaimed water via adsorption, biotechnology based on wetlands systems and hydrothermal carbonisation.

Feedback from the panellists

Odour problems: nature-based solutions implemented in INCOVER have been validated properly without any kind of odour treating anaerobic processes digestate.

Stakeholder involvement: Different types of actions for stakeholder engagement have been carried out. The main important ones were: Innovation workshops for market up-take, Advisory Board meetings for improving INCOVER technologies implementation and Dialogue workshops for INCOVER product acceptance.

Surface issue: Several INCOVER technologies will be used as decentralised solutions due to their large surface demand.

SMART-PLANT (Francesco Fatone - UNIVPM)

SMART-Plant has been scaling-up in real environment eco-innovative and energy-efficient solutions to renovate existing wastewater treatment plants and close the circular value chain by applying low-carbon techniques to recover materials that are otherwise lost.

9 pilot systems have been optimized for 2 years in real environment in 5 municipal water treatment plants, including also 2 post-processing facilities. The systems were automated with the aim of optimizing wastewater treatment, resource recovery, energy-efficiency and reduction of greenhouse emissions.

Validated results: A comprehensive SMART portfolio of energy and carbon-efficient SMARTechs and resources comprising biopolymers, cellulose, fertilizers and intermediates has been recovered and are currently processed up to the final end-products for application in agriculture/ construction/ additives and chemical sectors.

Main challenges: create cross-sectorial value chains, scale-up and finalize long- term multidimensional validation in real environment, legislative and regulatory framework; quality and safety of the recovered resources: need to high refining or need to find niche market for sustainable products

Feedback from the panellists

Policy, legislative and regulatory framework: although policy is promoting circular economy in urban water cycle, legislative and regulatory framework are mainly managed at member states national level. Need to support policy at regional/national level, need of harmonization of sludge management best practice EU-wide. Need to quantitatively recognize environmental benefits and regulate the holistic costs

Business models: urban water services are highly regulated, that could result in being conservative, so innovation procurement is a major issue. Energy-efficiency can be good driver to enable materials recovery and reuse. No need to achieve highest quality standard of the recovered materials, need to find the best available consumer or industrial product. Need of economy of scale that can result from public-public or private-public partnerships.

ETV: water utilities are often not aware of this certification scheme. If end-users are not aware, they do not value such a certification

HYDROUSA (Simos Malamis - NTUA)

HYDROUSA demonstrates the implementation of low-cost, nature-based and other engineered solutions for the recovery of non-conventional water sources (wastewater, seawater, rainwater, vapour water) to be used in agriculture and for domestic use. The focus of the project is in Mediterranean, water scarce areas.

HYDROUSA is implemented through six demonstration case studies in three islands. In one of the demonstration sites anaerobic treatment (UASB) is coupled with a two-stage constructed wetland, filtration and UV disinfection to treat domestic wastewater at community level and deliver a final effluent that is used to fertigate an agroforestry field. The whole system is completely circular since energy is recovered from sewage and used locally, nutrients are recycled and the generated sludge together with the agroforestry and wetland biomass is composted. HYDROUSA has the potential to be replicated in different contexts and there is already interest from farmers, hotels and water utilities outside the consortium to implement such solutions.

Feedback from the panellists

The discussion with the panel focused on the involvement of stakeholders from the early stages of the project as well as on the development of value added products which could benefit the local economy. HYDROUSA places significant emphasis on both. Several of the solutions are implemented together with key stakeholders. Co-creation workshops help to integrate the view of the stakeholders within the design of the systems. Products of local origin and use will be developed and valorised within the project.

SALTGAE (Robert Reinhardt - ALGEN)

The treatment of saline wastewater in presence of organic content represents a challenge for many industrial sectors. SaltGae has developed and demonstrated a techno-economically viable solution for the treatment of saline wastewater and valorisation of effluents (algae-based coatings, filers added to natural rubber, animal feed, extraction of lipids).

Among the main results: solutions to increase energy efficiency; algae replacing antibiotics in piglet feed; two stage anaerobic digestion in high salinity; algal WW treatment (just another case, but many are required before a routine solution will be achieved – salinity, wastewater & biogas are all important for biofuels – but relatively far future); Algal biomass successfully grown on excess water from food industry.

Feedback from Panellists

Panel discussion was focused on various marketing activities related to the technologies developed in scope of SaltGae and other projects.

PANEL 2

Chair: Simos Malamis – HYDROUSA

WATER EUROPE (Andrea Rubini), Aqua Publica Europea (Margot Auvray), Alto Trevigiano Servizi (Matteo Tartini), SMAT (Gerardo Scibilia), Socamex (Natalia Alfaro) ESPP (Ludwig Hermann/ Chris Thornton)

PROJECT-O (Ilaria Schiavi - IRIS)

Project Ô champions an integrated approach to water management that focuses on small loops of water management. It brings close to market new, flexible technologies for used water treatment but also provides planning and consultative instruments to allow their successful implementation in a water system. The objective of the project is to make sure that the technologies and the new loops they enable have the highest acceptability by all stakeholders – from planners to citizens to businesses adopting them.

Project Ô focuses on the small scale looking at opportunities for circularity deriving from small loops:

- Looking at whatever water is available in a location (rather than just the mains' water) matching it to the requirements for the application with or without treatment, to avoid overengineering

- Small loops equals to small volumes and small, affordable plants with light touch infrastructure intervention (low capex), to enable SMEs to invest but also developing mobile plants suitable for emergency interventions or to be used on an ad hoc basis (service provision). Many technologies exploit sunlight; all of them will be accompanied by an LCA and a cost estimate analysis.

- The new technologies are suitable also for problematic waters to support existing traditional water treatments; with an advanced control unit we consider for example the level of biodegradability of the water to deploy advanced technologies only if required to ensure the traditional microbiological treatment can cope with it (advantage also for water utilities)

As the approach is different, new tools for the decision makers are provided on a spatial planning and water resource use planning level; furthermore, the economic advantages deriving from recovering water and the compounds it carries become clear to the companies implementing such loops through the decision making platform. Potential regulatory instruments such as dynamic tariffing are also explored.

Feedback from the panellists

Photocatalytic technology: slit accumulation. The Project Ô technologies are built to be integrated with existing commercial technologies e.g. filtration to cope with similar issues.

Small plants: the management of small plants is an issue for water utilities in terms of resource effort, this is to be considered e.g. through automation of operation for example.

Water reuse issue, the view of the stakeholders: communication is key and we have found that using synonyms to "waste"water may help in improving acceptability of the concept.

nextGen (Jos Frijns - KWR)

NextGen aims at demonstrating innovative technological, business and governance solutions for water in the circular economy in ten high-profile, large-scale, demonstration cases across Europe.

The project will assess, design and demonstrate a wide range of water-embedded resources, including water, energy, materials (e.g. nutrients). In particular, NextGen will develop the necessary approaches, tools and partnerships, to transfer and upscale.

As an example, the NextGen sewer mining demo case in Athens was pitched. At an urban tree nursery, a modular mobile sewer mining unit (MBR and UV) extracts and treats wastewater from the sewer to be reused for irrigation. This solution is part of an overall approach to integrate water in the circular economy of cities. It also has a large replication potential to reuse wastewater from sewers at the point of demand, e.g. for park irrigation, street cleaning, process water for industry.

Feedback from the panellists

In the discussion with the panel, the importance to include operators from the start of planning for the sewer mining unit was stressed. NextGen indeed involves the operators from the water company and other stakeholders (municipality, regulators) through Community of Practice meetings. These Community of Practices could work as a kind of Living Lab, not only to co-develop the technology, but also to test supportive governance conditions.

Water2Return (Antonia M. Lorenzo - Bioazul)

Water2REturn aims to promote the recovery and recycling of nutrients present in the slaughterhouse wastewater by turning the treatment plants into bio-refineries and producing high added value products for agriculture: one liquid organic fertiliser and two biostimulants.

Water2REturn addresses water scarcity, circular economy approaches and industrial symbiosis as the base of business opportunity creation among different sectors: i) Wastewater treatment and energy engineering and consultancy companies, ii) Manufactures of fertilizers and biostimulants and iii) Slaughterhouses and meat industry.

Water2Return solution will be demonstrated in a real case study: "Matadero del Sur", a slaughterhouse in Andalusia region, Spain. A plant of 50 m^3/day treatment capacity is being installed

consisting on: one integrated wastewater treatment + nutrients & energy recovery system with three separated process units (water line, sludge line, algae line) and energy recovery module.

Main advantages of Water2Return system is its modularity, that allows the design of tailor made offers for the clients based on their needs, and its flexibility and replicability to be adapted to other food industries.

The expected impact foreseen is the application of a new business model aligned with the Circular Economy objectives, promoting industrial synergies and reducing the environmental footprint of the wastewater treatment process and the manufacturing and use of fertilizers and biostimulants

Main challenges of the project are associated to the legal framework as wastewater reuse and biobased fertilizers regulations are being revised, the economic viability and the end users acceptancy.

Feedback from the panellists

The pilot is being installed and no results are available at this stage. The panellists had interest on the parameters to be checked, especially with regards to emerging pollutants. Another question was about the area needed for the algae treatment proposed system.

DWC (Pascale Raoult - KWB)

DWC's main goal is to boost the integrated management of waters systems in five major European cities – Berlin, Milan, Copenhagen, Paris and Sofia – by leveraging the potential of data and smart digital technologies. Under the leadership of Kompetenzzentrum Wasser Berlin gGmbH (KWB), 24 partners from 10 European countries will develop and demonstrate the benefits of a panel of innovative digital solutions to address major water-related challenges. These include the protection of human health, the performance and return on investment of water infrastructures and the public involvement in urban water management. The main focus in Milan is the achievement of safe waste water reuse and efficient distribution for agricultural irrigation. An early warning system will be develop to assess the risk of contamination from water reuse; innovative drones will be used to monitor water stress and a serious game will be proposed to visualize and communicate to a wide audience the water-energy-CO2-nexus

Feedback from the panellists

Since the project DWC just started, there was no comment on project results but a high interest from the panellists in the solutions tested and demonstrated in DWC. Panellists were highly interested in following the project and its results. They asked about the project awareness regarding cybersecurity and interoperability issues for the utilities. This topic is crucial and a central pillar of DWC. It is addressed in a dedicated work package leaded by SINTEF (also project coordinator of STOP-IT). The aim is to ensure that the flow of information within DWC is secured and interoperable and that DWC solutions are designed and developed in a way in which data and information are protected

from unauthorized access. There were questions concerning risks due to the use of unvalid data to take automatical decisions. In DWC indicators (KPIs) are set to evaluate the performance of the digital solutions. Crucial KPIs are on false positive / false negative evaluation and impact on the different systems. DWC is aware about data validation. There is no global strategy on that topic because data validation depends on sensors, issues and risks of single solution. It is considered individually in each city and will be integrated in the Data Management Plan of the project.

Best pitch award to: SMART-Plant, Francesco Fatone – UNIVPM.

BREAKOUT SESSION

The breakout session aimed to discuss opportunities and challenges in the market uptake of the proposed circular economy solutions.

The session was chaired by Evdokia Achilleos, senior project adviser of the Executive Agency for Small and Medium-sized Enterprises (EC-EASME).

Based on the priorities and interests of participants, five thematic areas were set up and attendees joined groups around the themes.

The themes were:

1) Water & Energy (Chair: SMART-PLANT and EurEau)

2) Water Reuse (Chair: Project Ô and Water Europe)

3) Nutrient Recovery and Recycling (Chair: INCOVER and ESPP)

4) Bio-based Resource Recovery and Recycling (Chair: NEXT-GEN and Water Alliance NL)

5) Water-energy-food loops and their implications for water tariffs (Chair: HYDROUSA and Brunel University)

Each group was asked to provide their views and insights about selected projects and to highlight the opportunities, strengths, weaknesses and threats vis-a-vis the themes and objectives of those projects. The intention was to exchange experiences and knowledge amongst researchers, practitioners and stakeholders and draw conclusions related to these thematic areas, including relevance to policy, to further communicate.

Key messages from the discussion groups

#1 WATER AND ENERGY

Moderators: Bertrand Vallet – EurEau; Francesco Fatone – SMART-Plant

Water utility operators need to better understand the relationship between water and energy on the operational side and not only focus on electrical energy savings. If they are aware of the whole water/energy nexus, there is more chance that they see the overall benefit to act and invest into energy resilient infrastructures.

In order to do so, digitalisation and modelling can be the cornerstone to building the necessary intelligence and proof of the interrelationships between the parameters of water and energy consumption. The data acquisition and treatment are essential to bring intelligence in the choices made to improve a system. The better the system is known the wiser decisions can be taken. As data acquisition are easy to get for energy, the step to have an intelligent knowledge of the system is quite low and could be easily achievable. However, there should be prudent investment on acquisition and interpretation should be minimised. Therefore, automation for extracting intelligence and meeting the operators' targets of performance is crucial for success.

Moreover, the approach to energy consumption in water/waste water management sector has to be inclusive and holistic, including sewage sludge management and accounting for transportation and embedded energy, to be able to evaluate the overall water/energy nexus. In order to decrease energy consumption, it is important to consider all the sources of energy. Often energy considerations are limited to the energy for blowers providing aeration or pumping in the wastewater treatment plant (WWTP). It is necessary to look at other sources of energy consumption such as transport (of water, of sludge of chemicals), chemicals (for production) or sludge management solutions (incineration). Only when the total consumption is measured, will the best choices to improve the energy footprint be achieved. On the water side, the models should consider the whole urban water cycle. Drinking water, waste water treatment, distribution and collection system, as the whole urban water cycle requires heavy infrastructures that have long term investments horizon, it makes sense to consider the whole cycle to target the investments in the most cost-effective way.

Environmental Technology Verification can well address water-energy nexus by certifying actual energy efficient water technologies.

SWOT for Water Energy Nexus	
STRENGTHS: - Water and energy consumptions are measurable by support of relatively low-cost smart meters - Water-energy nexus is the first and most well-known and studied worldwide - Sustainable energy policies are better established and can be integrated with sustainable water policies	**WEAKNESSES:** - Operator awareness for water-energy nexus is not consolidated - Holistic approach (including full water cycle (e.g. sludge management, chemicals production, etc) to energy consumptions is not considered by incentive policies - Assessment tools are often not standardized or widely accepted by the market players
OPPORTUNITIES: - Digitalization and modelling can boost energy-water integrated efficiency because energy data are easy to be measured	**THREATS** - Water and energy consumptions are both increasing with population growth - Megacities will concentrate water and energy stress in smaller and highly populated areas

Main conclusions:

- Sustainability Indicators and Indices for the Water-Energy Nexus for Performance Assessment are not standardized
- There is a missing link between cross-sectoral resource utilisation and management, and full-scale adoption of the water-energy nexus has been lack of analytical tools to support policy and decision-making
- Digitalization and advanced modelling can support practitioner awareness and actual implementation of measures to improve water-energy nexus
- Need of intelligent incentives based on standard indicators instead of rigid target on energy- or water-efficiency in order to avoid wrong addresses for investments

#2 WATER REUSE

Moderators: Ilaria Schiavi, Project Ô; Andrea Rubini, Water Europe

The group discussed the opportunities and challenges in the market uptake of the proposed circular economy solutions for water reuse. Awareness raising, education financial instruments like tariffs for water use and reuse were raised as potential concerns. For example:

The value of water is not well communicated with the public; only the cost of water to the consumers (water tariffs) is being known to audience. Efforts should be put to create and convey the message that water is more valuable than simply the cost of use/treating.
There is a public misconception and psychological barrier to accept reused water or treated wastewater for reuse. The public believes that such water is still ''dirty water'' and entails health risks.

For example, coastal areas of Spain appear keen on water reuse more than internal areas despite the latter being amongst the most water stressed (strong agriculture sector). This is surprising considering how Spain has given full political support to the water reuse with a very well detailed Royal Decree. Apparently, this political support is not enough. There are however good examples around that can be looked at for replication.

Water reuse brings economic windfalls as new business models of water and nutrient/substance recovery, fertigation etc. are born. Water reuse thus creates economic opportunity for the public (jobs, innovations, services).

Digitalisation for supporting decision making also on water reuse is important but it was highlighted how the requirements for monitoring (waste) water imply high costs. This is due to both the number and characteristics of sensors required as well as the frequency of monitoring required by the regulations controlling waste water reuse. Often, water reuse solutions are still very expensive; hence water reuse is not affordable especially when compared with the use of "fresh" water when fresh water is readily available. Linked to the perception of the lack of value in (waste) water, treating the

latter is seen as a cost not an investment. In summary: when and while fresh water is cheap and abundant, water reuse is not chosen on economic grounds; on the contrary, given the effort required to obtain and monitor the quality of reused water, reuse is considered as a last option. This links in with the current view of the water as a low value commodity.

Water reuse is seen as an opportunity to respond to the emerging needs of water scarcity (both in quantity and quality, as available fresh water becomes less and less also considering extreme weather events, pollution increases). It is therefore proposed that new developments/settlements should be designed to include the experience gained in water reuse schemes from the projects. In urban settlements also there are opportunities for water reuse and overall the water flows should be reorganised the direct alternative sources of water to the right application, incorporating smart features and flexibility to match offer and demand.

Small loops of water management provide an opportunity for water reuse on a local basis, where infrastructure costs can be minimised and proximity to the source of used water means the ability to know and control the contamination and maximise the efficiency of the treatment and the recovery of dissolved compounds as concentration is likely to be higher. Furthermore, small loops of tare management open opportunities for using alternative sources of waters so to match required performance with available quality (multiple waters).

Water reuse requires a change in the attitude of the society: it creates opportunity.

SWOT for Water Reuse	
STRENGTHS: - Water is a need (it supports economy): it should be treated as a resource - New business models (water recovery, substance recovery, fertigation…)	**WEAKNESSES:** - Monitoring requirements are very expensive - Water reuse is not affordable vs fresh water in general (water price is not the water value) - "Wrong" perception of reused water ("dirty") - Wastewater treatment seen as a cost not an investment
OPPORTUNITIES: - New needs arising e.g. from extreme weather events/climate change (necessity is a driver; not just quantitative water scarcity but also quality lowering because of pollution) - Design of new developments could be driven by experience (to incorporate water reuse by design) - Organise better water flows: from "sources" to the suitable application (include flexibility and smart features) - Need for change should be seen as an opportunity for change	**THREATS** - Climate change - Going towards increasing instances of limitation of water use (hose bans, water available only for a few hours a day etc).

Main conclusions:

- Water reuse will not be pursued on economic grounds alone when fresh water is readily available at a very low price to the user: further drivers must be found, e.g. overall or future scarcity of the resource "fresh water" and competing users for the highest quality water.
- The public must be educated to stop perceiving waste water reused as dirty water
- Measures should be in place to enable a performance-based approach to the use of water, stopping the use of over-engineered water for low value applications.

#3 Nutrient Recovery and Recycling

Moderators: Chris Thornton – ESPP; Juan Antonio Alvarez – INCOVER

The group identified two factors, (i) positive image for wastewater local politicians, plant management and operators, and (ii) the availability of technologies and recycling routes. The team also identified a number of weaknesses; (i) public acceptance risks for recovered products, e.g. with possible adverse or misleading publicity on contaminants or risks, belief-based rejections (e.g. vegans), (ii) insufficient reliability of supply flows and markets for recovered products and most importantly (iii) the declining use and acceptance of biosolids valorisation in agriculture (currently over one half of sewage sludge nutrients are recycled as fertilisers through agricultural application of e.g. composted or digested sewage sludge). Challenges needing to be addressed to enable development of technical nutrient recovery and recycling identified by the group include:

- Lack of benchmarked data from large scale nutrient-recovery units operated for significant time durations in real waste treatment conditions
- Legislation or funding mechanisms not always supportive and in some cases not coherent
- Small scale and decentralised production requires new logistics and business models, to avoid high costs
- Complexity of regulation. In particular, disparate End-of-Waste processes and decisions in EU countries/regions prevents technology and experience transfer.

However, they also listed the potentials and opportunities as:

- New collaborations for wastewater operators (new market operators, new stakeholders)
- Increasing networking and knowledge sharing (e.g. through EU-funded projects)
- New EU Fertilising Products Regulation

The theme members suggested the following policy routes and pathways:

- There is need for join communications (by recycling technology suppliers, scientists and public authorities) to support public acceptance (including food industry) to promote

positive image of recycling and educate on resource conservation, safety of recycled products

- It is important to transform political objectives into stable, long-term regulatory support
- Water utilities and operators should look for and work with experts or companies having competences relevant to nutrient recycling (e.g. in fertiliser marketing, waste regulation, technology) and develop networking between water utilities / operators and these competences
- Platforms for knowledge exchange and data benchmarking should be developed, bringing together industries and stakeholders from different sectors relevant to nutrient recycling (technology, science, agriculture, food chain …)
- Address regulatory barriers, in particular the disparate implementation of End-of-Waste in different Member States / Regions

The group advises the EU to

- promote and support nutrient recovery and recycling in Horizon Europe, in particular: - networking between R&D and stakeholders / decision makers / industry / public – including to propose the vision and objectives - demonstration installations, both for communication to the public and users, and to provide benchmarked data for operators and industry
- Put in place a coordination of European MS national authorities competent for End-of-Waste, Water Policy and Circular Economy to exchange information and if appropriate propose coherent positions on End-of-Waste status for recycled or recovered materials from wastewater streams. This could be within the existing Waste Expert Group (e.g. as a sub-group). This coordination of Member State representatives could, if it so wished, consult (audition) stakeholders/industry representatives. It is suggested to focus on materials with recovery potential in several MS, that are not covered by or not concerned by the EU Fertilising Products Regulation (e.g. products distributed to local markets).

SWOT for Nutrient Recovery and Recycling	
STRENGTHS - Positive image for wastewater operators and local politicians. - Availability of technologies and recycling routes. - EU and national Circular Economy policies and political recognition of importance of nutrients (phosphorus on EU Critical Raw Materials List, nitrogen driven by Nitrates Directive and National Emissions Ceilings Directive)	**WEAKNESS** - Lack of coherent support by administration and incoherent legislation among countries. - Widespread production of small quantities = need for new logistic and market models. - Lack of operating data of larger-scale facilities, over time, in real wastewater industry conditions.

OPPORTUNITIES	THREATS
- Implementation of the current tested nutrient recovery technologies. - New collaborations and networking knowledge. - Implementation of new EU Fertilising Products Regulation and anticipated addition of STRUBIAS products - Phosphorus recycling obligations in Germany (in place) and possibly in the future in other Member States. - Possibility to make more coherent End-of-Waste status in different Member States (if action is engaged)	- Public acceptance of recycled nutrient products

#4 Bio-based Resource Recovery and Recycling

Moderators: Jos Frijns – NextGen; Hein Molenkamp – Water Alliance

This group discussed the opportunities and challenges in market uptake of recovered bio-based resources, focusing on granulated activated carbon and bioplastics.

First, the market development of granulated activated carbon (GAC) was discussed (NextGen-project). At the NextGen demo case of AVA and FHNW in Altenrhein (Switzerland), granulated activated carbon is produced through sludge pyrolysis and used to eliminate micro pollutants from the effluent at the WWTP Altenrhein. The main strengths of GAC were listed as:

- Sewage sludge and biomass available locally
- On-site use at WWTP for micropollutants (MP) removal
- 15 - 20% of sludge sufficient to supply GAC for a WWTP
- Synergies: waste heat from pyrolysis (for on-site use).

Also, some weaknesses and possible questions to be answered about the GAC. They are listed as:

- What is the quality of the GAC produced? Is the carbon stable in this way?
- 80% elimination of micropollutants possible with SS-GAC?
- GAC stable in filter for 1-3 years? Losses?
- Is reactivation possible? What is the reactivation regarding traditional Carbon? How long can you use it until reactivation?
- Measured SS-GAC surface significantly smaller than commercial GAC

- What are the logistics issue, with regard to the cement factory? Is this a one-time application because of the cement factory in this case? Where is the next project?

Next, the market development of bioplastic PHA was discussed (Phario-project). The observations on the strengths of bioplastics were that:

- they are a sustainable alternative to fossil plastics
- they encourage Circular Economy
- the overall public perception is positive.

However, a number of challenges and weaknesses were also identified in relation to bioplastic as:

- Bioplastics compete against large traditional players. Quality is crucial, it must be top quality to beat the alternatives
- New market players needed, do not focus on the existing large players. Find niche applications.
- Will the process be able to generate enough for large-scale market demand in a stable way? Is there any market demand for high amounts ?
- Will there be enough applications which are economical viable? Construction industry can be a potential market. Research showed that in Italy the price of bioplastic might be 20 % higher than other plastic.
- Can bioplastics play a significant role in reducing fossil plastics and plastic soup?
- Is the carbon footprint impact relatively positive?

SWOT for the market uptake of recovered bio-based resource	
STRENGTHS - Provides a sustainable alternative - Recycling possible within the water sector itself	**WEAKNESSES** - Does the quality of the recovered products meet its requirements? - Does the quantity of the recovered products meet its demand? - Is the impact (carbon footprint) of the recovery overall positive?
OPPORTUNITIES - Developing a niche market - Positive public perception	**THREATS** - Competition with traditional products - Insufficient economically viable applications - Regulatory barriers

Although GAC and bio-plastics have market potential, their success depends on a number of challenging conditions such as quality and quantity, price, regulations, positive show cases etc. In the

discussion around opportunities and threats related to the recovery of bio-based resources, it was highlighted to move away from a commodity market and aim for a niche market where people want to pay premium price. This can only be achieved by getting marketing people involved, so that the distribution market adopts it. A niche market could develop once there is a positive general perception. Moreover, engaging the public in a positive storyline could be used to influence the policy and generate supportive regulations. This is necessary as we have a price sensitive market and strict procurement rules are show stoppers.

As the main conclusion, the recommendations for policy are:

- Set up an incentive (finance) scheme for marketing firms to identify and develop the niche market for recovered bio-based resources.
- Develop regulatory requirements for big-supplier markets, including a CE labelling system for recovered resources (as part of their environmental responsible care).
- Apply green government procurement to include recovered (bio-based) resources.

 # 5 Water-energy-food loops and their implications for water tariffs

Moderators: Simos Malamis – HYDROUSA; Peyo Stanchev, Brunel University

In this breakout session the group discussed the ways in which the water-energy-food loops can have an impact on the water utilities tariffing system. The group started from the HYDROUSA story where decentralized water loops are applied to recover different types of non-conventional water sources. These loops are monitored in terms of water, energy and food production through a series of online and offline measurements supported by a tracking and tracing system of products and nexus modelling, allowing the circularity performance assessment. The question is whether such loops and data acquired can lead to improved tariffing system for the benefit of the consumer.

Circular economy in the water sector can present important opportunities for better water tariffing models. The valorisation of non-conventional water sources such as reclaimed water results in increased availability of fresh water, which could eventually lead to a lower water price, particularly in cases where fresh water is supplemented by energy intensive desalination plants. Furthermore, recovering resources from wastewater can result in increased income for water utilities, which could allow a full cost recovery of the wastewater service and decrease in the price of water.

However, there are also certain barriers which need to be addressed. Currently, the water tariffing system is not linked to water reuse or the recovery of resources. In many cases the water tariffing system is developed at a regional level, preventing local water utilities to develop pricing models based on local water loops. There is a clear absence of incentives for the consumers to recycle water as well as lack of knowledge and awareness of consumers regarding water pricing and available recycling technologies and practices.

Closing the gap between the water management cost and water tariff in water scarce areas is important and can be realized by implementing circular water solutions. Difficulties in monitoring water loops, particularly in cases where decentralized solutions are applied, is a potential barrier. The use of different types of energy (biogas, natural gas and electricity from the grid) allows resilience and savings for water utilities and can support the decrease of the price of water.

The key messages from this discussion were:

- Digitalization of water industry is required to allow full material and cost accounting of the water loops to enable new water pricing models
- The full cost of service needs to be included in water tariffing including the capital and operating expenses, but also the benefits resulting from the recovered products derived from sewage, as well as the environmental and social aspects of water cycle management.
- Decentralized, local tariffing can better support the link to local water loops and real costs of water.
- Increase customers awareness and engagement in the circular water management transition

SWOT for water-energy-food loops	
STRENGTHS - Valorizing non-conventional water sources (increased availability of fresh water) - Reclaimed water reuse / fertigation leading to lower water acquisition cost - Income from valorization of recovered energy/products - Local loops for local tariffs - Closing the gap between the water management cost and water tariff in water scarce areas	**WEAKNESSES** - High initial Investments to develop circular water loops - Absence of local tariffing system - Lack of incentives to save and recycle water at household level - Lack of customer awareness and knowledge about circular technologies and practices - Very low price of the water sold to farmers - No standardization for individual and appropriate wastewater treatment systems - Water tariff does not depict the efficiency of water loops

OPPORTUNITIES	THREATS
- Consideration of the full cost of service - New jobs - Digitalization of water loops – Tracking and tracing - Community based water management loops - Closing water loops reduces service cost for utilities - Multiple energy sources allowing resilience and cost savings - Social fairness in distribution	- Centralized water tariffing system affecting decentralized water use - Pollution risk from decentralized approach - Difficulties in monitoring and managing decentralized water loops - Stakeholders and regulators engagement - Subsidies

OVERALL CONCLUSIONS

In summary the panels reached the following conclusions:

- Larger leaps need to be made in the digitalization of water solutions. Effective and targeted digitalisation of the sector needs to further progress in order to support water reuse, resource recovery and the links of water management with energy efficiency. It can also promote better, more efficient and fair water pricing systems.
- Digitalization can help to increase water sector operators' awareness concerning the water-energy-carbon nexus and longer-term impact of their day-by-day activity.
- Demonstrating the water/energy/food and nutrients nexus can create water utilities with opportunities to decrease energy consumption, improve performance and link better with the water tariffing system. In this nexus the whole water supply chain needs to be considered from water acquisition up to wastewater treatment and disposal or reuse. Awareness of water utility operators and value chain actors can be raised by generally addressing and promoting the nexus in regulatory framework, initially without any obligation or target to be achieved.
- Resource recovery and safe reuse from water cycle needs integration and upgrading of skills and knowledge of water utility operators that possibly need to interface with niche market sectors.
- Water reuse is seen by some stakeholders as a threat increasing in capital and operating expenses; however, this notion needs to change. Water reuse should be considered as an opportunity to increase freshwater availability and meet water demand at a good price, and also in many cases as a route for nutrient recycling.
- Raising public awareness and acceptance for the use of recovered products in general (water, nutrients, other resources) is a crucial for overcoming social acceptance barriers that can hinder the uptake of innovative solutions. In addition, this can help overcome regulatory barriers as it may have a positive influence in enabling policy developments.
- Furthermore, engaging the public and user industries (such as the food industry for nutrients) in co-design co-creation processes can speed up the market uptake of the solutions.
- It is often difficult for the products recovered from wastewater to compete with traditional products which have been in the marketplace for several years with structured industrial production. The development of niche markets and decentralised logistics/business models could support the market uptake of recovered products.
- Energy efficiency, resource recovery and in general closing water loops can lead to more competitive water utilities and a decrease in the price of water.
- There is a need to address disparate approaches to End-of-Waste between Member States, product by product, for recovered and recycled products from wastewaters, in order to enable technology and experience transfer.
- The new Fertilizing Product Regulation can create opportunities, it is important to have a coherent implementation across Europe.
- EU support in Horizon2020, InterReg, LIFE has been effective and should be continued in Horizon Europe, in particular to support full-scale demonstration projects, enabling benchmarking in real waste industry operating conditions
- EU associations and supporting platforms (e.g. ESPP, Water Europe, EurEau, WAREG, Aqua Pubblica Europea etc.) play an important role in bringing together different stakeholders

(industry, science, regulators, consumers and downstream users) and different sectors (recycling technologies, waste industry, user industries) for knowledge transfer, dialogue and confidence building

- The full cost of service needs to be considered within the water sector. This includes the capital and operating expenses, cost savings from recovered products, the environmental and social aspects of water cycle management.
- Although Environmental Technology Verification (ETV) has been successfully tested in pilot actions and demonstration projects, the water utilities and end-users are still not aware of ETV credibility. In fact, ETV is still rarely required in public procurement pathways.
- Standardized key performance indicators and European labelling should be promoted to increase availability of scientifically-sound benchmarks that will support water utility decisions.
- Product certification schemes and investment /financing incentives can help address the market barriers.
- Cross-sector collaboration and industrial symbiosis should be encouraged by ad-hoc regulatory framework that supports long-term contracts and stable public-private partnerships.