Technological solutions in the context of the RIS3CAT communities within the Circular Economy

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Introduction

The contribution by RIS3CAT Communities to circular Catalonia

The circular economy is acquiring an increasingly significant role in industry and business and in public policies in Europe it is emerging as a driving force for employment, for investment and for the development of a carbon-neutral, resource-efficient, competitive economy. Various studies estimate that the circular economy contributes an additional 2 to 4% to GDP growth and a 1 to 3% increase in employment.

The circular economy as a proposal for change in the model of the production, use and consumption of resources, establishes three principles that also represent three challenges for business R&D&I:

- to prevent waste and pollution,
- to maximise the use of resources, time and value, and
- to regenerate natural capital.

Obtaining the maximum value from resources for the longest possible time requires disrupting the current production model and incorporating technologies that progress exponentially and will open up new opportunities for R&D&I and business collaboration.

Within this new industrial paradigm, a key role will be played by Catalan R&D&I companies and stakeholders working to coordinate the Research and Innovation Strategy for the Smart Specialisation of Catalonia (RIS3CAT), the RIS3CAT Communities.

Parallel to their work in transforming the strategic sectoral areas defined in the RIS3CAT, the Communities have cooperated in R&D&I projects and have thus advanced to respond to a new challenge raised by society itself and by the European framework through the **Implementation of the Circular Economy Action Plan**. With a view to raising awareness of the potential that both Catalonia and, particularly, participants in the RIS3CAT Communities have for the circular economy, for the first time a joint project has been established to harness skills, expertise and talent in order to yield maximum return on the innovation they generate in the Catalan ecosystem of R&D&I and enterprise.

This compilation features the first 29 solutions and technologies achieved through work performed in Catalonia by participants in the RIS3CAT Communities. They are the results of an initial collaborative phase to detect, identify and propose solutions at the service of the circular economy that may prove crucial for the economic transformation of Catalonia's productive system. The RIS3CAT Energy, Water, Utilities 4.0, Innopat (food chain) and COPTA (agrifood) Communities have taken an active part in it and provided the solutions and technologies that feature in this compilation by sectors of application.

The accredited RIS3CAT Communities have received a total of 53 million euros in grants. Some of these funds come from the ERDF Catalonia 2014-2020 Operational Programme. ACCIÓ has authorised 13 RIS3CAT Communities in the 7 sectoral areas defined by the RIS3CAT, which involve 480 Catalan institutions. Together, they have mobilised over 140 million euros in investment in research and innovation.

Application sectors:
Hospital Wastewater
Waste Industry

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Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Hybrid electro-oxidation and ozonation for the removal of emerging compounds in hospital wastewater
- **Project Name:** Eflucomp
- **Funding Programme:** ACCIÓ - RIS3CAT
- **Company Name:** LEITAT
- **Location:** Terrassa

Scope of Innovation Solution

Advanced Oxidation Processes (AOPs) such as electro-oxidation and ozonation generate highly reactive species such as hydroxyl radicals, that are able to remove recalcitrant compounds from water (e.g. pharmaceuticals). The combined use of these technologies allows efficiently eliminating these compounds from hospital wastewater, providing safe reclaimed water.

Innovation Solution

Electro-oxidation is based on the electro-generation of non-chlorinated oxidant species, which are able to disinfect water while also removing recalcitrant compounds from it. However, the presence of chlorine in water could lead to the generation of halogenated by-products such as trihalomethanes, chloramines… which are toxic. Among other alternatives, the use of ozonation has been reported as an efficient solution for the removal of these harmful by-products, while increasing the efficiency of electro-oxidation for both disinfection and pollutant removal. This combined technology is proposed as tertiary treatment for hospital wastewater reuse, since the most efficient way of being applied is after biological treatment which previously removes the biodegradable organic matter (more economically than AOPs). The recirculation of part of the effluent obtained after combined electro-oxidation of ozonation to the biological treatment could allow reducing aeration costs, since ozonation leads to a high concentration of dissolved oxygen.

Key Elements / Priorities

- Versatile technology, since the combination can be simultaneous or sequential.
- Synergic effects come from the combined use of the technologies.
- Optimization of electrochemical cells, minimization of the use of reagents, possibility taking advantage of the dissolved oxygen obtained.

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- Decentralized treatment of hospital wastewater would prevent the spread of pollutants which occurs when these effluents are treated in urban wastewater treatment plants along with urban effluents.
- The removal of pharmaceuticals (and other emerging pollutants) allows the safe reuse of water.

Kev Outcomes / Benefits

- The technology is applied to real wastewater during the project, which will help its integration in a real environment.
- The combination of electro-oxidation and ozonation could be applied not only to hospital wastewater but also as tertiary treatment in urban wastewater treatment plants, allowing the removal of emerging compounds for safe effluent discharge/reuse.
- The technology can also be applied to water recycling in industries (for example: the vegetable/fruit washing process), thus boosting circular economy benefits also in the industrial sector.
- Water quality improvement achieved by means of this technology would allow meeting the requirements of water reuse legislation (Royal Decree 1620/2007 for Spain or new European Directive on Water Reuse) but also anticipating possible new legislation on emerging contaminants in wastewater.

Innovation Solution Drivers

- Water management. Wastewater is treated with efficient technology that allows its reuse for different purposes.
- Climate change mitigation through energy saving by decentralized water reuse (avoids water transport for supply).
- Removal of harmful pollutants such as pharmaceuticals.
- Disinfection without generating harmful by-products and without external reagents.
- Efficient technology which benefits from synergic effects of the combined use of AOPs.

Outcomes and challenges

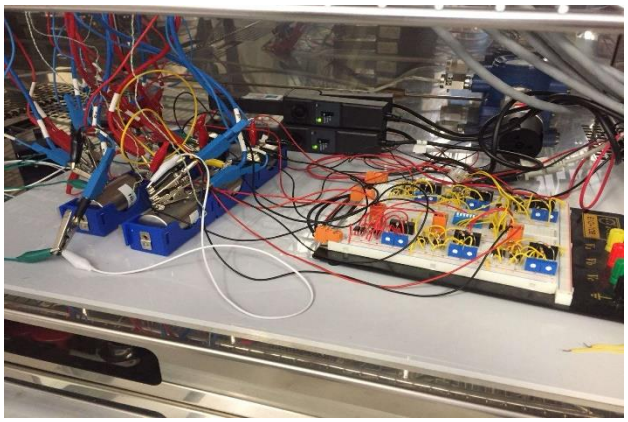
- Preventing the formation of halogenated by-products during electro-oxidation by using ozonation.
- Implementation of an innovative cell design for reducing the electrical consumption by the electro-oxidation process.
- Although electro-oxidation and ozonation are consolidated technologies, their combined application is still a challenge.
- Use of real hospital wastewater will allow obtaining results comparable to the real environment.
- Obtaining final water quality that allows its reuse according to legislation.

Additional information

The development of this technological solution is of special interest for diverse research and innovation centres but also for other industrial partners such as water engineering companies, water treatment companies, environmental consultants, etc. that have hospitals within their client portfolio. Progress in wastewater treatment knowledge will be generated at regional level, allowing the integration of circular economy principles and benefits in the water sector. It is important to note that the water sector in Catalonia accounts for >1.5% of regional GDP. The present project also has positive impacts on the environment derived from i) the removal of emerging contaminants, ii) the elimination of the use of reagents in the water treatment process, and iii) the possibility of reusing the water obtained, thus reducing fresh water consumption. Since water is becoming increasingly scarce and must be maintained in good quality, systems that allow the efficient removal of pollutants can have a significant impact on the circular economy. In this sense, the impact of this solution would be fundamental within the framework of the green economy, with the management and treatment of water, one of the basic and fundamental resources of society, decreasing costs and facilitating access to it.

Community name:
RIS3CAT Energia

- **Innovation Solution Title:** Environmental Life Cycle Assessment of Li-Sulphur Batteries
- **Project Name:** HELIS
- **Funding Programme:** H2020
- **Company Name:** Institut de Recerca en Energia de Catalunya (IREC)
- **Location:** Sant Adrià de Besòs



Scope of Innovation Solution

Lithium-ion batteries for electric vehicles (EVs) are thought to have achieved their theoretical specific energy, and thus alternative battery chemistries, such as Lithium-Sulphur (Li-S), are being researched to achieve higher values. Life Cycle Assessment (LCA) is used to compare the environmental impact of Li-S batteries with that of alternative batteries.

Innovation Solution

The replacement of Li-ion batteries with Li-S batteries is expected to be feasible from a technological and economical perspective. However, it should also make sense from an environmental perspective. Therefore, environmental life cycle assessment has been used to compare the impact of Li-S technology to that of Li-ion considering multiple impact categories, such as resource depletion, climate change, energy demand, acidification, eutrophication, photochemical ozone formation and metals depletion. LCA is used to quantify the overall impact for the technology incorporating the entire life cycle from raw material extraction through production to manufacture and final disposal. Thus, using a comparative LCA can help to identify the areas where one technology outperforms the other.

Key Elements / Priorities

- Data collection for the composition and performance of a Li-S battery in an EV.
- Establishing an appropriate scaling method for data obtained from the laboratory production of coin cells to data estimations for the production of batteries.
- Establishing an appropriate model for Li-S cell ageing from laboratory tests conducted under various conditions.

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Key Outcomes / Benefits

Key outcomes include production of Li-S cells on a laboratory scale, testing the effect of the ageing of these cells under various conditions, and estimating their cycle life. Furthermore, preliminary LCA results show that Li-S cells have the potential to reduce the impact due to metals depletion compared to Li-ion technology. However, further research is ongoing to develop Li-S technology, which will allow for better estimations to be made regarding the composition and performance of a Li-S battery, and thus to a clear demonstration of other potential environmental benefits of Li-S compared to Li-ion technology.

Innovation Solution Drivers

- The commercialization of electric vehicles (EVs), including battery, hybrid and plug-in hybrid electric vehicles (BEV, HEV, PHEV), is forecasted to increase worldwide in response to the global concerns regarding CO2 emissions, air quality in urban areas and energy security.
- Production of Lithium-ion batteries is relatively expensive, and the technology is thought to have achieved its theoretical specific energy.
- Li-S batteries are expected to obtain higher specific energies, to be produced at lower costs, and to use more abundant materials than Li-ion.
- Keeping in mind the circular economy principles, the environmental benefits of Li-S batteries compared to Li-ion batteries should be demonstrated on a life cycle basis.

Outcomes and challenges

There are many challenges when comparing the environmental impact of innovative technologies produced on a laboratory scale to those produced using conventional methods on larger production scales. The LCA of Li-S batteries is not exempt from this. The main challenges include the scaling of the composition and performance of Li-S coin cells to what would be expected for a Li-S battery. Research is ongoing and the potential of this technology to meet the performance of Li-ion batteries in EVs is very promising.

Application sectors:
Water
Agriculture Industry

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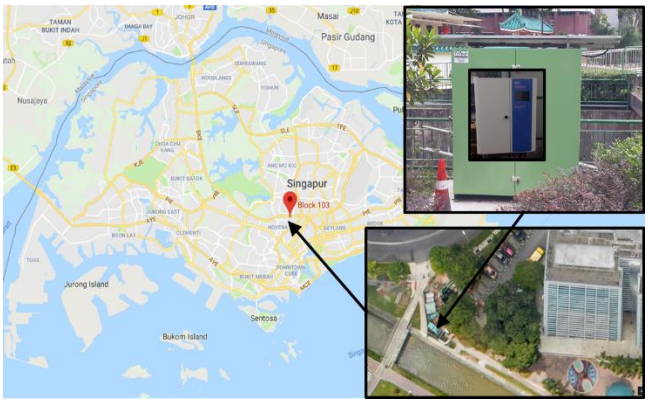
Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Online nutrients analyser
- **Project Name:** NEA Online Monitoring Station
- **Funding Programme:** Private
- **Company Name:** ADASA Sistemas
- **Location:** Singapore



Scope of Innovation Solution

Low power online water quality analyser for ammonia, nitrates and phosphates, for use in a monitoring network to control water quality in low flow drainage systems.

Innovation Solution

Analyser integrating the online measurement of nutrients (ammonium, nitrates and orthophosphates) in a single piece of equipment. The target market is environmental applications. The typical application in water quality control in facilities with no available power and low maintenance requirements.

Key Elements / Priorities

- Low layout.
- Low power consumption.
- Low reagent consumption.
- Must be able to operate in scenarios where there may be a lack of water.

Key Outcomes / Benefits

- Control of water quality before reuse.
- Reservoir inlet water quality monitoring.

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Community name:
Comunitat de l'Aigua

Innovation Solution Drivers

- Integration of nutrient measurement (ammonia, nitrates and phosphates) in one piece of equipment.
- Low power consumption design.

Outcomes and challenges

- Overall balance of power consumption, station layout, reagent consumption and measurement frequency.
- Working conditions with high operating temperature (Singapore average temperature is around 32ºC) and humidity levels.

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Resource recovery and valorisation from urban Digestate in the frame of circular economy
- **Project Name:** DigesTake
- **Funding Programme:** ACCIÓ– RIS3CAT
- **Company Name:** Universitat de Girona (UdG), Universitat de Barcelona (UB), Universitat Politècnica de Catalunya (UPC), Cetaqua, EURECAT, Leitat, Adasa, Aquambiente, Iberpotash, LEF
- **Location:** Barcelona

Scope of Innovation Solution

To generate new knowledge and expertise to develop technologies and processes for the treatment, recovery, valorisation and reuse of the resources present in the liquid and gaseous effluents produced by anaerobic digestion at WWTPs.

Innovation Solution

DigesTake is an industrial research project whose main objective is to develop new processes and technologies for the treatment, recovery, and reuse of resources of liquid and gaseous effluents (waste gases from biogas) resulting from anaerobic digestion at WWTPs, following the principles of eco-sustainability and energy efficiency. Technologies from transversal disciplines such as biotechnology, advanced materials or ICT will be applied to address technological challenges that involve multiple disciplines and areas of expertise (engineering chemistry, electronics, materials science, automation, electrochemistry, microbiology) through experiments on laboratory and pilot scale.

Project research efforts will be directed at valorising nutrients (3 pillars): "Carbon", "Phosphorus" "Nitrogen". The carbon pillar will focus on the conversion of carbon dioxide from biogas into organic compounds with added value through bioelectrochemical systems. Phosphorus recovery proposes two alternative processes: the recovery of struvite using mining sector by-products as reagents, and a new process of bio-induced phosphorus precipitation in a partial nitrite-anammox reactor. At the same time, an eco-sustainable biosensor system will be developed for in-situ phosphorus measurement. Nitrogen activity includes the production of ammonium salts by coupling ion exchange with membrane technologies, and a process to eliminate the surplus of nitrogen contained in water with low energy consumption.

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Community name:
Comunitat de l'Aigua

Key Elements / Priorities

- Production of butyrate and acetate by reusing the carbon dioxide present in biogas.
- Precipitation of struvite and k-struvite using alternative sources of Mg and K from the mining industry.
- Development of an innovative continuous P measurement system with zero chemical consumption and waste generation.
- Production of bio-based fertilizers (ammonium salts) from nitrogen recovered through a system based on ion exchange and membrane contactors.

Key Outcomes / Benefits

- Validation of Liquid-Liquid membrane contactor technology for ammonium salts production.
- Comparison between produced and conventional bio-based fertilizers.
- Production of specific N-P-K fertilizers depending on land requirements.
- Boosting the circular economy through the use of waste from the mining sector as a source of magnesium.

Innovation Solution Drivers

- Reduce the eutrophication potential of WWTP effluent.
- Reduce the carbon footprint of WWTPs and fertilizers (both in direct emissions and by substituting conventional fertilizers).
- Waste valorisation into fertilizers.

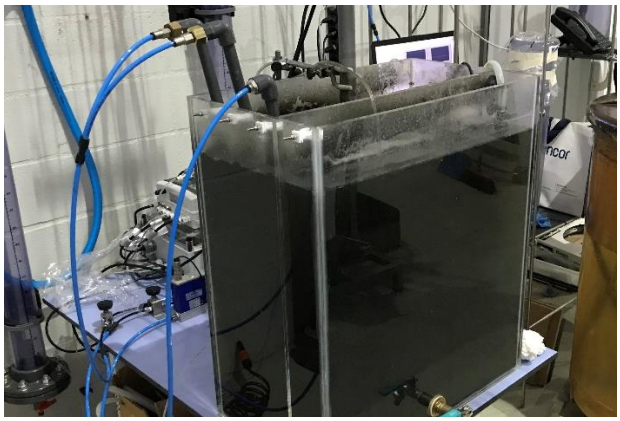
Outcomes and challenges

Progress by transforming the current WWTPs into Water resource recovery facilities (WRRF). To do so, several technologies are developed to maximize nutrient recovery (N&P) and reduce chemical and energy consumption.

The main challenges to overcome are the regulatory barriers that still forbid the direct use of recovered products in most of Europe. Projects like DigesTake are truly valuable due to their aim of demonstrating that recovered products can compete with other marketable products in terms of quality and purity.

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Moving bed biofilm reactor – membrane bioreactor (MBBR-MBR)
- **Project Name:** REGIREU
- **Funding Programme:** ACCIÓ
- **Company Name:** EURECAT, Universitat Politècnica de Catalunya (UPC) - INTEXTER, BIO-FIL
- **Location:** Manresa



Scope of Innovation Solution

The moving bed biofilm reactor–membrane bioreactor (MBBR–MBR) is based on the addition of moving carrier media inside the bioreactor, in which attached biomass grows. The MBBR–MBR system aims to partially mitigate the fouling concerns regarding MBR systems and the settleability issues in relation to MBBR systems.

Innovation Solution

The moving bed biofilm reactor–membrane bioreactor (MBBR–MBR) combines the advantages of attached biomass reactors and membrane separation processes. Those advantages include the decrease in suspended solids owing to the attached biomass growth, potentially decreasing membrane fouling in the MBR. Moreover, the biomass growing in biofilm instead of suspended flocs enables the decrease in reactor volume creating a highly compact technology. In general, fixed-film processes are less sensitive to environmental variations and, therefore, to toxic compounds. The long sludge age in biofilms permits the growth of slow-growing bacteria and the removal of recalcitrant compounds such as micropollutants or coloured molecules.

Key Elements / Priorities

- Research in hybrid MBBR-MBR systems to take advantage of both technologies by studying their synergy.
- Treatment of both urban and industrial wastewater for reuse.

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Key Outcomes / Benefits

- Decreased membrane fouling compared to conventional activated sludge-based MBRs.
- MBR volume reduction of up to 60%.
- Energy requirement reduction of up to 15%.
- Persistent pollutant concentration decreases by up to 95%.
- Significant increase of colour removal (up to 85%) compared to conventional biological systems.

Innovation Solution Drivers

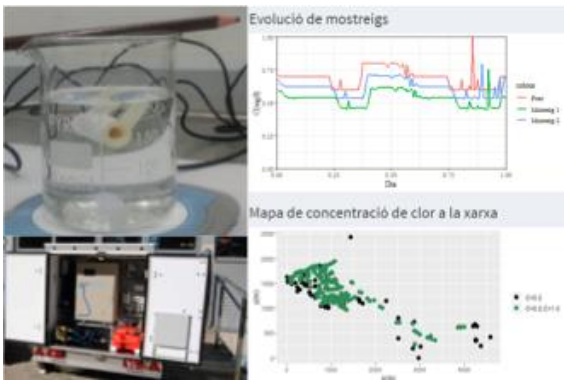
- Couple biological attached growth systems to membrane processes to increase the global performance of the hybrid systems.
- Increase biological efficiency in the removal of persistent pollutants in MBBR compared to conventional suspended growth systems.
- Wastewater reclamation aimed at water reuse.
- Reduce technology implementation and operation costs.
- Water reuse in textile dyeing processes. Dyed cotton fabrics fulfil quality standards in terms of colour reproducibility.

Outcomes and challenges

Tests of water reuse in textile dyeing processes have been performed at laboratory quality control scale. These promising results obtained at laboratory scale should be tested at industrial scale.

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Integrated Water Quality Platform
- **Project Name:** IMAQUA
- **Funding Programme:** ACCIÓ - RIS3CAT
- **Company Name:** EURECAT, AGIR-SST, PRODAISA, Universitat de Girona (UdG), BGEO OPEN GIS, Agbar, IDAEA - CSIC, Universitat Rovira i Virgili (URV), S::CAN, ADASA
- **Location:** Catalonia



Scope of Innovation Solution

Intelligent and open platform focusing on managing the distribution of water and associated resources throughout the entire water value chain. This platform holistically manages water quality and quantity meeting current regulations and ensuring the safety of the consumer.

Innovation Solution

The IMAQUA platform is an open source architecture focusing on the integral and holistic management of water from supply to consumption. Moreover, the tools involved on the platform are designed and implemented to ensure the optimal consumption of water and the subsequent quality of water during distribution. The platform consists of 4 main modules: (i) **monitoring and control of the contaminants** through the combination of offline (passive ceramic samplers) and online (optimal and defined substrate) technologies; (ii) **interoperability and knowledge management tools** in order to integrate and share information; (iii) **supervision and decision-making** tools in order to control and recommend suitable operational and management strategies; and (iv) **visualization and simulation environment** to offer a user-friendly experience and interaction with the system.

Key Elements / Priorities

- Reduce contaminant detection time through the characterization of contaminants (priority and emerging contaminants, metals and toxins).
- Improve the effectiveness of contaminant characterization using passive samplers and continuous measurements.
- Improve water quality in the distribution network through the supervision of control parameters.
- Reduce undesirable leakages in the distribution network through leakage detection tools.
- Improve resource management efficiency throughout supply and distribution.

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Key Outcomes / Benefits

- Decrease the contaminant determination time
- Identify contaminants and degradation products
- Improve water quality during distribution
- Optimize water distribution.
- Ensure compliance with the regulatory framework related to water quality and management.

Innovation Solution Drivers

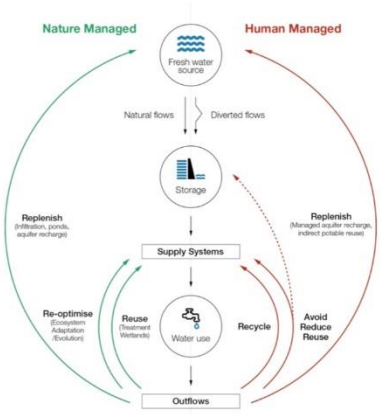
- Monitoring and control tools analyse specific samples without continuously controlling quality due to high costs and operational work.
- Lack of rapid responses to critical events that often cause high impacts on social, operative, environment and human health levels.
- Decision-making strategies often focus on local and sectorial aspects of the water network without considering the interrelationships between the different water value chains and cross-domain implications.

Outcomes and challenges

- Rapid detection of contaminants to guarantee water quality.
- Minimize the human health risk from the presence of contaminants in water.
- Improve management through more efficient strategies
- Energy efficiency in water transport and distribution.

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Water treatment technologies for the circular economy of the water cycle
- **Project Name:** Towards the next generation of water systems and services for the circular economy (NextGen)
- **Funding Programme:** H2020
- **Company Name:** Eurecat
- **Location:** Manresa



Scope of Innovation Solution

The project produces new understandings to underpin the exploitation of technologies that enhance our ability to recover, refine, reuse, repurpose, capture value from, and extend the useful life of an ever-increasing range of resources and products, thereby projecting the European water and allied sectors as global circular economy pioneers.

Innovation Solution

NextGen evaluates and champions transformational circular economy solutions and systems around resource use in the water sector. We aim to challenge embedded thinking and practices by bringing financially sustainable innovations to life. The project produces new understandings to underpin the exploitation of technologies that enhance our ability to recover, refine, reuse, repurpose, capture value from, and extend the useful life of an ever-increasing range of resources and products, thereby projecting the European water and allied sectors as global circular economy pioneers.

To achieve this, NextGen delivers technological, business and governance solutions for water in ten high profile demonstration cases across Europe (Braunschweig (Germany), Costa Brava (Spain), Westland region (Netherlands), Altenrhein (Switzerland), Spernal (UK), La Trappe (Netherlands), Gotland (Sweden), Athens (Greece), Filton Airfield (UK), Bucharest (Romania)) and three associate partners worldwide (Korea Institute of Science and Technology (South Korea), Taposya Social Welfare Organization (India), Jiangsu Institute of Environmental Industry (China)).

The circular economy transition to be driven by NextGen encompasses a wide range of water-embedded resources: water itself, energy and materials.

We aim to accelerate, transfer and upscale circular economy practices worldwide by sharing our collective experiences and insights in citizen and stakeholder engagement, business models and services. A marketplace and targeted development of spin off activities will market effective solutions.

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Key Elements / Priorities

- Innovative technological, business and governance solutions supporting a CE approach to water, energy and materials:
- Demonstration in ten high-profile, large-scale demonstration cases across Europe.
- Development of the necessary approaches, tools and partnerships, to transfer and upscale.
- Involving and engaging citizens and other stakeholders to give feedback on technology development, increase collective learning and shape solutions and behavioural change.
- Addressing social and governance challenges to ensure long-term adoption and support for circular economy solutions.

Kev Outcomes / Benefits

- Demonstrate new ways to increase the applicability and cost-benefit of alternative water resources.
- Demonstrate significant improvements in energy production from wastewater & heat recovery, storage and utilization, without affecting material recovery efficiency.
- Significantly boost material extraction, reuse technologies and market, including N, P and activate carbon, producing the quality (with reduced costs) that end users require.
- Change public perceptions on reuse across the whole range of water-energy-materials to positive drivers for water in CE.
- Provide clear navigation instructions for water in the CE through the current complex legislative and governance landscape and develop new business models and services for the CE.

Innovation Solution Drivers

- **Water CE approach**: Itself with reuse at multiple scales supported by nature-based storage, optimal management strategies, advanced treatment technologies, engineered ecosystems and compact/mobile/scalable systems.
- **Energy CE approach**: combined water-energy management, treatment plants as energy factories, water-enabled heat transfer, storage and recovery for allied industries and commercial sectors.
- **Materials CE approach**: such as nutrient mining and reuse, manufacturing new products from waste streams, regenerating and repurposing membranes to reduce water reuse costs, and producing activated carbon from sludge to minimize costs of micro-pollutant removal
- **Involving and engaging citizens and other stakeholders**: using communities of practice and living labs. Serious gaming and augmented reality will be immersive tools to explore the circular economy and behavioural change.
- **Addressing social and governance challenges**: this includes social acceptability testing, policy and regulation support and development of a European Roadmap for Water in the Circular Economy.

Outcomes and challenges

- Significant reduction (10-30%) in current water and energy consumption at regional and/or river basin scale.
- Replication of new business models in other areas.
- Replication of models for synergies between appropriate funding instruments at regional, national or European level.
- Interconnectivity between the water system and other economic and social sectors (agriculture, tourism, industry, etc.).
- Increased public involvement and citizen satisfaction in water management throughout the organization of Communities of Practices and Living Labs supported by ICT such as Serious Gaming and Augmented Reality tools.
- Closing of the infrastructure and investment gap in the water service sector by validating and promoting new business models that will generate revenues from the products recovered.

- Exploring new business models and supporting market creation.
- Providing evidence-based knowledge regarding the enabling framework conditions that facilitate a broader transition to a CE in the EU.
- Implementing the Sustainable Development Goals, in particular SDG 12 'Ensure sustainable consumption and production patterns' and SDG 6 'Ensure availability and sustainable management of water and sanitation for all', as well as the conclusions of the COP21 Paris Agreement.

Additional information

The consortium has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 776541 as part of the circular economy call CIRC-02-2016-2017. It is financed by this framework from 1 July 2018 – 1 July 2022 (4 years). It is led and coordinated by Dutch water cycle research institute, KWR.

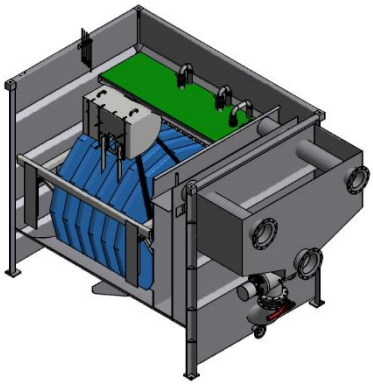
A wide mix of skills and actors combine to deliver NextGen. The project comprises a strong partnership of water companies, industry, specialized SME, applied research institutes, technology platforms, city and regional authorities. The members of the consortium are the following: KWR (Netherlands), KWB (Germany), FHNW (Switzerland), UCRAN (UK), STRANE (France), Eurecat-CTM (Spain), IVL (Sweden), NTUA (Greece), UNEXE (UK), ICCS (Greece), ESCI (Germany), UBATH (UK), IPSTAR (Netherlands), BIOPOL (Hungary), WssTP (Belgium), ANB (Romania), AVB (Germany), YTL (UK), STW (UK), AQM (Netherlands), PZH (Netherlands), WdD (Netherlands), ADASA (Spain), ACA (Spain), EYDAP (Greece), CoA (Greece), CHEM (Greece), RoG (Sweden), AVA (Switzerland), CTU (Switzerland)

For each of them, NextGen builds on an impressive portfolio of research and innovation projects and leverages multiple European and global networks to deliver real impact

The project website is: https://nextgenwater.eu/

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Compact and modular tertiary water reclamation system. Easy and safe production of reclaimed water from urban or industrial treated wastewater
- **Project Name:** REGIREU
- **Funding Programme:** ACCIÓ - RIS3CAT
- **Company Name:** teqma (tecnologías y equipos para el medio ambiente S.L.)
- **Location:** Vilanova i la Geltrú (Barcelona)



Scope of Innovation Solution

A compact, modular water reclamation system is developed based on innovative specific filtration and disinfection steps in a single compact unit to produce safe and reliable reclaimed water. The solution targets water-stressed urban areas or water-intensive industries where reclaimed water would be a valuable asset.

Innovation Solution

A compact, modular water reclamation system is developed. Proven innovative technologies with a long track record are efficiently combined in this compact, modular water reclamation concept. The main innovative aspect is the efficient combination of high performance and low OPEX filtration technology (Cloth media filtration) with an advanced design UV disinfection step in a single compact unit. The solution is flexible in terms of effluent quality requirements with different system configurations (customization) depending on the required reclaimed quality according to intended use (e.g. agricultural irrigation, golf course irrigation, environmental use or firefighting). All treatment step dynamics and requirements are efficiently managed to produce safe reclaimed water efficiently and reliably.

The solution will be demonstrated on a medium-sized pilot plant using real wastewater effluent form urban and industrial WWTP.

Key Elements / Priorities

- Evaluate the synergies of the combination of efficient filtration and disinfection technologies in a single autonomous treatment unit.
- Validate system robustness against increasing quality requirements under new EU regulations proposed for the use of reclaimed water for agricultural use.

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- Demonstrate system flexibility and reliability under different operational conditions and water matrices (urban and industrial wastewater).
- Obtain reported experiences to motivate stakeholders to consider this solution for water reclamation as a controlled risk activity.

Kev Outcomes / Benefits

- Significant reduction of construction, installation and commissioning time (30 to 60%) over conventional unitary reclaimed water treatment plants thanks to the compact, integrated plug and play-like concept.
- Advanced process control and improved energy efficiency with potential savings from 20 to 40% OPEX against conventional technologies available on the market. High reclaimed water yield, 90 to 95% conversion rate.
- Reliable and long track record of proven technologies set together in a single compact and modular solution.
- Decentralized solution offering point of-use treatment.
- Allows on-demand production and fit-for-purpose solution design (customization).

Innovation Solution Drivers

- Already proven state-of-the-art water reclamation technologies with further development possibilities as a basis for innovation.
- Improved system reliability providing real-time process monitoring for early warning and a reduced need for routine (lab-based) analysis.
- Compact, modular design concept offering a customizable platform able to tackle all kinds of specific needs.
- Reduced use of energy and OPEX costs for sustainable water reuse, of major concern to stakeholders and utility managers to ensure sustainable pricing for reclaimed water services.

Outcomes and challenges

The technologies used in the compact system have shown good performance as part of water reclamation schemes and its integration into a single compact unit is expected to increase synergies. Validation in real facilities treating conventional water effluent (urban or industrial) would be a perfect demo to fine tune the innovative solution if necessary as well as providing a showcase to motivate stakeholders to invest in water reclamation as a controlled risk activity with measurable benefits.

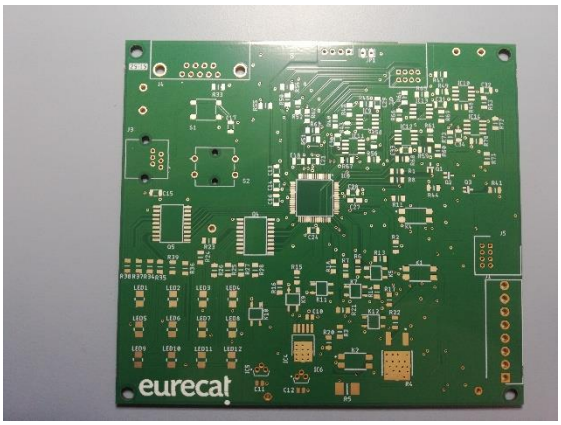
The current lack of harmonized regulations across Europe limits the expansion of water reclamation activities in certain areas. Newly proposed EU regulations on water reuse for agricultural purposes will be an opportunity while setting new quality requirements to be met also in currently operating water reclamation facilities. The innovation presented aims to provide a solution for all cases.

Additional information

teqma, as a specialized water technology solutions company, follows its water reclamation R&D programme started with the R3Water co-financed project (7th framework programme) resulting in the development and demonstration of doscontrol®, an innovative combined disinfection process (UV + Chemical oxidation) controller for water reclamation. https://www.teqma.com/tecnologias/doscontrol

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Optimal use of UV-LEDs for water disinfection
- **Project Name:** REGIREU
- **Funding Programme:** ACCIÓ - RIS3CAT
- **Company Name:** Fundació EURECAT
- **Location:** Manresa



Scope of Innovation Solution

Evaluation of the influence of pulsed excitation control of LEDs (PUV-Pulsed UV) against continuous excitation (CUV-Continuous UV) to reduce the energy requirements of the disinfection process while extending the lifespan of UV-LED emitters.

Innovation Solution

Oxidation and disinfection technologies equipped with conventional UV generation are currently used in different sectors such as the fields of urban and industrial wastewater treatment. The main disad-vantages of the use of conventional UV technologies are their high energy consumption, their space requirements, their short lifespan and the problems related to the management of used lamps, since they contain highly polluting metals. In recent years, UV-LEDs have emerged as a new generation source of UV radiation, which present several advantages in terms of performance, cost and durability.

These UV-LEDs have the capacity to work at specific wavelengths. In terms of environmental impact, they are considered as being a more sustainable option than conventional UV systems. They are compact, they consume less energy and have a longer lifespan.

Thus, the UV-LEDs open up a new range of possibilities for the optimization of wastewater treatment for reuse.

Key Elements / Priorities

- Study the influence of different control strategies for UV-LED operation in disinfection.
- Research several combinations of specific UV wavelengths and their impacts on disinfection.

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- Determine the optimal operation strategy of UV-LED disinfestation modules to reduce energy consumption.

Key Outcomes / Benefits

- Reduction of energy consumption and maximization of the efficiency of the disinfection process: There are several advantages of UV-LEDS compared to mercury lamps, such as their reduced dimensions and transportability, robustness, wavelength diversity. They provide the opportunity for new designs of reactors and therefore new applications.

Innovation Solution Drivers

- Combination of different wavelengths, enabling increasing disinfection effectiveness.
- Tailor-made control system to optimize the performance of the system while minimizing energy consumption.
- Development of a specific control circuit with the aim of driving the UV-LEDs while keeping under control their thermal requirements.

Outcomes and challenges

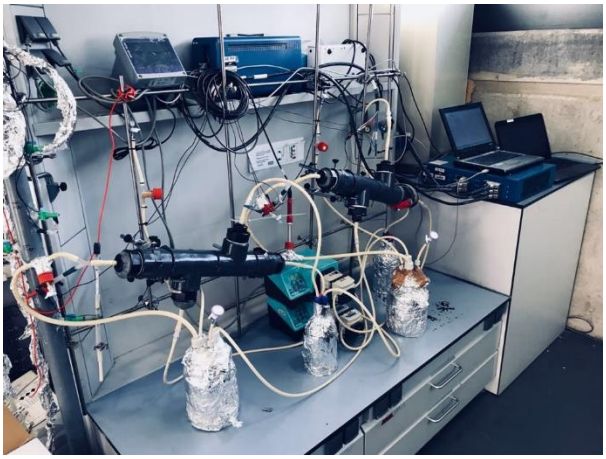
The main challenge for this technology is to reduce the costs associated with disinfection based on UV. These costs are incurred due to the fact that mercury lamps have low electrical efficiency, while their lifespan is limited to about 10,000 hours. On the other hand, UV-LEDS are up to 75% electrically efficient with an estimated lifespan of over 100,000 hours. In this field, there is still a lack of research in the application of UV-LEDs for water regeneration, which is this project's main challenge.

Additional information

Additional information related to the project's objectives and advantages can be found on the following web page: http://www.comunitataigua.cat/projects/regireu/

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Electro bio-conversion of recalcitrant CO2 streams to added value compounds (organics/biofuels)
- **Project name:** DigesTake – Recovery and valorisation of resources from urban digestate within the framework of the circular economy
- **Funding Programme:** ACCIÓ - RIS3CAT
- **Company Name:** Universitat de Girona (UdG) – research group "LEQUIA" (Laboratori d'Enginyeria Química i Ambiental)
- **Location:** Girona



Scope of Innovation Solution

Project DigesTake has one work package fully devoted to the electro bioconversion of CO2 from biogas into high added value organic compounds by means of microbial electrochemical technologies. Thus, CO2 from wastewater treatment plants is upgraded while new biological processes to produce high added value organic compounds (C4-C6) are developed.

Innovation Solution

Project DigesTake aims to produce new knowledge and skills to develop process treatments and technologies to recover, valorise and reuse resources from liquid and gaseous biogas effluents from wastewater treatment plants. Work Package 1, led by the UdG LEQUIA research group, investigates the bioconversion of carbon dioxide from biogas into organic compounds by means of bioelectrochemical systems. Expected results are new biotechnologies for biogas upgrading and production of organic compounds.

Key Elements / Priorities

- Upgrade biogas from wastewater treatment plants to boost electricity production from a renewable source.
- Convert carbon dioxide into organic compounds by means of bioelectrochemical systems.

Kev Outcomes / Benefits

- Reduce the carbon footprint of wastewater treatment plants.
- Reduce the use of fossil resources to produce organic compounds as commodities.

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- Optimize electricity production from biogas.

Innovation Solution Drivers

- Meet European and international targets for climate and energy.
- Increase the competitiveness of wastewater treatment plants by creating new business opportunities.

Outcomes and challenges

The project is currently under development. Preliminary experiments at lab scale have proven the high potential of the technology. The project will address the main challenges of its future industrial upscaling, such as i) low mass transfer of carbon dioxide and hydrogen from gas to liquid phase by producing H2 in situ, and ii) selective production of targeted compounds (minimizing downstream costs).

Additional information

http://www.comunitataigua.cat – Project DigesTake (WP1)

Community name:
RIS3CAT Energia

- **Innovation Solution Title:** Renewable gas production through biogas upgrading and catalytic methanation
- **Project Name:** Combustibles Sintètics (CoSin)
- **Funding Programme:** ACCIÓ – RIS3CAT
- **Company Name:** Naturgy, Cetaqua, Institut de Recerca en Energia de Catalunya (IREC), Labaqua
- **Location:** Barcelona

Scope of Innovation Solution

Producing high-quality renewable gas generated from organic waste as an alternative to the standard production of electrical and thermal energy at WWTPs. This biomethane or synthetic gas is of sufficient quality for use as fuel for vehicles or for direct injection into the natural gas grid.

Innovation Solution

An interesting, often undervalued renewable energy source is biogas generated by anaerobic digestion of organic waste, such as sewage sludge, agricultural or livestock waste. Biogas can be valorised by converting it to renewable gas of sufficient quality for use as fuel in vehicles or for injection into the natural gas grid. The production of biomethane represents a clear example of the circular economy, since it allows producing fuel from organic waste, such as wastewater treatment sludge. The process of converting biogas into renewable gas was optimized using membrane technology as well by chemical reaction with hydrogen. Biomethane allows the substitution of fossil natural gas at competitive prices. Membrane technology stands out for being compact and robust. Synthetic natural gas faces the challenge of managing renewable energy surpluses (power-to-gas concept). CO2 sources likely to feed the methanation process may include the residual current produced during biogas upgrading or combustion fumes. In this sense, the process of methanation can facilitate a greater presence of wind and photovoltaic energy in the electric mix, remove CO2 from the atmosphere, and reduce the consumption of fossil origin natural gas.

Key Elements / Priorities

- Production of synthetic fuels from carbon of biogenic origin or by reusing carbon dioxide and/or water.
- Use these synthetic fuels as large-scale energy storage that allows increasing the share of non-fossil-source energies.
- Development of a circular economy around CO2 emissions contributing to their effective reduction through the use of a closed loop of carbon of biogenic origin.
- Energy interconnection between the electricity and gas networks and promotion of new options and opportunities for the development of new energy models.
- Use of biomass and other sources of waste with organic content such as sewage sludge and/or slurry contributing to environmental improvements.

Key Outcomes / Benefits

- Validation of membrane technology for biogas upgrading.
- Demonstration of catalytic methanation technology.
- Comparison between methanation of biogas and CO2.
- Production of biomethane and synthetic natural gas of sufficient quality for use as vehicle fuel or for injection into the natural gas grid.
- Validation and comparison between quality measuring equipment's.

Innovation Solution Drivers

- Need to promote renewable energies.
- Waste valorisation into green energy.
- Need to store renewable energy surplus (power-to-gas).

Outcomes and challenges

Technically validate membrane technology for biogas upgrading and CO2 catalytic methanation through field evaluation and laboratory tests. Validate the integration of these technologies in a biomethane generation system from WWTP biogas. Establish a synergy between upgrading and methanation plants, using the CO2 of the former. Achieve suitable gas quality for injection into the natural gas grid, according to Spanish PD-01 and European drafts. It is a challenge to validate and identify the most competitive commercial equipment to control the quality from the technical and economic points of view.

It is a scientific and technological challenge to implement cheaper, more efficient components, processes and technologies, with less maintenance and operating costs. All these aspects become essential to reduce the cost of synthetic fuels to make them competitive, which is, nowadays, a serious economic challenge.

We must be aware of the fact that the most suitable technology for using biogas generated from organic waste and renewable energy will change over the years and we have to be able to adapt, for example, by upgrading to methanation, passing through a combination of both.

Application sectors:
Chemistry Industry
Other Industry

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Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Resources recovery from brine
- **Project Name:** Eflucomp
- **Funding Programme:** ACCIÓ - RIS3CAT
- **Company Name:** Eurecat
- **Location:** Manresa

Scope of Innovation Solution

The proposed solution aims to recover water and valuable compounds from brine using membrane-based technologies.

Innovation Solution

The solution will allow recovering valuable compounds and water and take advantage of brine, which is currently considered a waste product. The solution combines precipitation and membrane technologies to produce compounds such Mg(OH)2, Na2SO4 and NaCl that can be valorised in different industries. In the case of brine for the agrifood sector, brine will be obtained with a low organic matter content.

The main innovation of the solution is the use end-of-life reverse osmosis membranes to produce tailor-made membranes by applying a regeneration process.

The solution developed will be applicable to different brines increasing resource efficiency in industrial processes.

Key Elements / Priorities

- Versatile technology able to treat brines of different composition.
- Optimization of the membrane regeneration process to produce tailor-made membranes for different applications.
- Optimization of conditions for producing Mg(OH)2.
- Efficient separation of monovalent and divalent ions thanks to the use of tailor-made membranes.
- Efficient separation of organic matter from salt.

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Community name:
Comunitat de l'Aigua

Key Outcomes / Benefits

- Reduced investment cost thanks to the use of regenerated membranes.
- Reduced energy consumption in membrane processes.
- Removal of organic matter from agrifood brine obtaining NaCl that can be reused.
- Revenues from compounds obtained making the process economically feasible.

Innovation Solution Drivers

- Brines valorisation turning a waste product into a resource.
- Reduce implementation and operating costs in comparison with existing technologies used for brine treatment.
- Increase resource efficiency in the industry.

Outcomes and challenges

The main challenge is to develop a new solution capable of reducing the amount of brine produced in industries by recovering resources. Tailor-made membranes will be developed for different brines depending of the components to be separated. In addition, strategies for compound recovery will be evaluated in order to recover high purity compounds that could be valorised. Tests on industrial brine will be performed at laboratory and pilot scale.

Additional information

The need for a solution addressing brine management has led to the development of Zero Liquid Discharge (ZLD) systems that eliminate brine disposal through the conversion of brine into pure water and salt. However, though water is always exploited through recycling, the solid salts produced are considered of low value as they comprise a mix of different salts, and they currently end up in landfills.

In addition, brine containing organic matter are a big problem for the agrifood industries.

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Smart decision support system for the optimization of innovative wastewater reclamation technologies
- **Project Name:** INTEGROIL
- **Funding Programme:** H2020
- **Company Name:** ACCIONA Agua S.A.U.
- **Location:** El Prat de Llobregat (Barcelona)

Scope of Innovation Solution

Integroil has developed a robust, flexible and integrated solution for the treatment of water flows from water-intensive industries with the ultimate goal of facilitating its reclamation & reuse for different applications. This solution consists of a smart decision support system capable of dynamically selecting and implementing the most suitable treatment scheme.

Innovation Solution

The INTEGROIL solution is composed of five innovative treatment processes (dissolved air flotation (DAF), ceramic ultrafiltration (UF), catalytic wet air oxidation (CWAO), advanced oxidation processes (AOP) and reverse osmosis (RO)) controlled by a smart decision support system (DSS). This DSS is capable of selecting the most suitable treatment scheme based on the influent water quality (determined by online sensors) and the required water quality (selected by the end user based on its final use) at minimal cost. As a result, the DSS is able to determine, dynamically, which is the optimal treatment scheme and to actuate the system, activating/deactivating processes and conducting the associated actions (e.g. opening/closing valves, switching on/off engines, etc.). As a result, only those processes needed to achieve the required final quality are operative, reducing the associated operational costs and also avoiding overtreatment of the final effluent. This enables obtaining fit-for-use reclaimed water at minimal cost, increasing the industrial competitiveness and the sustainability of industrial activities, without the need for highly experienced personnel.

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Community name:
Comunitat de l'Aigua

Key Elements / Priorities

- Application of information and communication technologies (ICT) and machine learning tools to develop a DSS capable of selecting and implementing the optimal treatment scheme in real time. A high level of expertise is not needed, neither regarding water treatment nor ICT
- 1.5 m3/h nominal plant capacity comprising the above-mentioned 5 innovative technologies managed by the DSS:
    - Continuous operation 24/7
    - Fully automated & equipped
    - Remote access and control
    - Modular & compact
    - Reliable scale
    - Plug&Play concept
- Operation of the solution for 10 months in 2 different scenarios
    - Upstream, corresponding to oil abstraction
    - Downstream, corresponding to refinery
- Fit-for-use concept: avoiding overtreatment but ensuring final quality.

Kev Outcomes / Benefits

Within the case study selected:

- Replacement of freshwater with reclaimed water:
    - 70% of injection water (upstream scenario).
    - Up to 95% of wastewater (downstream scenario).
- Net freshwater saving from 0.88 to 1.04 m3 of freshwater per m3 of wastewater treated.
- Upstream scenario: reuse for injection leads to an overall benefit of 6.2 €2019/m3 produced water.
- Downstream scenario: Boiler reuse reduces costs by 54% compared to conventional treatments.

Innovation Solution Drivers

- Technical complexity of the treatment of industrial water.
- (Typically) high associated costs.
- Water scarcity and need to move towards the circular economy.
- Environmentally friendly formulations developed.

Outcomes and challenges

In order to ensure the implementation of INTEGROIL, not only it should be advantageous in terms of sustainability, but also in economic terms. Not in vain, the cost of technologies is identified as one of the main barriers that can prevent new technologies from entering the market. The integrated solution should present competitive costs compared to the conventional technologies currently used, also enabling greater competitivity of the industries adopting this approach.

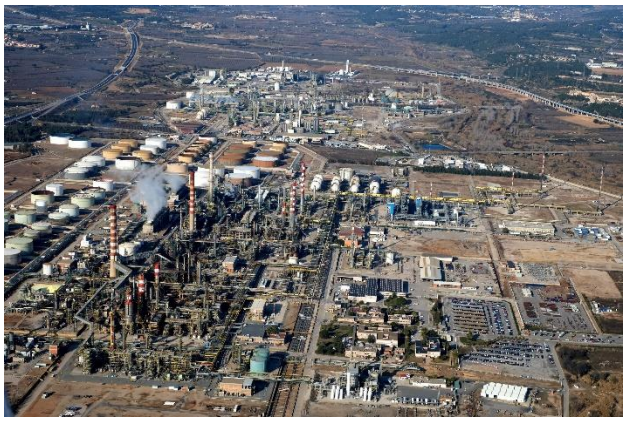
The social perspective is also important from a two-fold commercial perspective. First, the safety of reused water is always controversial for certain applications even though the safety of reclaimed water is ensured if proper treatment is implemented. Secondly, water-intensive industrial sectors are very sensitive to public perceptions. These industries are making a major effort to implement sustainable technologies that contribute to improving their commercial brand. INTEGROIL helps them to achieve their objectives.

Additional information

Despite the fact that the DSS has been assessed in the Oil sector, it is expected to be applicable in other industries with complex, highly variable water streams. In this case, other processes can be added to the DSS algorithm, and more sensors and associated parameters can also be considered in the DSS. Moreover, further water quality targets can be added to the DSS, customizing it as required.

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Innovative water recycling scheme in the petrochemical industry
- **Project Name:** Demonstration of an innovative recycling scheme to increase water efficiency in the petrochemical industry (LIFE REWATCH)
- **Funding Programme:** LIFE
- **Company Name:** Eurecat
- **Location:** Manresa (Barcelona)



Scope of Innovation Solution

REWATCH aims to develop, test and demonstrate innovative technology to enable water recycling in the petrochemical industry. Ensuring the safe and efficient use of water resources, improving its quantitative water management while preserving high water quality and avoiding the misuse and deterioration of water resources derived from its activities.

Innovation Solution

The on-site water recycling scheme proposed in the REWATCH project will include five different technologies to constitute a completely new treatment scheme never used before in the petrochemical industry: physicochemical pre-treatment, moving bed biofilm reactor (MBBR), ultrafiltration (UF), reverse osmosis (RO) and water deionization using ion exchange resins (IER). The process will be designed in such a way that the treated wastewater may be used after each treatment step depending on the desired water quality. One of the main challenges (but also the main innovation of the project) will be to demonstrate that the new process can be replicated at other petrochemical plants to improve their water efficiency. The proposed treatment scheme will be able to achieve different water qualities depending on the needs of the petrochemical plant, making the water treatment process as sustainable as possible through optimal energy and reagent consumption.

Key Elements / Priorities

- Demonstrate the feasibility and promote the implementation of the innovative water reuse scheme in petrochemical industries.
- Quantify and disseminate the environmental benefits and economic impact of the innovative water recycling scheme compared to the water management strategies currently applied.
- Develop a decision support tool to predict the environmental and economic benefits of the new technology.

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- Reduce freshwater consumption in the industrial sector, contributing to the challenges of climate change, as well as to the protection of ecosystems.
- Decrease carbon emissions from water management in the petrochemical industry, contributing to humans' adaptation to the new challenges of climate change.

Key Outcomes / Benefits

- Optimal operating conditions determined at bench scale for each step of the innovative water recycling scheme to properly design the prototype.
- Obtain a versatile water recycling scheme for the proper treatment of petrochemical wastewater (expected min. 65% water recovery).
- Quantify the environmental and economic gains of the innovative recycling scheme.
- Obtain effluents that can be reused in different points of the petrochemical industry, including those where high water quality is required, such as boilers (conductivity <1 µS/cm and TOC <1 mg/L).
- Develop a decision-support tool to predict the new process performance and encourage other petrochemical industries to implement the new water recycling scheme.

Innovation Solution Drivers

- Obtain a versatile water recycling scheme to treat different wastewater streams generated in petrochemical processes.
- Use five different technologies to constitute a completely new treatment scheme never used before in the petrochemical industry.
- Increase the availability of freshwater resources by using freshwater more efficiently.
- Educate and make society and industry aware of the impact of water reuse.
- Improve the status of Ebro river aquatic ecosystems.

Outcomes and challenges

- Reduce the environmental impact related to water management in petrochemical plants. After the project, full-scale implementation is expected to reduce the water footprint by a min. of 15%, energy consumption by 15%, and CO_2 emissions by 10% related to water management in petrochemical plants.
- Decrease the economic impact related to water management in petrochemical plants (min. 10% decrease in water management costs).
- Dissemination of the results obtained. The possibility of transferring the innovative water recycling scheme to other petrochemical industries is an expected added value of the project.
- Increase public awareness of the environmental impact caused by water management in the industrial sector.

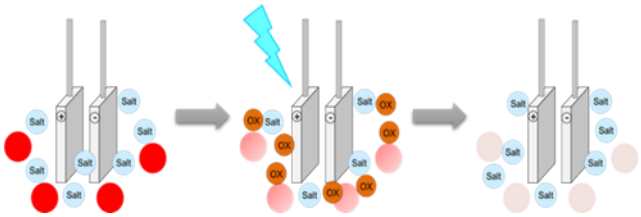
Additional information

The consortium has received funding from the European Union's LIFE programme under grant LIFE15/ENV/ES/000480. It is financed by this framework from 1 September 2016 – 31 December 2019.

The project website is: http://rewatch.eu/

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Electro-oxidation process to water and salt reuse
- **Project name:** ELECTRO-PURIFICATION OF INDUSTRIAL WASTEWATERS: TECHNICAL, ENVIRONMENTAL AND ECONOMICAL VIABILITY - ELDE
- **Funding Programme:** ACCIÓ (RIS3CAT)
- **Company Name:** INTEXTER – Universitat Politècnica de Catalunya (UPC)
- **Location:** Terrassa



Scope of Innovation Solution

Development of an innovative technology based on the electro-oxidation process that allows for reductions in the costs associated with the management and treatment of wastewater from the textile, chemical and tanning industries.

Innovation Solution

Electro-oxidation treatment is based on the generation of oxidant species from the salts present in the effluent. These species are able to break down organic molecules, in dyes for example, into smaller, colourless molecules. The technology was successfully applied in the textile sector to remove the colour of effluents and to reuse them in new dyeing processes.

The ELDE project, which is focused on the use of electro-purification techniques to treat and reuse industrial wastewaters, is currently underway. The term "electro-purification" includes those techniques that use electricity for the separation of ions and/or for the generation of chemical reagents that are able to purify wastewaters. The electro-oxidation process has been evaluated in two highly pollutant industrial sectors (chemical and leather), whose effluents are difficult to treat using conventional methods because of their high salinity and the presence of poorly-biodegradable compounds. The results showed that the electro-oxidation process can remove up to 65% of the colour of effluents generated by the tanning sector. In the chemical sector, the treatment yielded 60% removal of organic matter.

On the basis of the results, a 20L/h "multisector" pilot for the chemical and the leather sectors has been designed. It will be manufactured by the end of 2019.

Key Elements / Priorities

- Electro-oxidation process applied as sustainable industrial wastewater treatments
- Reuse of treated effluents in the industrial process.
- Improvement in industry's environmental impact.
- Technical and economic feasibility of electro-oxidation technique applied to the textile, chemical and leather sectors.

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Community name:
Comunitat de l'Aigua

Kev Outcomes / Benefits

- The reuse in-situ of water provides an opportunity to reduce the consumption of natural resources.
- The reuse of raw materials, such as salts, in new production processes.
- The application of the eco-design concept in the construction of the pilot plants is a way to increase the sustainability of wastewater treatments.
- The design and construction of a versatile multisector pilot, validated in chemical and leather sectors, could be applied to other sectors in further studies.

Innovation Solution Drivers

- Conventional wastewater treatments are inefficient in treating some types of industrial effluents as they contain high levels of salts, poorly biodegradable organic matter, etc. New technologies such as the electro-oxidation process must be developed and applied to deal with this problem.
- The reuse of water is a challenge in many industrial sectors and efforts should be made to improve its technical, economic and environmental feasibility.
- The successful development of a commercial electro-purification system to treat and reuse textile wastewater is a starting point from which to expand the technology in other sectors.
- The overconsumption of raw materials should be tackled with sustainable solutions such as the reuse of wastewater, the reduction of chemicals and eco-design.

Outcomes and challenges

The overall goal is the use of electro-oxidation process to treat the wastewater of companies that generate saline effluents, with a view to reducing the costs of wastewater and improving its quality. The technology has been validated in the textile sector where it has shown that it can completely remove the colour of effluents. In addition, the reuse of the treated effluents yielded a 70% reduction in water consumption and up to 100% salt recycling.

The main challenge of the ELDE project is to transfer the technology to the chemical and leather industrial sectors:

- Selection of the most suitable effluents for electro-oxidation treatment to yield a reduction of COD.
- Manufacture of a flexible multisector pilot plant able to treat 20L/h.
- Evaluation of the reusability of treated effluents.

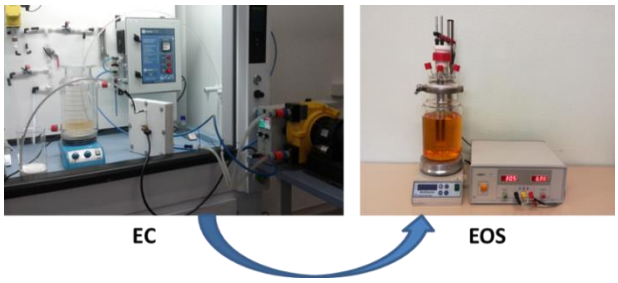
The impact of the processes in each sector will also be studied. The reduction of the environmental impact with the electro-oxidation technique will be evaluated with respect to current wastewater treatments. The technical and economic viability will be also determined.

Additional information

The ELDE project is coordinated by the INTEXTER research centre, which belongs to Universitat Politècnica de Catalunya (UPC). The consortium also includes the IREC and Eurecat technology centres and the SMEs Waterlogies, CIM Aigua and Lavola. This project (COMRDI16-1-0066) was co-founded by the European Union through European Regional Development Fund (ERDF). It is one of the projects developed by the RIS3CAT Water Community, accredited by the Catalan Government through ACCIÓ.

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Combination of electrocoagulation and electro-oxidation techniques to treat and reuse industrial effluents
- **Project name:** ELECTRO-PURIFICATION OF INDUSTRIAL WASTEWATERS: TECHNICAL, ENVIRONMENTAL AND ECONOMICAL VIABILITY - ELDE
- **Funding Programme:** ACCIÓ (RIS3CAT)
- **Company Name:** EURECAT i INTEXTER – Universitat Politècnica de Catalunya (UPC)



Scope of Innovation Solution

Development of an innovative technology based on electro-purification techniques that allow for reductions in the costs associated with the management and treatment of wastewater from the paper, chemical and tanning industries.

Innovation Solution

The ELDE project is focused on the use of electro-purification techniques to treat and reuse industrial wastewaters. The term "electro-purification" includes those techniques that use electricity for the generation of chemical reagents that are able to purify wastewaters: electro-oxidation in situ (EOS) and electro-coagulation (EC).

Three highly pollutant industrial sectors have been selected (paper, chemical and leather) whose effluents are difficult to treat using conventional methods because of their high organic load, high salinity and the presence of non-biodegradable organic compounds. The characteristic effluents of these sectors are studied in the ELDE project and treated using a combination of the two electro-purification techniques. Two pilots will then be constructed to evaluate the feasibility of treating and reusing the effluents generated: a 1m3/h pilot for the paper sector and a 20L/h "multisector" pilot for the chemical and the leather sectors. Another significant objective of the ELDE project is the development of a new high-efficiency power supply and the use of renewable energy sources to reduce the energy consumption associated with electro-purification techniques. Lastly, technical, environmental and economic viability will also be evaluated.

Key Elements / Priorities

- Electro-purification techniques applied as sustainable industrial wastewater treatments
- Reuse of treated effluents in the industrial process.
- Reduction of electricity consumption associated with electro-purification by developing a new power supply system and by using renewable energy sources.
- Improvement in industry's environmental impact.
- Technical and economic feasibility of electro-purification techniques applied to the paper, chemical and leather sectors.

Kev Outcomes / Benefits

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- The reuse in-situ of water provides an opportunity to reduce the consumption of natural resources.
- The application of the eco-design concept in the construction of the pilot plants is a way to increase the sustainability of wastewater treatments.
- The design and construction of a versatile multisector pilot, validated in the chemical and leather sectors, could be applied to other sectors in further studies.
- In the paper sector, the project is intended to support mainly the companies that are currently manufacturing with reused wastewater. The electro-purification of effluents makes it possible to obtain higher quality products while consuming fewer chemicals in the production process.

Innovation Solution Drivers

- Conventional wastewater treatments are inefficient in treating some types of industrial effluents as they contain high levels of salts, poorly biodegradable organic matter, etc. New technologies such as electro-purification techniques must be developed and applied to deal with this problem.
- The reuse of water is a challenge in many industrial sectors and efforts should be made to improve its technical, economic and environmental feasibility.
- The successful development of a commercial electro-purification system to treat and reuse textile wastewater is a starting point from which to expand the technology in other sectors.
- The development of higher-efficiency power supply systems and the promotion of renewable energies is currently of interest.
- The overconsumption of raw materials should be tackled with sustainable solutions such as the reuse of wastewater, the reduction of chemicals and eco-design.

Outcomes and challenges

The overall goal is the use of electro-purification technologies (EOS and EC) to treat the wastewater of companies that generate saline effluents with a view to reducing the costs of wastewater and improving its quality. Two fully automated pilot plants operated with renewable energy sources have been manufactured for the paper, chemical and leather sectors.

The project covers the following sectors:

Paper Sector:

- Manufacture of an electro-purification pilot plant (1m3/h) able to achieve a reduction of 8,000 mg/L COD.
- Reduction of the energy consumption associated with the selected technologies.
- Reuse of water in-situ in the industrial production process and validation of the system.

Chemical and leather sectors:

- Selection of the most suitable effluents for electro-purification treatment to yield a reduction of at least 50% COD.
- Manufacture of a flexible multisector pilot plant able to treat 20L/h.
- Evaluation of the treated effluents' reusability.

The impact of the processes in each sector will also be studied. The reduction of the environmental impact using electro-purification techniques will be evaluated with respect to current wastewater treatments. The technical and economic viability will be also determined.

Community name:
Comunitat de l'Aigua

Additional information

The ELDE project is coordinated by the INTEXTER research centre, which belongs to Universitat Politècnica de Catalunya (UPC). The consortium also includes the IREC and Eurecat technology centres and the SMEs Waterlogies, CIM Aigua and Lavola.

This project (COMRDI16-1-0066) was co-founded by the European Union through European Regional Development Fund (ERDF). It is one of the projects developed by the RIS3CAT Water Community, accredited by the Catalan Government through ACCIÓ.

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Molecular separation by electro activation of solutions
- **Project name:** ELECTRO-PURIFICATION OF INDUSTRIAL WASTEWATERS: TECHNICAL, ENVIRONMENTAL AND ECONOMICAL VIABILITY - ELDE
- **Funding Programme:** ACCIÓ (RIS3CAT)
- **Company Name:** WATEROLOGIES SL
- **Location:** Igualada, Catalonia, Spain.
- **Project Cost:** 289.000,00€
- **CE Value Created ($/year):** 2016

Scope of Innovation Solution

We can really break down molecules into smaller parts and paste them with others in a simple way and using only electricity for it. This causes a reduction in the production costs of some products such as fertilizers, pharmaceuticals, probiotics, while it can break down waste into non-polluting elements and convert them into by-products.

Innovation Solution

Molecular separation of elements from dissolved salts through ceramic membranes doped with graphene elements and other materials at the same time that they are subjected to an intense electric field. The elements are separated into two or more independent flows from each other. Specially to remove chlorides from waste. Also, to separate molecules in Pharma to synthesize more complex ones.

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Community name:
Comunitat de l'Aigua

Key Elements / Priorities

The priority elements are the doped metal materials and, above all, the technology of hydraulic contact with the electrodes through conductive membranes that allow filtration by molecular size, not only by pore size but by electrical attraction of the elements that compose it.

Kev Outcomes / Benefits

- Benefits. It allows reusing brines, separating undesirable elements in process and wastewater, valuing waste as by-products and designing simple and economical processes without reagents or batch reactors, but in continuous production. Savings of up to 80% in elimination of chlorides and convert them into ecological disinfectants.

Innovation Solution Drivers

- Electronic control of creation of new substances.
- Cheaper synthesis processes.
- Convert waste into by-products.
- Reuse reagents.
- Continuous processes in pharma.

Outcomes and challenges

We are working on creating multi-electrolytic cells capable of creating up to 4 different flows per process and designed equipment of up to 16 cells. Our intention is to create software to control any synthesis process from the initial molecules to the desired molecules.

Additional information

Waterologies, S.L. It is a basic level supplier of the United Nations group nº 466753. We collaborate with CSIC (ESP), INRA (FRA), IRAE (ITA), Diputació de Barcelona and we have been awarded the Deloitte Award (2013) for projects with greater expected social impact. In 2016 Techcrunch dedicated an article in its Silicon Valley and worldwide edition. In 2017 we were named as one of the companies with the greatest projection in the water sector worldwide, the only one in Europe.

We also develop electrochemical biosensors and emergency equipment for natural disasters, as well as industrial projects for resource reuse and recovery of difficult waste treatment.

Application sectors:
Construction
Energy

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European Regional Development Fund

Community name:
RIS3CAT Energia

- **Innovation Solution Title:** Second life of electric vehicle batteries
- **Project Name:** REFER, SUNBATT, PLATBATT, HELIS
- **Funding Programme:** ACCIÓ (RIS3CAT, Nuclis), Private, H2020
- **Company Name:** Institut de Recerca en Energia de Catalunya **(**IREC)
- **Location:** Sant Adrià de Besòs

Scope of Innovation Solution

Electric vehicle batteries are said to be inappropriate for traction purposes when their useful capacity decreases to around 20%, mainly because of range anxiety issues. However, these batteries are still useful, retaining 80% of their state of health and could be reused in less aggressive environments in stationary applications.

Innovation Solution

Li-ion batteries, which are set to dominate the energy storage market in the coming years, are still too expensive for mass deployment. However, second-life batteries could become an affordable and reliable alternative for stationary applications.

Also, the electricity market considers energy storage systems a solution to face new challenges regarding the expected electricity consumption increase caused, for instance, by the electro-mobility expansion and uncontrolled production caused by the entrance of distributed electricity generation systems.

The solution to re-use the electric vehicle battery in residential, tertiary and industrial sectors and in any part of the electricity transmission and distribution network needs to identify the technical capabilities, requirements, costs and benefits to estimate where participation is most interesting.

Key Elements / Priorities

- Determine possible battery reuse strategies and their transformation needs.
- Identify the stakeholders involved and the regulatory barriers.
- Determine the costs of battery reuse and how they could be reduced in new battery designs.
- Determine the economic and environmental benefits for each possible stationary application business case.
- Determine the expected lifespan of second-life batteries.

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Key Outcomes / Benefits

- New economic activities in the territory.
- Eenhance the emergence of renewable energy power sources.
- Enhance the sale of electric vehicles (battery sale at end of life should lead to a reduction in electric vehicle cost).
- Reduce waste and enhance the circular economy.
- Ease the incorporation of energy storage systems in the regulation of the electricity markets.

Innovation Solution Drivers

- The automotive sector is pressed to recycle and recover between an 85 and 95% of vehicle mass and battery weight is about 300kg.
- Waste management of the battery at the end of life in the automotive sector is complicated and expensive.
- EV batteries at their end of life in transportation have still 70-80% of their capacity.
- New Li-ion batteries are too expensive for mass deployment in stationary and grid-connected applications.
- Energy storage will enhance the emergence of renewable and distributed power sources and the possibilities to offer demand response services.

Outcomes and challenges

The idea of battery reuse first appeared as an alternative to the high cost of Lithium ion battery recycling when the first electric vehicles were sold. The idea was to take advantage of the remaining capacity of the electric vehicle battery for less intensive stationary applications and to identify which where the transformation needs for this transition.

The first outcomes showed that many of the challenges facing battery re-use could be easily solved by applying eco-design strategies from an early stage. That is, designing the electric vehicle battery considering the possibility to reuse it afterwards. Some of these challenges are: the need for a gateway to communicate with stationary systems instead of the vehicle control unit, the stack-ability of batteries for high energy and high power installations, battery dismantling for smaller energy storage systems, battery cooling systems, the functional voltage of the batteries on EVs (as nowadays there is no commercial inverter that works within the 200-400V range on the DC side), and similar actions.

Community name:
RIS3CAT Energia

- **Innovation Solution Title:** Tool for eco-innovation in innovative technologies of the energy sector
- **Project Name:** LCAEnerboost
- **Funding Programme:** ACCIÓ-FEDER
- **Company Name:** Inèdit Innovació SL, Precision Consulting SL
- **Location:** Barcelona

Scope of Innovation Solution

The project LCAENERBOOST® aims to ensure that technological energy innovations are also more sustainable options. Therefore, a transversal solution should be offered that allows companies from the entire RIS3CAT Energy Community to compare their innovations with other options available in the market throughout their lifecycle.

Innovation Solution

The main objective of the LCAEnerboost project is to incorporate eco-innovation as a driver of change in the energy sector. The project has allowed developing an online analysis tool by the name of LCAEnerboost that, from a lifecycle perspective, has systematically evaluated the current conventional technologies of the energy sector and future technologies to be developed within the framework of the RIS3CAT community.

The master lines of the work consist of: defining the chosen products of the energy sector and the relevant aspects to be considered; establishing a systemic methodology to measure the sustainability of the energy sector around Life Cycle Assessment (LCA), and creating an online tool in webpage format (LCAEnerboost) so that companies can verify their reduction in environmental impact. These actions will help boost eco-innovation strategies that promote reducing energy and raw materials consumption.

The LCAEnerboost tool can be used by any company in the sector to analyse the impact of the conventional technologies that appear in the database of the tool and especially for the companies participating in the project to compare their new technology with the conventional alternatives. Therefore, it is intended to solve the technical challenge of offering a transversal solution that allows companies throughout the community to be more competitive.

Key Elements / Priorities

- Use of Life Cycle Assessment to analyse technologies in the energy sector.
- Compare innovative solutions against their equivalent conventional technologies to ensure the environmental validation of the innovations.
- Identify hotspots in the innovations created within the RIS3CAT Energy Community.
- Support users to reduce their consumption of resources and energy and their generation of waste.

Key Outcomes / Benefits

- An online tool offering quality information from the energy sector that generates a database of the environmental performance of several innovations (public and private sectors).
- Environmental outcomes in the following impact categories and indicators: Carbon Footprint, Abiotic Depletion (fossil and resources), Eutrophication, Acidification and Cumulative Energy Demand.
- Provide environmental awareness and knowledge to the researchers and technicians working in other fields as engineering, chemicals, etc. to promote process improvement and eco-innovation.

Innovation Solution Drivers

- Incorporate environmental information into energy innovation projects to ensure more sustainable performance in the solutions.
- Verify the expected benefits of new technologies with a consolidated environmental impact methodology.
- Provide researchers and technicians concerned with the need to have environmental knowledge about their innovations.

Outcomes and challenges

During the project, 19 technologies have been analysed from a Life Cycle Assessment perspective working hand-in-hand with researchers, technicians and environmental experts.

For some technologies in their early stages, data collection only represents laboratory scale measures that are far from optimized industrial scale ones. Technicians are not familiar with the type and quality of data needed to achieve a rigorous result on environmental evaluations. However, the quality and the amount of data that has been collected and validated together technicians of each project and the team of LCAEnerboost.

Additional information

More information: http://www.ineditinnova.com/en/caso/tool-for-eco-innovation-in-innovative-technologies-of-the-energy-sector

Community name:
RIS3CAT Energia

- **Innovation Solution Title:** Environmental Life Cycle Assessment of innovative LED linear lighting
- **Project Name:** Repro-Light
- **Funding Programme:** H2020
- **Company Name:** Institut de Recerca en Energia de Catalunya **(**IREC)
- **Location:** Sant Adrià de Besòs

Scope of Innovation Solution

Repro-Light is rethinking the design of LED luminaires taking the principles of the circular economy into consideration with the aim of prolonging their lifespan and designing out waste. Life Cycle Assessment (LCA) is used to compare the environmental impact of the innovative LED luminaire design to current LED luminaire design.

Innovation Solution

The Repro-Light LED luminaire design aims to:

- include components that are easily removable, customizable and re-usable,
- use materials that have a low environmental impact and can be easily recycled,
- minimize the generation of hazardous waste that requires special treatment in both the production and disposal stages of the luminaire,
- minimize the generation of electronic waste through extending the lifespan, and
- reduce energy consumption during use of the lighting.

Key Elements / Priorities

- Determine the components of LED luminaire architecture that can be designed for modularity, replaceability and customization with the goal of improving the lifespan of the luminaire. This will enable a reduction in the waste generated and therefore a reduction in the environmental impact.
- Conduct an Environmental LCA of innovative design, focusing on the evaluation of the components, including production, manufacturing and disposal. Compare the results to those for current LED luminaire design.

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EUROPEAN UNION European Regional Development Fund

Key Outcomes / Benefits

The innovative, modular LED luminaire brings numerous benefits to the customer, the environment and the economy, including:

- Ability to repair luminaires, thus increasing their technical lifetime and reducing waste.
- Ability to upgrade luminaires to improve their performance resulting in greater energy savings, for example, installing a more efficient LED module or adding a sensor to the luminaire.
- Ability to service the luminaires, leading to the development of new business models and the creation of jobs, for example, new opportunities arise for professionals offering monitoring, maintenance and data analytics.

Innovation Solution Drivers

- Lighting products are one of the biggest electricity consumers worldwide and are subject to minimum energy efficiency and labelling requirements.
- Large amounts of electronic waste is continuously being generated, which poses both adverse environmental and health impacts.
- Luminaires cannot currently be upgraded or repaired when a failure occurs, resulting in the disposal of the entire luminaire as opposed to exchanging or upgrading a part of it.

Outcomes and challenges

The outcomes of the preliminary environmental LCA studies have shown that the key components of luminaires are the electronics, including circuit boards and LEDs. However, there are key challenges for the design of a modular luminaire, including the feasibility of using 3D-printed parts and the possibility of interdependencies between the modules meaning that an exchange of one module also necessitates the exchange of another. For example, the upgrade of a LED module to a new generation of LEDs may also require the exchange of the optical system in order to maintain the desired light distribution. In such cases, an integrated solution (LED Module and optics in one unit) may be a good option if it offers cost advantages and does not negatively affect the recycling process. Furthermore, detachable interfaces generally require greater development efforts and can lead to higher material consumption and costs. Thus, it is unclear which choices lead to the most ecological or economical designs, and the use of LCA can help to compare the environmental impact of the various design options.

Application sector: Food Industry

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European Regional Development Fund

Community name:
Community of Technologies for Agrifood Production

- **Innovation Solution Title:** New natural antioxidants from agrifood by-products and residues
- **Project Name:** LIPOXIFEED: Research and valorisation of fat by-products and antioxidants for animal production
- **Funding Programme:** ACCIÓ – RIS3CAT
- **Company Name:** Industrial Técnica Pecuaria, S.A. (ITPSA)
- **Location:** Barcelona

Scope of Innovation Solution

In response to the increasing demand for natural additives, ITPSA is doing research to provide new, natural, sustainable antioxidants from agrifood by-products, with high efficacy regarding fat, raw materials and feed, and a better cost-efficacy ratio in comparison with the current natural antioxidants (tocopherols, rosemary extract, etc.).

Innovation Solution

Currently, synthetic antioxidants are the most commonly used for raw materials and feed for animal nutrition. Although tocopherols and some plant extracts, such as rosemary extract, are effective antioxidants, their costs make them an unfeasible option for livestock feed. To date, an optimum natural antioxidant alternative has not existed. Therefore, new sources need to be investigated.

Specific flavonoids and some other phenolic compounds are known to act protecting lipids and other molecules from oxidation, because of their free radical-scavenging potential or their activity as metal chelators.

ITPSA, together with research centres, is studying different natural alternatives to current antioxidants, based on vegetable phenolic compounds from agrifood by-products. The innovation solution is the use of new natural antioxidants to be added to fat, other raw materials and feed for livestock, obtained from agrifood by-products to respond to the increasing demand for natural antioxidants. At the same time, the obtention of antioxidant extracts allows the re-valorisation of by-products from agrifood industries, reducing residues, and contributing to a circular economy.

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Community name:
Community of Technologies for Agrifood Production

Key Elements / Priorities

- Identification of agrifood by-products and residues with the potential to obtain alternative natural substances for the antioxidant protection of feed, fats and other raw materials.
- Development of extraction and isolation strategies to recover different fractions of active substances with high antioxidant properties.
- Validation of laboratory screening protocols for the evaluation and comparison of the efficacy of natural antioxidants in standardized feed and food matrices.
- Valorisation of available agrifood residues with low seasonality.
- Development and prototyping of natural antioxidant formulation with an optimized cost-efficacy ratio and following a more sustainable strategy than current options.

Key Outcomes / Benefits

- New, natural, highly-effective antioxidants as alternatives to synthetic antioxidants.
- New, natural antioxidants as alternatives to natural, non-sustainable-based antioxidants and with a competitive cost-efficacy ratio.
- Use of a natural antioxidant with beneficial biological effects (e.g. in vivo antioxidant effect, better quality or more stable animal products, gut health promotion, etc.).
- Valorisation of by-products and residues to obtain sustainable natural antioxidants with a beneficial impact in a model of circular economy.

Innovation Solution Drivers

The main innovation solution drivers can be classified into:

- Sector drivers: there is a clear trend towards the use of natural antioxidants for animal and human nutrition. However, there are few effective natural antioxidants in the market. Having agrifood by-products as raw materials to produce antioxidants will reduce production costs, obtaining antioxidants with better cost-efficacy ratios. This solution will provide new options to customers and will consolidate ITPSA as a world-wide reference in the production and marketing of antioxidants for feed and food. Among sector drivers we consider:
  - **New solutions for the sector.**
  - **Responding to market trends.**
  - **Value creation.**
  - **Cost-efficacy optimization**.

- Environmental drivers: re-valorising by-products or residues is important for reducing their volume and contributes to the eco-friendly production of antioxidants. The main environmental driver is:
  - **Re-valorisation of residues/by-products and prevention of deleterious environmental impacts led by a sustainable, eco-friendly strategy**.

Outcomes and challenges

The main outcome is the obtention of effective natural antioxidants from agrifood industries with no environmental drawbacks. Moreover, this solution will not only reduce the volume of residues, but also the residues derived from the production of synthetic antioxidants, thereby contributing to the sustainable production of antioxidants and to a circular economy.

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The first phase focuses on identifying sources rich in antioxidant active substances, such as polyphenols or peptides. These sources must be agrifood residues or by-products with no current value produced on a sufficient scale to guarantee a regular supply for production of the antioxidant. Sources must be easily available and preferably locally produced.

After identifying the potential sources of antioxidants, the extraction process is essential in order to guarantee the obtention of relevant molecules with technological antioxidant efficacy in feed, fats and other raw materials. This process must be optimized to obtain the profile and highest concentration of key antioxidant molecules in a sustainable, scalable process. Regulatory aspects are also important, not only for the extract obtained, but also in case of solvent extraction.

Additional information

Extracts from different agrifood industries, mainly flavonoid-rich extracts from vegetable by-products and residues, have already been identified as effective alternatives for preventing oxidation in different matrices, such as fats, oils, meals and feed. Some of these extracts have been obtained in collaboration with technology and research centres in the framework of the **Lipoxifeed** project (RIS3CAT project, funded by European Regional Development Funds), led by ITPSA.

ITPSA has already started assessing the efficacy of new antioxidant extracts and the results are promising. In some cases, the extracts show high antioxidant efficacy in different matrices, proving an effective alternative to current natural antioxidants such as tocopherols. In addition, we are also assessing the in vivo impact of the in-feed inclusion of natural antioxidants, such as polyphenols, in the oxidative status of animals, with health and welfare implications, as well as in the quality of animal-origin food (meat and eggs).

Although there are many cases where agrifood residues are used in animal nutrition as ingredients for feed or as a source of nutrients, the obtention of active substances from residues for use as additives in animal or food nutrition gives additional value to these residues. Besides antioxidant efficacy, other molecules obtained from agrifood residues may show other interesting benefits such as antimicrobial, prebiotic and anti-inflammatory properties, among others. These properties may induce beneficial biological effects in animals, improving their health, their performance or their welfare.

Community name:
Community of Technologies for Agrifood Production

- **Innovation Solution Title:** Transformation of fruit juice waste into tanning substances
- **Project Name:** ALDEFRUIT
- **Funding Programme:** MINECO – Retos Colaboración 2015
- **Company Name:** DBA Centre – University of Lleida (UdL), Cromogenia, Indulleida,
- **Location:** Catalonia

Scope of Innovation Solution

The tanning process relies on the use of some substances that pose environmental issues. The idea of this project is to explore the possibility of using carbohydrates from food industry waste to design a product for use in the tanning process.

Innovation Solution

The idea of the project is to use the carbohydrates contained in some discarded fractions obtained during the production of fruit juice to transform them into derivatives that can be used in the tanning process. During the manufacture of fruit juice and depending on the process used, several waste fractions can be obtained. Some of them are relatively rich in carbohydrates (mainly simple sugars, pectins and cellulose) that can be hydrolysed and/or isomerized into glucose and/or fructose which can in turn be transformed into other derivatives that can be used in the tanning process.

Key Elements / Priorities

- Characterization of several types of waste from the fruit juice industry in order to select the proper by-product to be used.
- Hydrolysis and isomerization of polysaccharides into monosaccharides.
- Transformation of monosaccharides into derivatives with different characteristics.
- Assay in the tanning processes of the products obtained.
- Scale-up of the process.

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EUROPEAN UNION European Regional Development Fund

Community name:
Community of Technologies for Agrifood Production

Key Outcomes / Benefits

- Valorisation of fruit juice industry waste.
- Development of transformation processes from waste components to tanning solutions.
- New tanning products and processes.
- Less environmental impact (less waste from the fruit juice industry and environmentally improved tanning process).

Innovation Solution Drivers

Several drivers can be highlighted:

Sector divers:

- Waste valorisation into marketable products.
- Reduction of waste.
- Less dependence on certain specific compounds used in the tanning process.

Environmental drivers:

- Reduction of the amount of waste generated in the fruit juice industry.
- Use of fewer contaminants in the tanning process.
- Application of circular bioeconomy concepts in the tanning processes.

Outcomes and challenges

The two main outcomes expected from this project are the reduction of waste from the fruit juice industry and the preparation of new, environmental-friendly products to be applied in the tanning process.

The main challenges are associated with:

- the fluctuations in the carbohydrate content and variations in the composition of the fruit juice waste.
- the intrinsic difficulties associated to the transformation process.
- the uncertainty of the efficacy in the tanning process of the derivatives obtained.
- the economic feasibility of the process on an industrial scale.

Community name:
Community INNOÀPAT

- **Innovation Solution Title:** Antioxidant and prebiotic fibre obtained from almond skin
- **Project Name:** MICROBIOTA
- **Funding Programme:** Private and ACCIÓ
- **Company Name:** Unió Nuts, SCCL
- **Location:** Reus

Scope of Innovation Solution

New antioxidant fibre with prebiotic properties obtained from almond skins in an industrial blanching process to be used as an ingredient in the food industry.

Innovation Solution

Most marketed almonds are blanched as an ingredient in the chocolate, confectionery, pastry industries and others. In the industrial almond blanching process, large amounts of almond skin are obtained as a by-product with no added value. This skin contains high levels of fibre and polyphenols. From an industrial process we can obtain an antioxidant fibre with prebiotic properties that could be used as a functional ingredient in the food industry.

Key Elements / Priorities

- Separate skin from almond grain.
- Dry the skin below 5% humidity.
- Grind the skin to the right size

Key Outcomes / Benefits

- Get added value from a by-product
- Introduce to the market a new fibre with prebiotic properties.

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EUROPEAN UNION European Regional Development Fund

Community name:
Community INNOÀPAT

Outcomes and challenges

- Our company has obtained a new functional ingredient from a by-product that we obtain in an industrial process. The internal challenge is for the ingredient to become one of many more in order to open a new business line in the company where we can market functional ingredients obtained from by-products of different industrial processes thus improving our circular economy.

Application sector:
Smart Cities

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Government of Catalonia
EUROPEAN UNION
European Regional Development Fund

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Open and participatory network of cities to leverage and replicate the substantial benefits of edible city solutions
- **Project Name:** EdiCitNet - Edible Cities Network - Integrating Edible City Solutions for social resilient and sustainably productive cities
- **Funding Programme:** H2020
- **Company Name:** Universitat de Girona (UdG) - "LEQUIA" (Laboratori d'Enginyeria Química i Ambiental) research group + Institut Català de Recerca de l'Aigua (ICRA)
- **Location:** Girona

Scope of Innovation Solution

EdiCitNet will leverage the substantial benefits that Edible City Solutions (ECS) have today at local level and catalyse their replication EU- and world-wide by launching a fully open and participatory network of cities.

Innovation Solution

EdiCitNet will leverage the substantial benefits that ECS have today at local level and catalyse their replication EU- and world-wide by launching a fully open and participatory network of cities, empowering their inhabitants by means of a common methodology:

a) to systematically explore the wealth and diversity of existing ECS,
b) b) to adapt, plan and implement successfully proven ECS in their specific urban context.

To enable this, EdiCitNet will close knowledge gaps in the effective implementation of ECS and their transformation into sustainable, innovative business models. This new insight will feed into an openly shared and globally accessible knowledge base and methodology to enable the sustainable and evidence-based integration of ECS into the long-term urban planning of cities covering a large spectrum of urban, climatic, social, environmental and cultural contexts.

5 Front Runner Cities (FRC), supported by a highly interdisciplinary consortium of city authorities, SME, NGOs and academia, will demonstrate their unique experience with their own Living Labs and transfer their knowledge to 7 dedicated Follower Cities (FC), determined to replicate ECS for the benefit of their inhabitants. The carefully selected group of FRC and FC allows studying and monitoring implementation in a large variety of environments and also ensures a truly global outreach with city partners based in Central America, Africa and East Asia.

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Community name:
Comunitat de l'Aigua

Key Elements / Priorities

- Close knowledge gaps in the effective implementation of ECS and their transformation into sustainable, innovative business models.
- Develop an openly shared and globally accessible knowledge base and methodology to enable sustainable and evidence-based integration of ECS into the long-term urban planning of cities covering a large spectrum of urban, climatic, social, environmental and cultural contexts.

Key Outcomes / Benefits

- Reduce cities' carbon footprint and energy consumption.
- Close water-food-energy loops in cities.
- Replicate solutions in other cities.
- A toolbox to facilitate the selection and implementation of ECS.

Innovation Solution Drivers

- City authorities.
- SMEs and NGOs devoted to developing circular economy solutions for cities.
- Academic institutions.

Outcomes and challenges

The systemic use of urban landscapes for food production is a major step towards more sustainable, liveable and healthier cities. A multitude of initiatives around the World, however fragmented, are prospering, forming a global movement of Edible Cities. Their products, activities and services – the Edible City Solutions (ECS) - empower local communities to overcome social problems by their inclusive and participatory dynamics and to create new green businesses and jobs, thereby generating local economic growth and fostering social cohesion. EdiCitNet will leverage the substantial benefits that ECS have today at local level and catalyse their replication EU- and world-wide by launching a fully open and participatory network of cities. One of the expected results will be a toolbox (development led by ICRA and LEQUIA). This toolbox aims to facilitate the selection and implementation of edible city solutions based on a web-based catalogue and a serious game for scenario analysis.

The project is currently under development. It started in September 2018 and will end in August 2023.

Additional information

https://cordis.europa.eu/project/rcn/216082/factsheet/de

Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** Electro green walls. Hybrid technology coupling green walls and MFC
- **Project Name:** Watertur
- **Funding Programme:** ACCIÓ - RIS3CAT
- **Company Name:** LEITAT
- **Location:** Terrassa

Scope of Innovation Solution

A complete vertical ecosystem to treat grey water from a hotel and remove its contaminants with the possibility of reusing the cleaned water for irrigation purposes while it generates electricity for energy harvesting devices and sensor platforms.

Innovation Solution

Electro green wall is a coupled technology that combines a green wall as an NbS and a microbial fuel cell (MFC). The electro green wall constitutes a new mild wastewater treatment and energy-producing technology that has the potential to able to treat wastewater and supply renewable energy to sensor platforms or smart lighting applications.

Electro green wall technology focuses on combining plants and electroactive microorganisms to treat wastewater and to harvest renewable energy 24h per day. Wastewater treatment and energy recovery are the dual outcomes of this coupled technology. Organic matter removal is similar to or greater than a conventional green wall, and can decrease the surface treatment area, reduce greenhouse gas emissions, prevent clogging and process monitoring. In terms of energy output, the power output and the coulombic efficiencies are lower compared to conventional MFCs

Key Elements / Priorities

Electro green walls constitute a green-based infrastructure in urban and peri-urban areas increasing the green areas that can act as drivers for sustainable development. In this sense they contribute, among others, to the reduction of the heat island effect, cleaning the air, reducing the noise, thus achieving a direct impact on human health at the same time as having positive effects for insects and birds helping to enhance the biodiversity.

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Additionally, for wastewater treatment, an electro green wall is able to remove organic matter, nitrogen and phosphorus from wastewater by means of physical, chemical and biological processes.

Key Outcomes / Benefits

The implementation of the electro green wall in a hotel will demonstrate its technical feasibility within urban and peri-urban environments. This NbS creates small green areas with water treatment and energy production.

The development of electro green wall technology will promote the commercial expansion of this NbS to create an innovative and replicable solution. This green solution consumes no resources. Therefore, this NbS can be located anywhere.

To sum up, currently very few electro green wall pilot-scale experiences have been reported. Therefore, the design specifications established in this work constitute a step forward to enhance this combined technology.

Innovation Solution Drivers

- Water management. Wastewater (mainly greywater) is treated with green technology allowing its reuse for irrigation.
- Climate change mitigation & adaptation/Energy harvesting systems. Treats water with no energy costs but rather as an energy producer. Reduces the heat island effect. May help reduce energy costs in buildings as a consequence of its thermal insulation.
- Green space management. Provide valuable compensatory habitats for insects and birds.
- Air quality improvement metabolizing harmful toxins while releasing oxygen and acting as a noise barrier.
- Urban regeneration (as a green environment) encouraging people to spend more time in outdoor spaces, increasing social interaction and cohesion. It increases the economic value and the lifespan of buildings.

Outcomes and challenges

Electro green walls offer economic, environmental, aesthetic and physiological benefits to the urban environment. The main role of LEITAT is to successfully develop an electro vertical living wall to transform technological challenges into economic and social value.

There are different possible configurations of the MFC included into the green walls. The wastewater that feeds the technology can be presented via several pathways. In all cases, electrode implementation and the electrical connection are established through the green walls to stimulate the development of an exoelectrogenic biofilm to transfer the electrons resulting from the degradation of the organic matter to an external circuit generating electricity. Wastewater treatment efficiency is also improved compared to conventional green walls.

Achieving electro green living walls technology involves preliminary tasks focused on (i) the selection of materials, vegetation and amendment for plant growth, (ii) the selection of the best materials and defining, testing the configuration and optimal functioning of the MFCs and (iii) all the control and monitoring parameters required to reuse the water and maintain the technology.

Additional information

As described above, the main purpose of LEITAT working on this innovative technology is related to developing an electro vertical living wall to treat grey water and remove its contaminants with the aim of reusing it in garden irrigation, for instance, while producing electricity that can be used for its own maintenance.

This technology is not yet mature and there are not that many green walls treating wastewater, although some do exist for ornamental purposes. Even more importantly, including the MFC into the living walls is an innovative green technology. In this sense the efforts to first design and prototype and then implement the technology on an operational scale, functioning under real conditions, is an opportunity and a big step forward in the development of the technology and its subsequent use and commercialization. It may lead to improved human and environmental health in urban and peri-urban areas.

Community name:
Comunitat de l'Aigua

- **Project Name:** New methods for preventive microbiological risk assessment in reclaimed water
- **Funding Programme:** ACCIÓ – RIS3CAT
- **Company Name:** Cetaqua
- **Location:** Cornellà de Llobregat

Scope of Innovation Solution

Regireu - Activity 4: Evaluation of new methods for preventive microbiological risk assessment in reclaimed water. Specifically, evaluation of BACTcontrol, *E. coli* online analyser, and the performance of reclaimed water QMRA (Quantitative Microbiological Risk Assessment) in two sites.

Innovation Solution

Reclaimed water use can be helpful in high hydric stress areas and during drought periods. In order to use reclaimed water and convey reliance to the end user, microbiological risk assessment is needed. New emerging online monitoring tools and technologies can guarantee reclaimed water use safety by improving the implementation of SSP (Sanitation Safety Plans). In this project, an online microbiological analyser is evaluated regarding these applications. The device is first evaluated offsite and then at the exit of an MBR in a reclaimed water plant and at a reclaimed distribution network. Data obtained is checked against a validation method (Colilert®) and compared to physicochemical parameters and system operation.

Moreover, QMRA (Quantitative Microbiological Risk Assessment) is performed for the purpose of distinguishing the key microbiological parameters in reclaimed water that permit safety control. Therefore, the objective is to establish control limits for each of these parameters. In addition, other parameters not defined in the legislation are added and evaluated in the QMRA. With the results, adapted actions for the production and distribution of reclaimed water will be established, including online sensors, to focus on evaluating risk and eliminating acute risk and pathogen exposure.

Key Elements / Priorities

- *E. coli* online analyser, BACTcontrol, obtains *E. coli* activity results every two hours approximately. Consumables are needed.
- QMRA (Quantitative Microbiological Risk Assessment) for reclaimed water. It provides control over safety parameters.

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Community name:
Comunitat de l'Aigua

Key Outcomes / Benefits

- New tools and technologies are evaluated for online microbiological control and technical knowledge is obtained throughout the experimental plan.
- Regulatory control parameters are evaluated, whose control limits are established. Other non-regulatory parameters are also evaluated.

Innovation Solution Drivers

- High frequency, continuous mode real-time microbiological results.
- QMRA (Quantitative Microbiological Risk Assessment) for reclaimed water for water safety management for this type of water.

Outcomes and challenges

- Achieving the value reduction of control parameters in upcoming legislations. To do so, new tools and technologies such as online analysers can help.
- Improving reclaimed water safety management to reduce risk and enhance social acceptance.

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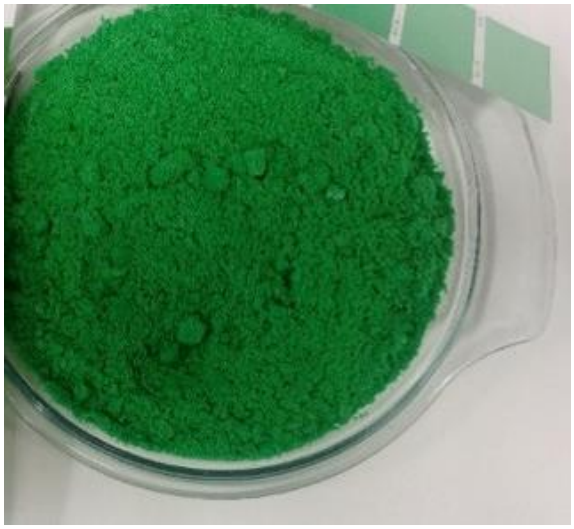
Community name:
RIS3CAT Energia

- **Innovation Solution Title:** Catalyst development for synthetic natural gas production
- **Project Name(s):** “CO2 - Loop for Energy storage and conversion to Organic chemistry Processes through advanced catalytic Systems (CEOPS)” (FP7-NMP-2012-309984), “Synthetic fuels (CoSin)” (COMRDI15-1-003), “Scale-up of catalyst fabrication for obtaining renewable natural gas” (2018-LLAV-00066)
- **Funding Programme:** EU-FP7, ACCIÓ, AGAUR
- **Company Name:** Catalonia Institute for Energy Research (IREC)
- **Location:** Barcelona



Scope of Innovation Solution

Offering suitable catalysts for advanced methanation reactors. The innovation supports the valorisation of carbon dioxide to renewable natural gas by increasing the efficiency of catalytic chemical reactors.

Innovation Solution

The circular carbon dioxide economy is a field in constant growth. The conversion of carbon dioxide into renewable natural gas allows: i) the chemical storage of renewable energies in which production cannot be adjusted to demand (wind, photovoltaic), ii) the contribution to a circular economy of CO2 (CCU) with reduction of GHGs, and iii) less dependence on fossil fuel imports, specifically natural gas. There is currently a large number of methanation pilot plants in operation in Europe. Regarding the Catalan scenario, there is a 37-kW synthetic natural gas pilot plant at the Riu Sec water treatment plant in Sabadell, owned by Naturgy and operated by the Catalonia Institute for Energy Research (IREC).

Based on the experiences in Sabadell, commercial catalysts do not meet the necessary requirements to work in decentralized plants. In Europe, these emerging facilities are based on modular and compact reactors, instead of building high-volume chemical reactors as conventional energy plants. To meet these new standards, we propose a material that meets the standards of these reactors, since the commercial options could not be used directly. Results show that the catalyst is more active and stable than commercial ones.

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Key Elements / Priorities

- Offering an alternative to fossil natural gas consumption.
- Decarbonization of the gas grid and natural gas vehicles.
- Valorisation of carbon dioxide.
- Converting renewable electricity into storable natural gas.
- Supporting the incorporation of intermittent wind and solar power sources.

Key Outcomes / Benefits

- Development of advanced materials that meet the standards of novel methanation reactors.
- Higher activity and stability than commercial catalysts.
- Production of synthetic natural gas of sufficient quality for use as vehicle fuel or for injection to the natural gas grid.

Innovation Solution Drivers

- Change in renewable gas policy.
- Scientific and technical skills.
- Social environmental awareness.

Outcomes and challenges

The main challenge is to scale up the manufacturing process of catalysts in quantities greater than 1 kg of material. With this amount, it would be possible to compare the proposed materials in advanced reactors in an operational environment in order to validate and qualify the system completely. The scientific stage (composition, formulation, preparation, calcination, activation) is considered to be completed and at this time, the next challenge is the engineering and adaptation of the manufacturing process to current industrial processes. The project consists of an adaptation phase of the current wet impregnation to dry impregnation manufacturing method. The preparation method is adapted to the process that could be carried out by industrial companies that manufacture catalysts, to establish bilateral agreements. The challenge is to develop a new catalyst formulation adapted to each CO2 source/capture technology.

Community name:
Community UTILITIES 4.0

- **Innovation Solution Title:** Real-time tools for biofilm monitoring in drinking water distribution networks
- **Project Name:** Senix
- **Funding Programme:** RIS3CAT - ACCIO
- **Company Name:** CETAQUA
- **Location:** C/Esplugues 75, Cornellà de Llobregat 08940

Scope of Innovation Solution

Optimization of two real-time biofilm monitoring sensors for drinking water distribution systems. The two sensors will contribute to improving drinking water quality and safety management in terms of biofilm formation.

Innovation Solution

Biofilm growth in drinking water distribution systems can reduce water quality and safety. For instance, biofilm can serve as a refuge for human pathogenic microorganisms, compromising water safety. Besides, its occurrence can cause a reduction in dissolved oxygen and changes in water taste and odour, affecting its quality. Therefore, biofilm control becomes crucial to guarantee water quality and safety for the population.

In this project, two real-time biofilm monitoring sensors are tested in a laboratory-scale water distribution system, which allows keeping the same conditions as the real distribution network. The sensors will operate for one year to monitor their performance under different conditions. Real-time data reported by the sensors are frequently analysed for early detection of biofilm formation. Early biofilm detection is a key factor to prevent its negative effects, as well as to better control water disinfection treatments and dosage.

In parallel to the real-time sensors, a coupons system is installed, which allows biofilm sampling directly from the distribution pipe, without flow interruption. This system is used to confirm the results obtained from the online sensors and for biofilm characterization in terms of its structure and metabolism, by performing laboratory analyses.

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Community name:
Community UTILITIES 4.0

Key Elements / Priorities

- Real-time biofilm monitoring sensor based on bioelectrochemical analysis
- Real-time biofilm monitoring sensor prototype based on optical analysis
- Coupons system which allows biofilm sampling from the water pipe without flow interruption

Kev Outcomes / Benefits

New tools for biofilm growth monitoring in drinking water distribution systems, allowing the early detection of biofilm formation in these systems, with the main advantages of:

- Early detection of decreased putative water safety and quality due to biofilm growth
- Optimization of water disinfection treatments and dosage

Innovation Solution Drivers

- Continuous monitoring of biofilm growth in drinking water distribution networks
- Biofilm sampling and characterization directly obtained from drinking water distribution systems

Outcomes and challenges

Outcomes: Enhancing water distribution network control and operation. Real-time quality sensors contribute to improving and implementing smart water distribution systems. Real-time systems that allow the early detection of water quality and safety depletion i.e., due to biofilm formation, contribute to better decision-making to improve water systems management.

- Challenges: establishing biofilm formation thresholds to determine its potential to compromise water quality and safety and better operate prevention and treatment controls.

Application sector:
Tourist Sector

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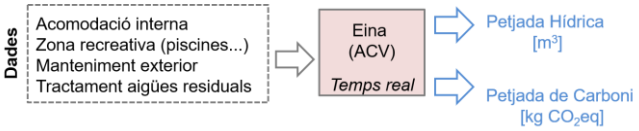
Community name:
Comunitat de l'Aigua

- **Innovation Solution Title:** On-time Water and Carbon Footprint evaluation tool for the hotel sector (Watertur project)
- **Project Name:** Watertur
- **Funding Programme:** ACCIÓ
- **Company Name:** Lavola
- **Location:** Barcelona



Scope of Innovation Solution

- To develop a tool which facilitates the calculation of the on-time water and carbon footprint in hotels.
- To optimize material, energy and water flows, among others, linked to the improvement in water technologies.
- To position the Catalan hotel sector as a reference regarding sustainability and water management.

Innovation Solution

The calculation of water and carbon footprint is based on a large amount of data to be collected and further processed and interpreted. Currently, the calculation of the footprint for a hotel requires the manual collection of water and energy consumption, time for collecting the data regarding each parameter considered, etc. Therefore, it can be a time-consuming procedure associated to high costs and dependent on a third party. The proposed tool will allow calculating the water and carbon footprint automatically and on-time, based on a large volume of information. Consequently, the hotel will be able to evaluate consumption trends and take objective decisions from an environmental perspective, as well as detect the hotspots to be tackled in order to improve the environmental impact and promote circular water management.

Key Elements / Priorities

- Identification of all the input and output flows for consideration in the calculation, as well as those to be collected from automatic systems.
- Interpretation of the results to maximize the benefits derived from the use of the tool.

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Community name:
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Key Outcomes / Benefits

- Tool to calculate on-time water and carbon footprint for the hotel sector.

Innovation Solution Drivers

They are related to the Water Community goals:

- To decrease the financial costs and time devoted to water management.
- To protect the ecosystems.
- To preserve the natural resources and ensure access to water (in amount and quality).
- To promote the circular economy.

Outcomes and challenges

This project faces the challenge of calculating the water and carbon footprint considering a continuous evaluation that helps to make decisions regarding operational as well as investment changes in a hotel complex, instead of considering a static and occasional interpretation to be made once an activity is finished. The 'smartization' of the facilities will enhance the collection of data required for this purpose.

Additional information

This tool will be developed in the context of the Watertur project (RIS3CAT), "Research in technologies for the intelligent and sustainable management of the water cycle in tourist facilities".

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