

Innovative Technologies for Water Savings in the Touristic Facilities

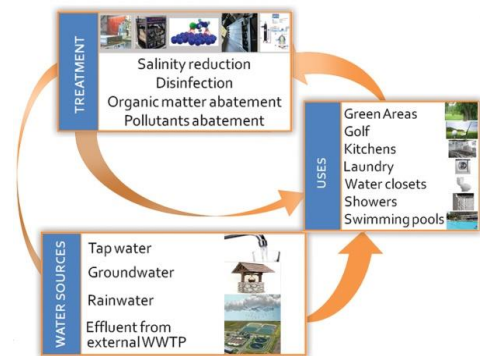
demEAUmed offers cutting-edge **innovative water technologies** resulting in the **reduction of fresh water consumption** and **efficient water management** in touristic establishments.

By using demEAUmed technologies, establishment owners will be able to:

- 1) **Lower water and carbon foot prints,**
- 2) **Lower their operating costs** (Water and/or energy).
- 3) **Increase sales** via obtaining a **green image and/or labels.**

Eight different categories of innovative treatment technologies (for safe cleaning different types of effluents) together with a **monitoring control tool** and decision support system are integrated and demonstrated in real-life situation at Samba Hotel (441 rooms), near Barcelona, Spain:

- a) 172 NM UV treatment,
- b) Electrochemical ozonation;
- c) Electrocoagulation-flotation technology (EC-EFI);
- d) Plimmer technology;
- e) Smart air MBR.
- f) Solar photo-electro-Fenton process (SPEF);
- g) UVOX technology and
- h) vertECO: Vertical Ecosystem technology



These technologies provide cost-effective solutions for a safe reuse of treated waste water. They can be used individually or in a package.

More information on demEAUmed technologies at: www.demEAUmed.eu

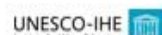
demEAUmed is a European water innovation project (2014-2017), involving tourist and water industry representatives, policy-makers, research centers and other stakeholders from 7 EU countries.

Project lead by: Administrative management:

LEITAT Technological Center member of TECHNO

Scientific management:

ICRA



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demEAUmed Technologies

Plimmer® Technology

Eight categories of innovative technologies together with a monitoring, control and decision support system are integrated and demonstrated in a real life situation within the European project demEAUmed "demonstrating integrated innovative technologies for an optimal and safe closed water cycle in Mediterranean tourist facilities." This factsheet presents one of these eight technologies; the **Plimmer®** technology.

Description

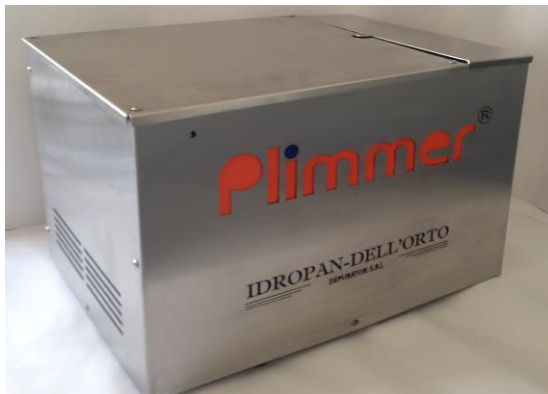
Plimmer® is a non-Membrane technology which treats ground/surface water to drinkable standards.

It requires very low pressure and results in low power consumption. It reduces water wastage since water is not pushed into a membrane under high pressure.

This technology has 12 patents in terms of number of electrodes, coating on electrodes and electronics required to handle the process and no chemicals are required for treating water. Electrodes require just 1.6 V charge to operate – providing an option to run on alternative energy sources (e.g. solar).

Depending from model of Plimmer® salt reduction vary from 65% to 95%.

The values refer to a conductivity input of 400us. Salt removal percentage decreases with increasing the conductivity of the water inlet and vary with the types of salts dissolved in it.



Applicability

Plimmer® system provides a largely accessible method of desalinating water in domestic, commercial and industrial contexts. It perfectly removes substances that dissociate in ions which present in raw water. Common target pollutants/substances are:

- Temporary hardness,
- Permanent hardness,
- Sodium chloride,
- Sodium sulfate,
- Nitrates,
- Nitrites,
- Ammonia,
- Metals; such as Fe, Mg (if they present as ions),
- Arsenic (if it presents as ion) and
- Hexavalent Chromium.

Design Criteria

Size can be

33 cm (w) X38 cm (l) X28 cm (h)
57 cm (w) X37 cm (l) X47 cm (h)

For demEAUmed:

33 cm (w) X38 cm (l) X28 cm (h)

Location

Packed Plimmer® units must be stored in a dry environment (free from condensation) and protected from the weather. The allowable storage temperature range is 5°-50°C.

Flow

For all size the drain is around 20% of income water.

Operation and Maintenance

Plimmer® systems do not require difficult maintenance procedures. It automatically injects maintenance solution to avoid fouling inside the cell. Its web-platform allows remote monitoring and control, making the technology easily controllable. It also allows the user to control water quality without having direct access to the machine.

Advantages of Plimmer®

- Eco-friendly treatment process: Citric

Acid is an organic acid extracted from lemon trees which also provides the electrodes a longer useful life.

- Low Carbon Footprint: It ensures 30% less energy required to desalinate water.
- Improved Water Footprint: It recovers 80% - 90% of fresh water.
- Automatic Operation.

Costs issues

Capital expenditure is similar to a standard Reverse Osmosis units. It is very low where the Return On Investment (ROI) is expected in less than a year.

Contact:

Plimmer® Supplier:

Idropan Dell'Orto Depuratori S.r.l.

Phone: (+39) 02 66800267

Fax: (+39) 02 66800754

Email: contatti@idropan.it

Please find further information and updates on demEAUmed project, its technologies and DSS at: www.demeaumed.eu



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demEAUmed Technologies

vertECO: Vertical Ecosystem technology

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Description

This technology treats grey water through an indoor vertical constructed plant-based wetland. The underlying principle is the employment of certain plant species in a special sequence for cleansing of the polluted water, grey water in this case; hence, improving the water quality which enables a reuse of the treated water.

The investigated plant species function in symbiosis with rhizosphere specific microorganisms providing intrinsic water cleaning abilities.

For the constructed plant based wetland, a vertical set-up is employed combined with a subsurface horizontal flow. An approach with a green wall unit with three meters length employed for a grey water pollution level of tourist facilities revealed already very promising results.



Applicability

The vertical ecosystem is used for the treatment of:

- Greywater,
- Shower water and
- Laundry water.

This technology effluent, according to parameters of Spanish legislations, can be used for:

- Toilet flushing,
- Golf irrigation,
- Private garden irrigation,
- Groundwater recharge and
- Laundry.

Design Criteria For demEAUmed

Size

1,5 m (w) x 5m (l) x 2,8m (h)
Indoor/ semi-indoor, light conditions

Location

At the pool bar in the back (demEAUmed demonstration).

Flows

0,5-1,5 m³/d semi-continuous batch.

Vegetation

Different species of marshplants (e.g. Typha, Iris), graminoids (Carex, Cyperus) tropical and subtropical plants (e.g. Ficus, Spathiphyllum, Epiprenum)

Operation and Maintenance

A gardener is needed to take care of the vertical ecosystem.

Advantages of vertical ecosystem:

- Water savings,
- Aesthetic value,
- Clean air,
- Green image and
- Visualizing water cycles.

Costs issues (or additional value)

- Comprehensibility of ecosystem services,
- Aesthetic value,
- Improve the indoor environment and
- Positive effects on well-being.

Contact:

vertECO Supplier: **alchemia nova**

Phone: (+43)-1-810 1000

Fax: (+43)-1-810 1000-10

Email: office@alchemia-nova.net

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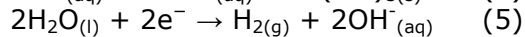
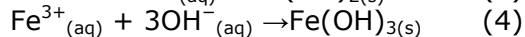
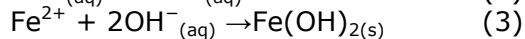
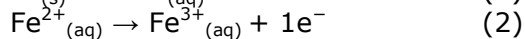
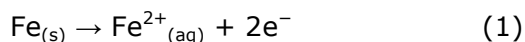
demEAUmed Technologies

Electrocoagulation-flotation technology

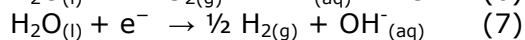
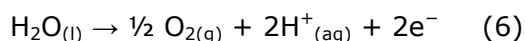
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Description

Electrocoagulation-flotation (EC-EFI) is an electrochemical process used as an alternative to conventional coagulation/flotation processes. In this advanced technology, coagulum agents are generated through electrochemical oxidation of sacrificial metallic plates (e.g. iron or aluminium) used as anodic material (Equation 1). Obtained Fe(II)/Fe(III) (Equation 2) or Al(III) precipitate with hydroxide ions (Equations 3 and 4) generating coagulum particles which destabilize and adsorb water pollutants by surface complexation or electrostatic attraction. Pollutants are removed by sedimentation or electro-flotation producing bubbles of hydrogen gas at cathode surface (Equation 5).



The innovation of EC-EFI lies behind the polarity inversion which performs several times per minute in order to combine the electrocoagulation process with flotation due to hydrogen and oxygen generation in the electrodes (Equation 6 and 7):



Applicability

Electrocoagulation-flotation process is used as primary treatments for wastewater treatment in order to remove suspended solids, oils, fats and slightly reduce the turbidity and the organic matter content. If needed, it could be also applied for kitchen effluent treatment.

EC-EFI is used for other effluents such as industrial pollutants which have high suspended solids, metal and organic matter content.

Design Criteria for demEAUmed

Size

The dimensions of the pilot plant are expected to be around 2m x 2m x 2m.

Location

As EC-EFI will be used as primary treatment, thus it has to be located close to both wastewater catchment and secondary treatments.

Flows

From approximately 0.1m³/h to 1m³/h.

Operation and Maintenance

- Acidic cleaning systems in order to remove the fouling on electrodes and in the inner part of the CPC borosilicate.
- Changing the electrodes periodically.

Advantages of EC-EFI

- It is a compact system.
- Minimization of the use of chemicals externally added.

- Possibility of water reuse.
- Removal of toxic/recalcitrant emergent pollutants.
- Possibility to be fed by solar PV panels.

Costs issues (or additional value)

- Generation of in-situ coagulants that avoid the use of external chemicals.
- Solar light could be used as an energy resource.

Contact:

Electrocoagulation-flotation Supplier:

LEITAT Technological center

Phone: (+34) 93 788 23 00

Fax : (+34) 93 789 19 06

Email : leitat@leitat.org

Please find further information and updates on demEAUmed project, its technologies and DSS at: www.demeaumed.eu



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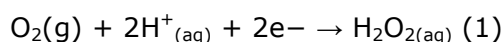
demEAUmed Technologies

Solar Photoelectro-Fenton process

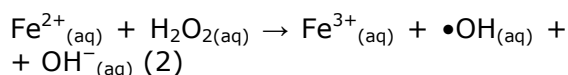
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Description

Solar photoelectro-Fenton (SPEF) process is an advanced electrochemical oxidation process (AEOP) that has been developed for the remediation of acidic wastewaters containing hazardous organics. This process is based on the H_2O_2 generation from the two electron reduction of O_2 at a carbonaceous cathode:

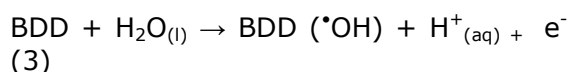


and the addition of a small amount of Fe^{2+} to the treated solution to produce $\bullet OH$ and Fe^{3+} from the classical Fenton's reaction:



Since Fe^{2+} can be regenerated from Fe^{3+} reduction at the cathode and due to solar radiation (solar photo-Fenton process), Eq. 2, it can be propagated due to the catalytic behaviour of the Fe^{3+}/Fe^{2+} system.

The most frequently used anodes in the indirect electro-oxidation EF systems are Pt and boron-doped diamond (BDD). The latter is preferable due to its higher oxidation power on organic pollutants. If the electrochemical process is carried out in an undivided cell, apart from the electro-Fenton mechanism, organics can also be destroyed by $\bullet OH$ produced at the anode surface from water oxidation (3) in the case of a BDD anode¹:



Applicability

The technology is applied as tertiary treatment for removing emergent/prior pollutants and disinfecting (swimming pool effluents, greywaters, wastewaters...) as well as primary treatment for recalcitrant and/or toxic industrial effluents (such as pharmaceutical, landfill leachate, etc.).

Design Criteria for demEAUmed Size

The dimensions of the pilot plant expected to be around 2m x 5m x 2m.

Location

Outside where solar light could irradiate the CPC system. It has to be located close to secondary treatments.

Flows

From approximately $0.05m^3/h$ to $0.5m^3/h$.

Operation and Maintenance

- To remove the dust of CPC.

- To ensure continuous air flow through the cathode. Otherwise, the system could fail.
- Acidic cleaning systems in order to remove the fouling on electrodes and in the inner part of the CPC borosilicate.

Advantages of SPEF technology

- Use of solar light as driving-force of the process as well as for feeding the power supply.
- Minimization of the use of chemicals

externally.

- Water disinfection and reuse.
- Removal of toxic/recalcitrant emergent pollutants.

Costs issues (or additional value)

- Generation of in-situ oxidants with high oxidant power to mineralize non-selectively organic matter.
- Solar light could be used as an energy resource.

Contact:

Solar photoelectro-Fenton process Supplier:

LEITAT Technological center

Phone: (+34) 93 788 23 00

Fax: (+34) 93 789 19 06

Email: leitat@leitat.org

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demEAUmed Technologies

Smart Air MBR® Technology

Eight categories of innovative technologies together with a monitoring, control and decision support system are integrated and demonstrated in real life situation within the European project demEAUmed "demonstrating integrated innovative technologies for an optimal and safe closed water cycle in Mediterranean tourist facilities." This factsheet presents one of these eight technologies; the **Smart Air MBR®** technology.

Membrane bioreactors (MBR) are a consolidated technology for biological treatment of industrial and municipal wastewater. They guarantee high water quality which has led to a growing demand for this technology, especially in areas where water is scarce and its re-use must be prioritised.

The main MBR disadvantage is membrane fouling. Its minimization can be achieved by supplying air and incorporating backwashing cycles or relaxation modes to clean the membranes, actions that significantly increase operating costs.

Smart Air MBR® is the only product on the market that effectively reduces the energy costs associated with MBR air-scour according to the online monitoring of permeability, and places it in an excellent competitive position.

Applicability

The technology is innovative compared to existing technologies, which do not take into account the status of membrane fouling in real-time to control the process. It is suitable for the treatment of:

- Greywater; e.g. shower water and laundry water, and
- Domestic/industrial Wastewater.

Target pollutants are:

- Biodegradable organic matter,
- Nitrogen,
- Micropollutants such as pharmaceuticals and
- Microbiological charge.

The Smart Air MBR® technology, according to parameters of Spanish reuse legislations, could be potentially used for:

- Toilet flushing,
- Golf irrigation,
- Private garden irrigation and
- Groundwater recharge.



Design Criteria

In general, at demEAUmed Size

1,4 m (w) x 1m (l) x 2m (h); indoor

Flows

0.5-1 m³/d, in continuous

Location

At the greywater room storage for greywater treatment.

At the wastewater room for wastewater treatment.

Operation and Maintenance

Several parameters of biological treatment and membrane filtration, level sensors and alarms are implemented in the system and can be monitored on-line in real-time.

An operator is needed to check and clean the membrane (physical and chemical cleaning).

Advantages of MBR® technology

- Reductions down to 20% of the air scour required to clean the membranes.
- Savings up to 35% of the cost of membrane aeration.
- Reliable control of membrane fouling parameters evolution together with biological process parameters.

- Optimisation on the frequency of maintenance cleanings.
- Stabilisation of the biological nutrient removal, maintaining or improving the quality of the effluent, in comparison with existing control systems.
- Extension of membrane life.
- Adaptation to any membrane configuration.

Costs issues (or additional value)

It only requires the standard instruments of a conventional MBR (permeate flux and transmembrane pressure), and it does not need any additional equipment other than remote connection and a server. Energy saving and water reuse are guaranteed.

Contact:

Smart Air MBR® Supplier: **Laboratory of Chemical and Environmental Engineering**
(LEQUIA, lequia.udg.cat)
Phone: +34 972 41 98 59
E-mail: ignasi@lequia.udg.cat

Institut Català de Recerca de l'Aigua

Phone : (+34) 972 18 33 80
Fax : (+34) 972 18 32 48
Email: irodriguezroda@icra.cat

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demEAUmed Technologies

UVOX Technology

Eight categories of innovative technologies together with a monitoring, control and decision support system are integrated and demonstrated in real life situation within the European project demEAUmed "demonstrating integrated innovative technologies for an optimal and safe closed water cycle in Mediterranean tourist facilities." This factsheet presents one of these eight technologies; the **UVOX** Technology.

Description

The UVOX process combines the disinfecting effect of ultraviolet light with the oxidising effect of ozone and hydroxyl radicals in one single system with one single lamp. UV-Disinfection, Ozonation and the advanced oxidation by means of hydroxyl radicals lead to the inactivation of all pathogens and microorganisms in the water (e.g. bacteria, viruses and algae) and to the oxidation of (micro) pollutants (such as nitrite, cyanide, pesticides, chlorinated hydrocarbons, hydrosulphides, odours, humic substances and pharmaceutical products).



Applicability

UVOX Systems provide environmentally friendly, healthy and non-residual water treatment for:

- Public swimming pools,
- Private swimming pools,
- Natural pools & swimming ponds,
- Koi & Fish pond, fish hatcheries,
- Aquariums & zoos,
- Drinking water and
- Process water / grey water.

Design Criteria

Size

1.5 m (w) x 1.0 m (l) x 1.2 m (h)
Indoor/semi-indoor

Location

In the technical water treatment room near the filters and greywater tank.

Flows

20-80 m³/h, max. pressure 1.2 bar.

Operation and Maintenance

The integrated UVOX UV-Compact Measurement and Control Unit guarantees optimum functioning of the UVOX system. Therefore it requires only:

- Limited maintenance, and
- Replacement of the UVOX lamp at the end of its lifetime (16.000 hours).

Advantages of UVOX technology:

- UVOX destroys organic compounds and inactivates pathogens and algae up to 99, 99 %.
- It enables reduction of residual chlorine concentration and thus reduces the formation of disinfection by-products (DBP`s) such as mono-, di- and tri- chlorine and THM.
- Lesser usage of chemicals, water and

energy reduce costs associated with the application of UVOX system.

- Eliminates unpleasant odours and tastes and provides healthy, residual-free water.

Costs issues (or additional value)

- Low capital and running costs.
- Early Return On Investment (ROI) due to cost savings.

Contact:

UVOX Manufacturer: **Wapure International GmbH**

Nassauer Allee 45
D-47533 Kleve (Germany)
Tel.: +49 2821 9780047
Fax: +49 2821 9780048
Email: info@uvox.com
www.uvox.com

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demEAUmed Technologies

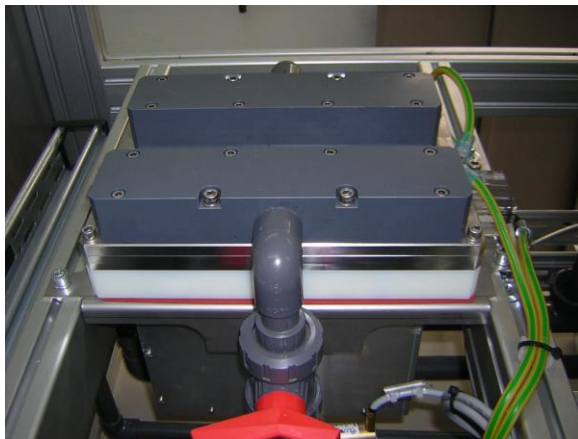
172 NM UV Treatment

Eight categories of innovative technologies together with a monitoring, control and decision support system are integrated and demonstrated in real life situation within the European project demEAUmed "demonstrating integrated innovative technologies for an optimal and safe closed water cycle in Mediterranean tourist facilities." This factsheet presents one of these eight technologies; the **172 NM UV** treatment.

Description

In this Advanced Oxidation Process (AOP) hydroxyl-radicals are used to degrade complex and persistent organic molecules which present in the water as contamination.

172nm UV directly attacks different pollutants and it's able to break down resilient and harmful molecules.



Applicability

The 172nm UV technology can treat every type of waste water as long as the water is free from suspended solids and/or sludge.

In demEAUmed, targets for 172nmUV are trace organic pollutants:

- Cleaning agent residuals and pesticides,
- Different pharmacological substances,
- Persistent, non-biodegradable organic pollutants

The performance depends on the degree of the pollution in the water.

For demEAUmed, the water in the operational tank is treated and

continuously analysed by a TOC analyser until the desired quality is reached.

Design Criteria

Size

In general:

5,3 x 1,8 x 1,2 m

For demEAUmed:

3,3 x 1,7 x 0,8 m

Location

172nm UV Equipment should be located in a dry, ventilated area. Temperature range between 5-45°C. The System needs a separate electrical ground connection.

Flows

Flow depends on the degree of pollution and the reduction target(see applicability). The demEAUmed installation is built for ca 20l/h.

The system is scalable by the number of treatment chambers to meet the requirements of different installation sites.

Operation and Maintenance

Automatic operation. Regular simple maintenance is required.

Advantages of 172nm UV technology:

- Automatic operation,
- Chemical free process – no need to add hydrogen peroxide, ozone or catalysts,
- Adjustable treatment capacity,

- No gas exhaust, no noticeable smell,
 - Disinfection of the treated water as a side-effect,
 - Independent from the salinity or hardness of the stream
 - Independent from UV-absorbance of the feed water
- Costs issues (or additional value)**
The process runs until the desired output quality is reached.

Contact:

172 NM UV-treatment Supplier:

Sico Technology GmbH

Tel.: + 43 4244 5151 0

Fax: + 43 4244 5151 20

Email: mr.superglass@sico.at

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demEAUmed Technologies

Electrochemical Ozonation Technology

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Description

The Electrochemical Ozonation technology uses electrodes coated with boron doped diamond which produce an oxygen-ozone mixture with higher ozone concentration than can be achieved with conventional gas discharge ozone generators. The ozone is produced in the wastewater and therefore directly and perfectly dissolved in it. Less apparatus is involved when compared with conventional ozone generators and there is no need to provide an oxygen feed line. Different concentrations of pollutants pose no problem as integrated measuring/control system makes the system energy-efficient and ensures continuous operation.

Applicability

The technology holds potential as polishing treatment for small to medium scale installations in view of achieving drinking water quality of the treated water. It removes emergent and priority

pollutants even at trace levels and disinfects the water. The technology is used today to remove organic substances from ultra-pure water and to directly treat recalcitrant or toxic industrial effluents.

Advantages

- No oxygen feed needed
- Automatic operation
- Chemical free process – no need to add hydrogen peroxide, ozone or catalysts
- Adjustable treatment capacity
- Adjustable treatment intensity (saving energy)
- Disinfection of the treated water as a side-effect
- Independent of UV-absorbance of the



Costs issues (or additional value)

- Low running costs.
- In pre-treated domestic wastewater the system oxidizes > 90% of trace organic pollutants with an electrical energy input of less than 1 kWh/m³.

Contact:

Electrochemical Ozonation Technology Supplier:

Eilenburger Elektrolyse- und Umwelttechnik GmbH

Tel.: +49 3423 7063900

Fax: +49 3423 7063909

Email: office@eut-eilenburg.de

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demEAUmed Monitoring Control Tool

Eight categories of innovative technologies together with a monitoring control tool and decision support system (DSS) are integrated and demonstrated in the demonstration site of the European project demEAUmed 'demonstrating integrated innovative technologies for an optimal and safe closed water cycle in Mediterranean tourist facilities.' This factsheet presents **demEAUmed monitoring control tool**.

Description

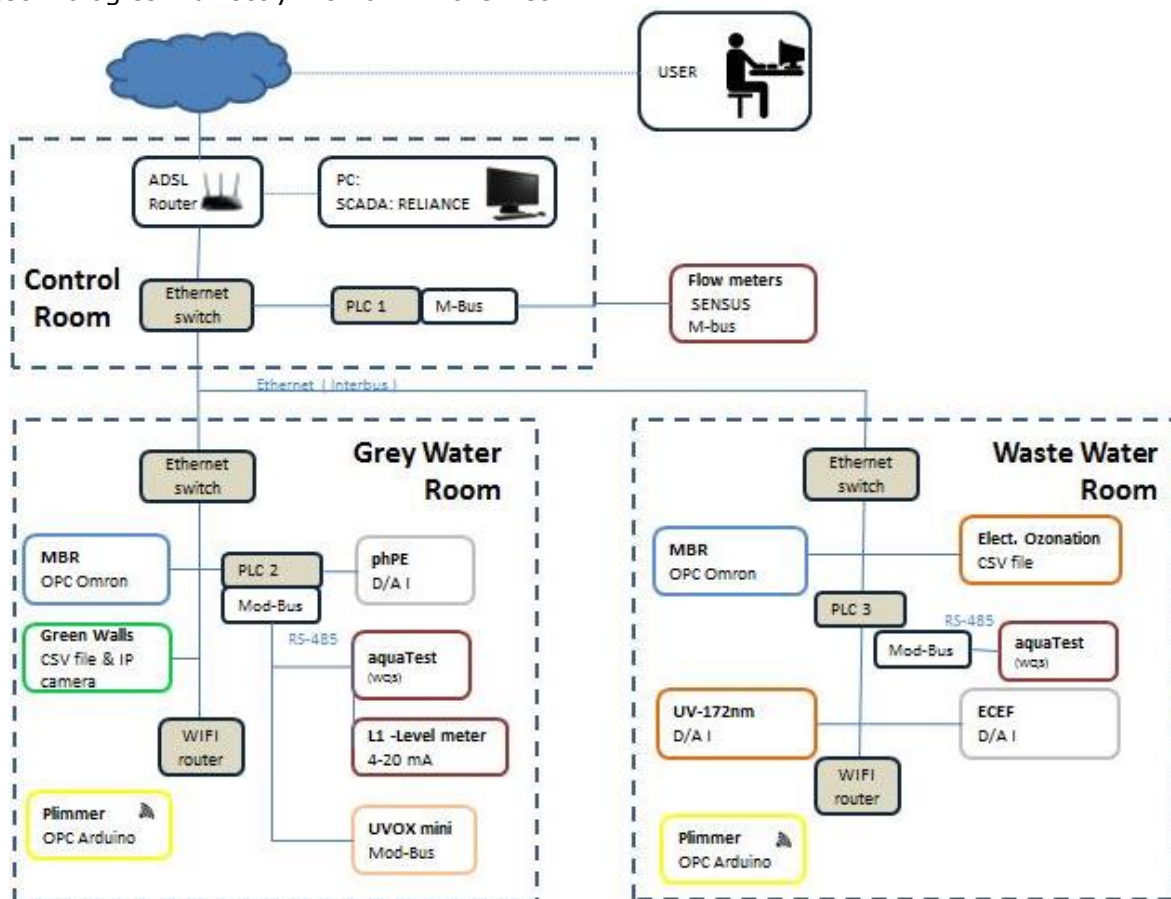
demEAUmed monitoring control tool is a platform to show, control, generate alarms and record the information of the different water values thought the hotel.

The physical architecture is a Power-Line Communication (PLC) network which takes the inputs of the different emitters and manages the generated information where a Reliance licensed system, SCADA/HMI, is used for the visualization.

The core of the system is a Control PC with the SCADA software. These industrial SCADA can get the data from technologies directly throw Ethernet

connection and from the PLC network. The PLC network integrates 3 Phoenix Contact PLC, one as a master and the other two for the main water areas of the facility (see the figure below).

The SCADA allows users to connect remotely. It allows displaying windows with real-time visualized data and controlling them, displaying and acknowledging current alarms, displaying historical data, trends and reports as well as displaying historical alarms.



Applicability

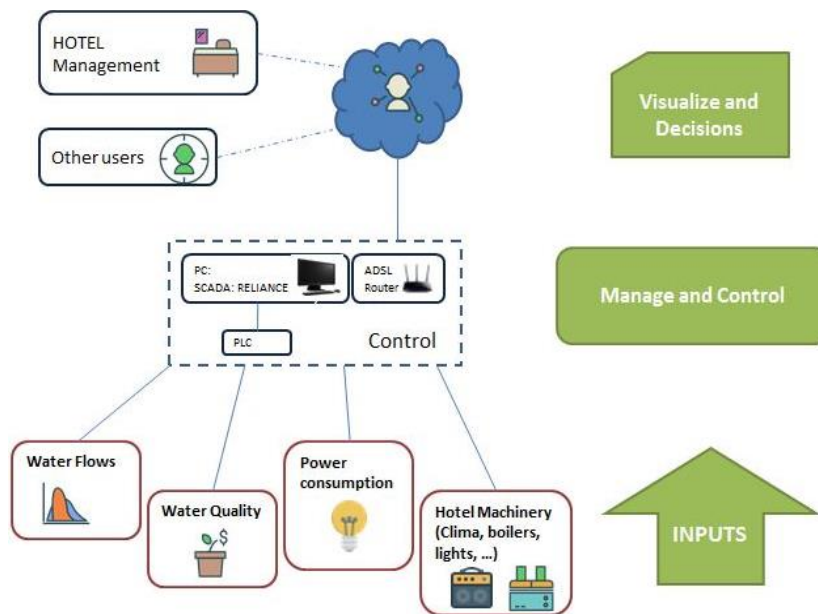
demEAUmed monitoring control tool can be used in facilities that require efficient water management since it is important to know, in real time, the different flows, quality and amounts of water. In addition, the tool can be used to improve and manage other information and values about the hotel heart, such as room/areas temperature, electrical consumption, machine information (pumps pressure, flow, boilers temperature, etc.)

The tool is applicable for other facilities/sectors such as the urban use in small and remote communities dealing

with water shortages and commercial buildings market in specific water stressed areas.

Innovation Factor

- The use of industrial application for water management in hotels providing information about water quality and consumptions.
- Introducing Big Data in Resorts & Hotel Management to improve efficiency and reduce cost.



Contact:

Jordi Cros Herrero, ADASA

Tel.: (00 34) 932640602, Fax: (00 34) 932640656

Email: jcros@adasasistemas.com

Please find further information and updates on demEAUmed project, its technologies, DSS and monitoring tool at: www.demeaumed.eu

demEAUmed Decision Support System and Modelling

Eight categories of innovative technologies together with a monitoring control tool and **decision support system** are integrated and demonstrated in the demonstration site of the European project demEAUmed demonstrating integrated innovative technologies for an optimal and safe closed water cycle in Mediterranean tourist facilities.’ This factsheet presents the **decision support system**.

Description

demEAUmed Decision Support System (DSS) defines best water management options in touristic facilities taking into account the considered water treatment solutions. It evaluates different scenarios of water sources, water/wastewater quality, demands and changes in the environmental conditions and to define the best management alternatives for each scenario.

The DSS is composed of three components:

- **Water cycle model** - the user designates the services offered by the hotel and then inputs the characteristics of the water-using devices of the hotel.
- **Reuse technologies** - the user determines the reuse pathways between the water-using devices as well as chooses the treatment technologies to be used to treat the reclaimed water
- **Optimization layer** - determines ideal reuse technology use scenarios by comparing the environmental, social, and economic indicators.

Once run, the results show the water flows, qualities, and savings. In addition, the environmental, social and economic impacts are also quantified.

This program is web-based and assumes steady state for the hotel that is being modelled. It is programmed in Java and can be used by anyone with an interest in the possible benefits of implementation of an onsite water reuse system in a hotel. If necessary the user can also modify values such as the frequency with which the guests use the various water-using devices to improve model accuracy.

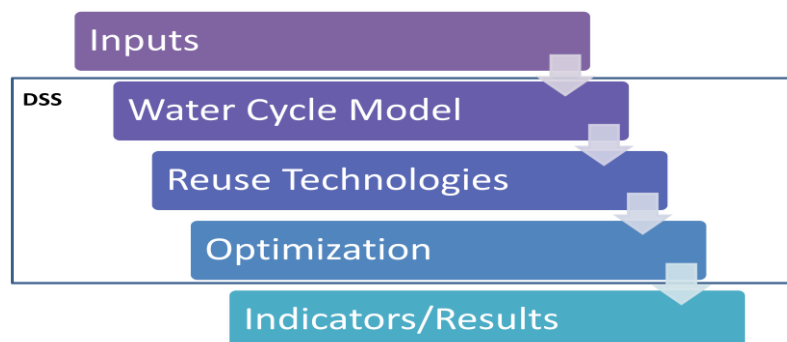


Figure 1: Conceptual design of the DSS

Applicability

This DSS can be used to model the water management systems of most types of hotels. Accuracy is determined by how specific the data is to the hotel being simulated. This tool can aid hotel managers and water treatment technology companies quantify the following:

- Savings due to water reuse
- Water flows throughout the water management system
- Water qualities of all of the water flows
- Energy use associated with the operation of the treatment systems
- Chemicals needed for treatment

In addition, the DSS can also quantify the degree to which water management systems affect the environment, incur economic costs, and affect the society. Comparisons can also be made between scenarios to determine the optimum technologies.

Innovation Factor

- Possibility of simulating a diverse array of hotel water management systems in many contexts
- Determination of the quantity and quality of each of the water flows within the hotel
- Estimation of the water savings via water reuse systems
- Estimation of the environmental, social and environmental impacts of different water management system configurations

Contact: Mark Santana
Institut Català de Recerca de l'Aigua (ICRA)

Phone : (+34) 972 18 33 80

Fax : (+34) 972 18 32 48

Email: msantana@icra.cat

Please find further information and updates on demEAUmed project, its technologies, monitoring control tool and DSS at: www.demeaumed.eu



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