THERBIOR

Thermal Energy Recovery from a Novel Sequencing Batch Biofilter Granular Reactor

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Water JPI
WaterWorks2014 Cofunded Call
18 May 2016, Rome

CONSORTIUM DESCRIPTION

ACRONYM	TOPIC	Coordination	Partners
THERBIOR	**I**		
Thermal Energy Recovery from a Novel Sequencing Batch Biofilter Granular Reactor		**municipal sewage treatment; pilot plant; water's energy re-use; off-grid water source heat pump**	

PRINCIPAL INVESTIGATOR	INSTITUTION	COUNTRY
Francisco Javier Batlles Garrido	**University of Almeria (UAL)**	**Spain**
Claudio Di Iaconi	CNR-IRSA National Research Council – Water Research Institute	Italy
Ivan Munoz	2.0.-LCA Consultants	Denmark

About University of Almería

- Research/education-oriented public university founded in 1993 in Spain.
- Main R&D areas of interest in technical disciplines are agricultural engineering, automatics and renewable energies.
- Currently >13.000 students, 30 departments, 125 research groups, 7 research centers.
- Participation in THERBIOR will be undertaken by:
  - **The Solar Resource Assessment and Climatology group**
  - **International Management School group**

About 2.-0 LCA consultants

- Science-based consultancy company.
- Founded in 2000 in Denmark.
- Headquarters located at Aalborg University.
- Currently seven scientific staff (4 male, 3 female) from four countries: DK, ES, IT, FR.
- All its scientific staff hold PhDs.
- Its turnover is composed approximately of:
  - 50% by research projects (EU FP7, H2020)
  - 50% by work for entrerprises, NGOs and governments

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2.0 LCA consultants

About CNR-IRSA

- **IRSA-CNR** Water Research Institute of National Research Council, was founded in 1968 and today is located at three sites: Monterotondo (RM), Brugherio (MI), Bari.

- **Main R&D areas of interest in technical disciplines are**: 1. Fate and effects of contaminants 2. Aquatic ecosystems 3. Treatment of urban and industrial wastewater 4. Management of wastewater and solid waste 5. Remediation of polluted sites 6. Sustainable management of water resources 7. Interactions groundwater, rocks and surface ecosystems.

- The IRSA activities are developing **in three main directions**: 1. innovative research; 2. pre-regulatory investigations; 3. education activities.

- Currently IRSA holds: **70 Researchers**, **40 Technicians** and about 30 units of students/scholarship etc.

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IRSA CNR

About Hedera Helix I&B

- Company dedicated to engineering and biotechnology projects, specialized in automatization and control in climatization, renewable energy based systems and PCM technologies.

- Founded in 2008 in Spain, headquarters located at Abanto y Zierbena near BILBAO.

- Currently 5 Engineers and Technics staff from SPAIN.

- Last projects of special relevance:
  - ✓Installation of solar cold accumulation in PCMs using geothermal head pump technology.
  - ✓International project in Dominican Republic installing a solar-assisted cold accumulation in PCMs for vegetables conservation.

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OBJETIVES of the project

THERBIOR focuses on the development, implementation and diffusion of technologies to improve energy efficiency in wastewater treatment plants using a solar-assisted heat pump system, applicable in the Mediterranean tourism sector.

The main goal is:

- To reuse the heat from the novel Sequencing Batch Biofilter Granular Reactor (SBBGR) reactor into an air conditioning system, backed up by storage based on Phase Change Materials (PCM), capable of covering the cooling/heating (CH) and domestic hot water (DHW) demand of an experimental test laboratory (ETL).

- Analyse this innovative application's viability for incorporation into Almeria's (Spain) and Bari's (Italy) tourist facility network. Evaluate how much energy we can gain from a specific urban wastewater network to reduce energy consumption (coming from fossil fuels) for cooling/heating purposes in tourist buildings located in the cities.

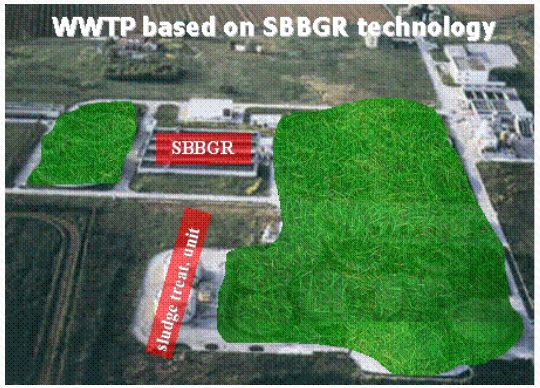
Originality and innovative aspects of the project

SBBGR is an advanced innovative biological treatment system developed by CNR-IRSA.

In comparison with the conventional treatment systems, SBBGR is able of:

- performing in a single stage the entire wastewater treatment train (i.e., primary, secondary and tertiary treatment);
- reducing the area requirement;
- reducing the sludge production (up to 80%);

The ***technical originality*** is to merge and exploit the SBBGR plant features and the unusual biomass employed in the reactor by means of devices for heat recovery and alternative energy use.



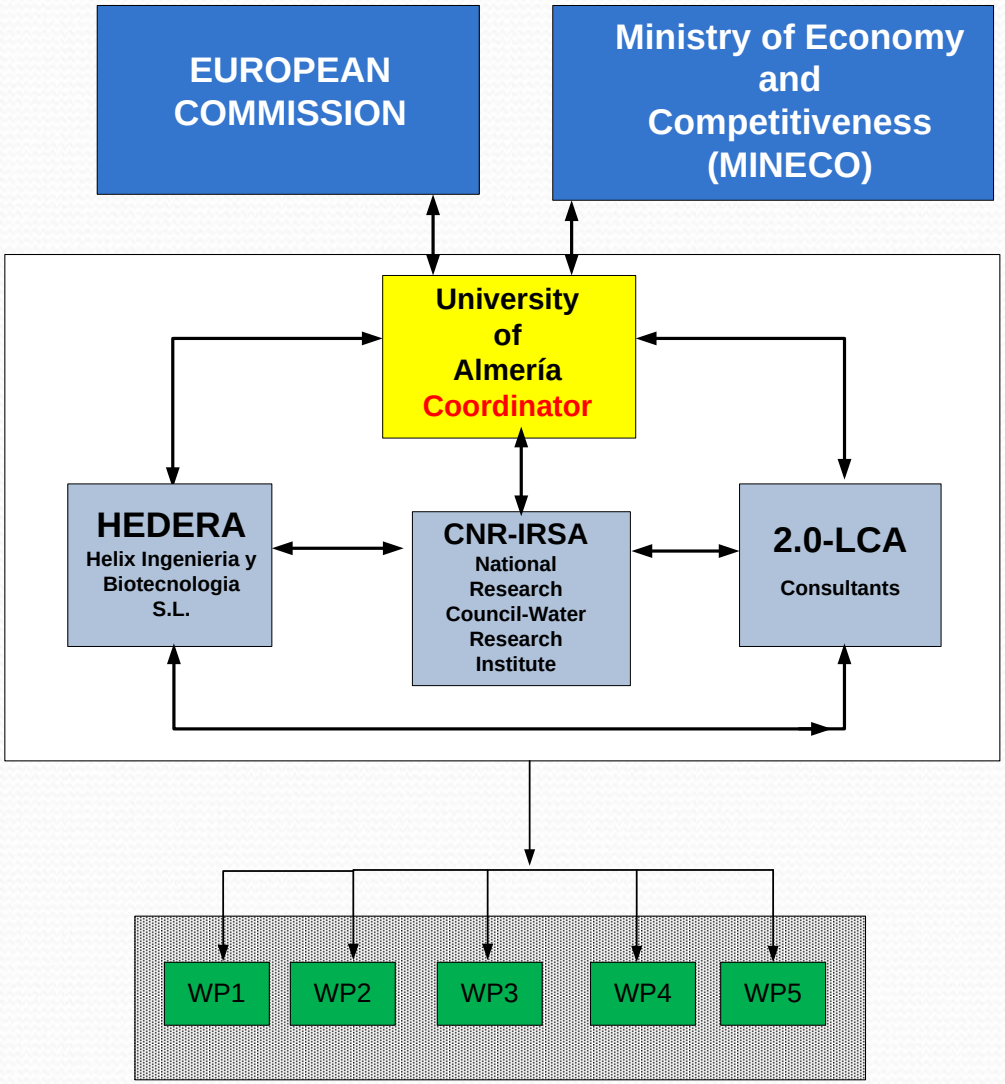
An existing SBBGR pilot plant will be upgraded for the project.

The plant will be fed with the wastewater coming from a residence located in Adriatic Sea coast of Bari, a southern Italy town.

Originality and innovative aspects of the project

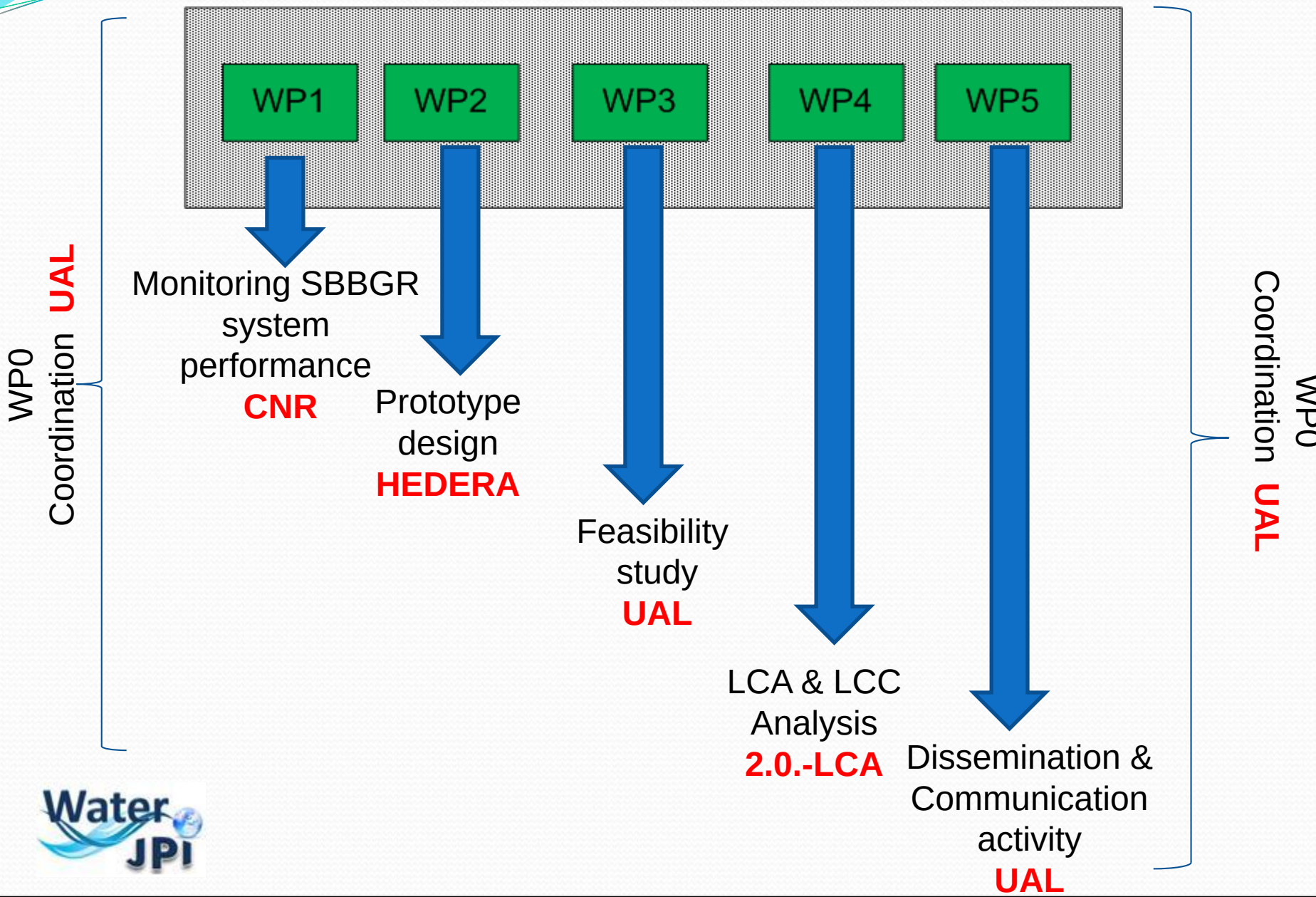
Applying innovative solar-assisted fully off-grid building cooling/heating and wastewater hybrid (SCHW) system, based solely on renewable energy sources, and applicable in any European location, will make the use of fossil fuels redundant, helping to mitigate global climate change, giving access to clean water and air, and making the society healthier.

Managment structure



APRIL 2016- APRIL 2018

Work package description



WP 1: Monitoring SBBGR system performance and key parameters for thermal recovery feasibility

- COD, BOD, TSS, VSS, N-NH4, pH, conductivity, DOC, chlorides, wastewater temperature fluctuations within the WWT process will be constantly monitored.
- Daily and seasonal temperature trends and SBBGR reactor efficiency.
- Energy balance and a thermal energy recovery rate evaluation will be analysed.

WP Leader: CNR
Groups involved: CNR, UAL, HEDERA

Task life: 24 months

WP 2: Prototype design

- Development of the prototype of the solar-assisted heat pump coupled to the heat exchanger submersed in the SBBGR reactor will be carried out.

- Installation of novel PCM-based thermal energy storage units, operating at -3°C and 50°C, respectively, and coupled to the prototype to cover ETL's annual CH and DHW demand.

- Using PV modules as the main energy source to supply SHP will allow operation with no additional fuel deliveries or batteries.

- The operation of the SCHW system will be controlled completely automatically, managing all key monitoring variables, choosing the best system control settings, matching the instantaneous energy production of the PV modules to the SHP's power needs and allowing the surplus energy to be accumulated in the form of PCM wherever possible.

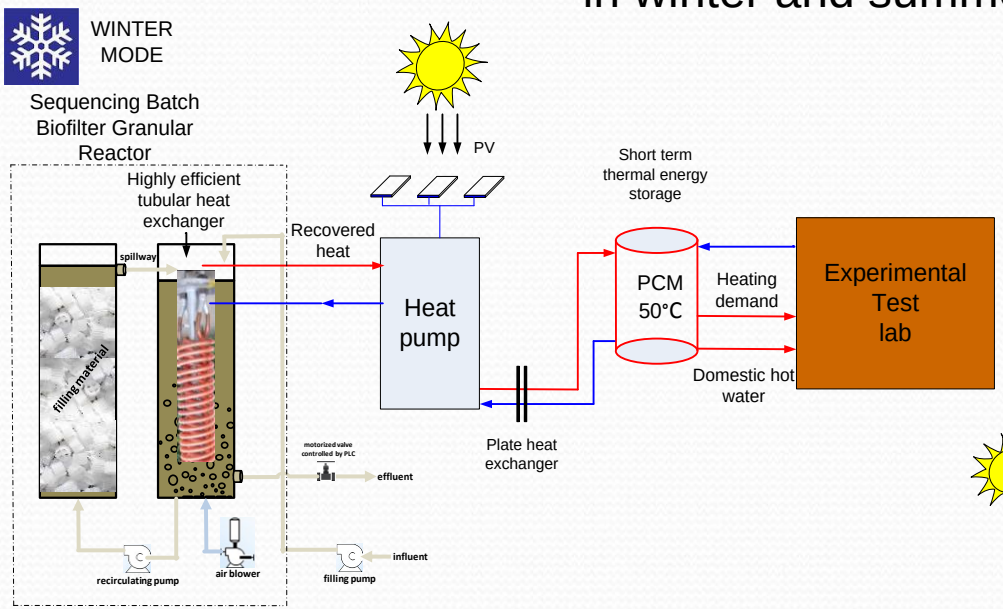
- Throughout the project the cost reduction during fabrication and installation will also be presented to facilitate the implementation of these systems.

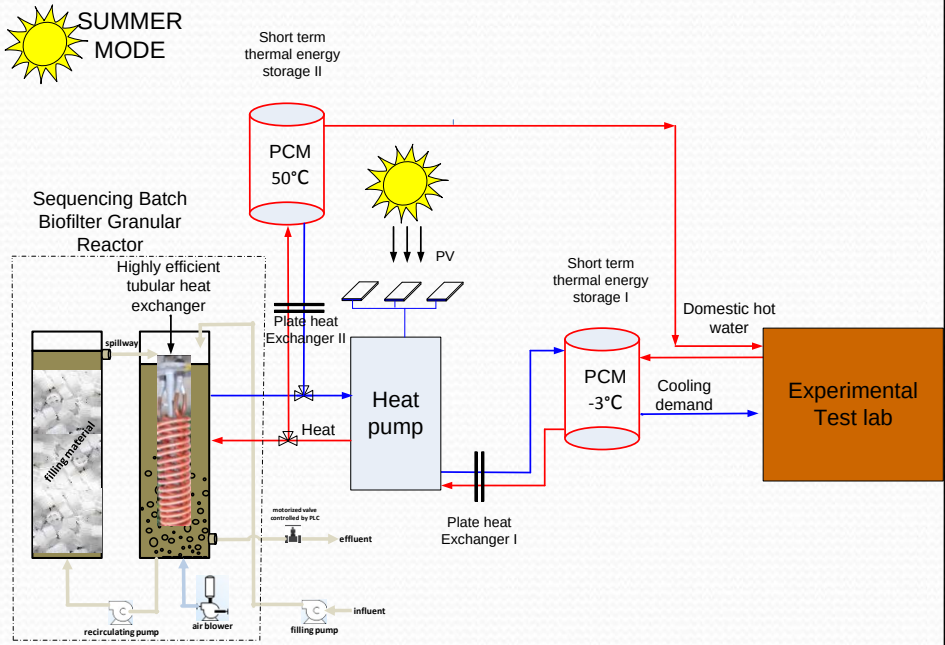
WP Leader: HEDERA
Groups involved: CNR, UAL, HEDERA

Task life: 24 months

WP 2: Prototype design

General scheme of the prototype SCHW system working in winter and summer mode





WP 3: Feasibility study

The feasibility study will be assessed in terms of:

- Energy savings, initial costs, operating costs, payback period and environmental performance.

- Artificial Neural Networks techniques will be applied to predict the performance of the studied prototype SCHW systems.

- Exergy analyses of this system helping to find the irreversibilities of each SCHW system's components.

Economic viability:

- Through Costs-Benefits Analysis methodology.
- To ascertain the economic benefits produced by the new system.

Business viability:

- Defining and honing the most suitable business model for the commercialization of the system.
- To assure the business viability of the companies involved in the project.
- Explore benefit generation business strategies.

WP Leader: UAL
Groups involved: UAL

Task life: 12 months (12-24M)

WP 4: LCA and LCC analysis

- Data sources:
  - Primary data from pilot plant
  - Secondary data from LCA databases (ecoinvent, Exiobase)
- Tools: professional LCA software SimaPro
- Impact assessment method: Stepwise2006
  - Developed by 2.-0 LCA consultants
  - Includes around 15 impact indicators
- LCC expressed as net present value (NPV)

WP Leader: 2.-0 LCA

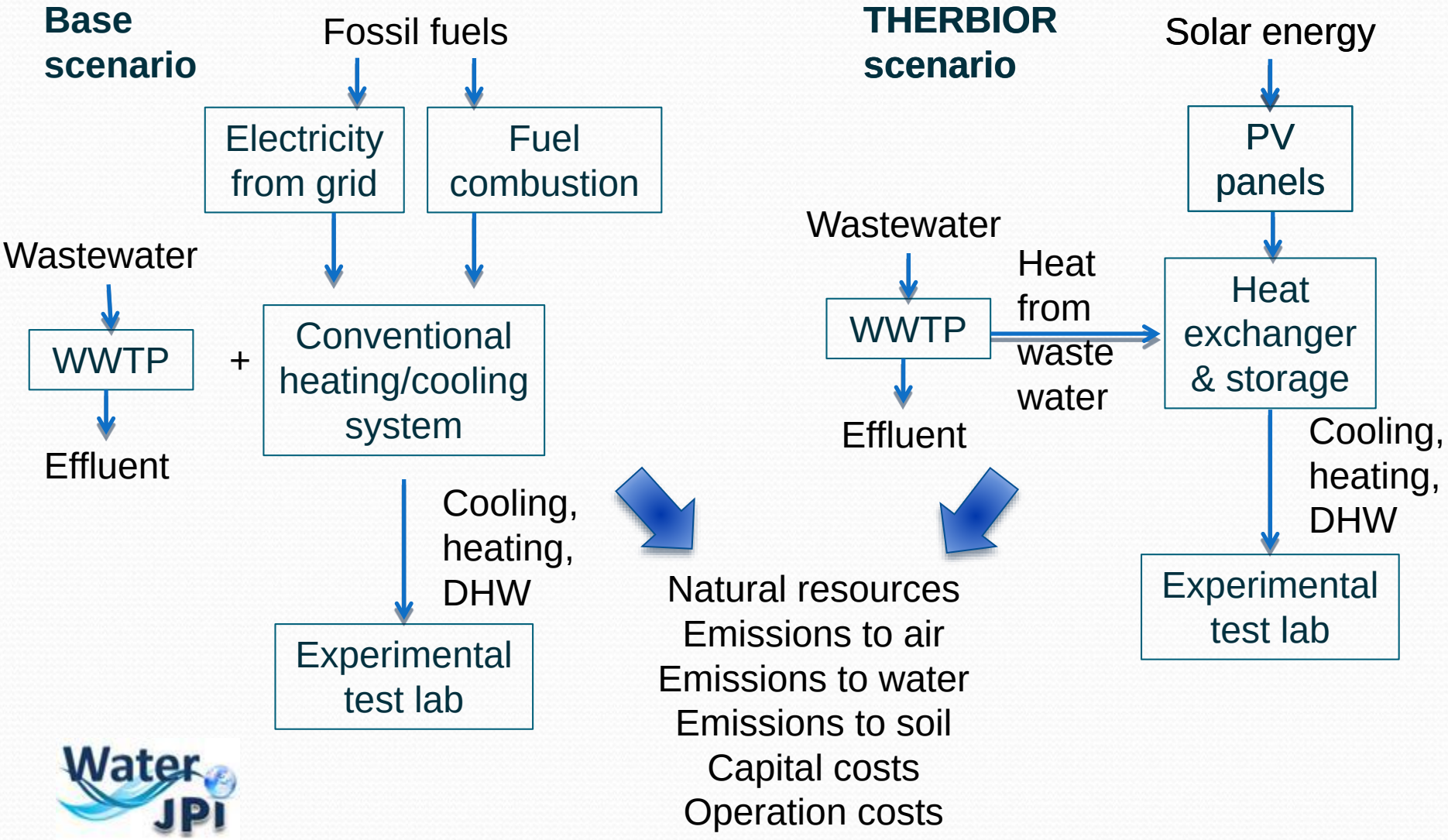
Groups involved: 2.-0 LCA, UAL, HEDERA

Task life: 12 months (12-24M)

The concept of life cycle

- Each life cycle stage consumes resources and creates pollution

WP4: scenarios to assess



WP 5: Dissemination & communication (D&C)

We will develop a communication plan that will include, at least:

- Communication activities to relevant stakeholders, for instance:
  - Potential customers
  - Regulators
  - Researchers in related areas
- The **project website**
  - 1st prototype in 3 months.
  - Will Include all the delivereables and relevant info about the project (leaflets, etc.)
- Promotional **video** (available on the project website) outlining the concept and the work performed within the project in order to produce audio-visual material that can have a high impact throughout the internet.
- Project **logo** will be used in all partner communications.
- **Publications** in leading international scientific journals and international conference presentations in all the scientific fields addressed by the project.

WP Leader: UAL

Groups involved: All groups

Task life: 24 months

Expected impacts

THERBIOR will achieve the following impact:

- Development of an innovative, highly-efficient and cost-effective solution to reuse energy from wastewater in tourism sector.
- Better water managment and more efficient use of renewable energy potential in the wastewater sector in Europe.
- Daily monitoring of reused water and produced energy.
- Creation of new market oportunities in the water-reuse sector.
- Increased water treatment process efficiency (e.g. low energy consumption and smaller footprints).

Thank you very much for your attention!

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