Low valued energy sources UPgrading for buildings and industry uses

LowUP installation Plan for relevant environment 2

Deliverable D4.2

Lead Beneficiary: Acciona Construcción
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About LowUP

LowUp – Low valued energy sources UPgrading for buildings and industry uses – is developing efficient alternatives to supply heating and cooling for building and industries, based on the use of renewable free energy and heat recovery from non-valuated residual energy sources that are currently wasted. As a result, these technologies will contribute to reducing significantly CO_2 emissions and primary energy consumption, and increasing the energy efficiency in buildings.

Led by the Spanish firm ACCIONA, the LowUp project gathers 13 partners (3 large companies, 3 research and technology organisations and 7 SMEs) from 7 European countries. During 48 months, the consortium will develop efficient alternatives to supply heating and cooling for buildings and industries based on renewable free energy as well as non-valuated wasted thermal sources:

- 3 technologies will be developed and demonstrated: one heating and one cooling system for buildings, and one heat recovery system for industrial processes.
- The systems will be demonstrated at 5 demo sites: A Pilot Office building in Seville (Acciona Construction, Spain), a Waste Water Treatment plant in Madrid (Canal de Isabel II & Acciona Water), a Pulp and Paper mill in Setubal (Portugal, The Navigator Company) a Student Hall in Badajoz (Spain, University of Extremadura) and a thermal lab in Gipuzkoa (Tecnalia, Spain).

For more information visit: www.lowup-h2020.eu

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Executive Summary

The aim of this deliverable is fulfilling all activities necessary for executing the proper implementation of LowUP concepts at emulated test-site scale in relevant environment 2, a pulp and paper factory in Setubal (Portugal), a wastewater treatment plant in Madrid (Spain), and the thermal lab of Tecnalia in Gipuzkoa (Spain), upgrading the already installed technologies and minimizing the investment for the execution. An execution plan to a proper integration of the HP-LowUP systems in these demo sites will be stablished.

The first demo site is the wastewater treatment plant placed in Madrid (Spain), named EDAR Arroyo Culebro. The purpose is to recover the remaining low exergy heat contained in the sludge, produced after the anaerobic digestion, one of the stages in the process of water treatment. The digested sludge is released at a constant temperature around 35°C, suitable to carry out an upgrade.

The second demo site is the pulp and paper factory, placed in Setubal (Portugal) and called Navigator company. With a high water consumption, the P&P mills produce large volume of wastewater (at different temperatures). The HP-LowUP concept pretends to recover the unused low exergy waste heat from this polluted wastewater. This energy recovery will be monitored and data collected will be stored to be used in subsequent emulations.

Finally, the last demo site is the thermal lab of Tecnalia, placed in the Gipuzkoa (Spain). As a technological corporation, part of its activity is dedicated to thermal systems testing. The heat pump, the key of the HP-LowUP concept, will be totally characterized in this thermal lab.

This activity will allow to define the installation/integration procedures and activities needed for correct preparation prior execution of construction process.

A detailed planning is here defined after the design phase, identifying possible blank spots, delays, techno-economic constraints, risk analysis and contingency plans (in synergy with WP5).

Keywords

Installation plan, risk and contingency plan, space conditioning, heat pump, wastewater, heat recovery unit

List of acronyms and abbreviations

HP	Heat Pump
HP-LowUP	Heat Pump LowUP
EDAR	Estaciones depuradoras de aguas residuales (Wastewater treatment plant)
RHeX	Acronym of the new design of the improved self-cleaning rotating exchanger
P&P	Pull and Paper
PC	Personal Computer
PLC	Programmable Logic Controller

1 Introduction

In this second phase of the project, the goal is the design, installation, operation and validation in relevant environment of the LowUP systems. This deliverable is focused on HP-LowUP systems, which will be tested in real industry environments.

According to results from previous tasks (mainly within WP3), HP-LowUP prototypes and the necessary auxiliaries according to results from dimensioning engineering process, previously individually fully tested, will be shipped to the sites; these devices will be integrated in three pilot plants: Navigator Company, EDAR Arroyo Culebro and Tecnalia.

The HP- LowUP concept is based on an effective and reliable heat pump based system, and 100% thermal powered by residual and rejected low temperature energy sources (below 45°C), for application at industrial processes with temperatures up to 80 °C. This temperature upgrading solution is based on the combination of heat recovery technologies, from low valued energy sources like rejected and process waste heat (20-45°C), with high efficiency-high temperature water-to-water heat pump for the production of process heat between 55-80°C.

As shown from the Figure 1, HP-LowUP system is composed by the following technologies:

- A sludge/wastewater-to-water or water-to-sludge/process water heat exchangers that could be used as a heat recovery system or as a heat delivery system.
- High efficiency electrically driven heat pump.

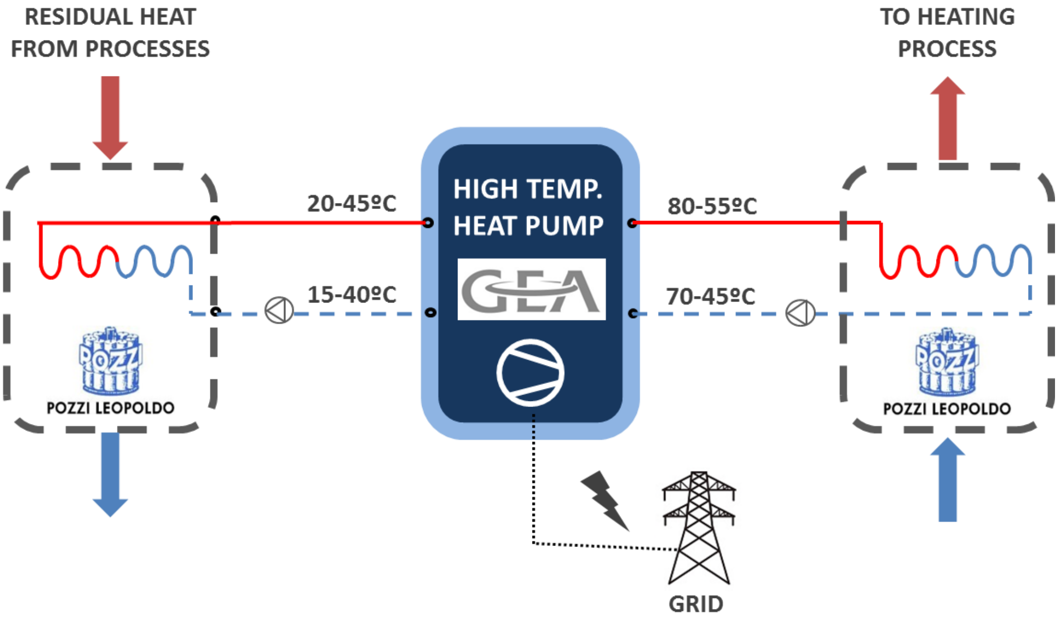


Figure 1: HP-LowUP concept

From now on, there are four partial objectives in the frame of this demonstration work package (WP4):

A - Design at component level: Engineering process for electromechanical adaptation of relevant test sites to LowUP System/technologies. Engineering process for test site control system adaptation to operational necessities.

B - Installation at component level: Test sites conditioning for LowUP System implementation, from civil to electromechanical works.

C - Design at system level: Engineering process for integration of LowUP System with relevant test sites.

D - Installation at system level: Functional integration/implementation and commissioning of LowUP with real and simulated test facilities (relevant environment), from electrical, hydraulic and energetic point of view.

E - Control and operation: Characterization of LowUP System from limit to operational working conditions. Continuous operation and maintenance at nominal and modulating working conditions. Validation of predictive maintenance and continuous commissioning techniques. Calibration of simulation models and control strategies.

This deliverable aims to fulfil the description of objectives A, B and C, dealing with the preparation of the sites where LowUP technologies will be deployed and giving an optimized installation plan. The objective of the related task in the project (Task 4.3) is fulfilling all engineering activities necessary for executing the proper implementation of LowUP concepts at emulated test-site scale. Factory plants will be modified according to integration with waste heat recovery systems; the heat pump will be totally characterized in the thermal lab of Tecnalia; both systems, after their characterization, will be integrated in a virtual environment in order to be tested working together.

2 Installation plan for Wastewater treatment plant

The purpose of this section is to give a detailed overview of the LowUP demo site in Madrid (Spain), describing the current state of the demo site, the systems that will be integrated and their main features, the necessary works to adapt the place and the installation and risk management plans.

2.1 Description of Madrid demo site

Located in Getafe (Madrid), the EDAR Cuenca Baja del Arroyo Culebro, is in charge of the treatment of the waste water produced in Pinto and Getafe. The capacity is around 172800 m3/d and a population equivalent of 1.3 million people [1].

Figure 2: EDAR Arroyo Culebro Cuenca Baja

A brief resume of the process is presented as follows (for more information it can be consulted the deliverable D3.1 “Case studies description”):

The sewage sludge produced in wastewater treatment plant, products from the primary and secondary treatments, requires to be treated. Anaerobic digestion is a proven technology for sewage sludge treatment because it allows a high reduction of the solid matter in the sludge.

The sludge is pumped into the anaerobic continuously stirred tank reactors, Figure 3, where digestion takes place, usually at mesophilic temperature (35 – 39 °C).

After the anaerobic digestion, the digested sludge is released at a constant temperature around 35°C so as to be dewatered. At this point, the remaining low exergy heat contained in the sludge will be recovered, through the Heat Recovery System developed by Pozzi.

Figure 3: Anaerobic digester in EDAR Arroyo Culebro Cuenca Baja

Next image shows the location of the biodigester reactors area in the plant:

Figure 4: Biodigester reactors area location in the EDAR Arroyo Culebro Cuenca Baja

2.2 Description of the HP-LowUP system to be installed in Madrid

This section aims to describe in detail the main system to be installed in Madrid, setting out the requirements of all of them to be properly integrated in the waste water treatment plant.

A concept scheme of the installation is presented as follow:

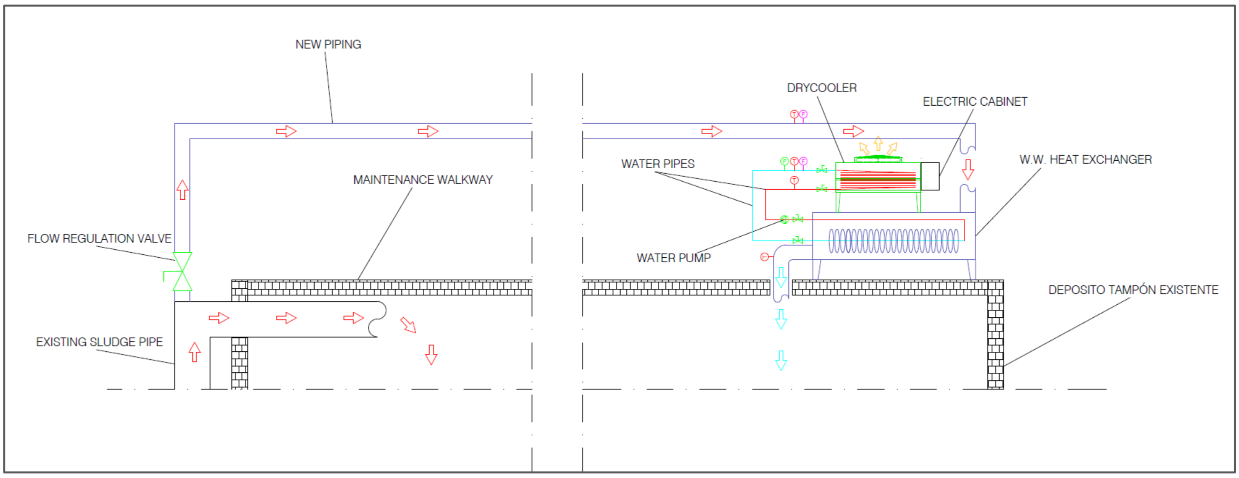


Figure 5: Madrid Demo Site conceptual P&ID diagram

The system is composed by three mainly devices (they can be identified in the images above):

- Heat exchanger
- Dry cooler
- Water pump

The technology developed in the frame of the LowUP project to be installed in Madrid is the RHeX heat recovery unit. The rest of the systems are considered as auxiliaries whose function is the impulsion of the clean water and the dissipation of the heat.

2.2.1 RHeX heat recovery unit

The heat exchanger is the most important part of the heat recovery system and it has been designed specifically for the requirements of this project.

The heat exchanger unit consist of:

• One rotating heat exchanging element made of AISI 316L stainless steel.

• One external tank with protection lid¡. The tank has connections for discharge water outlet and inlet, overflow pipe and tank emptying valve.

• Two or more sealing groups and support assemblies to allow the rotation of the rotor

• Rotating joints for fresh water inlet and outlet connected to the rotor.

• One safety valve on the fresh water circuit.

• One motor group consisting of one or two moto-reducers with pulleys and toothed belts.

• One inverter to allow for the pre-setting of rotational speed of the machine and of the start – stop ramps.

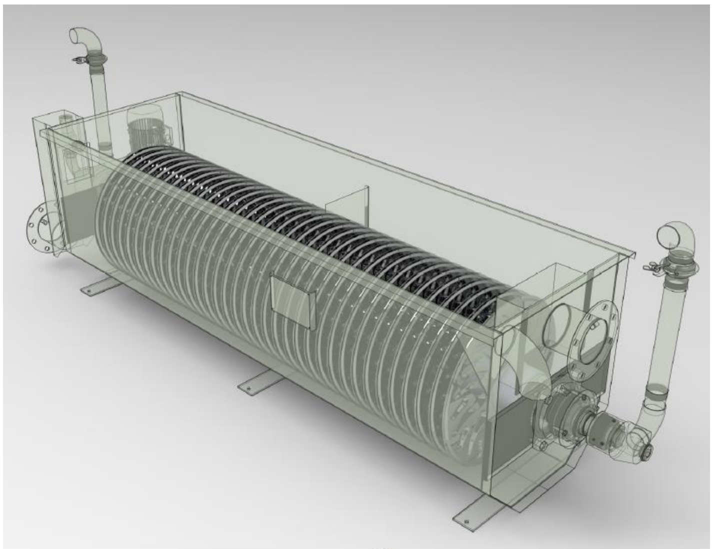


Figure 6: Design of the RHeX

Fluid circuits requirements:

- A primary fluid, flowing outside the rotor of the exchanger (inside the trough of the exchanger). This fluid will be highly polluted even with mechanical impurities. The primary fluid generally consists of fluid coming out of a continuous process that could be operating while the heat exchanger needs special cleaning and maintenance.
- A secondary fluid, flowing inside the rotor, counter current to the primary one. This fluid will be free from mechanical impurities. In this case the secondary fluid will be water. The secondary circuit connects the heat exchanging element (the rotor) to the clean fluid network. In order to avoid deposits or sedimentations caused by hardness, it is suggested that this fluid should be softened and filtered.

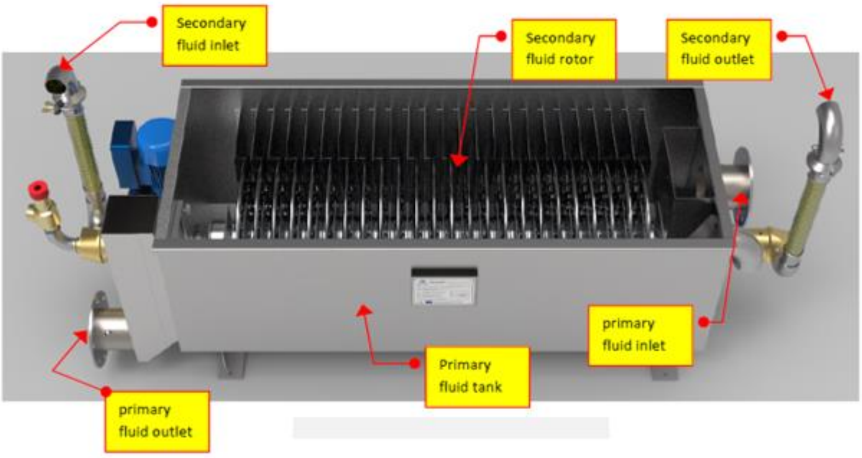


Figure 7: RHeX working principle

Site requirements:

The area where the RHeX is installed has to fulfil few requirements:
Once running, machine surfaces can become very hot, therefore it is mandatory that proper protecting fences or paddings are available to avoid accidental contact with surfaces and to prevent operators from eventual scorching. However, such protections must allow for maintenance and/or temporary cleaning of the unit, so the following minimum side clearances are required: 0.5m on the short sides, free access to the side where the identification plate is installed, and 0.1m on the opposite side.

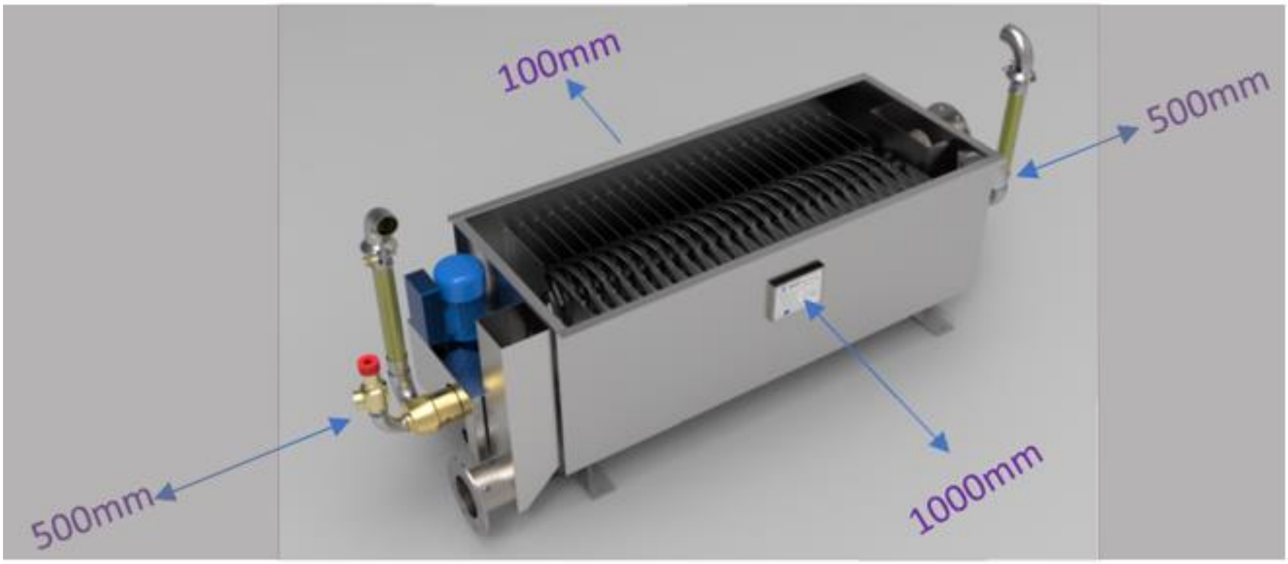


Figure 8: space requirements of RHeX system

According to deliverable D3.2, the necessary exchanging surface of the RHex system in the Madrid demo site will be the following:

RHeX populated with 14 lenticular discs.

2.2.2 Auxiliary systems

In this section the main requirements of the auxiliary systems will be presented. Two systems are considered essential for a proper working of the system, the dry cooler and the water pump. The main considerations to take into account are the required space and power:

Dry cooler:

Its main function is the dissipation of the heat from the water, previously heated through the RHeX systems.

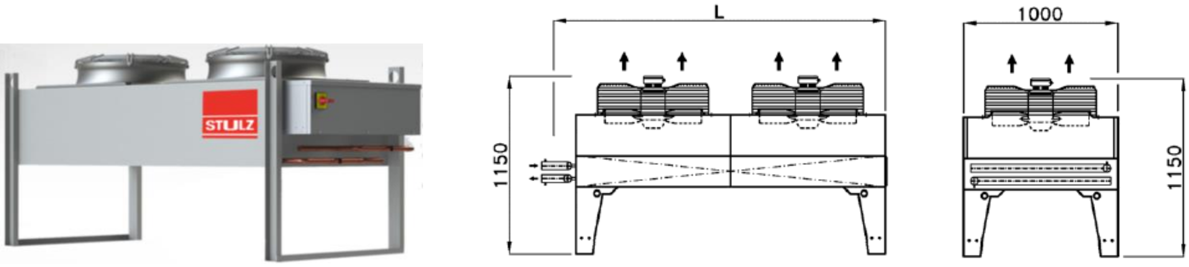


Figure 9: Dry cooler

Main features:

L = 2.145 m

Power consumption = 1.9 kW

A more detailed description will be provided in deliverable D4.5.

Water pump:

The water pump is in charge of the secondary fluid circulation.

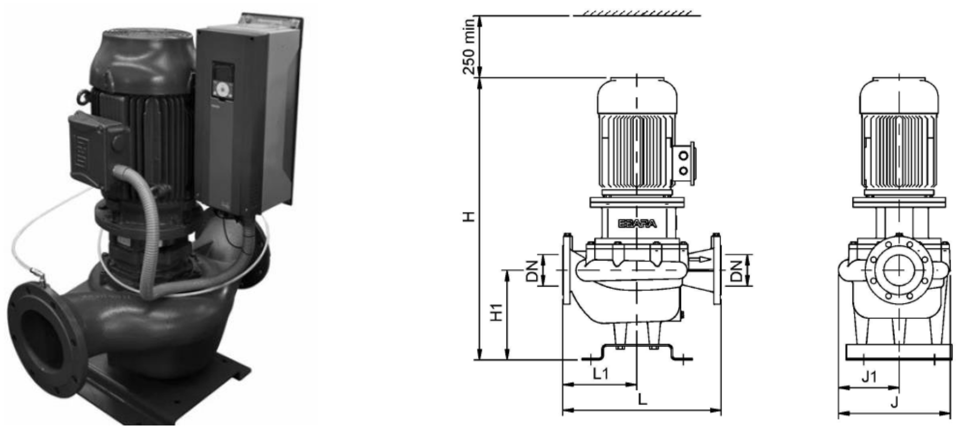


Figure 10: Water pump

DN = 50 mm	L1 = 190 mm
H1 = 145 mm	H = 535 mm
L = 350 mm	J = 255 mm

Weight = 45 kg

Power consumption = 0.75 kW

A more detailed description will be provided in deliverable D4.5.

2.2.3 Skid construction

A pre-installed skid with all the necessary attachment and instrumentation is considered, in order to integrate all the systems in a single unit, simplifying the installation process. A picture is presented as follows:

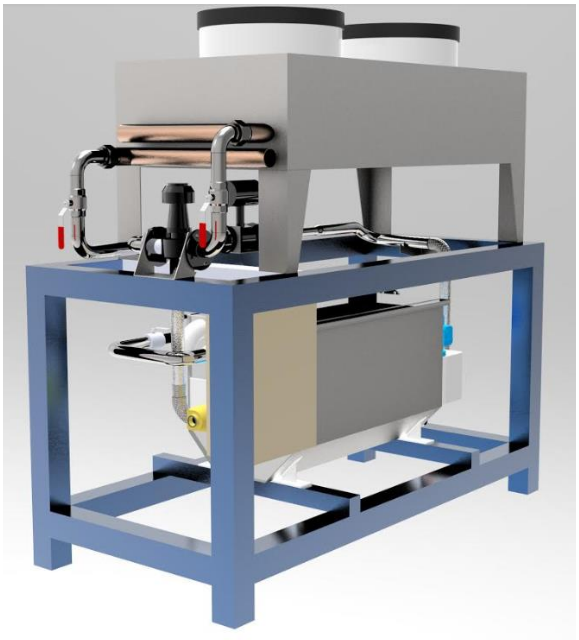


Figure 11: RHeX system integrated with the auxiliary systems in a single unit

As it can be observed in the image above, the RHeX system, the dry cooler and the water pump are integrated in a single unit.

The main requirement to install the systems are:

- Ground conditioning to ensure an stable support
- Available space

The size of the skid is showed in the following image:

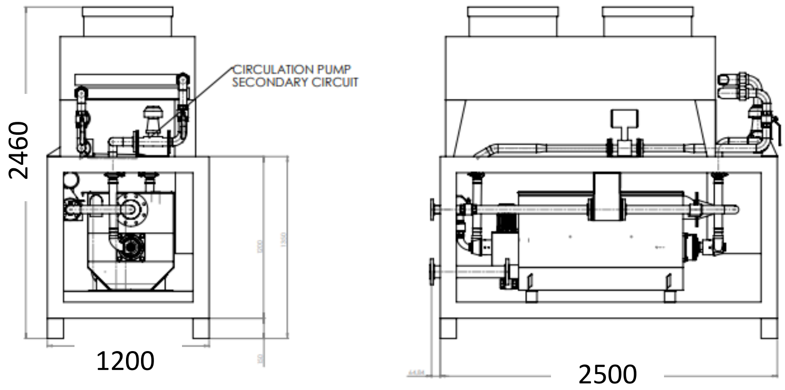


Figure 12: skid unit dimensions

2.3 Preparation works

This section aims to describe all the preparatory works which are needed to be executed in the demo site of Madrid to allow a proper systems integration, minimizing the impact and the investment. A preparatory works plan will be presented at the end of this section.

2.3.1 System integration in the plant

As it has been said in previous sections, the system will be integrated in the biodigester reactors area. This area is showed in the image below:

Figure 13: biodigester reactors area

The available space is enough to host the system and the it will be located near from the sludge pipe which is currently used to sample collection (see Figure 14):

Figure 14: sludge pipes used for tests

As it has been said, these pipes are used to collect some sludge samples in order to be analysed. To integrate the Heat recovery system with the reactor, one of the sludge pipes will be adapted to allow this integration. So, the cut-off valve (see Figure 14), which is opened only when a sample is required, will keep open to feed the LowUP system with the sludge. In this case the circulation of the sludge will be produced by the gravity force, without the necessity of using a circulating pump. The adaptation of the pipe system will be considered as a preparation work to integrate the system in the plant.

Water and power supply:

In this demo site, the water and power supply points are not a critical issue, due to both are guaranteed.

Structure anchoring:

To ensure an stable support of the skid, a concrete foundation slab will be built. This will allow anchoring the structure to the ground.

2.3.2 Monitoring/control system

The main purpose of this system is to collect data in order to characterize the system working with an specific fluid and to emulate this in a virtual environment. For this reason, some probes, sensors and controllers will be installed. The following image shows an scheme of the control system structure:

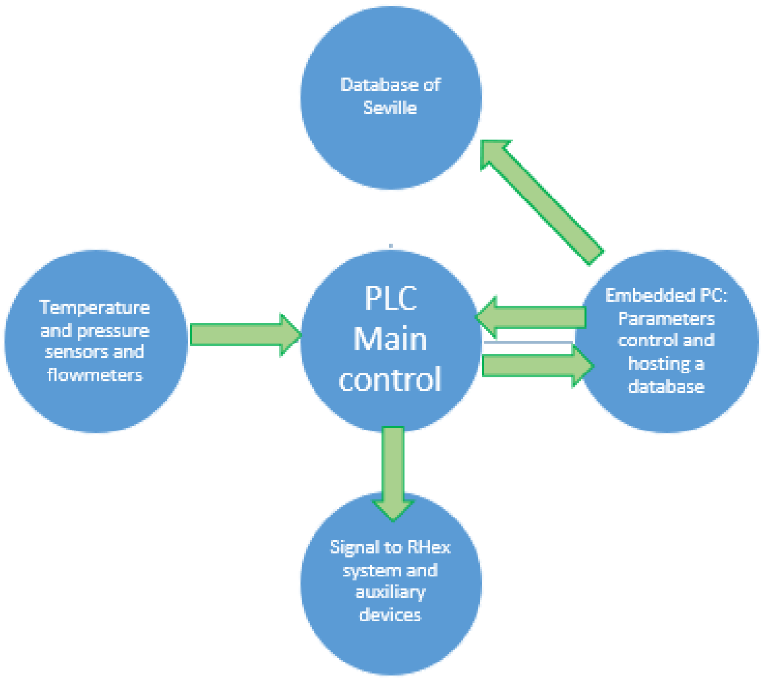


Figure 15: monitoring system scheme

A brief description is presented as follows:

The main system will be the PLC. This PLC receive a signal from the temperature and pressure sensors, and from the flowmeters. Depending on this data, and the parameters stablished by the user through the PC, the PLC sends the orders to the frequency inverters of the different devices (rotor, drycooler, water pump).

All the data will be collected in a database of the embedded PC installed in the plant, but also will be saved in a database of Seville.

The temperature probes, that have a critical importance in the proper operation of the system, will be installed to characterize the temperature of the environment, the sludge and the water.

2.3.3 Engineering works

To ensure a proper working of the system in the plant some activities related to engineering works will be done. The following set of activities will be carried out:

- Updating the P&ID schemes and layouts
- Sizing the pipe networks: clean water and sludge
- Selection of the HReX system according to LowUP project requirements
- Selection of the dry cooler to ensure the dissipation of the heat
- Calculation of the pressure losses
- Auxiliaries selection: According to the pressure losses previously calculated, sizing the plumbing system.
- Select the monitoring devices
- PLC programming and interface generation to allow user activity.
- Skid design and construction

All the engineering designs will be widely described in the deliverable D4.5.

2.4 Installation Plan

This section aims to propose a timetable, collecting all the activities related to engineering and preparatory works, analysed in previous sections, and the installation and the commissioning of the systems.

Table 1: Installation Plan - Madrid Demo

Act.	Work to be executed	Description of activities	Partners involved
1	Research + Development activities	- Design and testing of a new Heat Exchanger, following the requirements of the LowUP project	- Pozzi
2	Engineering works	- P&ID generation - Pipe networks and auxiliary devices selection - Selection of monitoring devices - PLC programming - Skid design	- Acciona - Pozzi - Eurecat
3	Manufacturing and delivery of products	- Sizing of equipment - Manufacturing - Skid construction - Delivery	- Pozzi
4	Systems installation	- Installation of each system, following the manufacturer instructions	- Acciona - Local installers
5	Systems connections	- Installation water and sludge pipe network, auxiliary devices, electrical connections and monitoring systems.	- Acciona - Local installers
6	System commissioning	- Startup of global system	- Acciona - Pozzi

Table 2: Installation Plan – Madrid Demo - Timetable

	sep-17	oct-17	nov-17	dec-17	jan-18	feb-18	mar-18	apr-18	may-18	jun-18	jul-18	aug-18	sep-18	oct-18	nov-18	dec-18
Research + Development activities (Units testing)	■	■														
Engineering design works		■	■	■	■											
Manufacturing and delivery			■	■	■	■	■	■	■	■						
System installation											■	■				
System connections													■	■		
System commissioning															■	■

2.5 Risks and contingency plan

In next table, the main risks of the Heat Recovery System integration and operation will be defined and characterized, as well as the contingency plan considered to solve each of them.

Table 3: Risk and contingency plan – Madrid demo site

Risk	Probability	Impact	Contingency Plan
The sludge nominal flow is not reached	Medium	High	A sludge pump will be purchased in order to allow a proper operation of the system.
Power cuts or failure	Medium	Medium	Acceptable as long as the power cut is short and not repeated in moderated time. Maintenance staff will play a role in case of the general switch of the Heat Recovery System electrical cabinet keep down after power supply restoring.
Network connectivity failures	Medium	Medium	Acceptable. In case of a failure in the 3G connection, data will be collected in a local data base.
Auxiliary systems breakdown	Medium	High	Repairing or replacing the equipment.
Main systems deterioration or damage	Low	High	Preventive maintenance, according to maintenance manual provided by manufacturers.
Failure in monitoring systems	Low	High	Data collected must be reliable. In case of a failure in a monitoring device, it has to be recalibrated or replaced
Water or sludge leakages	Medium	Medium	Leakage detection and correction
Delay in integration process	High	Medium	Adaptation of test plan

3 Installation plan for Pulp and Paper factory

The purpose of this section is to give a detailed overview of the LowUP demo site in Setubal (Portugal), describing the current state of the demo site, the systems that will be integrated and their main features, the necessary works to adapt the place and the installation and risk management plans.

3.1 Description of Setubal demo site

The Navigator company, located in the Mitrena industrial area in Setubal (Portugal), is composed by a Pulp factory and two Paper factories and it is considered as a European reference in the production of pulp and paper. The Pulp factory of Setubal has a production capacity of 550 thousand tons, whereas, the two Paper factories have a combined production of 775 thousand tons [2]. This facility also hosts a cogeneration and a biomass power plants.

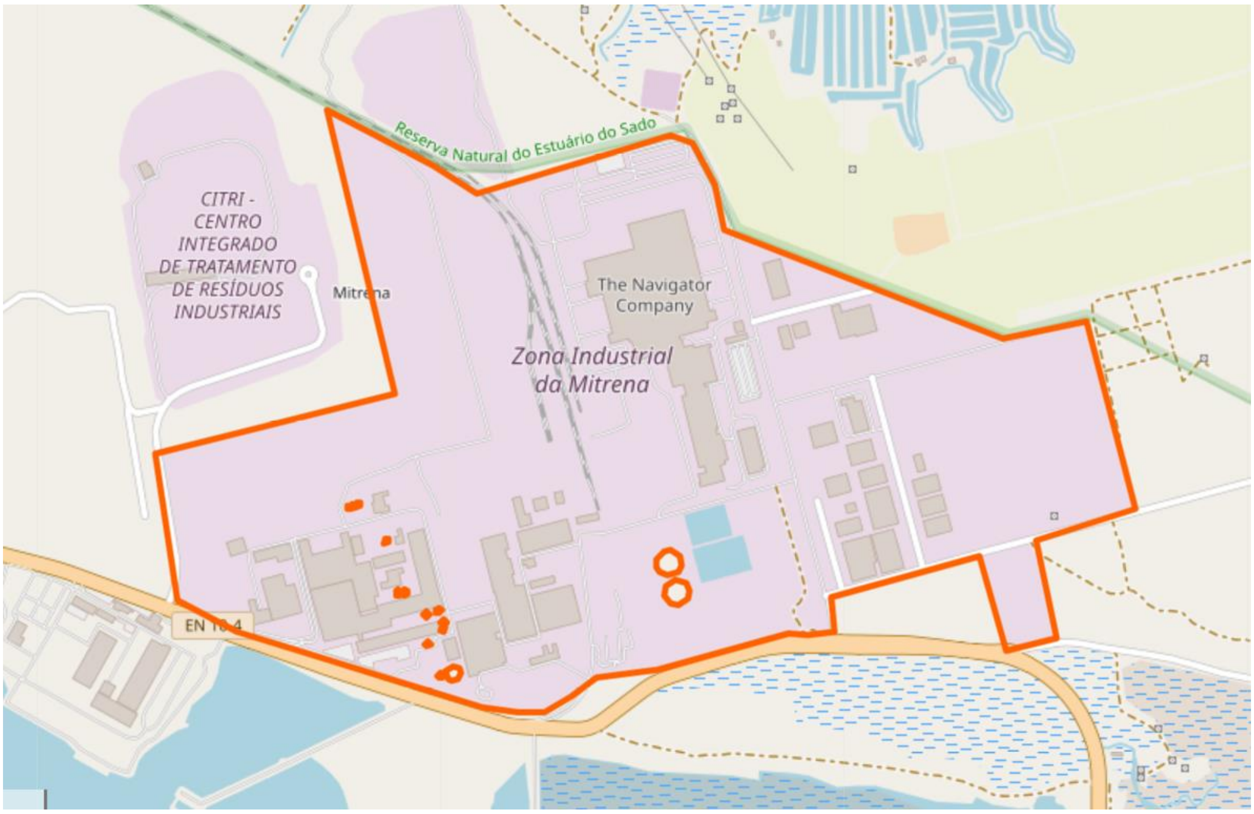


Figure 16: Navigator company location

The pulp and paper (P&P) industry is one of the heaviest users of water within the industrial economy, requiring 54 m^3 on average of water per metric ton of finished product. With water used in nearly every step of the manufacturing processes, P&P mills produce large volumes of wastewater (at different temperatures) and residual sludge waste, presenting a number of issues in relation to wastewater treatment, discharge, and sludge disposal. Approximately 85% of the water used in the P&P industry is used as process water, resulting in relatively large quantities of contaminated water and necessitating the use of onsite wastewater treatment solutions. More information about the process can be consulted in deliverable D3.1.

Divided in different sections, the Navigator company facilities host a small residual water treatment plant, where the treatment of the polluted water takes place. As it has been said in the last paragraph, due to the high requirements of water in this kind of factories, the recovery of energy from this water is considered. The HP-LowUP concept pretends to benefit the P&P industry recovering the unused low exergy waste heat from polluted wastewaters, increasing the energy efficiency of the entire production process, and boosting it for other energetic purposes. The effluent has here temperatures around the 35-45°C.

Figure 17: Navigator Company (red area) and its water treatment plant (green area)

Through a deep analysis of the complete process of the Pulp and Paper factory, it has been concluded that, due to elevated consumption of steam, the low exergy heat (recovered from polluted water), can preheat the desmineralized water, used for steam generation, reducing the contribution of fossil fuel from steam boilers.

3.2 Description of the HP-LowUP system to be installed in Setubal

This section aims to describe in detail the main systems to be installed in Setubal, setting out the requirements of all of them to be properly integrated in the factory.

A concept scheme of the installation is presented as follow:

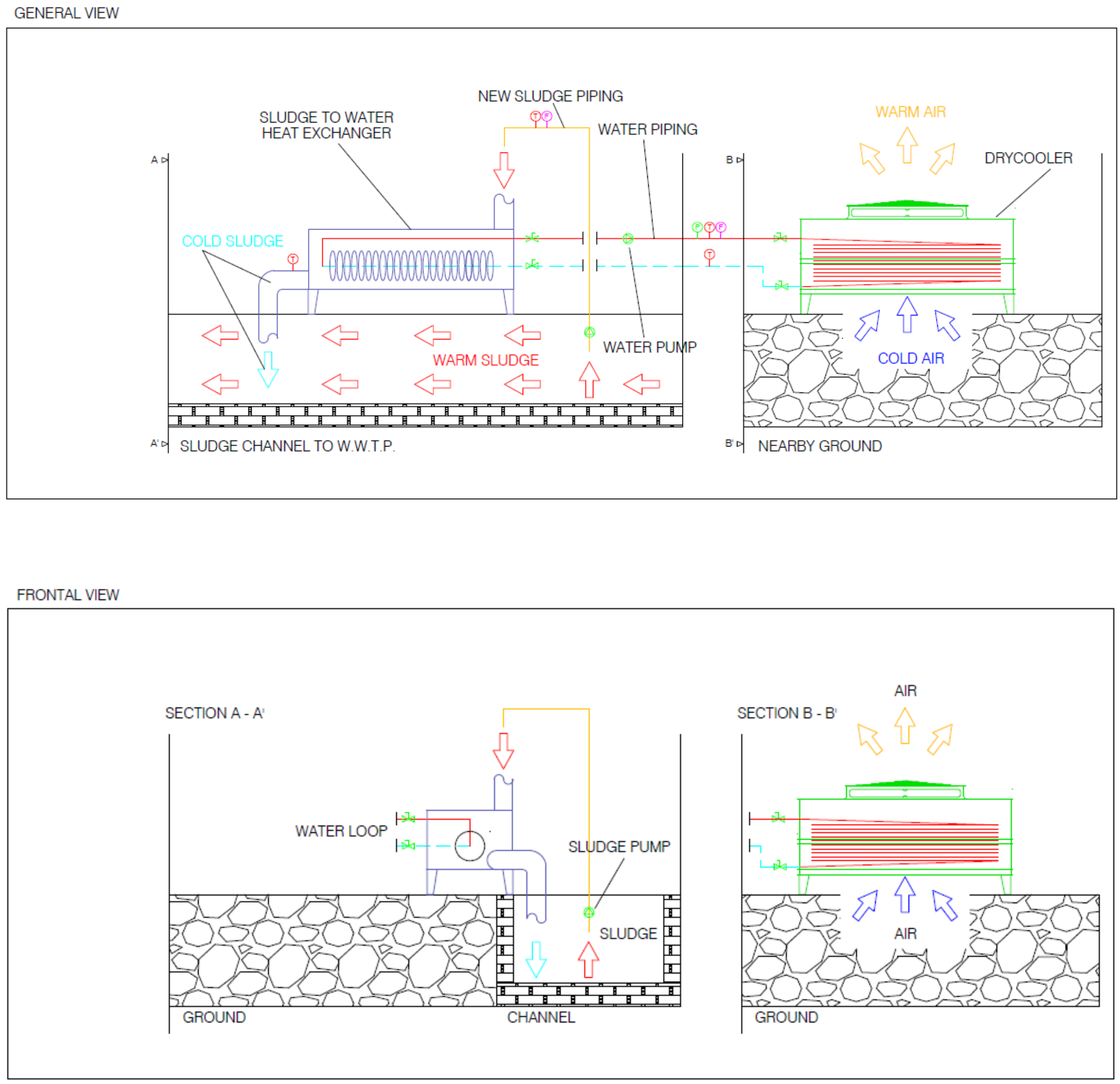


Figure 18: Installation scheme of HP-LowUP concept in Setubal

The system is composed by four mainly devices (they can be identified in the images above):

- Heat exchanger
- Drycooler
- Water pump
- Sludge pump

The mainly characteristics, and requirements for the integration in the plant of these devices are described in the following subsections.

3.2.1 RHeX heat recovery unit

Due to the system to be installed is the same as Madrid, the main features and requirements can be consulted in section 2.2.1 of this document

Figure 19: Heat exchanger to be installed in Setubal

According to the calculations (Deliverable D3.2), it has been decided that the necessary exchanging surface will be as follows:

- **For the pulp & paper mill case**: RHeX populated with 12 lenticular discs.

In order to simplify design and construction, and prove the modularity and scalability of the RHeX, it has been decided that the actual trough of the 2 exchanges will be the same and will be designed for a maximum of 14 plates independently from the final number of plates mounted onto its rotor.

In the pulp & paper mill case, the rotor will be made up of 12 lenticular discs and 2 placeholder sleeves which will make up the same length of rotor as in the wastewater treatment plant case, this will provide the extra advantage of having the possibility to eventually add 2 further discs at a later time and be able to test the same unit with different exchanging surfaces.

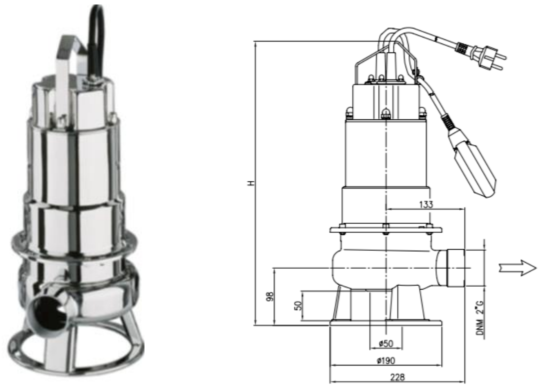
3.2.2 Auxiliary systems

The dry cooler and the water pump will have the same features as the devices installed in Madrid demo site. So, it could be consulted in the section 2.2.2 of this document.

Figure 20: dry cooler and water pump of Setubal demo site

Sludge pump:

In this case, a sludge pump will be required for the primary fluid circulation. This kind of pumps is submersible and can work with sewage. The dimensioning will be able to be consulted in the deliverable 4.5. The main features are presented below:



Power consumption: 0.55 kW

Max. solid passage: 50 mm

Main requirements: this pump needs to be submerged in the sludge, for a proper operation of the system. It also be connected to the heat exchanger through a pipe network.

3.2.3 Skid construction

As in the case of the demo site of Madrid, a pre-installed skid with all the necessary attachment and instrumentation is considered, in order to integrate all the systems (except the sludge pump) in a single unit, simplifying the installation process.

With this proposed solution, the assembly RHeX heat recovery + dry-cooler + water pump will be the same for both demos, with the dry-cooler mounted on the top of the heat recovery, with enough space in between for maintenance issues.

3.3 Preparatory works

This section aims to describe all the preparatory works which are needed to be executed in the demo site of Setubal to allow a proper systems integration, minimizing the impact and the investment. A preparatory works plan will be presented at the end of this section.

3.3.1 System integration in the plant

The main requirement of the heat recovery system in order to be integrated in the pulp and paper factory of Setubal, is the available space and the power and water supply.

Related to the open spaces where the system can be installed, as it is observed in the image below, the space surrounding the sludge pool is wide, but there are some considerations to take into account:

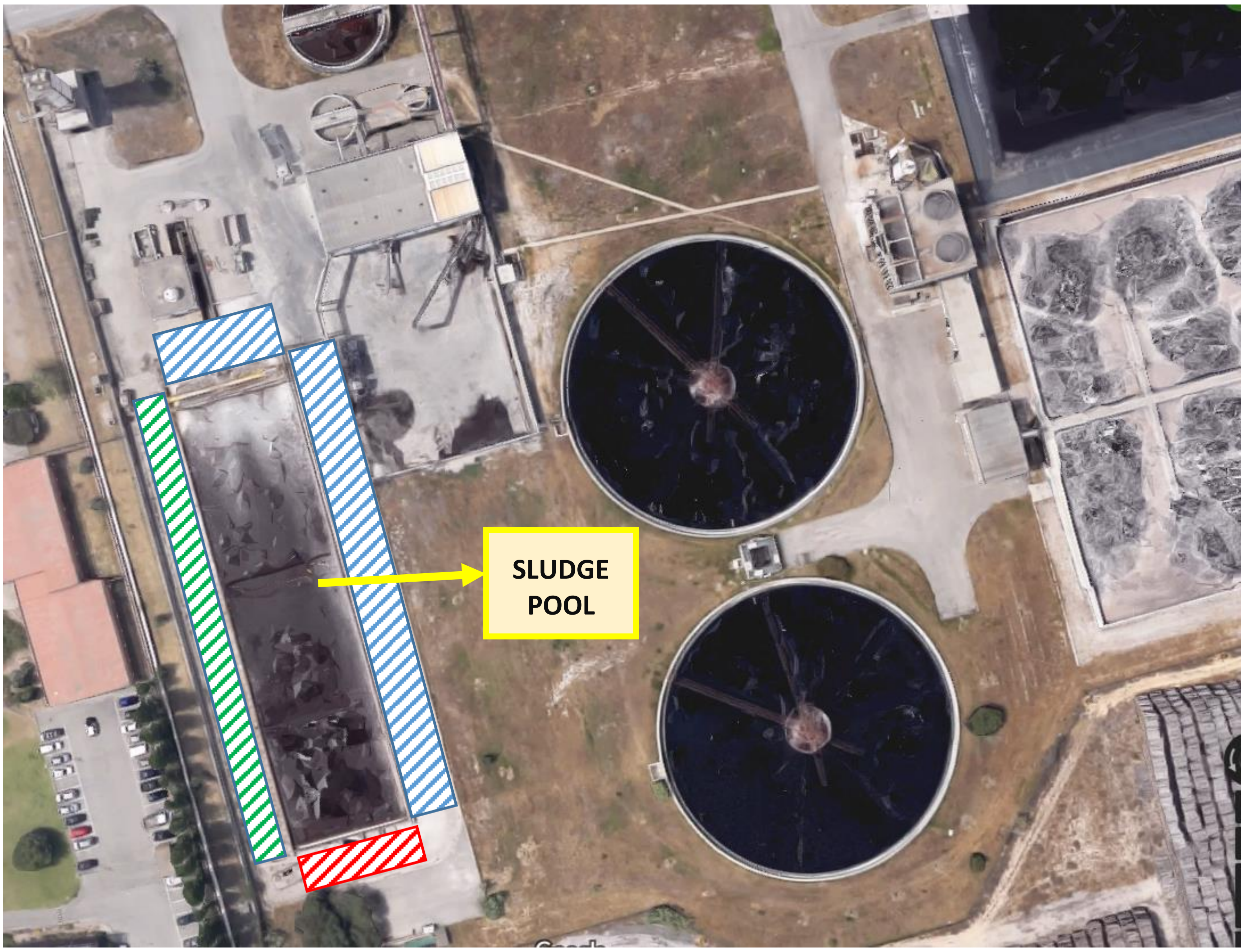


Figure 21: Available space to system integration in the Navigator Company

The blue area cannot be considered as an available space, because it is a vehicles circulation zone.

The green area could be considered as a suitable zone for system integration, but, as it is showed in the next image, the existence of some fences hinders this.

Figure 22: Fences location

So, the system will be installed in the red area. The available space there is enough to host the system. The most important problem is the dealing against the aggressive environment that exists in this zone, with high level of humidity and powder.

Electrical connection

A 3-phase electrical connection is required for a proper operation of the system. This requirement is fulfilled in the red area:

Figure 23: power supply point

Water supply

Due to water will be the secondary fluid, a water supply source will be necessary to fill the secondary circuit. In this case, any water supply point is available, therefore two alternatives are considered:

1- Use the private fireman service from the Navigator Company to fill the installation and to refill this when the pressure drops below 2 bar.
2- Install a 100 liters tank, that provide water automatically when the pressure drops below 2 bar.

Structure anchoring:

To ensure an stable support of the skid, a concrete foundation slab will be built. This will allow anchoring the structure to the ground.

3.3.2 Monitoring/Control systems:

The main purpose of this system is to collect data in order to characterize the system working with an specific fluid and to emulate this in a virtual environment. For this reason, some probes, sensors and controllers will be installed. The scheme of the control structure is similar than in Madrid demo site (see Figure 15).

3.3.3 Engineering works to fulfil system requirements:

To ensure a proper working of the system in the plant some activities related to engineering works will be done. The following set of activities will be carried out:

- Updating the P&ID schemes and layouts
- Sizing the pipe networks: clean water and sludge
- Selection of the HRex system according to LowUP project requirements
- Selection of the dry cooler to ensure the dissipation of the heat
- Calculation of the pressure losses
- Auxiliaries selection: According to the pressure losses previously calculated, sizing the plumbing system (water and sludge).
- Select the monitoring devices
- PLC programming and interface generation to allow user activity.
- Skid design and construction

All the engineering designs will be widely described in the deliverable D4.5.

3.4 Installation plan

This section aims to propose a timetable, collecting all the activities related to engineering and preparatory works, analysed in previous sections, and the installation and the commissioning of the systems.

Table 4: Installation Plan - Setubal Demo

Act.	Work to be executed	Description of activities	Partners involved
1	Research + Development activities	- Design and testing of a new Heat Exchanger, following the requirements of the LowUP project	- Pozzi
2	Engineering works	- P&ID generation - Pipe networks and auxiliary devices selection - Selection of monitoring devices - PLC programming - Skid design	- Acciona - Pozzi - Eurecat
3	Manufacturing and delivery of products	- Sizing of equipment - Manufacturing - Skid construction - Delivery	- Pozzi
4	Systems installation	- Installation of each system, following the manufacturer instructions	- Acciona - Local installers
5	Systems connections	- Installation water and sludge pipe network, auxiliary devices, electrical connections and monitoring systems.	- Acciona - Local installers
6	System commissioning	- Startup of global system	- Acciona - Pozzi

Table 5: Installation Plan – Setubal Demo - Timetable

	sep-17	oct-17	nov-17	dec-17	jan-18	feb-18	mar-18	apr-18	may-18	jun-18	jul-18	aug-18	sep-18	oct-18	nov-18	dec-18	jan-19	feb-19	mar-19
Research + Development activities (Units testing)																			
Engineering design works																			
Manufacturing and delivery																			
System installation																			
System connections																			
System commissioning																			

3.5 Risk and contingency plan

In next table, the main risks of the Heat Recovery System integration and operation will be defined and characterized, as well as the contingency plan considered to solve each of them.

Table 6: Risk and contingency plan – Setubal demo site

Risk	Probability	Impact	Contingency Plan
Power cuts or failure	Medium	Medium	Acceptable as long as the power cut is short and not repeated in moderated time. Maintenance staff will play a role in case of the general switch of the Heat Recovery System electrical cabinet keep down after power supply restoring.
Network connectivity failures	Medium	Medium	Acceptable. In case of a failure in the 3G connection, data will be collected in a local data base.
Auxiliary systems breakdown	Medium	High	Repairing or replacing the equipment.
Main systems deterioration or damage	Low	High	Preventive maintenance, according to maintenance manual provided by manufacturers.
Failure in monitoring systems	Low	High	Data collected must be reliable. In case of a failure in a monitoring device, it has to be recalibrated or replaced. In this demo site this could be a critical issue due to the aggressive atmosphere. The corrosion could affect the proper working of the monitoring systems, so, devices that work well in this kind of environment should be acquired.
Water or sludge leakages	Medium	Medium	Leakage detection and correction
Delay in integration process	High	Medium	Adaptation of test plan

4 Installation plan for Tecnalia Thermal Lab

The purpose of this section is to give a detailed overview of the LowUP demo site in Guipuzkoa (Spain), describing the current state of the demo site, the systems that will be integrated and their main features, the necessary works to adapt the place and the installation and risk management plans.

4.1 Description of Gipuzkoa Demo Site

The thermal lab of Tecnalia, located in Gipuzkoa (Spain) bases its activity in the development, testing, evaluation and optimization of thermal systems, based on sustainable technologies, both existing and emerging [3]. Due to its heating and the dissipation capacity, this thermal lab is suitable to carry out the characterization of the high efficiency Heat Pump, the technology developed by GEA in the frame of the LowUP project.

Next image will show the Tecnalia facilities in Guipuzkoa and the place where the Heat Pump will be installed:

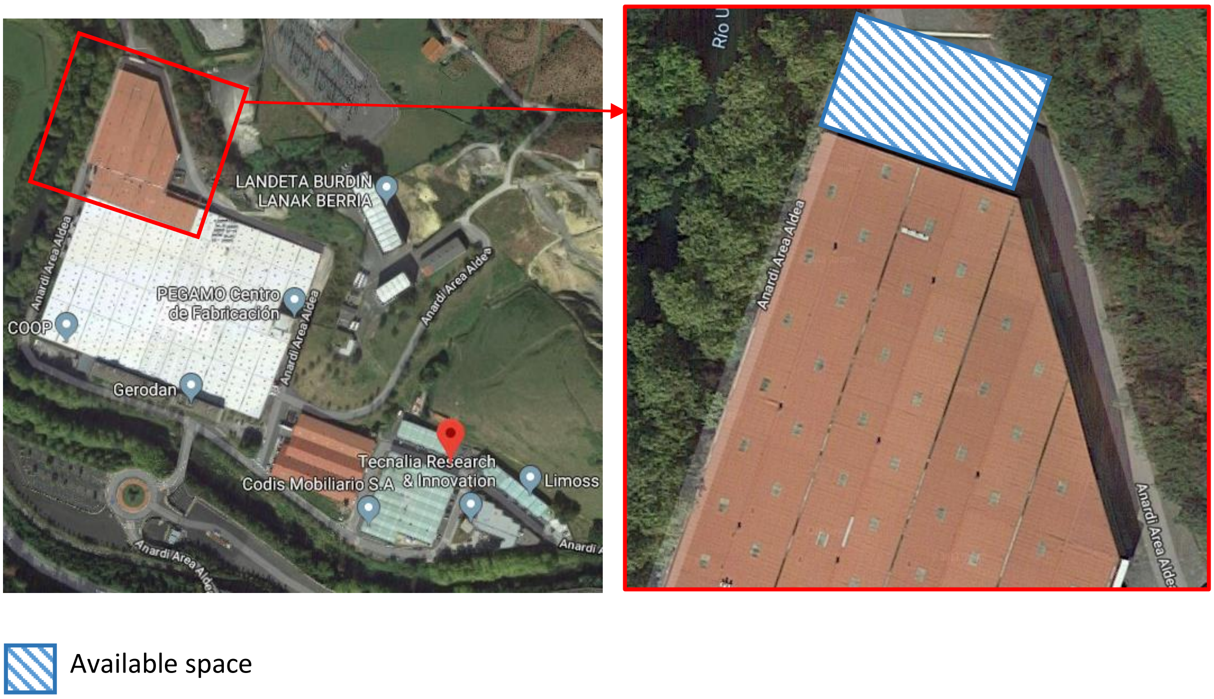


Figure 24: Available space considered in Tecnalia Thermal Lab to install the Heat Pump

The current state of the available space showed in the previous images, is presented as follows:

Figure 25: Current state of the available space

4.2 Description of the HP-LowUP system to be installed in Gipuzkoa

This section aims to describe in detail the main systems to be installed in Gipuzkoa setting out the requirements of all of them to be properly integrated in the thermal lab.

A conceptual scheme of the installation is presented as follow:

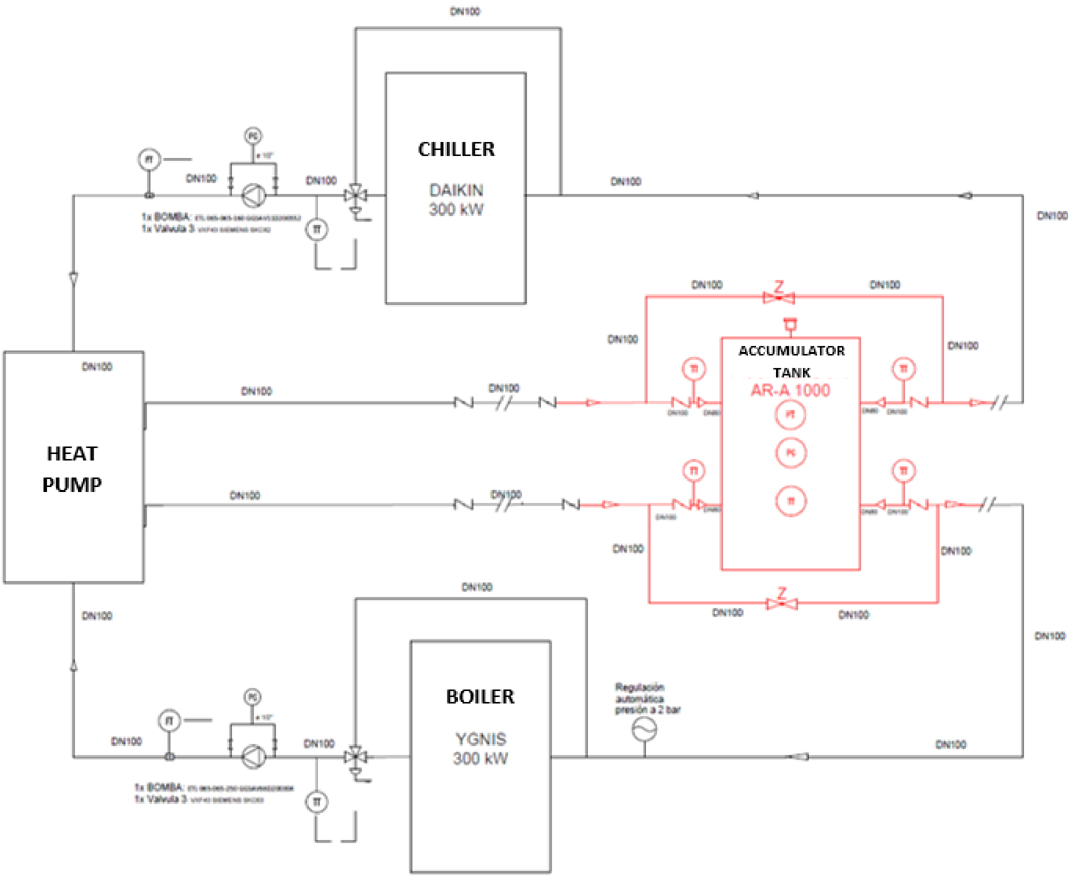


Figure 26: Installation scheme of HP-LowUP concept in Gipuzkoa

The system is composed by three mainly devices (they can be identified in the images above):

- Heat Pump
- Boiler
- Chiller

A water accumulator tank of 1000 litres is proposed to premix the flows, avoiding in this way that the heat dissipation only depends on the chiller.

4.2.1 Heat Pump

Developed in the frame of the LowUP project by GEA, the description of this technology could be resume as follows: High temperature cost effective heat pump, an industrial heat pump with characteristics beyond the state of the art, using natural refrigerant together with specific improvements able to increase its global efficiency. A more detailed description could be consulted in the deliverable D3.3.

This system is composed by a set of systems (compressor, evaporator, condenser…), however, it is not the aim of this document the description of these components.

The final view of the Heat Pump is presented in the next image:

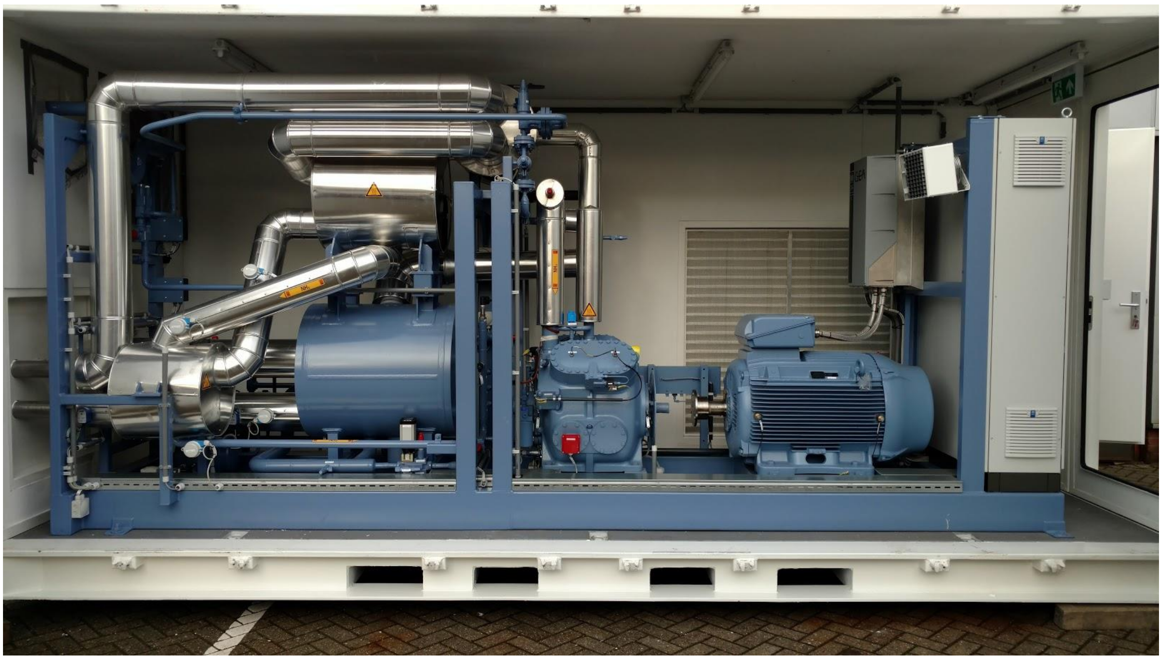


Figure 27: Heat Pump developed by GEA

All the components are integrated in a container. This container has some hydraulic connections, to connect the HP with the boiler and the chiller, and it only needs to be power supplied.

Figure 28: HP container

Figure 29: Hydraulic connections and the electrical cabinet to be power supplied

The main requirements of this system are related to available space and power supply. The main features are presented as follows:

- Dimensions: 7 x 2 x 3.5 meters
- Needed power supplies:
  1 x 400 VAC for general panel 500 Amp
- Weight: 12500 kg

4.2.2 Auxiliary systems

The main auxiliary systems of this installation will be the boiler (to heat production) and the chiller (to heat dissipation). The boiler needs to produce heat between 20 - 50 °C and the chiller needs to dissipate heat from 80 - 60 °C to 75 - 55°C.

Due to the usual activity of the thermal lab to test different technologies, the boiler and the chiller are systems that Tecnalia already host in its facilities. These systems have to be integrated with the Heat Pump in order to characterize it. The main features of the boiler and the chiller are showed as follows:

Boiler:

Model: Ygnis WA-250

Fuel: Natural gas, gasoil, propane

Capacity: 291 kW

Efficiency: 88%

Figure 30: Boiler installed in Tecnalia thermal lab

Chiller:

Model: Daikin EWAH290TZSSB1

Capacity – Cooling: 288.6 kW

Power consumption: 96.96 kW

EER Cooling Efficiency: 2.977

Figure 31: Chiller installed in Tecnalia thermal lab

Other auxiliary systems, like water pumps or 3 ways valves, will be necessary for a correct operation of the system.

4.3 Preparation works

This section aims to describe all the preparatory works which are needed to be executed in the demo site of Gipuzkoa to allow a proper systems integration, minimizing the impact and the investment. A preparatory works plan will be presented at the end of this section.

4.3.1 System integration in the plant

As it was said in previous sections, the available space considered is enough to install the HP. Due to the HP is connected with other two systems that are already installed in Tecnalia facilities, the main integration requirement is the closeness with them.

The HP will be installed outdoors (see blue area in Figure 32), so the water pipe networks will have to cross the wall of the building. It has been considered that the best way to do this is through the sheet metal wall, as it is marked in Figure 32 with the yellow area.

Figure 32: HP integration in Tecnalia facilities

Due to the high weight of the HP a metal structure will be built to ensure a proper support.

On the other hand, as a thermal lab whose main activity is the testing of the different thermal systems, the water and the power supply points are guaranteed.

The most important aspect of the installation will be the integration of the HP with the systems that are currently installed. These systems, the boiler and the chiller, have to be hydraulically connected with the HP, according to the schemes. In the following images, it can be observed the current state of the pipe networks of both systems:


Figure 33: Pipe network of the boiler and chiller systems before HP integration

4.3.2 Monitoring/control system

The main purpose of this system is to collect data in order to characterize the HP. Once the HP is totally characterized, it will be simulated in a virtual environment. For this reason, some probes, sensors and controllers will be installed. In this case, the control structure is a little bit different than the installations of Madrid and Setubal. The data will not be saved in the database of Seville, only in the servers of Tecnalia. The following image shows an scheme of the control system:

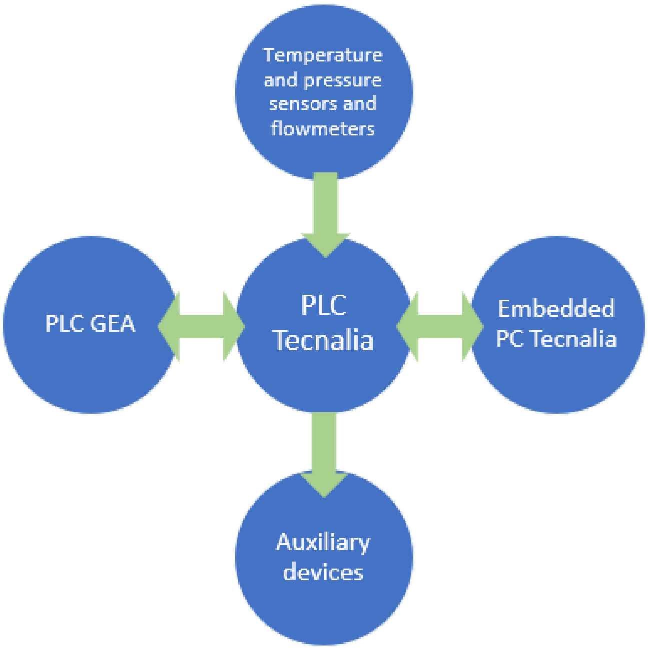


Figure 34: control system structure in Tecnalia

A brief description is presented as follows:

The main system will be the PLC of Tecnalia. This PLC receive a signal from the temperature and pressure sensors, and from the flowmeters. Depending on this data, and the parameters stablished by the user through the PC, the PLC sends the setpoints to the different devices (chiller, boiler, water pumps…) and to the PLC of GEA.

All the data will be collected in a database of the PC installed in the plant.

4.3.3 Engineering works

To ensure a proper operation of the system in the plant some activities related to engineering works will be done. The following set of activities will be carried out:

- Updating the P&ID schemes and layouts
- Sizing the pipe networks: connection with the boiler, chiller and water accumulator.
- Selection of the HP system according to LowUP project requirements
- Integration analysis of the heat generation and dissipation systems.
- Calculation of the pressure losses
- Auxiliaries selection: According to the pressure losses previously calculated, sizing the plumbing system.
- Select the monitoring devices
- PLC programming and interface generation to allow user activity.

All the engineering designs will be widely described in the deliverable D4.5.

4.4 Installation Plan

This section aims to propose a timetable, collecting all the activities related to engineering and preparatory works, analysed in previous sections, and the installation and the commissioning of the systems.

Table 7: Installation Plan – Gipuzkoa Demo

Act.	Work to be executed	Description of activities	Partners involved
1	Research + Development activities	- Design and testing of a new high efficiency HP, following the requirements of the LowUP project	- GEA
2	Engineering works	- P&ID generation - Pipe networks and auxiliary devices selection - Selection of monitoring devices - PLC programming - Integration analysis	- Tecnalia - Acciona - Eurecat
3	Manufacturing and delivery of products	- Sizing of equipment - Manufacturing - Delivery	- GEA
4	Systems installation	- Installation of each system, following the manufacturer instructions	- Tecnalia - Local installers
5	Systems connections	- Installation water pipe network, auxiliary devices, electrical connections and monitoring systems.	- Tecnalia - Local installers

6	System commissioning	- Startup of global system	- Tecnalia - GEA

Table 8: Installation Plan – Gipuzkoa Demo - Timetable

	jan-17	feb-17	mar-17	apr-17	may-17	jun-17	jul-17	aug-17	sep-17	oct-17	nov17	dec-17	oct-19	nov-19	dec-19	jan-20	feb-20
Research + Development activities (Units testing)	■	■	■	■	■												
Manufacturing and delivery						■	■	■	■	■	■	■					
Engineering design works													■	■			
System installation														■			
System connections														■	■		
System commissioning																■	■

4.5 Risks and contingency plan

In next table, the main risks of the Heat Pump System integration and operation will be defined and characterized, as well as the contingency plan considered to solve each of them.

Table 9: Risk and contingency plan – Madrid demo site

Risk	Probability	Impact	Contingency Plan
Power cuts or failure	Medium	Medium	Acceptable as long as the power cut is short and not repeated in moderated time. Maintenance staff will play a role to restore the power supply in case of a failure.
Auxiliary systems breakdown	Medium	High	Repairing or replacing the equipment.
Main systems deterioration or damage	Low	High	Preventive maintenance, according to maintenance manual provided by manufacturers.
Failure in monitoring systems	Low	High	Data collected must be reliable. In case of a failure in a monitoring device, it has to be recalibrated or replaced
Water leakages	Medium	Medium	Leakage detection and correction
Delay in integration process	High	Medium	Adaptation of test plan
Damage in system during the transportation	Low	High	Due to the high cost of the HP, a damage caused by the transportation could be fatal. An insurance will be taken out.

Conclusion

This deliverable gives a full description of the sites where HP-LowUP technologies will be installed and tested: the wastewater treatment plant in Madrid (Spain), the pulp and paper factory in Setubal (Portugal) and the thermal lab of Tecnalia in Gipuzkoa (Spain). The demo site in Setubal and Madrid will host the Heat Recovery systems, while the demo site in Tecnalia will host the Heat Pump system.

All the equipment has been described in detail, explaining the main features and requirements of each one. Regarding these requirements, some previous works to adapt the demo sites have been proposed. These works are mainly: demo sites analysis in order to carry out the integration with a minimum investment, all the engineering activities to a proper integration of the systems in the demo sites and the control system structure definition.

Finally, a detailed plan has been presented, with a summary of all tasks involved in the demo sites adaptation and systems integration. An schedule is also proposed, in order to have a fully descripted plan to be fulfil in next months. A risk and contingency plan complement this information.

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