Action A1: Parametrization of the potential input from renewable energy sources and operational and aeration control consumption cost.

Beneficiary responsible	*Status*
ASA	Finished

Time schedule per Annex I	*Starting date*	*End date*
6 Months	July 2014	December 2014

Real time schedule	*Starting date*	*End date*
6 Months	July 2014	December 2014

The duration of this action was six months (from July to December 2014) without delays, and ACCIONA SA. has been in charge of carrying out this activity. A description of their implementation is detailed below.

Task 1.-Parameterization of the potential input from renewable energy sources.
The purpose of this action was to obtain data and parameters of the potential energy input that could be obtained from renewable sources, in order to design the better mix renewable generation installation.
First of all, different parameters of irradiation and wind data have been obtained and analysed from a nearby installed weather station. As this station is really near to the demonstrator plant, weather conditions are exactly the same.
The weather station is formed by an acquisition/processor unit and different transducers. The main unit reads the different signals sent by the transducers in a certain time range, process it and send it to the monitoring board which is in charge of uploading the information into the web server. The different transducers are:

- An anemometer which gives a pulse signal which frequency directly depends on the wind speed (m/s) it is measuring.
- The weather vane which points towards (and then reports) the direction (º) from which the wind is blowing.
- Solar cells, which give a specific current and it directly depends on the irradiation parameter (W/m^2).
- Temperature transducer, gives the temperature in (ºC)

For each month of the action, data has been obtained in 5 min. intervals. These data have been processed and analysed, with the purpose of generating a report (Deliverable A1.2 in Annexes) with all the relevant data of the potential resource situation which will be used to design the better mix renewable generation installation.
In addition, data from local weather stations have been obtained through the webpage in order to compare different sources irradiation and wind data and generate a detailed report.

The following webpages have been used: NASA Atmospheric Science Data Centre (URL: https://eosweb.larc.nasa.gov/sse/), European Commission: Institute for Energy and Transport (IET) (URL: https://ec.europa.eu/jrc/)

Task 2.- Water treatment plant load consumption study. It was required to make an analysis of the load demand of the demonstrator plant in order to evaluate the energy needed and the different parameters needed for designing the renewable energy input, as current and voltage consumption, connections, safety protection systems and other important parameters.

For this action it was necessary to breakdown the power demand from the different motors feeding the WWTP in order to determine the energy demand on which the demonstrator plant will be operating.

ASA engineers evaluated the different motors which work in the WWTP in order to evaluate its energy demand and mode of operation. In addition, by analysing the electrical diagram of the initial electrical installation of the WWTP was possible to fully understand and generate the information needed for the design of the demonstrator.

In the following table monthly consumption 1-year average on each stage of the water treatment process is exposed:

1-Year averaged monthly consumption (kWh) in the different water treatment stages						
Water Flow (m3)	WWTP Consumption	Pretreatment	Biological	Tertiary	Deodorization	Sludge Line
162.269	**113.486**	**13.618**	**65.822**	**15.888**	**7.944**	**10.214**

Task 3.- Optimization of the water treatment process at the WWTP

Biological reactor: the biological reactor is one of the most demanding parts of the WWTP, in terms of energy requirements, representing about 44% of the total energy demand of the WWTP.

During this action different actuations related with the parameterization of the operation and aeration consumption cost have been carried out for optimizing the waste water treatment process:

I. Optimisation of the reactor, especially by adjusting its components (diffusors and probes), which have an effect on certain parameters, as nitrogen concentration, phosphorous concentration, pressure. Control algorithms will help to operate these systems in a combined and improved way.
II. Work began with variable pressures in the form of steps. This procedure slightly reduced electricity consumption, but worsened the quality of the final product. Therefore, we have developed a pressure control algorithm based on the average degrees of air valve opening. This control system will enable us to reduce between 10% - 30% the energy intake, while optimizing the quality of the effluent.
III. For the first time we have developed, nitrogen and phosphorus probes capable of operating in the specific conditions of the reactors.
IV. Nutrient removal is another process to be controlled. Thus, aeration cycles will be reduced and optimized. In this case it will be achieved by monitoring ammonia and nitrate in the last aerated sector of the reactor and with a new algorithm to control operating conditions for nitrogen and phosphorus removal. With the implementation of this action a 10% of reduction in energy consumption in the aeration process is expected

First of all the WWTP economical cost distribution has been deeply study. As shown in the following diagrams, the energy consumption represents 35 % of the total cost. In addition, the biological reactor of the aeration system shows a high energy consumption rate which can be optimized. By reducing its energy consumption, the economic cost of water treating can be significantly reduced.

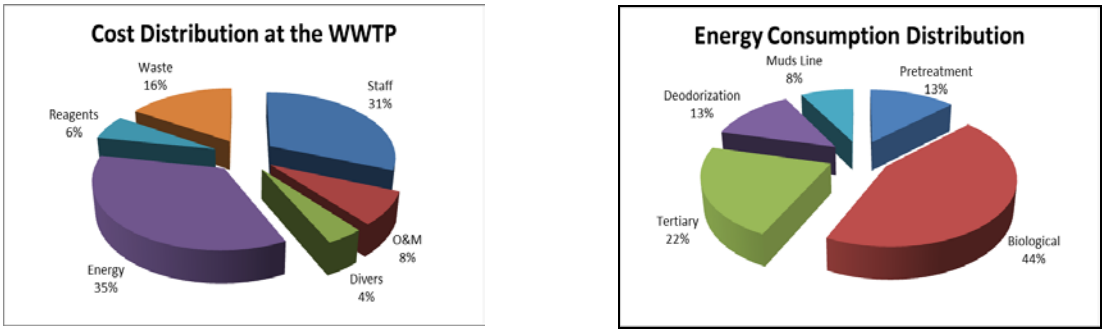

Figure 1Cost distribution at the WWTP and energy consumption distribution

The study carried out during this action, started by analysing all the stages involved in the biological treatment, and finding the most optimal solution for each of them. In the following graph, the four stages which have been studied are shown and the different actuations on each of them:

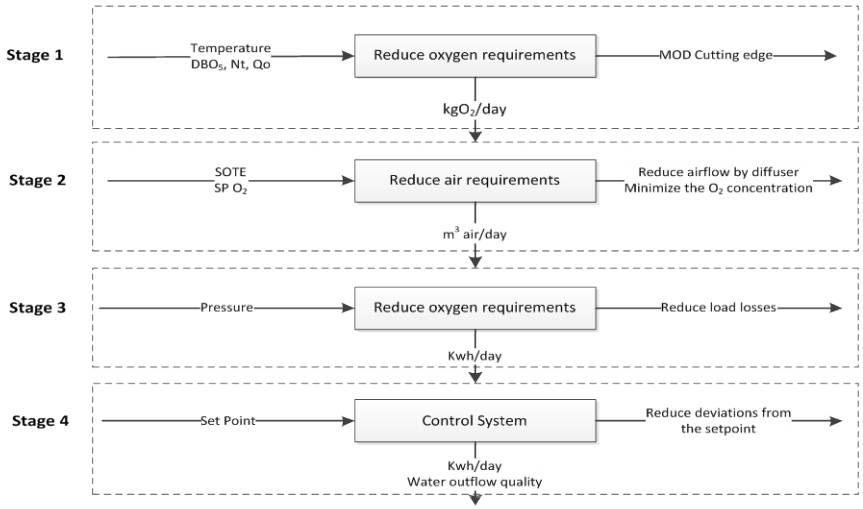

Figure 2Stages included in an energy optimization of a aeration system

The research has been based on the minimization of the air flow which is necessary to introduce on the process, pressure work reduction and definition the control strategy (the oxygen and the pressure, the start-up and stop of the blowers).

During this step the way to optimize nutrient removal is another process to be controlled. Thus, aeration cycles will be reduced and optimized. In this case it will be achieved by monitoring ammonia and nitrate in the last aerated sector of the reactor and with a new algorithm to control operating conditions for nitrogen and phosphorus removal.

Once the research about the biological reactor was finished, the study was focused on the efficiency of the aeration equipment, specifically on the tri-lobular displacement blower, which was needed before choosing new aeration equipment.

With the implementation of this action a 10% of reduction in energy consumption in the aeration process is expected. However, this energy demand varies depending on:

- the quality of the incoming water in terms of organic matter content
- the easily biodegradable organic matter needed to ensure biological phosphorus removal
- the performance and configuration of the aeration
- the accuracy of the probes in the aeration system

The time duration of this action was from the beginning of the project 1/07/2014 till the 31/12/2014.
The expected results of this action were to obtain a complete database (the indicators of progress described in the proposal about % of database is widespread) for renewable sources potential energy supply and demand and the water treatment process optimization study (Annex 7.2.7). Thereby it can be concluded that the action has been successfully completed as expected and the results obtained are satisfactory for continuing the project.
The planned milestone **"parametrization is completed"** associated to Action B1 has been fulfilled during the first 6 months of the project duration:

It is important to highlight that no delayed was found on this action and the following deliverables were created on time:

- Report on the parameters and data of the energy sectors of the WWTP (demand and operational patterns)
- Report on the parameters of the potential energy input from renewable sources and the design of the better energy mix

Thereby the action progressed as expected. In addition, project objectives have been satisfactory achieved and the indicator of progress about the design of photovoltaic, wind power plant, aeration control system and integrated control system software are at 100% of its progress, as shown in the deliverables related to the activity A1 (see Annexes 7.2.2.7 "A.1 Report on the parameters of the potential energy input from renewable sources and the design of the better energy mix" and 7.2.2.8 "A1 Report on the parameters and data of the energy sectors of the WWTP").