# Title: Improvement of Energy Efficiency in Waste Water Treatment Plant, Pogradec City, Albania (Case Study)

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## ABSTRACT:

This article is summary of a Study on Energy Saving and Energy Efficiency in a typical Waste Water Treatment Plant (WWTP) in Albania, specifically in Tourist City of Pogradec, lying near Ohrid lake, one of the Europe's deepest and oldest lakes, which was declared a World Heritage site by UNESCO in 1979. In this study are given the conclusions and recommendations to improve the energy efficiency, to save energy, to optimize the cost and work conditions of the WWTP and sewerage system and to encourage the using of solar energy.

The following represent the five direction constituted the basis for development of this study:

***- To save the energy and to improve the energy efficiency in WWTP of Pogradec City ;***

***- To optimize the cost with relevant facilities of electric system in WWTP and Pumping Station;***

***- To improve Availibility&Reliability, to optimize the assets implementing SCADA connected with MCC;***

***- To optimize processes and hydro systems:***

- ***To improve work conditions increasing the storage capacity of waste at pumping station;***
- ***To separate the sewerage system and storm water system;***

***- To use alternative energy sources specifically the renewable/solar energy providing a cost effective and environment protection power supply system.***

**MAIN TEXT:**

## 1- Introduction

Albania is a Mediterranean country in South Eastern Europe with total area of 28 750 square kilometers and a population of 4.2 million peoples.

**Albania is blessed with water and sun energy**. The mean annual precipitations in Albania are **1485 mm** and the mean annual volume of water discharged by all the rivers in the Adriatic& Ionian Sea is **1250 m3/sec**, one of the highest in Europe. Today, We produce electric energy only from water energy of our rivers (more than 10 TWH/year or 1500 kWh/inhabitant) that is only 35 % of their energy. Sunshine duration is **2520 hours** per year and solar energy is 1366 W/m2. (Highest that average of the Europe).

WWTP of Pogradec City at present is serving with waste water treatment an urban population some 25000 residents, continuing further in another phase of his extension, which is going to cover with his service also the rural area with a number of 75 000 inhabitants approximately. The **treatment capacity of WWTP is 1, 68 million m3/year.** The waste water treatment process is based on biological treatment using technology of secondary biological treatment and drop filter.

Flow at inlet of WWTP is about 38 l/s, which entering in Plant through an Pumping Station in a distance of 2 km from the Plant. The current surface of WWTP is **15 ha**.



Study refers the current technical and operational Status of Plant, based also on history and evaluation of technical data during his operation.

## 2- Measurement for Improvement of Energy Efficiency

Energy efficiency is a crucial operation cost element in Albanian Water Industry. The energy consumption occupies 30% of total costs in water and waste water sector. The same reasoning also applies for WWTP stressing at present are under construction a different number of WWTP, dominating mainly those which are being built in tourist areas. Focusing in this element in order of his improvement, it should be one of main directions of Utilities Management, in which they have to organize their work.

**Improvement of Energy efficiency in WWTP is based on three main directions:**

- **Energy Saving**
- **Cost Optimizations**
- **Availability & Reliability**


Also, we have studied the using of the renewable/solar energy, improvement of work conditions of system (increasing of storage capacity of Waste water) and separation of waste water system with storm water system.

- **ENERGY SAVING:**

  - **Energy Saving with Variable Speed Drive**

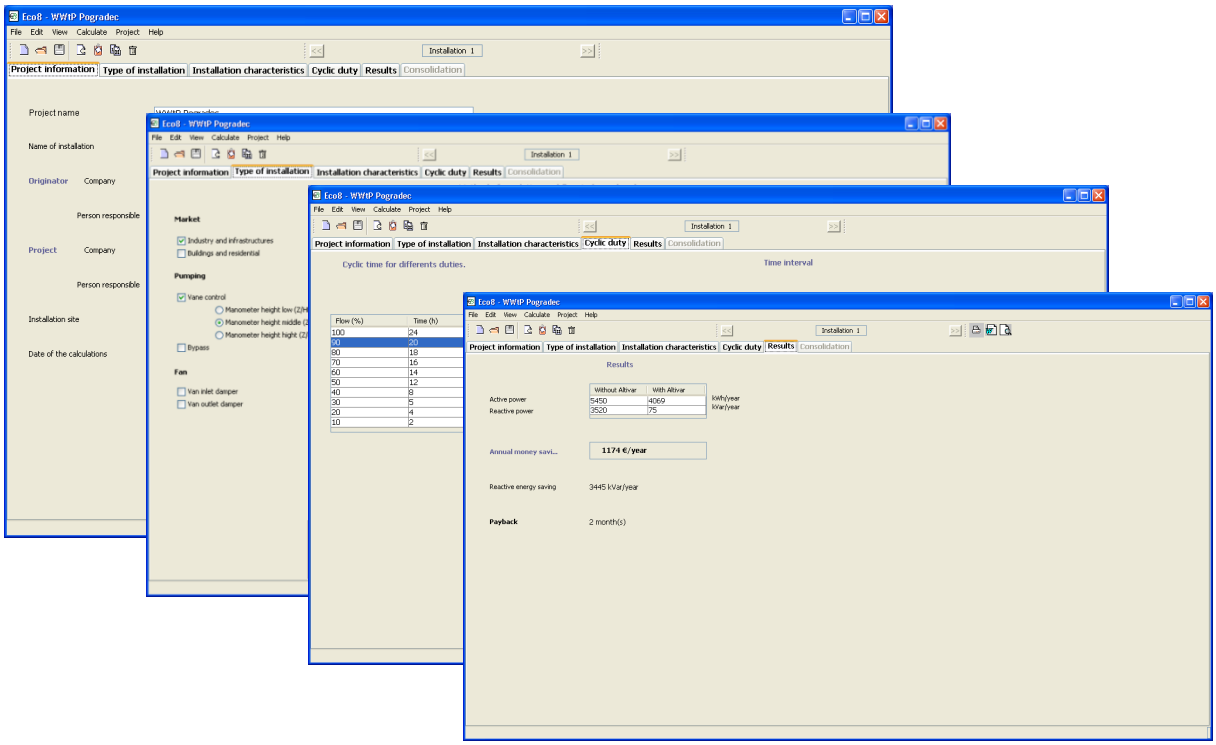
Refer to **Pumping Station** (PS) as mentioned above, we have to do with a Station type P1 (small station) with two surface pumps, each of them with an installed power of 45 kW. Their capacity is 140 l/sec. Near of the PS is built a reservoir with a storage volume of W=100 m3. The average daily flow production from Pogradec City is Q=4500 m3/day.

One of the pumps is always under operation and another operating as back-up. Pump is operating with two levels of incoming flows up to 70l/s and 140 l/s. For each of these levels of flows, pump automatically is operating with his half capacity at under flow level of 70 l/s, and with his full capacity under flow level of 140 l/s.

Instead of two levels of pump operations can be installed a Variable Speed Driver (V.S.D), one for each of pump in case of any possible defect in one of pumps, in order to provide the continuity of operation.

V.S.D would have a capacity of 45 kW and is going to provide the output mechanical shaft power depending on incoming flow. Regulating respective power depending from the flow, it means to save energy in a considerable manner. Reducing pump speed the power produced by pump is significantly reduced.

According to relevant calculation (fulfilled with respective soft), which has been as following,




- Has been selected the relevant V.S.D of 45 kW;

**Estimation of Energy Saving Obtained**

| | | Without V.S.D | With V.S.D |
|---|---|---|---|
| 1 | Consumption of active power | 5450 | 4069 kWh/year |
| 2 | Consumption of reactive power | 3520 | 75 kVar/year |
| | **Estimated energy saving** | 1174 Euro | |
| | **Payback period** | 2 month(s) | |

❖ **Energy Savings with High Efficiency Motors**

Because of long hours of operation in **Pumping Station** with more as 4000 hours specifically at 4500 hours, it can be planned in frame of an energy saving management program, the motor of pump to be replaced with a high efficiency motor EEM, EFF1-code IE2, 4 pole motors for 50Hz., 45 kW. The energy efficient motors EEM are an opportunity, which can be usefully in our case of Pogradec WWTP, leading to large cost-effective energy savings, improving of the industrial economic efficiency and reducing the environmental impacts.

It can be considered that EEM motor in our possible future application is more efficient than standard motor and rewound motor. Using high efficiency motor EEM **in Pumping Station** it **is going to be saved energy in a value of 4423 kWh.** A **payback about 0,8 year** can be considered in this case.

In **the Treatment Plant** are installed among others also 3 surface pumps of Drain Filter, with a installed capacity each of them of 40 kW. Operating one by one depending on the level of water, they are under a continuing operation.

Being in same conditions also regarding to operation hours of motor with more as 4000 hours operation, in existing pump of drain filter in **the Treament Plant**, we can consider also total possible the replacing of existing motor of pump of drain filter a high efficiency motor EEM, having results:

- A **saved energy of 3962 kWh;**
- A **payback about 0,8 year.**

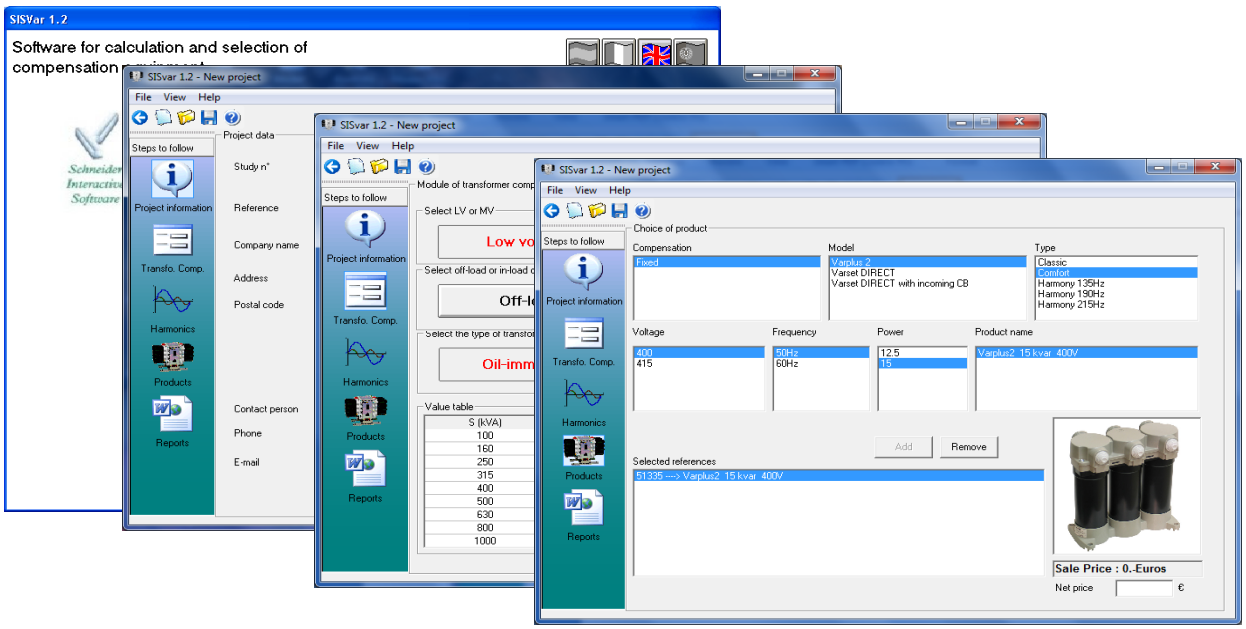
## COST OPTIMISATION

### ❖ Cost optimization with Power Factor Correction (P.F.C)

Having a look for a P.F.C installed as a device in **Pumping Station**, was verified missing of using of such device.

Using P.F.C can be realized avoid charge of reactive energy, reducing demand current and to allowing to use the total. In our case we refer to realize the compensation on transformer. In Pumping Station is being used a 250 kVA oil transformer. Using such a kind of device is going to be reduced the amount of electrical bill.

Refer to calculations (fulfilled using respective software), has been selected the product:



- With a capacity of 15kVar 400V/50Hz.

The compensation of reactive energy means to save energy. In our case, in which is required an improvement of cos fi > 0,9, at present with a cos fi=0,8, its energy bill will include also the amount of reactive energy. The save in this case thanks compensation of reactive energy, for the transformer 250 kVA will be **in amount of 1200 euro/year** (this is annual cost without compensation of reactive energy). The compensation of reactive energy means also **the transformer to work with its full capacity** and to reduce its losses;

Considering the same importance and necessarily of its using we are calculating same way as above done, installing of a P.F.C in **Treatment Plant**. The compensation is being realized on oil transformer, which has same capacity of 250 kVA, installed in Plant. Being on same circumstances as in Pumping Station case, will have a P.F.C:

- With capacity of 15kVar 400V/50Hz.

## AVAILABILITY&RELIABILITY

### ❖ Asset optimization with iMCC

Important is having an Intelligent Motor Control Center, which should be connected with bus communication to SCADA. At present missing an Intelligent Motor Control Center in Pogradec WWTP, which obligates top management of utility to think about this important issue also in frame of an entire energy saving management program.

- In Pogradec WWTP case can be used a typical integrated control&monitoring system for Small Plant, type T2, with a power demand up to 1250 kVA forecasting also the next phase of extending of plant planned to offer the service for a number at around 75 000 inhabitants. Having an integrated control and monitoring system following with all other relevant aspects of energy efficiency will be usefully in order to achieve all targets of an efficient energy management. A **cost saving about 30%** is a possible achievable target in case of implementing this system.
- In **Pumping Station** can be provided an integrated solution called on **Intelligent Pump Control**. This system among others can reduce energy uses. The integrated solution can manages pump station, data optimizing settings and maintenance actions. Refer to pump management functions among others can be stressed:
  - fully considerable **electricity tariff management settings**,
  - **efficiency testing**,
  - **remote control**, etc.

Using this system can be achived a **reduction at about 30% of operating cost**.

- **INCREASING OF STORAGE CAPACITY OF WASTE WATER RESERVOIR**

Near of Pumping station is constructed a reinforced concrete reservoir with capacity of W=100 m3. This reservoir collects the waste water from gravity sewerage system of city. The above capacity is small for normal working condition of waste water system. The system discharge 3600 to 4500 m3/day. Also, during the analyze of daily production of pumping station, we have seen that the highest discharge in the reservoir is from 7.00 am to 10.00 am and 19.00 pm to 22.00 pm (In this period, the energy tariff is highest). Also, we have seen that the lowest discharge is from 01.00 am to 05.00 am and 10.00 am to 13.00 am. (In this period the energy tariff is lowest). The daily non uniformity coefficient of waste water discharge is 2. So, the increasing of reservoir capacity will reduce the non uniformity coefficient of pumps, will create the work condition of pumps set during the lowest peak (during the night that the energy tariff is lowest), will increase the safety of environmental protection of lake from waste water discharge, etc. According to the calculation, the best solution for this issue will be the construction of a new reservoir with volume W=200 m3. The construction cost of the new reservoir will be approx. 30 000 Euro. So the total storage capacity will be W=300 m3 that is enough to collect the volume of waste water of 3 hours. So, the pump can work in normal condition during the highest peak of waste water discharge from the system. Also, we can increase the working hours and capacity of them during the night that the energy cost is lowest. In this case, we can save till **10 % of the energy cost**.

- **SEPARATION OF THE RAIN SYSTEM FROM SEWERAGE SYSTEM**

Before the construction of WWTP, there was a combined system (Rain and sewerage system). Today, mainly parts of the system are separated but two areas continue to discharge the rain and waste water in the system. The amount of waste water discharge is 15-20 % highest than amount of drinking water production. So, **the working capacity of the pumps and WWTP can be reduced in the future forecasting to save energy in a value of 14000 kWh** after the completion of new sewerage system in the two above area.

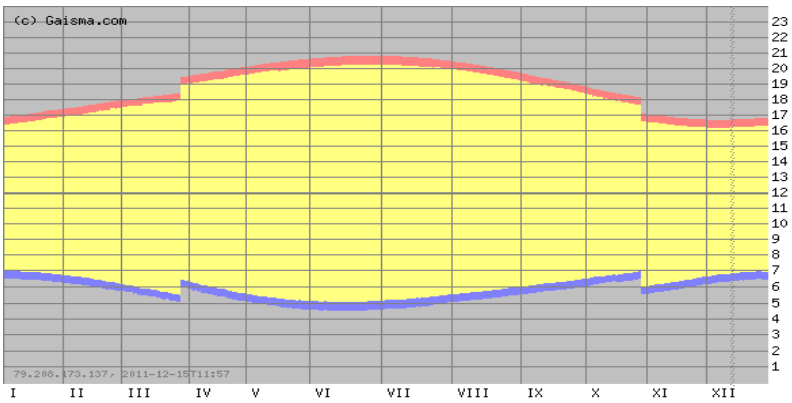
### 3- Using of the Alternative Renewable/Solar Energy

A solution from solar panel-photovoltaic (PV) systems output to grid connection, including contract with performance guarantee, leading to the lowest cost of energy which has all possibilities for application in case of Pogradec WWTP

The average annual value of the solar radiation intensity is the main indicator that guarantees the economic efficiency for a solar power plant.

Also, According to some measurement of sunshine duration in this area, we have seen that the sunshine duration is approx. 2500 hours/year. There are more than 250 days/year with sun.

Following presenting respective graphic of average sun intensity during the months, which take into consideration the region of Pogradec City:




According to respective law in Albania, which regulates the energy sector in country, it specifies the energy production in frame of renewable energy production. This producer can use the distribution grid supplying "the eligible customer". The tariff setting in this case as it is provided in from Energy Regulatory Authority.

More electricity is produced with more sunlight, but energy can still be produced in overcast or cloudy conditions, so PVs can be used successfully in all parts of Albania, including Pogradec city. In this part of Albania which corresponding with south-east part of country, at an elevation of 30-400 however in Albania even flat roof receive **over 90% of the energy of an optimum system.**

Radiation map of Albania

Incorporating PVs into a development will enable the Plant to produce in a satisfactory percentage of its electricity for free and in this case also usefully in frame of environmental issue, without emission of greenhouse gases.

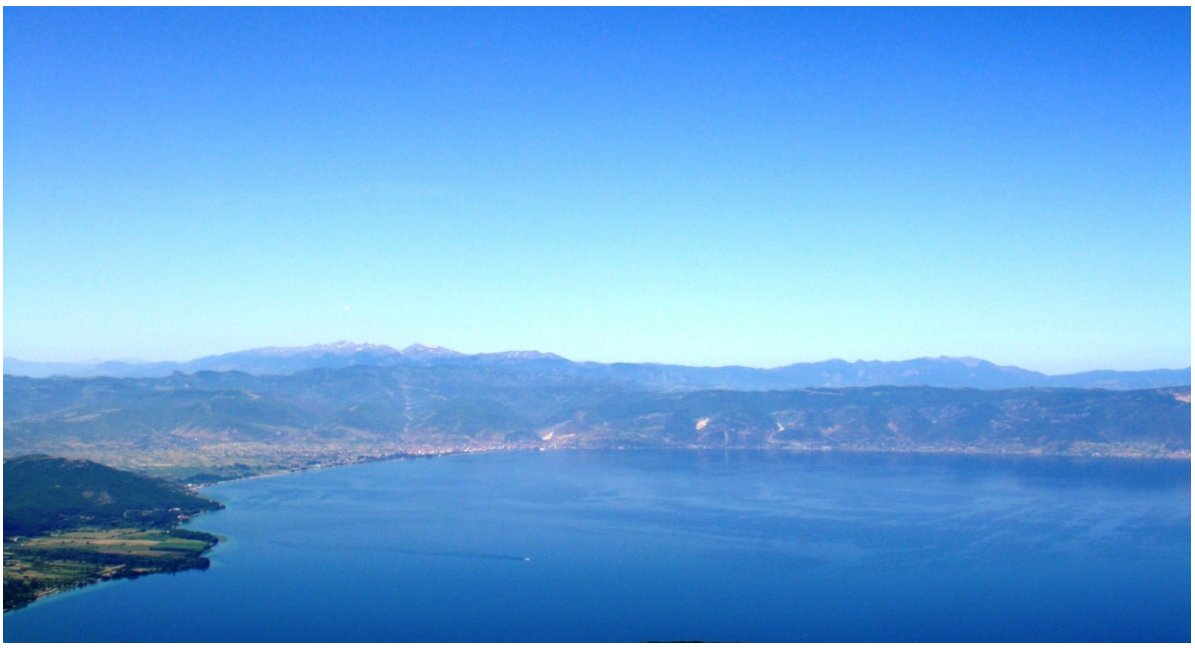
Another important benefit is also a low maintenance cost of the Solar Plant, which according to relevant calculation indicates that **an annual O&M cost computed as around 0.17% of the total installed cost**.

## 4- Results and Recommendations

Based on Review of Situation Analyses, the above calculations and other measurements for improvement of energy efficiency, we conclude that there is necessary to take in the consideration some new solutions to improve the energy efficiency, to save the energy, to optimize the works conditions of pumps and WWTP.

As above, we recommend:

- To install the Integrated Control and Monitoring System for WWST;
- To install Inteligent Controll Pump to monitor and remote control of pump set in Pumping station;
- To install the Variable Speed Driver at Pumping Station;
- To install the High efficiency Motors for both pumps sets;
- To install Power factor Correction both to Pumping Station and in the Plant;
- To construct the new waste water reservoir with capacity W=200 m3 near of existing reservoir;
- To complete the new sewerage system in two areas of the city and separating storm from sewerage system;
- To provide solar Energy/the Photovoltaic system inside of WWTP;



**View of Ohrid Lake and Pogradec City, Albania**

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