University of West Attica

Department of Mechanical Engineering

Master in Energy Systems
ENERGY ECONOMICS

2nd Assessment-Project (January-2022, V-5)

"FINANCIAL EVALUATION OF RES-BASED HYBRID POWER STATIONS IN GREECE INCLUDING ENVIRONMENTAL ASPECTS"

In the 1st Assignment of the Energy Economics Module you have been asked to undertake a preliminary cost-benefit study, associated with the implementation of a hybrid RES based project of 10MW for a remote area based on two different renewable energy technologies; the first regarding the installation of a small wind park (based exclusively on 1MW wind turbines) at a high wind potential island area and the second concerning a small hydro power station (based exclusively on 2MW hydro turbines) to be installed in a low elevation (15m) area. In this 2nd Assignment, for both technologies examined, environmental aspects are also to be taken into account, while the status of the local electricity market should also be examined taking into consideration the existing system of subsidy and support for RES applications in the course of time.

For this purpose, in both Assignments the following should be considered.

- Financial evaluation of the project should be based on the estimation of the investments' (simple and complete) pay-back period, NPV (npv) and IRR value. However, the final evaluation of the proposed hybrid power station should be based on the estimation of the levelized (on life cycle basis) total electricity production cost (including externalities).
- Investment cost shall derive from the combination of the initial installation cost and the corresponding maintenance and operation cost, considering the entire economic life of each investment and including the possibility of State subsidy.
- Revenues from the operation of the plants should be estimated by using the current selling price of electricity, valid for autonomous island networks and grid connected hybrid RES-based power plants (hydro and wind), while taxation should also be taken into account. The annual escalation rate of the local market electricity price should also be considered, excluding the case of the simple pay-back method.
- Cost estimation of atmospheric pollution, either caused or avoided, should be based on the mainland and island system emission coefficients as well as on the CO_2 charges of existing air pollution quantification schemes, e.g. the current Emission Trading System (ETS).
- Embodied energy values should be drawn from the international literature, presenting also any assumptions adopted, while you may assume that both the wind and the hydro turbine manufacturers are located in Europe.

In this context, using the available information for the local economy you are asked to extend your analysis in the following issues:

PART TWO (40%)

1. Apart from the strictly financial evaluation part, you are asked to record and if possible valuate (*using well documented scientific resources*) the LC environmental impacts attributed to each of the proposed hybrid RES-based solutions. All externalities should be considered and gathered in a list. **(10%)**

2. Subsequently, emphasis should be given on the energy consumed previous to and during the plants' operation (*decommissioning included*). In this context, estimate the amount of "embodied energy" carried by each potential configuration. In addition to that, estimate the energy pay-back (amortization) period of the proposed investments, taking into consideration the LC energy content of each solution along with the corresponding energy production during its entire useful period. What conclusions may be drawn from the results obtained? **(10%)**

3. Moreover, suggest a micro-siting of the best and the worst hybrid power station scenarios estimating the corresponding land usage taking into consideration the special topography and the size of the Greek islands. **(10%)**

4. On the other hand, operation of both RES projects implies the avoidance of atmospheric pollution and other environmental impacts/benefits through the production of "clean" electrical energy and the replacement of heavy polluting thermal power stations. Record the impacts avoided by the operation of RES installations and estimate the charge that the Greek government should otherwise pay, based on existing air pollution quantification schemes, e.g. the current Emission Trading System (ETS) orders. Subsequently, estimate the annual oil imports avoided due to the operation of the RES installations and compare your findings with the corresponding purchase cost of wind and hydro turbines' (imported) equipment. Note that oil comprises the main/sole fuel supply of island thermal power stations. **(10%)**

PART THREE (25%)

5. Briefly present the existing subsidy schemes (*concerning the European and local electricity market*) and describe their impact on the estimated pay-back period, NPV and IRR values. How do you characterize the existing subsidy schemes for private investments in the RES applications sector? Give some comments on the policy measures adopted. Are they socially fair or not?

   For this purpose one should take into consideration the relation between the cost avoided by the LC production of "clean" energy and the feed in tariff premiums (initial investment subsidy also included). What is the actual premium that the Greek society attributes to each kWh_{el} of wind and hydro energy production? Do you think that the policy applied by the Greek State is necessary or may at some level be irrational? Is the cost disadvantage of hydro and wind technology being mitigated? Do you think that the measures adopted are efficient for both the investor and the Greek State? Express your opinion.

   Close with a concluding paragraph where you may synopsize results and weigh the environmental and financial performance of each proposed solution. On top of any arguments collected, give your own personal opinion! **(15%)**

6. Finally, taking into consideration that the interest in installing hybrid power stations in collaboration with appropriate energy storage systems continuously increases in several European countries, you are now asked to present the most established energy storage technologies for remote islands describing their main advantages and disadvantages. What are the main benefits that an energy storage system provides to a hybrid power station? **(10%)**

Note that answering to all the questions is critical for your mark. Give clear and coherent answers to each of the questions and try not to exceed the total maximum of 6,000 words (including figures and tables). Furthermore, make any reasonable assumptions wherever required and since work will be carried out in ***groups of two****, keep in mind that co-ordination is essential.*

This project should be submitted in the MSc in Energy Systems platform no later than ***February28, 2022.***