USE OF RENEWABLE ENERGY IN AQUACULTURE:
AN ENERGY AUDIT CASE-STUDY ANALYSIS

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ABSTRACT

In this paper we propose a framework for energy audit and renewable energy utilization for a Mediterranean fish hatchery station. A concise literature review concerning the use of renewables in aquaculture is provided, followed by a step by step framework for energy audit in aquaculture stations. The developed framework is subsequently applied to a real case study concerning an aquaculture unit in Greece. A combined PV and Solar-Thermal panel project is proposed, based on the energy audit results. The well-known clean energy software *RETScreen*, developed by *Natural Resources of Canada*, has been utilized as an assessment tool of the proposed project. It was found that that the proposed project could not fully cover the electric and thermal load of the station; nevertheless, the project is economically viable and could de realized, provided that the necessary financial resources become available to the entrepreneurs.

KEYWORDS: Aquaculture, Energy Audit, Renewable Energy, RETScreen, Greece.

INTRODUCTION

It is widely acknowledged that fish supplies from world fisheries are unlikely to increase substantially and that the expansion of the aquaculture sector will probably provide the solution to the problem of the projected shortfalls (Chamberlain and Rosenthal, 1995). Although European Aquaculture makes up only a small percentage i.e. 3.9% (FAO, 2006) of the worldwide aquaculture production, it presents considerable growth (Blancheton, 2000).

The aquaculture production of seabass and seabream in the Mediterranean basin has been one of the most highly developed seafood industries in Europe (Theodorou, 2002). Greece in particular, has become the leading country among the EU in the aquaculture sea cage farming of seabream and seabass (Belias *et al.*, 2003). Its production share accounts for approximately 52% for the seabream and 46% for the seabass of European production. The success came up due to the ideal environmental conditions and the availability of well protected areas, suitable for cage farming installations (Papoutsoglou, 2000). Nowadays, the production of seabream and bass in Greece has already exceeded the 80,000 tones per year (CIHEAM, 2005).

One of the major problems that modern aquaculture is facing worldwide, is the increased production cost which is directly linked to the increased operational and maintenance cost of the hatchery stations (Colt *et al.*, 2008). In the operational cost of a hatchery station, several estimates are included such as live feed, chemicals, power, fuel, maintenance, consumables, administration etc. A marine fish hatchery station is a very intensive production system and exhibits high energy demand. This is because of its complex structure, the critical environmental conditions needed for the rearing of the young fish larvae (e.g. specific water & room temperature, salinity, dissolved oxygen, etc.), as well as the numerous sophisticated mechanical equipment i.e. advanced water pups, UV filters, air conditioning, heaters, and lighting required.

In this paper we propose a framework for energy audit in aquaculture, we apply it in a large scale fish hatchery station in Greece and we investigate the possibilities for renewables exploitation in

order to cover part of the recorded energy demand. In the next section we provide a synoptic literature review on the use of renewables in aquaculture; subsequently we develop a step by step framework for energy audit in aquaculture and then we provide an application of the framework to a case-study hatchery station in Western Greece. Following, we investigate the possibilities for exploiting solar PV and Solar-Thermal energy in order to cover part of the electrical and thermal loads. The well-known clean energy software RETScreen® International[1], developed by Natural Resources Canada, has been utilized as an assessment tool for the proposed project. Finally, we summarize our conclusions.

USE OF RENEWABLE ENERGY SOURCES IN AQUACULTURE

The benefits from the use of Renewable Energy Sources (RES) can be of major importance with viable results, particularly when used in large scale aquaculture projects (Skoglund *et al.*, 2010). The introduction and application of new energy technologies in the marine fish hatchery production is of major importance and in this aspect several studies have investigated the use of RES in off-shore aquaculture with encouraging results (Menicou and Vassiliou, 2010).

Colt *et al.* (2008), evaluated the resource and energy requirements of six different types of land-based hatchery production systems of Atlantic salmon smolts; in the same article the authors mention that up to 2008, there were less than 20 published studies concerning the energy requirements of aquaculture production systems.

Studies related to the assessment of alternative aquaculture technologies of salmonid species, in respect to minimize energy consumption, were done by Ayer and Tyedmers, 2009; Pelletier *et al.*, 2009; and Pelletier and Tyedmers, 2008. A broader study, concerning the environmental impacts of aquaculture in regard to energy demand and consumption can be found by Ayer *et al.*, 2007.

Pelletier and Tyedmers (2008), presented a detailed sustainability assessment dealing with the high energy flows in aquaculture and its products. Lai and Linb (2006), proposed a small-scale wind power system in a land prawn aqua farm in Taiwan, to fulfill its energy demand. Ayer *et al.* (2009), studied issues related to seafood production with an emphasis on cleaner and more efficient harvesting, culture, processing and distribution of seafood products, while they gave special attention to innovations related to cleaner practices and processes in regard to sustainable aquaculture products.

Generally, the energy and resource consumption of aquaculture production systems have not been clearly documented and compared with existing production systems (Colt *et al.*, 2008). Thus, it seems that there is some lack of knowledge on the use of RES in fish hatchery stations.

In the next section we develop and propose the main steps of a framework for energy audit in aquaculture.

DEVELOPMENT OF A FRAMEWORK FOR ENERGY AUDIT IN AQUACULTURE

Energy audit is initially linked to the detailed recording of the energy flows (demands) of a studied system. In that aspect, it is proposed that the examiners must study and understand the corresponding system in full detail. A recent case-study analysis for a cement factory in Greece is presented by Moussiopoulos *et al.*, 2012. Figure 1, presents a step by step framework for Integrated Energy Audit in Aquaculture units. The framework consists of four (4) steps: Step1: Identification of the different production methods, techniques and processes; Step2: Classification of the different type of energy usage per used equipment; Step3: Detailed recording of the energy demands; Step4: Use of an integrated energy technology assessment method in order to perform a technical, cost and feasibility analysis.

Steps 1 to 3 could be usually applied in a straightforward way, nevertheless, Step 4 includes the application of some kind of 'clean' energy technology evaluation model like, for example, the *RETScreen* (Economou, 2010; Modi *et al.*, 2009; Harder and Gibson, 2001), and *TRNsys* (Choi *et al.*, 2011).
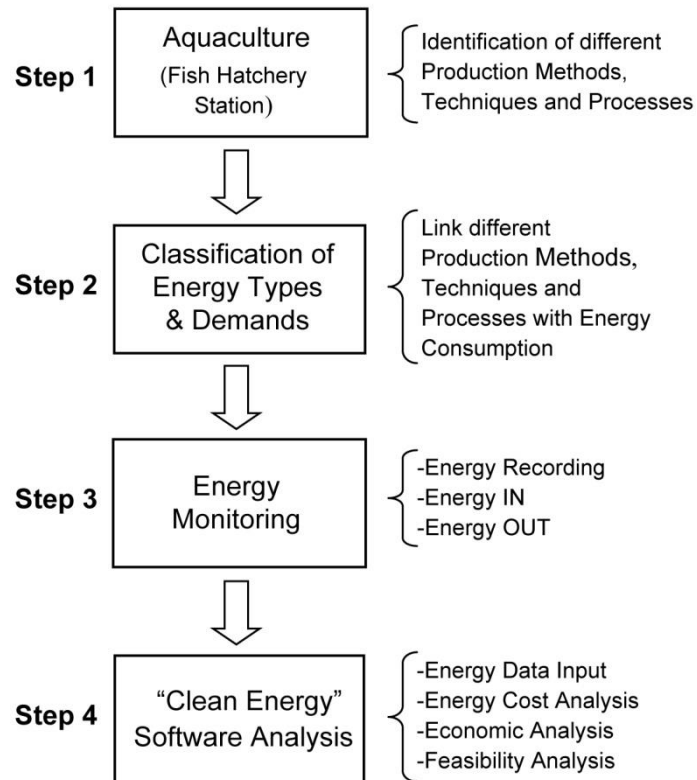
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[1] http://www.retscreen.net

Figure 1. Proposed framework for energy audit in aquaculture; A step by step analysis

Particularly, the *Clean Energy Project Analysis Software RETScreen* seems to be a promising tool in order to evaluate an integrated energy production system (Rehman, 2005; Houri, 2006; Rehman *et al.*, 2007). *RETScreen,* constitutes a unique decision-making support tool that seeks to implement renewables in many different applications from household to industry scale. It is capable of assessing energy resource availability at project site, equipment performance, initial project costs, "base case" & "proposed case" scenarios, on-going and periodic project costs, avoided energy costs, financing, taxes on equipment and revenues, environmental characteristics of the displaced energy, environmental credits and/or subsidies (Mohandes *et al.*, 2000). Its main prospects are to reduce the cost of pre-feasibility studies, disseminating knowledge, help entrepreneurs make better decisions and train them in regard to optimal analysis, technical and financial viability of possible RES projects.

In the next section we present an application of the proposed framework for energy audit in aquaculture in a fish hatchery station in Western Greece.

IMPLEMENTATION OF THE PROPOSED FRAMEWORK FOR ENERGY AUDIT IN AQUACULTURE

Marine Fish Hatchery Station Description

The studied hatchery station is situated in the Western Hellenic Coast, close to the city of Nafpaktos (Figure 2). More than 25% of Greek fish farms are located in Western Greece (Dimitriou *et al.*, 2007).

The annual production of the studied hatchery station exceeds the 35 million fish larvae per year. The produced fish species are seabream and seabass white seabream. Total production includes 8.0 million larvae of seabream, 25.5 million larvae of seabass and 1.5 million larvae of White Seabream. It should be noted that a typical medium scale fish farm, of total production 200 tones per year, needs approximately 1 million fish larvae (Moretti *et al.*, 2005).
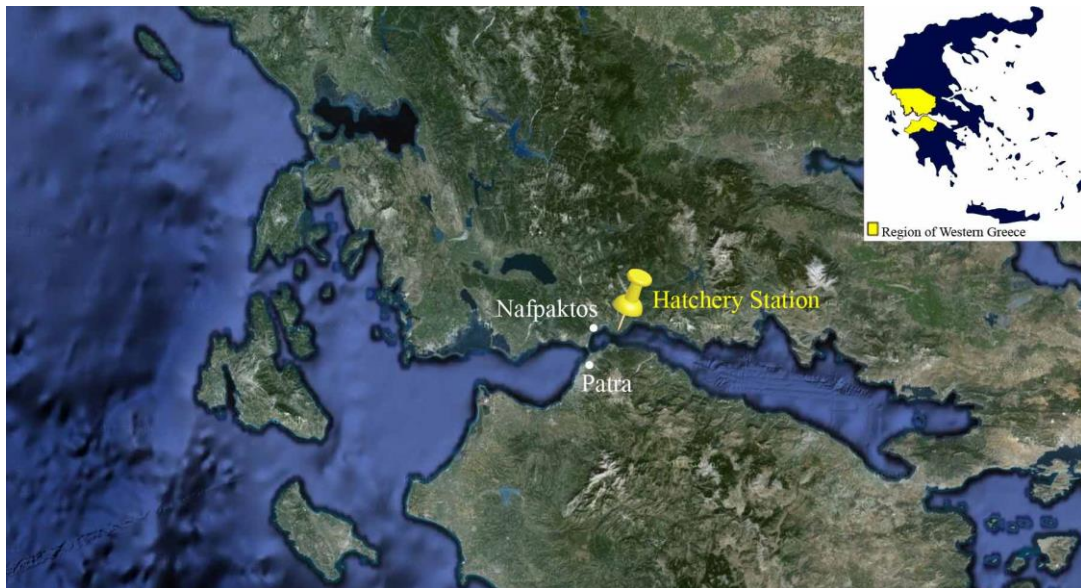
Figure 2. Location of the studied marine hatchery station (Western Greece)

The examined hatchery station follows the layout of a typical Mediterranean fish hatchery station. In particular, it is divided in the following five major units: i) Broodstock Unit; ii) Live Feed Unit; iii) Hatchery Unit; iv) Weaning Unit; v) Support Units. In the following Figure 3, we illustrate the production cycle and the type of energy demand of each unit of the Marine Fish Hatchery Station.

In the broodstock unit, the maintenance of adequate stocks of parent fish is taking place in order to assure timely supply of fertilized eggs. The fertilized eggs are subsequently transferred in the next production unit for the larval development. In the live feed unit, the large scale production of microalgae, rotifer and artemia is taking place. Fish larvae are fed exclusively on live feed. Following, the Hatchery Unit is the main part of the hatchery station. It is where the eggs are hatched and incubated and where the first feeding of the young fish larvae occurs. Usually, in this particular unit the energy demands are moderate high. In the Weaning unit, the young fish larvae are reared before they are moved into the sea cages.

The energy demands of the Broodstock unit are moderate high due to the water supply circuit, intense lighting, and controlled room and water temperature. In the Live Feed unit there exists a series of equipment used constantly in order to assure totally controlled rearing conditions, resulting in increased energy demand. In the Hatchery unit water temperature is the most important variable to be controlled, (between 18-19°C), since the young fish larvae are very vulnerable in temperature fluctuations. According to the month of the year, water might need heating or cooling. A boiler and a chiller are used for that purpose. In the Weaning unit the energy requirements are not that intense and mainly have to do with the water supply pumps. The energy demand is mainly associated with the controlled water temperature and quality parameters, the room temperature and lighting.

Energy monitoring

The monitoring of the energy demand of the particular aquaculture unit took place in situ, with successive visits in the hatchery station and detailed recording of the equipment used. For each part of the aquaculture station, data were collected and corresponding analytical databases were created. The resulted energy data are given in Table 1, while the detailed energy demands recorded can be found in Appendix 1, Table 6.

As it can be seen out from Table 1, the total installed capacity is approximately 2.1 MW. In order to cover locally the increased energy demands, a diesel oil power production substation has been installed in the site area by the Public Power Corporation.

During the yearly operation of the Hatchery Station, there is a three month period in which the Station operates in lower capacity. This is due to operational programming and maintenance reasons. Figure 4 presents the monthly energy demands (kWh) of the Hatchery Station for two successive years i.e. 2010, 2011, while Figure 5 shows the monthly electric and thermal load share (average values for 2010 and 2011).
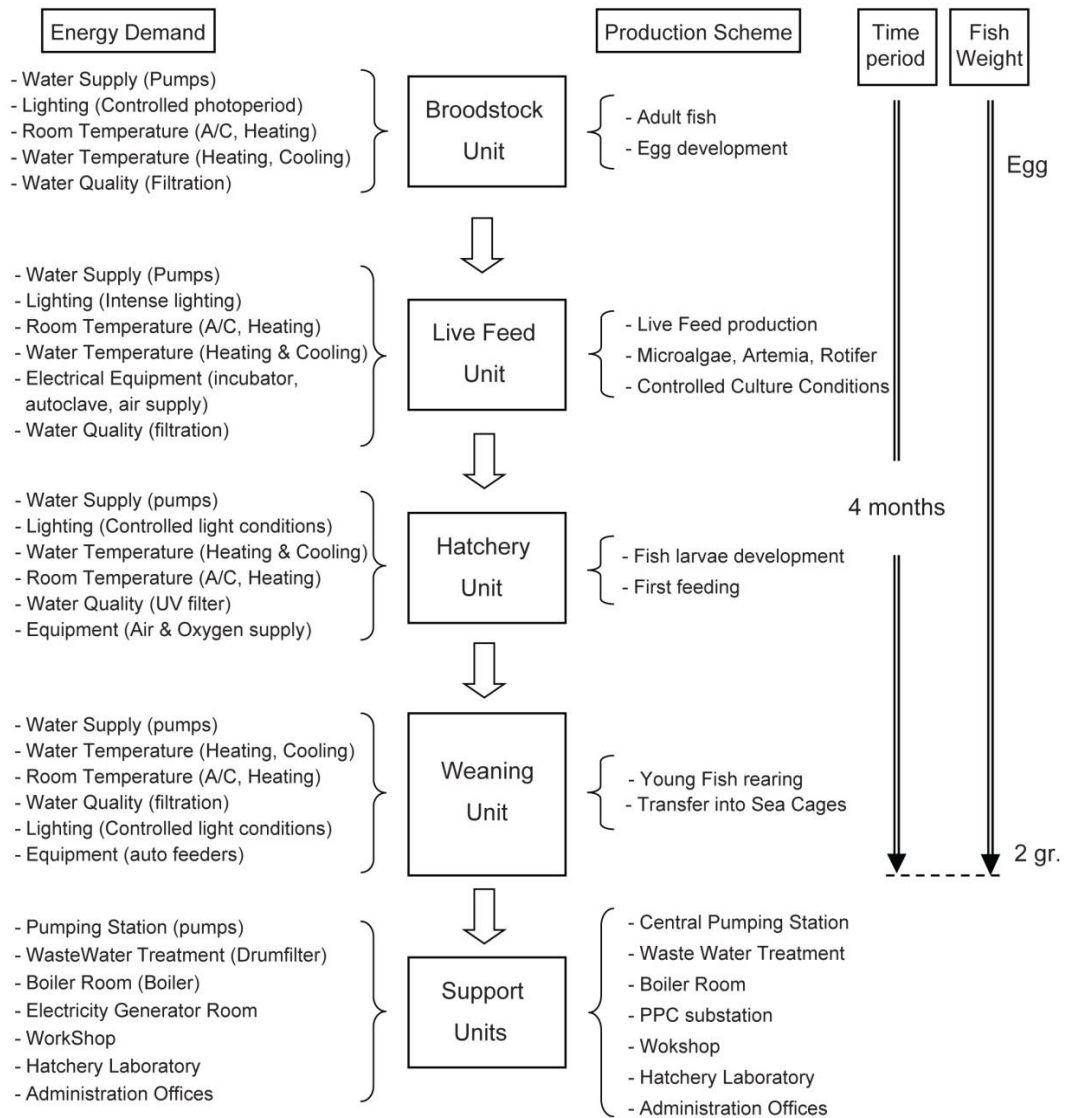
Figure 3. Production cycle and type of energy demand of each unit of the
Marine Fish Hatchery Station

Table 1. Energy demand of the aquaculture unit

|	LOAD TYPE	TOTAL kW	TOTAL kWh/24h
A. LIVE FEED UNIT	Electricity	168.05	1,622.82
	Thermal	56.0	340.00
B. HATCHERY UNIT	Electricity	152.13	1278.71
	Thermal	1048.00	3144.90
C. BROODSTOCK UNIT	Lighting	1.45	8.7
D. WEANING UNIT	Electricity	382.00	3849.00
E. DRUMFILTER	Electricity	33.55	369.05
F. FATTENING SECTOR	Electricity	44.00	308.00
G. CENTRAL PUMPING STATION	Electricity	189.00	2004.00
H. ADMINISTRATION BUILDING	Electricity	17.20	94.90
TOTAL		2,091.38	13019.18
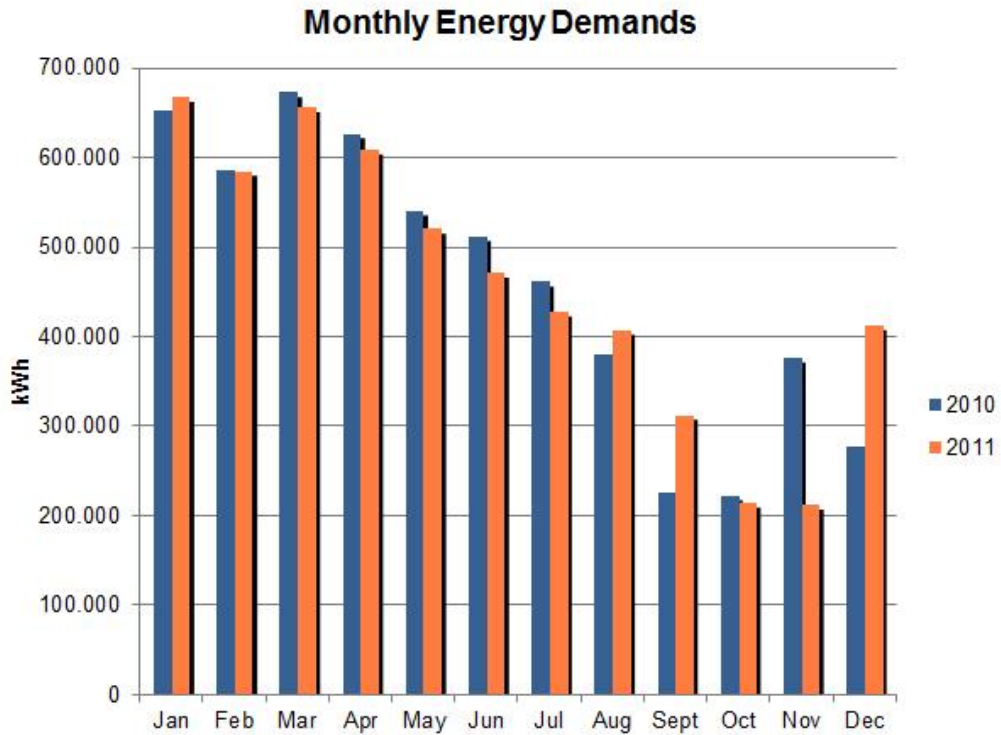
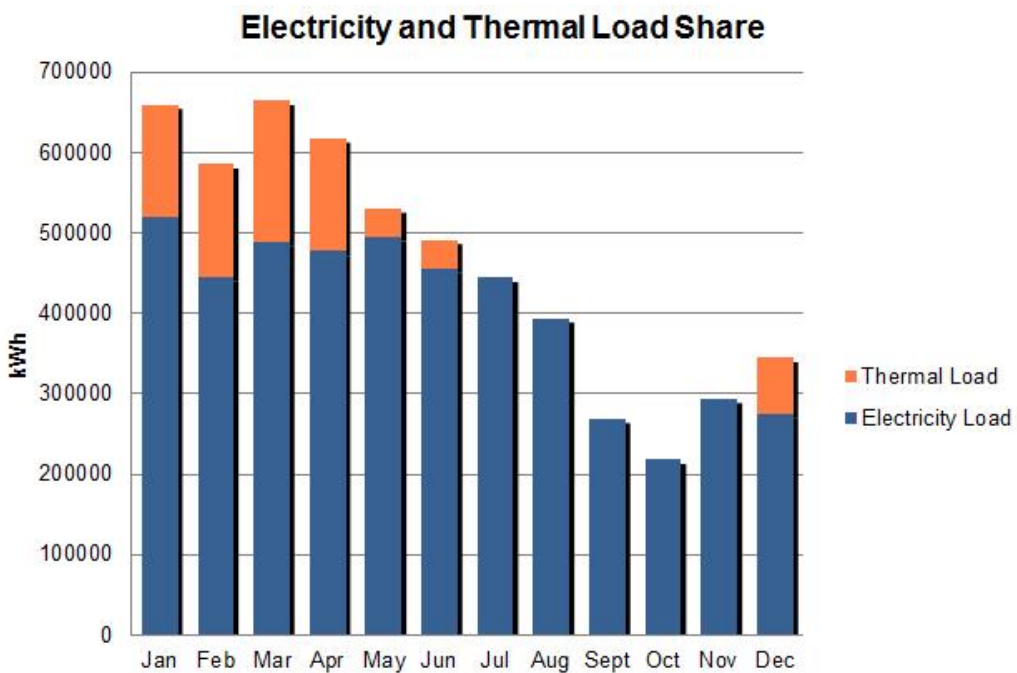*Figure 4.* Monthly energy demands of the hatchery station for years 2010 and 2011

Figure 5. Share of electricity and thermal load of the hatchery station

In the next section we present an application of the 'clean' energy software *RETScreen* in order to assess the technical and financial viability of the introduction of RES to cover part of the energy demand of the particular aquaculture station.

CLEAN ENERGY *RETScreen* ANALYSIS

Introduction

An integrated PV and Solar-thermal panel system designed to fulfill total energy demand (approximately 4,752,000 kWh of electricity and 737,733 kWh thermal on a yearly basis) couldn't be achieved because of not enough adequate land, where the installation could be developed. Moreover, because we are dealing with a large project of high initial investment cost we didn't want to add on that by buying extra land. Our approach is to identify the best possible set up, suited for the available space. In our case study, the available space for the RES system development is approximately 22,700m^2 of land space and 15,000m^2 of flat roof space; Land and roof space, are suitable for PV and Solar-Thermal panel installment.

After consulting with the engineers of the hatchery station it was decided to install 120.3 KW of Solar-thermal panels (501 panels in 2.800m^2) and 1.5 MW of PV panels (6,250 panels in 34,000m^2). Total covered area would be 36,800m^2, corresponding in 97.6% coverage of the available space. So, the proposed project development will take almost full advantage of the available space, without adding extra costs in the initial investment. In the following Table 2, the technical characteristics of the proposed project are given.

Table 2. Technical characteristics of the proposed project

		PV	Solar-Thermal
Panels (240W)	No:	6,250	501
Capacity	kW:	1500	120.3
Surface area	m^2 :	34,000	2,800
Total Surface area	m^2 :	36,800	

The *RETScreen Clean Energy Project Analysis (V. 4.0)* software has been chosen as an analysis tool. *RETScreen* is developed specifically in order to facilitate the identification and tabulation of all costs and perform an energy production and financial analysis. Next, technical and financial parameters are analyzed for our proposed project.

Technical Analysis

PV Installation
The electricity demand will be partially fulfilled by the PV panels. A total installation of 1.5 MW is chosen, corresponding in 6,250 PV panels, each of 240W capacity. The PV panels that are selected for the installation are made of polycrystalline copper tubes with the following specifications: efficiency 11.34%, capacity factor 17.5%, dimensions 2.35x1.07 m, gross area 2.51 m^2 per panel. For preventing shading effect and having adequate space for maintenance and operational purposes a total gross surface area of 34,000 m^2 will be needed. It is calculated that the annual electricity produced could supply about 50% (2,607,633 kWh) of the electricity demand.

Solar-Thermal Installation
In order to partially fulfil the heating demand, solar-thermal panels of 240 W capacity each are chosen. The dimensions of each panel are 2.36x1.07m with a gross surface area of 2.53m^2 per panel. A number of 501 solar-thermal panels will be installed needing a total surface area of 2,800 m^2, including on that the appropriate maintenance and operational space as well as prevention of shading effect. It is calculated that the annual thermal energy produced could fulfil almost 100% (737,733) of the thermal demand.

Economic Feasibility Analysis

An economic feasibility study was performed for the proposed project. Primarily, we had to calculate the detailed initial cost (Table 3) for both PV and Solar-Thermal installations.

Apart from the initial cost, needed for the development of the proposed project, there are also additional costs i.e. "Operation & Maintenance cost", on a yearly basis, for both projects, which have been taken into account for the economic feasibility analysis. The corresponding O&M costs are 15,000.0 € and 10,000.0 € respectively for the PV and Solar-Thermal panel installations.

Table 3. Detailed installation cost analysis for the proposed project

	PV Inst.	Solar-Thermal Inst.
	Cost (€)	Cost (€)
Pre-Feasibility study	40,000	30,000
Panels	2,718,750	257,514
Panel bases	331,250	50,601
Inverter	397,500	-
Panel installation	159,000	16,283
TOTAL	3,646,500	354,398
GRAND TOTAL	4,000,898	

The total investment for the proposed project is 4,000,898.0 €, corresponding in 3,646,500.0 € for the PV installation and 354,398.0 € for the Solar-Thermal installation. Subsequently, a discount rate of 7% was used, in order to assess the financial feasibility of the given project. *RETScreen* software uses the discount rate in order to calculate the annual live cycle savings. Financial parameters are summarized in Table 4.

Table 4. Input financial parameters

		PV Inst.	Solar Inst.
Inflation Rate	:	2.7%	2.7%
Project Life	:	25 yrs	20 yrs
Debt Ratio	:	70.0%	-
Debt Interest Rate	:	6.0%	-
Debt Term	:	20 yrs	-
Incentives and Grants	:	30.0%	0.0%
Discount rate	:	7.0%	7.0%
Electr. Export Escal. rate	:	5.2%	-
Fuel Cost Escal. rate	:	-	2.5%

For the PV installation, we consider a 25 years project life. On the other hand, for the Solar-Thermal installation, since we are dealing with a smaller project, a 20 years project lifetime is considered, while no incentives were taken into consideration since there is currently no relevant economic aid on such investments. Table 5 presents a summary of the financial analysis performed.

Table 5. Financial analysis summary

	PV Inst.	Solar Thermal
Pre-tax IRR (equity) (%) :	9.4%	22.2%
Net Present Value (NPV) €):	199,91	676,698
Annual life cycle savings (yr):	17,155	58,068
Simple payback (yr) :	20.8	5.1
Benefit-Cost (B-C) Ratio :	1.18	2.91
GHG emission reduction (CO_2):	2,226.5	360.6

The pre-tax IRR (return of the investment), which represent the true interest yield provided by the project over its life span before income tax, is for both projects positive i.e. 9.4% for the PV installation and 22.2% for the Solar-Thermal installation, making both projects acceptable. In addition, for both PV and Solar-Thermal installations NPV is positive i.e. 199,919€ and 676,698€ respectively and the simple payback period is 5.1yrs for the Solar-Thermal installation and 20.8yrs for the PV installation.

The *RETScreen* model also calculates the reduction of GHG as a result of using renewables. The resulting values of the net annual GHG emission reduction in tCO_2 are also given in *Table 6*.

In the following Figures 6 and 7 we can schematically see the cumulative cash flows for both PV and Solar-Thermal installations within the given project life time.
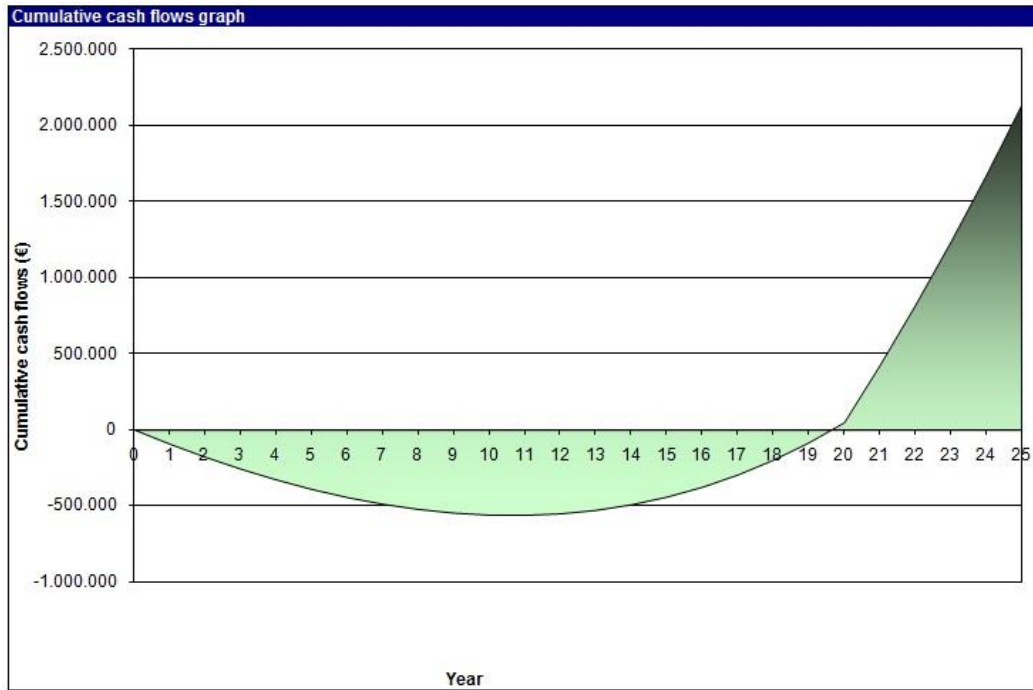
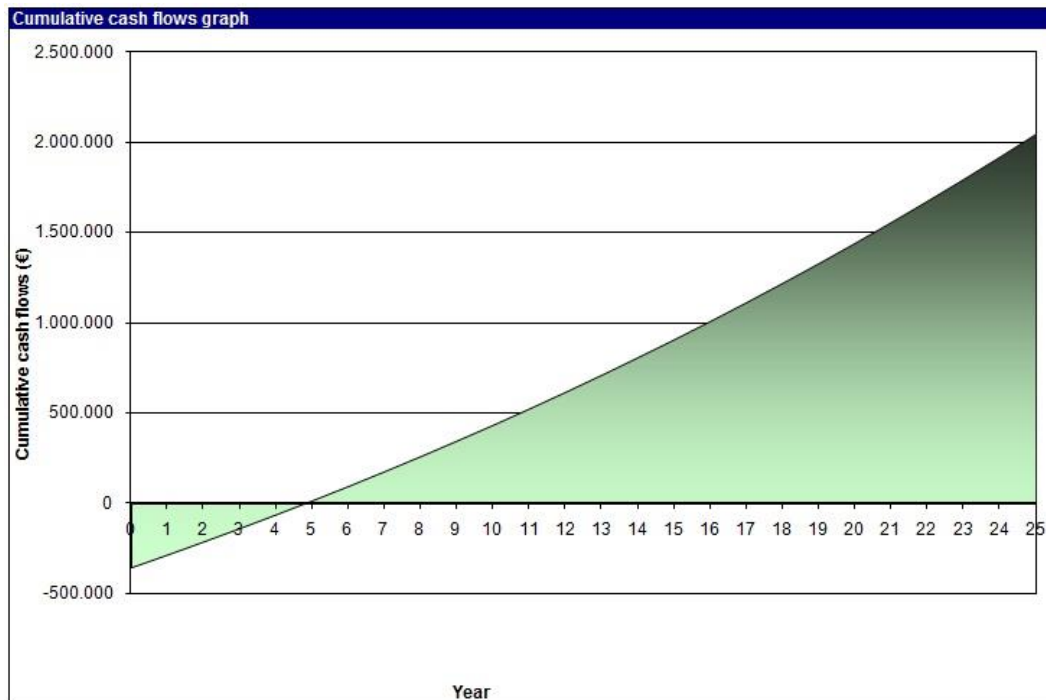*Figure 6.* Cumulative cash flow of the PV installation

Figure 7. Cumulative cash flow of the Solar-Thermal installation

As it can be figured out, the PV installation is starting to have a limited profit from year 20 onwards, while for the Solar-Thermal installation marginal profit starts almost from year 5.

CONCLUSIONS

In this paper we proposed a framework for renewable energy utilization and energy audit in a Mediterranean fish hatchery station. The developed framework was subsequently applied to a real case study concerning an aquaculture unit in Greece. A combined PV and Solar-Thermal panel installation is proposed, based on the energy audit results. The well-known clean energy software

RETScreen@ International, developed by the *Natural Resources of Canada*, has been utilized as an assessment tool of the proposed project.

It was found that the proposed project could theoretically supply 50% and 100% of the electricity and thermal load respectively. The economic analysis concludes that the proposed project is economically feasible with payback period of 21 and 5 years for the PV and Solar-Thermal installations respectively. Nonetheless, the results of the economic analysis for the Solar-Thermal panels seem to be very optimist in contrast with the ones for the PV installation which seems to be more realistic.

Further research would focus on the development of a hybrid RES system, i.e. including in the design the exploitation of wind power. Finally it would be worth investigating whether the development of a storage system based on batteries would be economically viable, ensuring at the same time energy supply whenever needed.

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APPENDIX 1: DETAILED ENERGY AUDIT

Table 6. Detailed Energy Audit

A. LIVE FEED UNIT		LOAD TYPE	CAPACITY (kW)	QUANTITY	TOTAL kW	OPERATION h/24h	TOTAL kWh
1.	Water Pumps (1.2 Hp)	Electr.	0.88	4	3.52	2	7.04
2.	Water Pumps (1.5 Hp)	Electr.	1.50	2	3.00	3	9.00
3.	Compressor (2.5 Hp)	Electr.	2.00	1	2.00	5	10.00
4.	Headlight	Electr.	2.00	2	4.00	9	36.00
5.	Light bulb for Algae	Electr.	0.25	32	8.00	9	72.00
6.	Light bulb for Algae	Electr.	0.058	656	38.05	10	380.48
7.	Refrigerator	Electr.	0.75	2	1.50	9	13.50
8.	Incubator	Thermal	2.00	1	2.00	5	10.00
9.	Autoclave room	Thermal	9.00	2	18.00	8	144.00
10.	A/C – "Phyto1" (25,000 BTU)	Electr.	7.32	1	7.32	10	73.20
11.	A/C – "Phyto1" (9,000 BTU)	Electr.	2.64	1	2.64	10	26.40
12.	A/C – "Phyto2" (25,000 BTU)	Electr.	7.32	1	7.32	10	73.20
13.	A/C – "Zooplankton 1" (25,000 BTU)	Electr.	7.32	1	7.32	10	73.20

A. LIVE FEED UNIT		LOAD TYPE	CAPACITY (kW)	QUANTITY	TOTAL kW	OPERATION h/24h	TOTAL kWh
14.	A/C – "Zooplankton 2" (87,300 BTU Cool / 91,300 BTU Heat)	Electr.	26.75	1	26.75	10	267.50
15.	A/C – Room: "Algae 1" (50,800 BTU Cool / 33,600 BTU Heat)	Electr.	14.88	1	14.88	10	148.80
16.	A/C – Room: "Algae 2" (87,300 BTU Cool / 91,300 BTU Heat)	Electr.	26.75	1	26.75	10	267.50
17.	Central Heating	Thermal	2.00	1	2.00	9	18.00
18.	Electrical Heater – Artemia (1)	Thermal	2.00	1	2.00	4	8.00
19.	Electrical Heater – Artemia (2)	Thermal	3.00	6	18.00	5	90.00
20.	Electrical Heater- Algae & Rotifer	Thermal	2.00	7	14.00	5	70.00
21.	Blowers (aerators)	Electr.	7.50	2	15.00	11	165.00
B. HATCHERY UNIT							
22.	Water Pumps	Electr.	1.80	2	3.60	3	10.80
23.	Water Pumps	Electr.	3.00	1	3.00	10	30.00
24.	Water Pump (Venturri Filter)	Electr.	4.50	1	4.50	8	36.00
25.	Water Pump (submerged)	Electr.	7.50	3	22.50	8	180.00
26.	Boiler (450,000 Kcal h^{-1})	Thermal	524.00	2	1,048.00	3	3,144.00
27.	Boiler Circulator	Electr.	4.00	1	4.00	10	40.00
28.	Boiler Circulator	Electr.	1.00	1	1.00	10	10.00
29.	Blower (aerator)	Electr.	7.50	2	15.00	10	150.00
30.	Chiller	Electr.	29.00	1	29.00	5	145.00
31.	Chiller Circulator	Electr.	4.00	1	4.00	8	32.00
32.	UV Filter (Atlantium)	Electr.	10.00	3	30.00	10	300.00
33.	UV Filter (Hanovia)	Electr.	21.00	1	21.00	10	210.00
34.	Ozonizator	Electr.	1.60	1	1.60	10	16.00
35.	Refrigerator for Artemia	Electr.	4.50	1	4.50	8	36.00
36.	Freezer (3 Hp)	Electr.	2.50	2	5.00	11	55.00
37.	Freezer	Electr.	0.16	3	0.48	11	5.28
38.	Light bulbs (58 W)	Electr.	0.058	44	2.55	**15**	38.25
39.	PC's	Electr.	0.15	2	0.30	8	2.40
40.	Printer	Electr.	0.05	2	0.10	0.5	0.05
C. BROODSTOCK UNIT							
41.	Light bulbs	Electr.	0.058	25	1.45	6	8.70
D. WEANING UNIT							
42.	Water Pumps (5.5 Hp)	Electr.	4.50	9	40.50	**9**	364.50

A. LIVE FEED UNIT		LOAD TYPE	CAPACITY (kW)	QUANTITY	TOTAL kW	OPERATION h/24h	TOTAL kWh
43.	Water Pump (100 m^3 h^{-1})	Electr.	5.00	1	5.00	7	35.00
44.	Water Pump (200 m^3 h^{-1})	Electr.	6.00	6	36.00	7	252.00
45.	Water Pump (200 m^3 h^{-1})	Electr.	18.50	12	222.00	11	2442.00
46.	UV Filter (Berson)	Electr.	7.50	3	22.50	8	180.00
47.	UV Filter (1000 m^3)	Electr.	21.00	2	42.00	11	462.00
48.	UV Filter (backup system)	Electr.	7.00	2	14.00	11	154.00
E. DRUMFILTER							
49.	Water Pump (5.5 Hp)	Electr.	4.50	7	31.50	11	346.50
50.	Drumfilter	Electr.	2.05	1	2.05	11	22.55
F. FATTENING UNIT							
51.	Water Pump (100 m^3 h^{-1})	Electr.	5.00	4	20.00	7	140.00
52.	Water Pump (200 m^3 h^{-1})	Electr.	6.00	4	24.00	7	168.00
G. CENTRAL PUMPING STATION							
53.	Water Pumps (600 m^3 h^{-1})	Electr.	45.00	2	90.00	11	990.00
54.	Water Pumps	Electr.	37.00	2	74.00	11	814.00
55.	Water Pumps (30 Hp)	Electr.	25.00	1	25.00	8	200.00
H. ADMINISTRATION BUILDING							
56.	PC's	Electr.	0.15	6	0.90	8	7.2
57.	Printer	Electr.	0.05	4	0.20	1	0.20
58.	Fax, scanner etc.	Electr.	0.017	1	0.017	1	0.017
59.	Coffee machine	Electr.	2.00	1	2.00	1.5	3.00
60.	Room A/C (12.000 BTU)	Electr.	3.52	4	14.08	6	84.48
TOTAL			**958.64**		**2091.38**		**13019.41**