AdriAquaNet

Enhancing Innovation and Sustainability in Adriatic Aquaculture

Deliverable WP 3 – Activity 2.2

Waste management, emission reduction, renewable energy and energy saving

DL 3.2.2. Technical-scientific report on *THE ENERGY USE IN INTENSIVE AQUACULTURE, EVIDENCING THE MOST CRITICAL POINTS AND THE TECHNIQUES WHICH CAN BE APPLIED FOR A FAVOURABLE ENERGY SAVING*

A. Manfrin[1], M. Lazzarin[1], M. Bullo[2], F. Da Borso[3], E. Tibaldi[3]

[1]Istituto Zooprofilattico Sperimentale delle Venezie

[2]University of Padua, Italy

[3]Department of Agricultural Food Environmental and Animal Sciences, University of Udine, Italy

Legnaro (PD) 28.06.2022

Project number:	10045161
Project Acronym:	AdriAquaNet
Project Title:	Enhancing Innovation and Sustainability in Adriatic Aquaculture
Start of the project:	01/01/2019
Duration:	42 months
WP/activity:	WP3, Activity 3.2.2
Deliverable name:	The potential of biogas technology applied to wastewater from fish farms, and assessment of energy recovery and environmental impact reduction
WP leader:	LP (UNIUD), partners involved PP4, PP8, PP9 and PP10
Author (s):	A. Manfrin, M. Lazzarin1, M. Bullo, F. Da Borso, E. Tibaldi
Delivery date:	30/06/2022
Status:	Final

European Regional Development Fund
prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences
Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

CONTENTS OF THE DELIVERABLE

The present Document, constituting the Deliverable of WP 3 - Activity 2.2, is divided into 2 parts:

- **PART 1**

  The first part provides details and assessment of the WP objectives related to the primary subject of the report and the implementation and results, compared to the information already provided in the different progress reports, in order to give back a cumulative illustration of what the project delivered in relation to this task.

  This part is structured as follows:

  A. Report highlights
  B. WP 3 – Activity 2.2 output and results
  C. Durability and transferability of the project and its results
  D. Capitalization of the results
  E. Partnership cooperation
  F. Target groups involvement

- **PART 2**

  The second part provides the final results and a collection of data from the WP and project in relation to the General objectives at the Programme level that are also described in the final report of the Project.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

PART 1

A. REPORT HIGHLIGHTS

1) ***Context*** – Aquaculture of the '20s has the capacity for further growth, but as it intensifies production, the sector must face the enormity of the environmental challenges, demanding new sustainable aquaculture development strategies (FAO, 2020). According to the European Climate Law, Europe's economy and society must become climate-neutral by 2050. Furthermore, net greenhouse gas emissions must be reduced by at least 55% by 2030, compared to 1990 levels. Therefore, all EU countries as a whole must cut emissions, invest in green technologies, and take actions to protect the natural environment throughout all the different productive sectors. The intensive aquaculture sector is not exception and, as a result, steps must be taken to make it more energy efficient and ecological.
2) ***Challenge*** – The main objective of WP3.2 was to analyse the energy use in intensive aquaculture, evidencing the most critical points and proposing alternative technologies and techniques which can be applied for a favourable energy saving.
3) ***Expectations*** –To contribute at reducing the energy consumption of fish hatcheries/farms and make them more energetically sustainable.
4) ***Solution*** – Current water heating methods have been found to be one of the most energy consuming processes carried out in intensive aquaculture plants. Generally, water for fish tanks is heated up by means of resistance immersion heaters or gas boilers. Resistance immersion heaters require long times to bring the entire water volume up to target temperature and are characterized by high power consumptions. On the other hand, gas boilers operate with a non-renewable energy source. The replacement of traditional water heaters with the heat pump technology represents a key instrument to achieve the goals set by the European Climate Law. Moreover, the implementation of a photovoltaic power plant allows to produce renewable energy in fish hatcheries/farms.
5) ***We started by*** analysing the energy use in PP9 intensive aquaculture farm located in south Italy.
6) ***Then,*** we tested alternative and innovative solutions for the reduction of energy consumption in fish hatcheries and farms.
7) ***What we achieved*** - An innovative heat pump water heater was designed and assembled. First, the most suitable heat pump equipment was selected and installed in a small-scale test site. The indoor unit was connected to a custom-made steel tube heat exchanger, shaped as a rectangular coil. The heat exchanger was placed inside a water tank, where it served as a condenser to transfer heat from the coolant to the water. Experimental tests with the aim of evaluating the performance of a heat pump compared with a resistor unit have been performed. The heat pump water heating system showed a significantly higher performance than the resistor system. Therefore, the prototype was installed to the Ittica Caldoli PP9 farm and adapted to work with an existing water tank. Two days of training were held by experienced technicians to instruct the plant's workers on how to operate the system.

   A photovoltaic power plant (82 kw) was also installed at the Ittica Caldoli PP9 farm. Its use in combination with heat pump technology (renewable sources) allows to produce clean energy to improve water heating for inland mariculture and reduce CO_2 emissions.

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it

B. WP 3.2.2 OUTPUTS AND RESULTS

Increasing environmental sustainability of fish farming through fish farm waste management, emission reduction and renewable energy production by anaerobic digestion

New approach to heat water in marine hatchery

Experimental tests with the aim of evaluating the performance of the heat pump water heater compared with a resistive immersion heater installed at Ittica Caldoli PP9 farm have been carried out by the Department of Industrial Engineering - University of Padua (PP4 subcontractor). Two identical tanks were filled with 0.5 m^3 of water. One tank was equipped with the resistor and the other tank was equipped with the heat pump system. The rated thermal power of the heat pump is 8 kW. During the heating process, a small submersible pump agitated the water to homogenize its temperature.

The experimental setup consists of a PC, a data logger acquiring temperature data from a set of thermocouples placed inside the water tanks at different positions, and a power analyser to measure the electrical consumption of the heat pump. Temperatures, currents, and power were continuously monitored for about two days. The results are showed in the following figures and are briefly discussed. Figure 1 shows the temperature measured by the thermocouples during the experimental test. The curves in the upper part of the graph are related to the heat pump heater tank, whereas the curves in the lower part of the graph are related to the resistive heater tank.

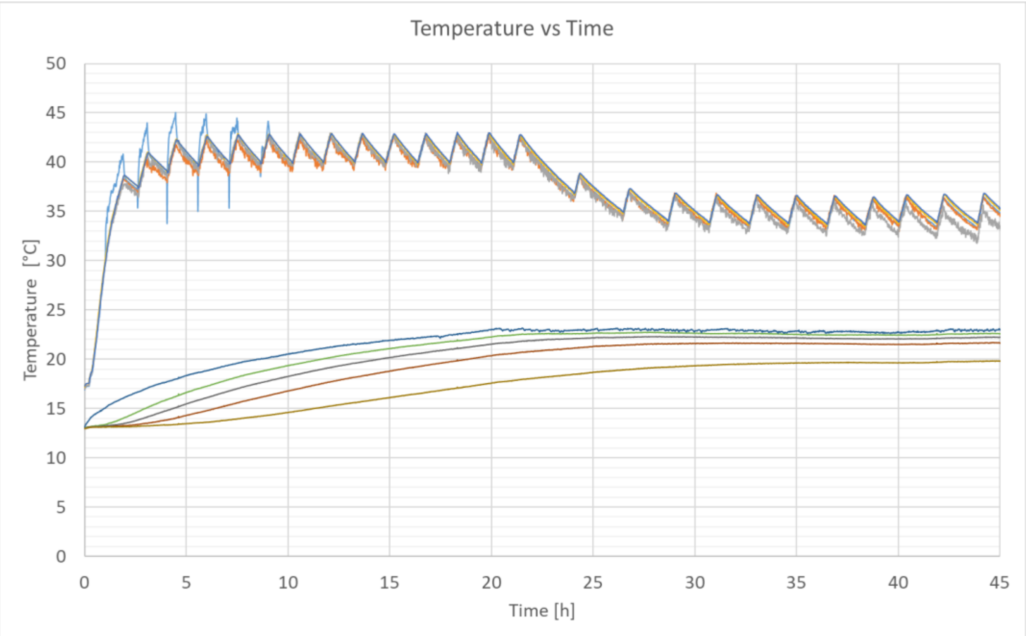

Figure 1 – Temperatures in the heat pump heater tank (up) and resistive heater tank (down) at Ittica Caldoli PP9 farm.

The heat pump water heating system showed a significantly higher performance than the resistor system. Thanks to the power regulation capabilities of the heat pump system, the target temperature can be reached earlier and maintained over time with a smaller overall power consumption. In fact, a high value of power can be demanded to the system to shorten the heat-up phase and then, once the target

European Regional Development Fund
prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences
Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

temperature is reached, only a small amount of that power is required to maintain the average temperature constant. On the other hand, the resistor system is quite slow at reaching the equilibrium temperature due to its low power density and localized heat generation. Furthermore, a non-uniformity arises in the temperature distribution inside the water tank. In order to speed up the heating process and reduce the thermal non-uniformity, a use of more resistive elements and the regulation of the temperature using an on/off control logic could be applied. However, this approach is inefficient because all the additional power is withdrawn directly from the mains. On the contrary, a consistent part of the heat can be obtained at the expense of the outside air by using a heat pump. In other words, less electrical power is needed to transfer the same amount of thermal power to the water.

Figure 2 shows the graphs of the 3-phase supply current and power of the heat pump water heating system. Two different phases of the heating process are clearly visible:

1) a ramp-up phase characterized by high currents, until the water reached the target temperature;
2) a temperature maintenance phase characterized by a series of on/off cycles.

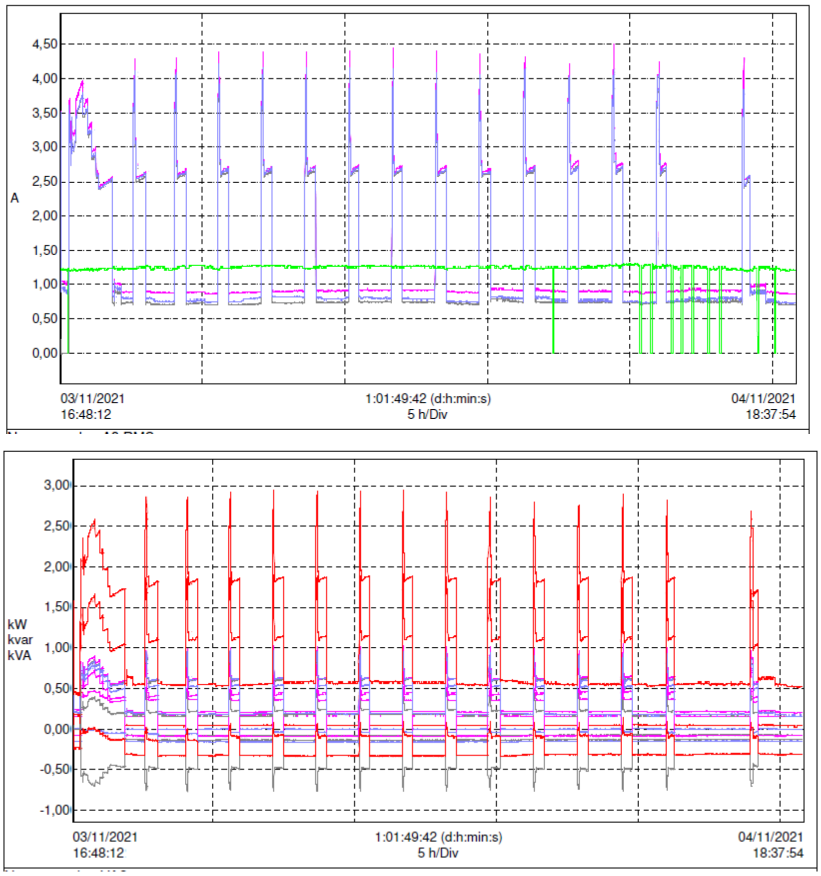

Figure 2 - Phase supply current and power of the heat pump water heating system at Ittica Caldoli PP9 farm.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

The prototype heat pump water heater system was moved to the Ittica Caldoli plant and adapted to work with an existing water tank. Two days of training were held by experienced technicians to instruct the plant's workers on how to operate the system.
Thanks to the good results obtained with the prototype, Ittica Caldoli PP9 farm bought a second heat pump with a rated power of 17 kW and a new heat exchanger about 5 times bigger than the first one. The second version of the system was able to increase the water temperature from 19°C to 23°C in almost all the tanks located in the hatchery, for a total water volume of about 280 m^3.

Figure 3 – Prototype water heater installed in Ittica Caldoli PP9 farm.

Photovoltaic plant at Ittica Caldoli PP9 farm

In the context of this project, a solar power plant (82 kW) was installed in Ittica Caldoli PP9 farm to reduce both the use of primary energy and CO_2 emissions. First, an analysis of the plant's power requirements was carried out. The monthly energy consumption in the year 2020 is shown in Figure 4. Moreover, Figure 5, 6 and 7 depict the annual average energy consumption, the monthly average energy consumption and the weekly average energy consumption, respectively. Figure 8 represents the power consumption frequency curve, which is the number of hours per year in which a certain value of hourly average power consumption appears.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it

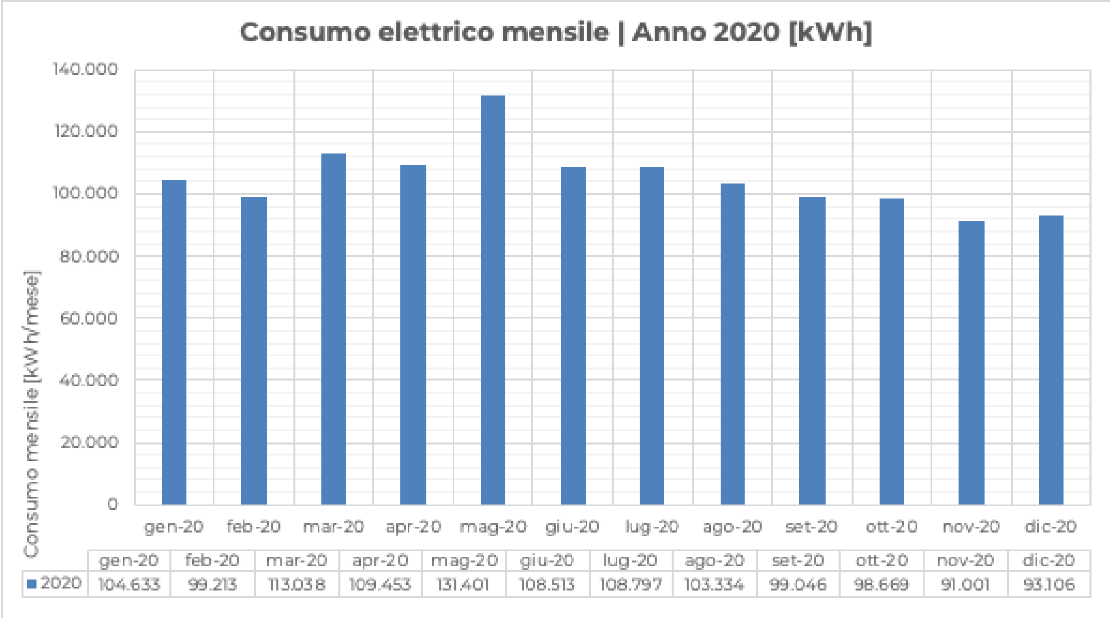

Figure 4 – Monthly energy consumption of Ittica Caldoli PP9 farm.

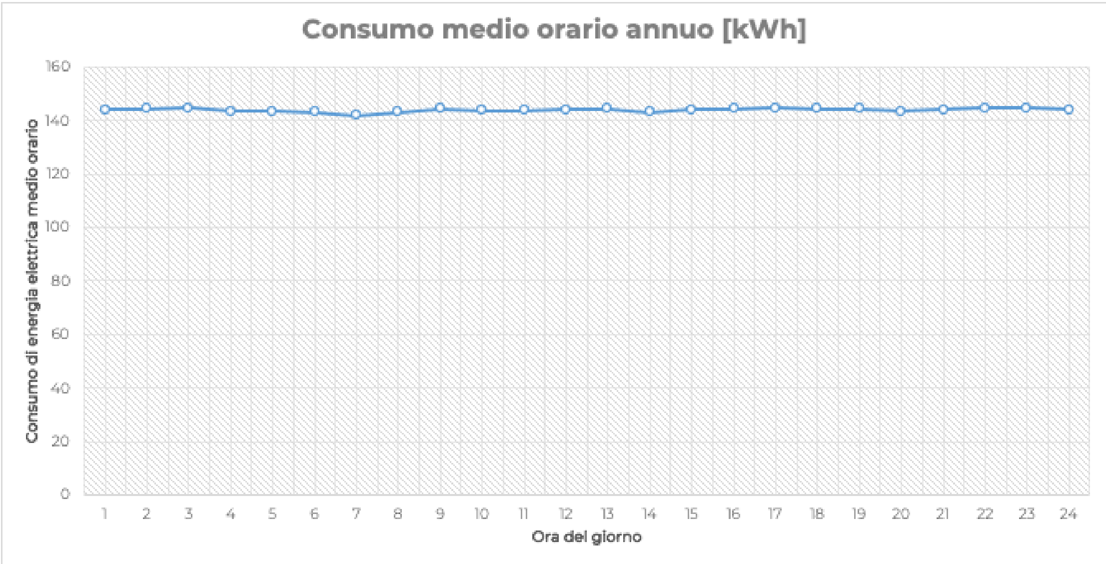

Figure 5 – Annual average energy consumption of Ittica Caldoli PP9 farm.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

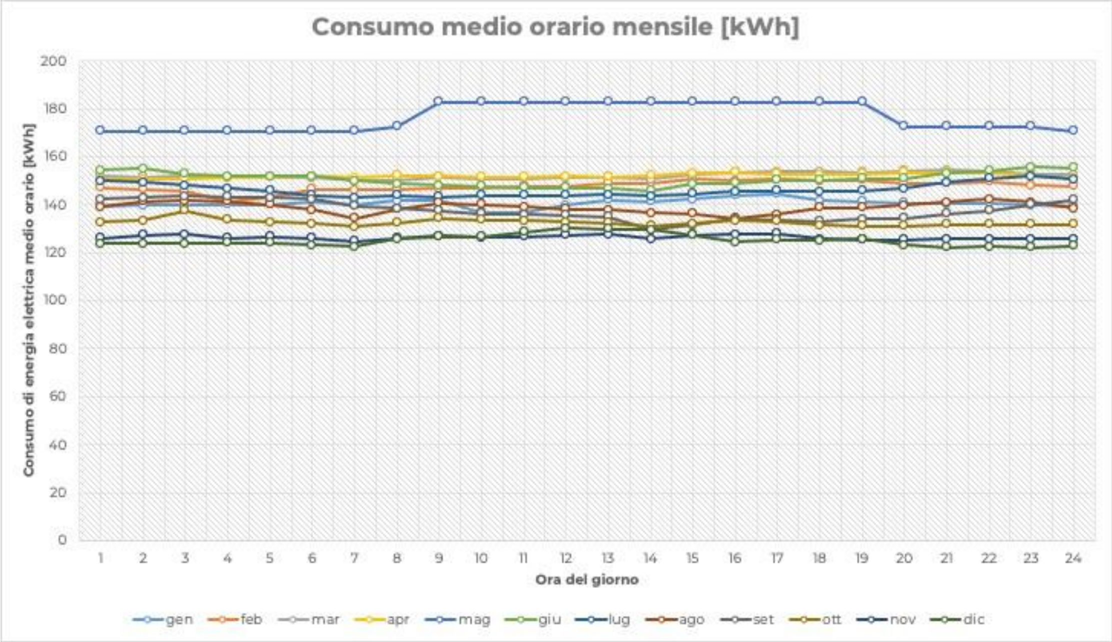

Figure 6 – Monthly average energy consumption of Ittica Caldoli PP9 farm.

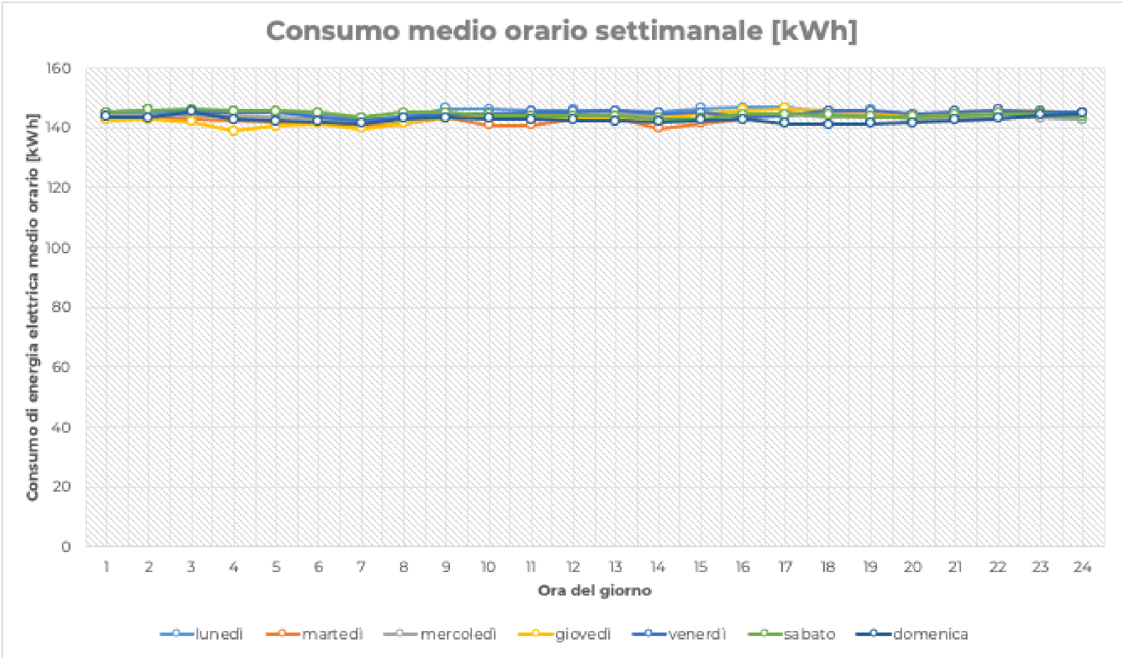

Figure 7 – Weekly average energy consumption of Ittica Caldoli PP9 farm.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

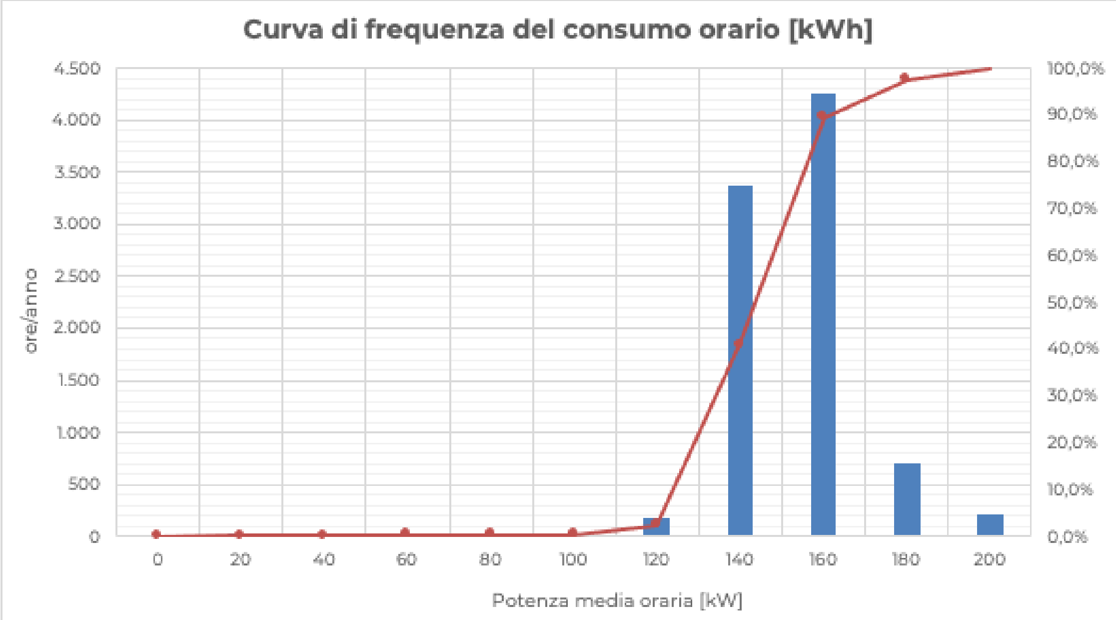

Figure 8 – Power consumption frequency curve of Ittica Caldoli PP9 farm.

Based on the graphs represented in Figures 4-8, some conclusions can be drawn:

- the weekly productive cycle is characterised by a flat energy consumption profile, due to the nature of the electrical loads involved;
- the plant's power consumption profile is somewhat constant between 140 kW and 160 kW, with peaks that reach as high as 200 kW.

The analysis on the power requirements of Ittica Caldoli PP9 farm served as a starting point for the design of an appropriate photovoltaic power plant, which is capable of significantly reducing the need for a withdrawal of electricity from the national grid. The layout of the photovoltaic plant is depicted in Figure 9. The total installed power of the power plant is 82 kW, which corresponds to more than half of the average power consumption of the fish farm. Therefore, the application of a high-performance photovoltaic system has made possible to considerably reduce the costs of electricity consumption by Ittica Caldoli PP9 farm and also reduce the production of carbon dioxide.

Overall, the results shown above clearly indicate that the combination of a technology for clean energy production (installation of a photovoltaic plant) and high efficiency processes based on the use of electrical energy (use of heat pump) is the key to improve the efficiency of water heating in fish farms and can allow to reach the goal of the European Climate Law, which expects that Europe's economy and society will become climate-neutral by 2050. In this context, the energy efficiency in inland marine aquaculture must be a priority. Moreover, it is important to highlight that the percentage of not consumed energy is really close to zero and correspond to a minimum quantity that is not necessarily absorbed at certain times of the day. No resale of energy or generation of profit occur and all the energy is intended for self-consumption.

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it

Figure 9 –Photovoltaic power plant at Ittica Caldoli PP9 farm.

Reasons of discrepancies between planned and realized outputs (if any)

The activities at PP9 farm were temporarily suspended from March 2020 to September 2020 due to the restrictions related to the COViD-19 sanitary emergency. However, no discrepancies between the planned and realized output have been registered.

Impact of outputs underachievement on project results

The activities were recovered and were conducted according to the schedule within the overall time of the project. No negative impacts on the outputs or any underachievement in terms of the project results have been detected.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

Additional results (was the project able to reach additional outputs /results besides those foreseen in AF?
The researchers of PP4 involved in the AdriAquaNet project also chose to purchase two electric outboard engines equipped with rechargeable batteries by solar panels (Figure 10) that was provided to Friskina PP8 farm. Zero environmental impact, no use of fossil fuels and no stress both for the fish and the operators were the most important advantages. Furthermore, the model used was light (16 kg of which 6 kg of removable battery against 25/30 kg of a classic petrol outboard), always ready to use thanks to a small solar panel available on board and finally there was no fuel costs. The purchase price was comparable to a classic petrol model of 4 HP, but the power was lower and not suitable in bad weather conditions. Its use is therefore limited to the inspection of off-shore cages, even in larger plants, where they can act as a support to larger boats used for the most important operations (for example, distribution of feed or harvesting of animals for selling to the consumers).


Figure 10 – The electric outboard engines equipped with rechargeable batteries by solar panels, provided to Friskina PP8 farm.

C. DURABILITY AND TRANSFERABILITY OF THE PROJECT AND ITS RESULTS

Please describe shortly:

How will the outputs and results be maintained and developed further after project end?
The photovoltaic system and the heat pumps installed at the PP9 fish farm will remain active and operational for the next 5 years, guaranteeing reduced energy consumption and high energy performance.
How has the availability of project results and outputs for general public and other stakeholders been ensured during the project life and eventually after the project end?
All the improvement actions carried out and the results obtained during the project were illustrated during the training days to the other partners and to the public participating in the events. Specifically, 3 training courses were lectured to technicians, farmers, associations, veterinaries and operators of the sector in general. The training lessons entitled "Motori a propulsione elettrica con stazione fotovoltaica di ricarica della batteria per le imbarcazioni di servizio. Un approccio ecosostenibile di utilizzo di energia rinnovabile applicato all'allevamento in gabbie" (Ostuni, Italy, September 2020) and "Photovoltaics (PV) and Heat Pump in Marine Aquaculture: High efficiency and low C02 emissions processes for water heating" (Padova, Italy, November 2021; Ostuni, Italy, May 2022) presented the results and outputs of the project to general public and other stakeholders. The material was distributed and will remain available even after the end of the project.

European Regional Development Fund
prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences
Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

D. CAPITALISATION OF RESULTS

Please provide information about capitalisation:

Was the project able to capitalise or influence future calls or other projects? Please specify main results or output to be considered for future capitalisation action. The reduction of energy consumption is one of the main objectives to ensure the economic sustainability of aquaculture companies. The use of alternative energy sources guarantees a reduced impact, also improving the environmental sustainability of intensive aquaculture systems. The results of the project can therefore be used in other fish farms with similar characteristics in full compliance with the green policy of the European Union (Green Deal and Blue Economy). **Are there any obstacles of legal or administrative nature that the project has encountered and which hampered cooperation? Is there any room to solve these obstacles?** No obstacles of legal or administrative nature have been encountered during the project that have limit the cooperation among people and institutions.

E. PARTNERSHIP COOPERATION

Please provide an assessment of the participation and involvement of the partners in the project, answering the following questions:

Which Partners were active in your WP and the activities related to the report? Were all the Partners involved also active? Ittica Caldoli PP9, PP4 and LP (WP 3 leader) were actively involved in this task. The following activities were performed by PP4 in close cooperation with Ittica Caldoli (PP9) and LP: - Monitoring of farm energy production; - Installation of the photovoltaic power plant and heat pumps; - Testing the efficacy and savings of the new technologies; The researchers of the Department of Industrial Engineering of the University of Padua (PP4 subcontractor) performed all the technical evaluation tests of the photovoltaic system, the development of the prototype for water heating and the construction of the pilot plant installed in the hatchery to heat the water of 10 tanks.
Were they all able to attract other local/regional actors and involve them in the project activities? A small plumbing company – SME (Gas Clima Service, PP4 subcontractor) was actively involved in the development of the heating system and the installation of heat pumps at Ittica Caldoli PP9 farm. Furthermore, Ittica Caldoli (PP9) is an established company with a solid relationship with the territory; therefore, it will be able to effectively spread the present outcomes to other stakeholders of the aquaculture sector even after the end of the project.
What was the added value given by the cooperation? All the partners were active and gave their own contribution, both technical and economical. The cooperation with Ittica Caldoli (PP9) allowed having a better view of farm problems related to the farm energy consumption and the results of the in field tests can be considered strictly related to real operative conditions. Thanks to this profitable cooperation, the assessment of the scale transfer of the process was more effective. The cooperation with the researchers of Padua University resulted in strengthened knowledge on the investigated topics and could be the base of future research projects.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

Which were the main problems encountered?
Due to Covid19 movement restrictions, only a limited numbers of visits to PP9 were possible in 2020 and 2021. PP9 owner also passed away suddenly but the new owners were able to finish all the activities. The extension of the project allowed us to restore all the scheduled activities and achieve the project objectives without any limitations.
Was the project able to create links with other projects?
All the results are available on the AdriAquaNet website but until today no specific links have been created with other projects.
Will the PPs cooperate in the future even without funding (if yes explain the main aims of this cooperation)?
The cooperation with the researchers of Padua University allow possible future exchanges and participation in research projects. Moreover, the PPs will be involved in training courses and events for ensure the dissemination of project results.

F. TARGET GROUPS INVOLVEMENT

Please list the main target groups that benefited from your WP project's achievements as inserted in the relevant Report Section in SIU that you will find on the left (the numbers are our project numbers). In few word provide further details on how they were able to make use of the outputs/ results of the project.

TARGET GROUPS	*Description*
SMEs (50)	2 farms directly involved in OWIs tests, 5 SMEs (Fanin, Bluefarm, Gas Clima Service, Skretting, RINA Service) participating to Padova training (see also LP and PP2 reports)
Universities, technology transfer institutions, research institutions (10)	Scientific collaboration among LP, PP1, PP2, PP3, PP4, PP5 UNI FIRENZE, UNI PADOVA, UNI BOLOGNA, UNIPVM (see also LP and PP2 reports)
NGOs, associations, innovation agencies, business incubators, cluster management bodies and networks (5)	Italian Fish Farmers association (API) (see also LP and PP2 reports)
Centers of R excellence (5)	ISPRA and IRBIM-CNR (see also LP and PP2 reports)
Local, regional and national public authorities (10)	4 local veterinary services, Friuli Venezia Giulia Region central veterinary department (see also LP and PP2 reports)
General public (1000)	Dissemination of results on the IZSVe online channels (website, social network and newsletter), on the AAN project website (see also LP and PP2 reports) and through radio and tv

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

PART 2

A. CONTRIBUTION TO EUSAIR

Please provide a description of the project contribution to the EUSAIR in terms of synergy with the Strategy's pillars and alignment of implemented project's activities with the Action Plans and labelled projects.

The AAN project contributes to the EUSAIR project within the first "blue growth" pillar, which aims at enhancing aquaculture in the Adriatic area, in particular the development of a strong, high-quality sector that is economically sustainable and environmentally friendly, contributes to job creation and to supply of healthy food products, respecting the EU and international rules. The project directly involved researchers from University and public Institute, fish farms and hatcheries, enterprises (SMEs being part of the aquaculture business chain such as companies for feed producing, recycling wastes, fish food transforming), and different type of stakeholders (experts, general public, productive associations, policy) from Italy and Croatia in order to improve the competitiveness of the mariculture sector of the Adriatic Sea. The project approach, the innovative technologies for energy saving that were tested during the project and are proposed for an application in sea bass/bream intensive farming, and the outcomes can be easily transferred to other territories of the EUSAIR macro region.

B. CONTRIBUTION TO HORIZONTAL PRINCIPLES

Please provide a description of the project contribution to the horizontal principles of equality between men and women, non-discrimination and sustainable development.

Within the project, no distinction was made based on gender, culture, religion or origin. The project engaged technical and administrative staff based on personal characteristics, complying with the equal opportunities and without discriminations. The focus was on the one common goal, or rather on the promotion of a healthy and sustainable product from the Adriatic regions, bringing together farmers, scientists, consumers, veterinarians and experts in the field. New efficient technologies for saving energy were tested and improved in order to ensure a better productivity and profitability of fish farms, providing permanent employment opportunities and increase the sustainability of the aquaculture sector.

C. COMMUNICATION ACTIVITIES

Please refer to the Final Communication Report template and provide a summary on the main achievements trying also to identify which were the most successful communication tools in reaching general public/decision makers/other target groups.

All the activities performed to reach the present DL have been documented with photos and videos taken by PP4 communication specialists. The material has been uploaded on the Intranet website of the project. Some of the materials was used to produce this report (see above), and to produce communication materials (e.g. the project video released by Divulgando and presented at Barcolana 2021; some social media posts on the AAN pages and accounts).

The aforementioned activities have been presented at the training event held in Padua in November 2021 (for details see the promotional news items on the IZSVe website ITA | ENG) and in a similar training events (Ostuni 6-7 May and Zadar 02 June 2022). During the final conference in Zadar (3 June

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

2022) and Udine (20 June 2022) a summary of the most important results have been presented by PP4 researchers. Numerous reports, meetings, brochures, training courses, conferences, a website and a YouTube channel have been produced to communicate the results.

D. NATURA 2000

Please describe, if it is the case, measures foreseen and implemented by the project:

a) In case the project involved Natura 2000 sites, describe what measure the project envisaged and implemented to avoid any negative impact: No Natura 2000 sites are included in the areas where the project activities have been carried out; therefore, no measures have been envisaged and implemented during the project in order to avoid negative impacts.
b) In case the project had a positive effect on Natura 2000 sites, please describe which measure the project has foreseen and implemented in order to reach a direct or indirect positive impact: No Natura 2000 sites are included in the areas where the project activities have been carried out; therefore, no measures have been envisaged and implemented during the project in order to avoid negative impacts.

E. TYPES OF ACTIONS ADDRESSED (as defined in the Cooperation Programme)

These are our primary objective's types of actions, that we addressed by the Project:

Specific Objectives	***Types of action***	***the most relevant one within the SO addressed by your project***
1.1 Enhance the framework conditions for innovation in the relevant sectors of the blue economy within the cooperation area	*Joint projects and actions aimed at creating platforms, networks and at supporting exchange of good practices in order to enhance the knowledge transfer and capitalization of achieved results in the field of blue economy*	***X***
	Actions aimed at cluster cooperation, joint pilot initiatives in order to boost the creation of marketable innovative processes and products, in the field of blue economy	***X***

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

F. TYPES OF OUTPUTS PRODUCED

Specify the types of outputs generated by your activity that are reported here and provide a brief description

Output typology	Description
Trainings	5 training courses in Italy and Croatia regarding the potential of the investigated technologies applied for energy saving in fish farms have been performed during the project.
Monitoring systems	N.A.
SMEs clusters	Potential collaboration and exchange of work and resources among enterprises involved in the aquaculture business chain such as fish farms and companies that develop technologies for energy saving were established. The innovative techniques and systems implemented during the project within the task 3.2.2. can be applied in other Italian and/or Croatian fish farms and facilities. The cross border production chain that involves Italian hatcheries, which grow sea bass and sea bream fingerlings and juveniles, and Croatian on-growing sea cages-based farms, which than exported the fish to the Italian market, was implemented thanks to the project training courses and events.
New networks	New collaborations among project partners, subcontractors and researchers of Padua University were developed during the project in order to achieve the task 3.2.2 objectives. Moreover, an active cooperation among researchers of PP4 and fish farmers of PP9 was developed so as to improve the interest of entrepreneurs for R&D and innovation as well as allow the project to respond to their needs.
Platforms	N.A.
Adaptation plan	N.A.
Building renovation	Design and implementation of a photovoltaic plant at PP9 farm for the access to sustainable energy sources, based on an innovative low temperature heating water system with an efficient heat pump, an instantaneous electrical heating based on induction principle, sensors and actuators. It will ensure a detailed monitoring of electricity consumption taking into account not only the electrical quantities like active and reactive power but also temperature, pressure, flow rate, chemical composition of water in order to check and to properly control all the electrical quantities and obtain an effective energy saving.
Others (please specify)	N.A.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it
www.italy-croatia.eu/adriaquanet

G. TYPOLOGY OF IMPACTS

Please indicate what type of impact(s) your project has had. You can choose more than one answer. For each tangible impact selected, please provide a concrete example from your project, where possible supported by quantitative information.

TANGIBLE IMPACTS

Tangible impacts	Example/ quantitative information
Improved access to services	N.A.
Cost savings	Reduced consumption of electricity thanks to the PV panel in PP9 facility. Lower petrol costs thanks to the boat electric engines, powered by solar panels, used to move around PP8 facility.
Time savings	N.A.
Reduced energy consumption	See Cost saving row
Reduced environmental impact	Reduced environmental impact thanks to PV and solar panels.
(Man-made, natural) risk reduction	N.A.
Business development	N.A.
Job creation	N.A.
Improved competitiveness	N.A.
Other tangible impacts (specify)	N.A.

INTANGIBLE IMPACTS

Intangible impacts	Example/quantitative information
Building institutional capacity	N.A.
Raising awareness	The project has stimulated the attention of fish farmers regarding the issues of energy saving through the study of efficient technologies for the production of renewable energy in hatcheries and sea cages, so to improve the sustainability of Mediterranean aquaculture.

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it

Changing attitudes and behavior	The project provide to fish farmers and efficient photovoltaic power plant and rechargeable battery as new environmental friendly approaches for the production of renewable energy to be applied in hatcheries and sea plants, so to improve the sustainability of Mediterranean aquaculture and consequently the competitiveness of sector.
Influencing policies	N.A.
Improving social cohesion	N.A.
Leveraging synergies	The project lead to the strengthening of relations between Italian and Croatian research groups, as well as between universities or centers of excellence and fish farmers. This collaboration may be exploited in the future for the drafting and implementation of new research projects aimed at improving aquaculture farming systems and waste/energy management in fish farms.
Other intangible impacts (Specify)	N.A.

European Regional Development Fund

prof. Marco GALEOTTI DVM, Dipl. E.C.V.P.
University of Udine
Department of Agricultural, Food, Environmental and Animal Sciences

Via Sondrio, 2, Udine, 33100, Italy
+39 0432-558594
marco.galeotti@uniud.it