Prepared by:

REDAWN – Reducing Energy Dependency in Atlantic area Water Networks

PROJECT REPORT

Economic Feasibility Assessment

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REDAWN Reducing Energy Dependency in Atlantic Area Water Networks

Interreg Atlantic Area European Regional Development Fund

EUROPEAN UNION

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1. Introduction

The objective of the REDAWN project is to reduce the energy dependence of water networks in the Atlantic area (AA), improving the energy efficiency of water networks through the use of micro hydropower (MHP) technology. The energy consumption linked to the water industry is such that it is responsible for significant contributions to climate change, thus, some measures are needed to transform the sector into a more sustainable system. Potential energy recovery from Micro-hydropower plants (MHP), using small-scale traditional turbines and pump as turbines (PATs), present an option to reduce this energy consumption. These are being assessed in the REDAWN project across public drinking water networks, private industrial water networks, waste water networks, and irrigation networks are investigated.

The introduction of MHP in water networks will have an economic impact in the water activity. This effect not only suppose a potential reduction of costs due to a self-consumption of the electricity generated but also a potential increase in the competitiveness of the management of the network thanks to the access to electricity in isolated areas where could be used electrical devices to improve the management of the grid. The content of this report tries to give some indications to the owners and managers of the water networks related to the economic benefits that the installation of MHPs could have for the water companies.

More specifically, this report of economic feasibility assessment will comprise three parts. The first part is a summary of the analysis of the energy potential in the main hydraulic infrastructures located in countries in the Atlantic Area, including an identification of optimal sites to install micro-hydro devices. Those infrastructures are:

- Urban and industrial wastewater networks, including sewage treatment plants.
- Drinking water supply networks.
- Irrigation infrastructures.

A sluice gate in an irrigation canal

The second part is an evaluation of economic conditions that can affect the viability of a MHP in order to define their economic profitability.

The third part is a quantification of the potential economic impact of the exploitation of the available sites identified for hydropower exploitation in the project. The work will include the impact of MHP energy recovery on the operating energy costs of water supply, waste water treatment, irrigation, and process industry.

An irrigation system

2. Potential water resources and water network components database in AA

2.1. Ireland

Table 1 summarises the data collected on MHP potential in water networks in Ireland, including the number of existing sites identified, an estimate of their power potential and an extrapolation of that potential, in terms of energy, to the entire region of Ireland. Extrapolated data was conducted on the basis of the relationship between population and energy production estimations from the existing sites. These extrapolations are subject to significant uncertainties.

Table 1. MHP potential in Ireland measured and estimated in the REDAWN project

Data Description	Drinking Water	Irrigation	Wastewater	Industry	Total
Number of sites identified	44	0	535	22	601
Theoretical Power Potential (kW)	668	0	219	212	1099
Extrapolated Energy* (GWh)	13.7-40.0	0	1.8	2.3	17.8-44.1

*Annual potential

The drinking water sector in Ireland was estimated to hold an annual potential between 13.7 and 40.0 GWh of available energy for MHP installations. This estimate is on the basis of extrapolation of data from 7775 sites in the countries included in the area of interest and a ratio of energy potential to population serverd based on different assumptions, including the average and the median for the individual ratios of all countries with data, and the individual ratio for Ireland of 0.35 kW/1000 people.

No irrigation potential was identified in Ireland as such infrastructure is not common or not required in this climate.

Data on 535 wastewater treatment plants was collected and an estimate 1.8 GWh was determined for the full country as annual energy recovery potential in this sector.

Data was collected from a limited number of large industrial water users with a potential for MHP of 212 kW. Extrapolation was then carried out based on information about wastewater discharges for industries in Spain, and the gross domestic product related to the industrial activity for each country, estimating an annual energy potential for Ireland around 2.3 GWh.

A turbine in a water treatment plant near Dublin

2.2. United Kingdom

Table 2 summarises the data collected on MHP potential in water networks in the UK, including the number of existing sites identified, an estimate of their power potential and an extrapolation of that potential, in terms of energy, to the entire region of the UK. Extrapolated data was conducted on the basis of the relationship between population and energy production estimations from the existing sites. These extrapolations are subject to significant uncertainties.

Table 2. MHP potential in the UK measured and estimated in the REDAWN project

Data Description	Drinking Water	Irrigation	Wastewater	Industry	Total
Number of sites identified	7684	0	0	0	7684
Theoretical Power Potential (kW)	24637	0	0	0	24637
Extrapolated Energy (GWh)	191.7-689.1	0	25.7	15.2	232.6-730.0

*Annual potential

The drinking water sector in the UK was estimated to hold an annual potential between 191.7 and 689.1 GWh of available energy for MHP installations. This estimate is on the basis of extrapolation of data from 7775 sites in the countries included in the area of interest and a ratio of energy potential to population served based on different assumptions, including the average and the median for the individual ratios of all countries with data, and the individual ratios for Scotland (4.28 kW/1000 people), Wales (0.25 kW/1000 people) and Northern Ireland (0.47 kW/1000 people). No individual ratio was obtained for England as no information about potential sites was collected for this country.

No irrigation potential was identified in the UK as such infrastructure is not common or not required in this climate.

The waste water sector in the UK was estimated to hold the potential for annual MHP energy recovery of 25.7 GWh. This was estimated using a linear correlation between the power potential for MHP and the population served based on information about wastewater discharges for Irish and Spanish plants.

The extrapolation for the industry sector, based on data about the industrial wastewater discharges in Spain, amounted to a total energy potential of 15.2 GWh for the UK. This extrapolation was based on information about wastewater discharges for industries in Spain, and the gross domestic product related to the industrial activity for each country.

Turbine installation in UK water treatment works

2.3. France

Table 3 summarises the data collected on MHP potential in water networks in France, including the number of existing sites identified, an estimate of their power potential and an extrapolation of that potential, in terms of energy, to the entire region of France. Extrapolated data was conducted on the basis of the relationship between population and energy production estimations from the existing sites. These extrapolations are subject to significant uncertainties.

Table 3. MHP potential in France measured and estimated in the REDAWN project

Data Description	Drinking Water	Irrigation	Wastewater	Industry	Total
Number of sites identified	2	0	0	0	2
Theoretical Power Potential (kW)	0	0	0	0	0
Extrapolated Energy (GWh)	188.6-548.8	0	25.3	14.4	228.4-588.6

*Annual potential

The 2 potential sites identified for the drinking water sector in France did not presented enough power to be considered viable (minimum of 2 kW), being not included in the total. For that reason, the estimations for this country, for the diferent sectors, were based on the relation found between the energy potential and population served in countries in which data was available, following different assumptions. Thus, a total annual energy recovery potential between 188.6 and 548.8 GWh was estimated for the drinking water sector.

The estimation for the irrigation sector was not finally included for France, as no information about the surface with similar irrigation networks to those included in the analysis of the 18 pressurized irrigation networks for Southern Portugal and Spain was found.

The estimations for the wastewater sector were based on the correlation between the power potential and population served extracted from the Irish and Spanish treatment plants, accounting to a total of 25.3 GWh for France.

For the private industry sector a total of 14.4 GWh of potential energy recoverable throughout the year was estimated, based on wastewater discharges licenses of private industries included in the database analysed for Spain.

2.4. Spain

Table 4 summarises the data collected on MHP potential in water networks in Spain, including the number of existing sites identified, an estimate of their power potential and an extrapolation of that potential, in terms of energy, to the entire region of Spain. Extrapolated data was conducted on the basis of the relationship between population and energy production from the existing sites. These extrapolations are subject to significant uncertainties.

Table 4. MHP potential in Spain measured and estimated in the REDAWN project

Data Description	Drinking Water	Irrigation	Wastewater	Industry	Total
Number of sites identified	34	173	343	87	637
Theoretical Power Potential (kW)	95	2946	982	1403	5426
Extrapolated Energy (GWh)	135.7-396.1	221.4	18.2	12.3	387.7-648.1

*Annual potential

The drinking water sector in Spain was estimated to hold an annual potential between 135.7 and 396.1 GWh of available energy for MHP installations. This estimation is on the basis of extrapolation of data from 7775 sites in the countries included in the area of interest and a ratio of energy potential to population served based on different assumptions, including the average ratio and the median for the individual ratios of all countries, and the individual ratio for Spain of 0.09 kW/1000 people.

The irrigation sector extrapolations were based on the potential found for the pressurised irrigation networks analysed in the south of Portugal and Spain, as well as the information about the localised irrigation surface and the ratio between the surface water and total water used for irrigation. The total extrapolation reached 221.4 GWh for energy recovery potential for irrigation in Spain.

Data of the discharge licenses for 343 wastewater treatment plants were collected in Spain, and together with the Irish data, a linear correlation between the power potential and the population served was found. This correlation determined a total energy recovery potential for the wastewater sector in Spain of 18.2 GWh.

The industry sector was examined considering the annual wastewater discharge volumes for the set of industries included in the database of wastewater licenses of the country, amounting to a total annual energy recovery potential of 12.3 GWh.

Wastewater treatment plant in Spain

2.5. Portugal

Table 5 summarises the data collected on MHP potential in water networks in Portugal, including the number of existing sites identified, an estimate of their power potential and an extrapolation of that potential, in terms of energy, to the entire region of Portugal. Extrapolated data was conducted on the basis of the relationship between population and energy production estimations from the existing sites. These extrapolations are subject to significant uncertainties.

Table 5. MHP potential in Portugal measured and estimated in the REDAWN project

Data Description	Drinking Water	Irrigation	Wastewater	Industry	Total
Number of sites identified	11	4	0	1	16
Theoretical Power Potential (kW)	34	49	0	10	93
Extrapolated Energy (GWh)	29.6-86.4	23.9	4.0	2.6	60.1-116.9

*Annual potential

The drinking water sector in Portugal was estimated to hold a potential between 29.6 and 86.4 GWh of available energy for MHP installations. This estimate is on the basis of extrapolation of data from 7775 sites identified in the countries included in the area of interest and a ratio of energy potential to population served based on different assumptions, including the average ratio and the median for the individual ratios of all countries, and the individual ratio for Portugal of 0.31 kW/1000 people.

Irrigation potential extrapolation was based on the potential found for the pressurised irrigation networks analysed in the south of Portugal and Spain, as well as the information about the total surface in the region with similar irrigation networks. 4 sites were found in the assessment of the Aboro network. The extrapolated energy potential for Portugal was then identified as 23.9 GWh.

The waste water sector in Portugal was estimated to hold the potential for 4 GWh of energy throughout the year. This was estimated on the basis on the population and the linear correlation found between the potential for MHP in the wastewater treatment plants analysed and the population served in Ireland and Spain.

Data was collected for the industry sector in Portugal from the pilot plant at Renova S.A. Extrapolation was then carried out based on information about industrial wastewater discharges in Spain, estimating an annual energy potential for Portugal around 2.6 GWh.

3. Conditions of economic feasibility assessment of a MHP

In assessing the economic viability of the installation of a MHP in water infrastructures in operation (supply, wastewater treatment, industrial water and irrigation) is necessary to consider various parameters.

As in any economic analysis, starts on an evaluation of the benefit of the investment. Depending on the outcome of this assessment you can calculate the payback period of the investment required and, therefore, the viability of the installation. The benefit will be the result of the difference between the incomes and costs of the installation. It should be noted that income refers to the economic revenue for the electricity generated, either for sale to the grid or as a reduction of energy consumption costs. By other hand, the costs are not only the operation and maintenance costs but also the depreciation costs of the equipment.

In order to assess the income, it has to be taken into account a number of variables that significantly influence in its generation.

Firstly, a key factor is the available resource that defines the capacity of power generation of the system. The available resource and its energy potential depend on two parameters, flow and head. The electrical energy that is capable to produce the MHP device in a year is determined in the following way:

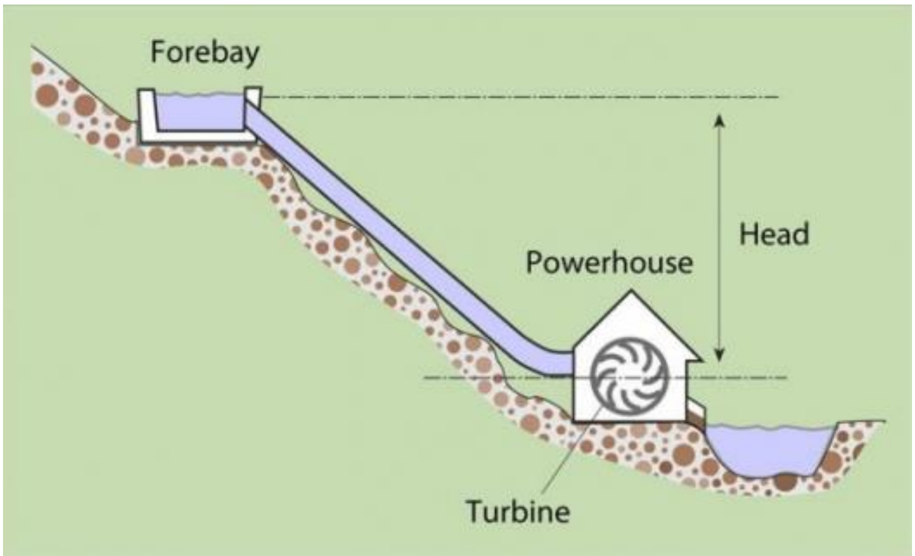
$$E = \rho \cdot g \cdot h \cdot Q \cdot \eta \cdot t$$

Where

E	Energy, in kWh/year
ρ	Water density in kg/dm^3
g	Acceleration of gravity, in m/s^2
h	Net head, in m
Q	Average flow, in m^3/s
η	Performance of the mechanical and electrical equipment
t	Annual hours of operation, in h/year

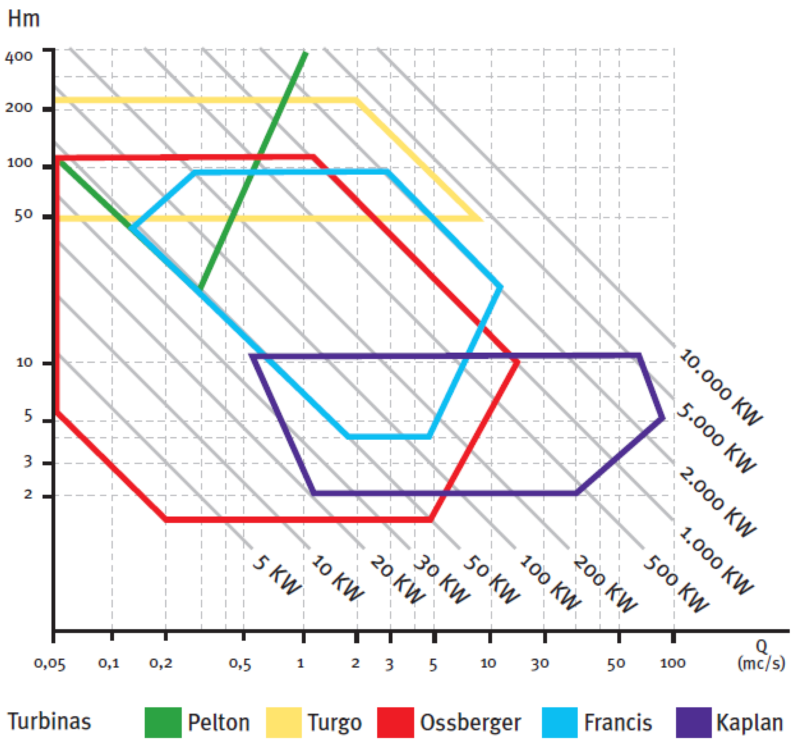
Knowledge of the flow regime is essential for the determination of the flow of the turbine design. In pipes of water, as opposed to natural flows, such as rivers or streams, this is easier to determine.

As for the head, the really important parameter is the net head, that is, the difference in dimensions between the hydrant point and the point of discharge after discounting the load losses along the pipelines.



Head and water flow in a MHP. Source: US Department of Energy

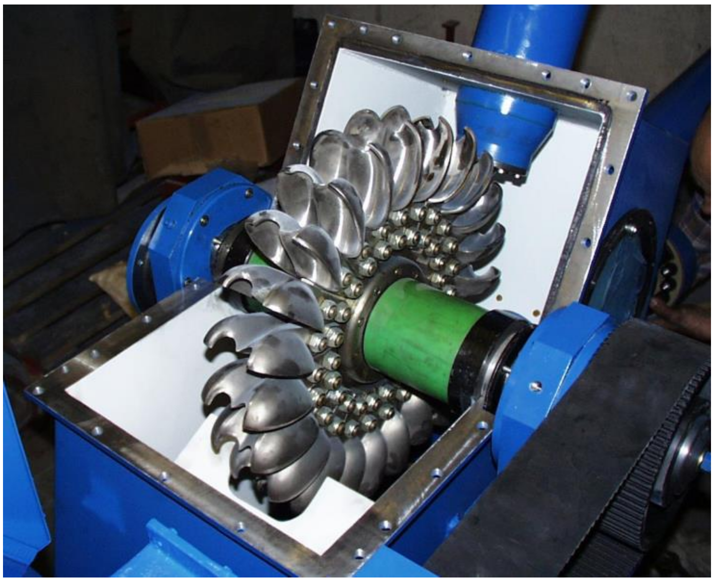
A second key aspect is the choice of the type of technology and the turbine (power) size. The efficiency of the installation affects the generation of electricity and, therefore, the revenues of the plant. Hydraulic turbine is the key and distinguishing element in this type of plants since the rest of the equipment is relatively similar, regardless of the technology employed. The operating range of the different turbine technologies available on the market is defined by the conditions of the two mentioned parameters, flow and head.



Operating range of hydraulic turbines. Source: IDAE

Hydraulic turbines are classified into two groups: action turbines and reaction turbines. In an action turbine the water pressure becomes first into kinetic energy. In a reaction turbine water pressure acts as a force on the surface of the fan blades and decreases as it moves towards the exit. Pelton, Turgo and Ossberger turbines are action turbines, while the Francis and Kaplan are reaction turbines.

In general, the criteria of its use, according to the figure above, would be the following: Kaplan for small heads and medium-high flows, Francis for higher heads and medium flows, and Pelton or Turgo for large heads with low flows and low-medium respectively. The turbine Ossberger (cross flow) is the turbine with wider range of application.

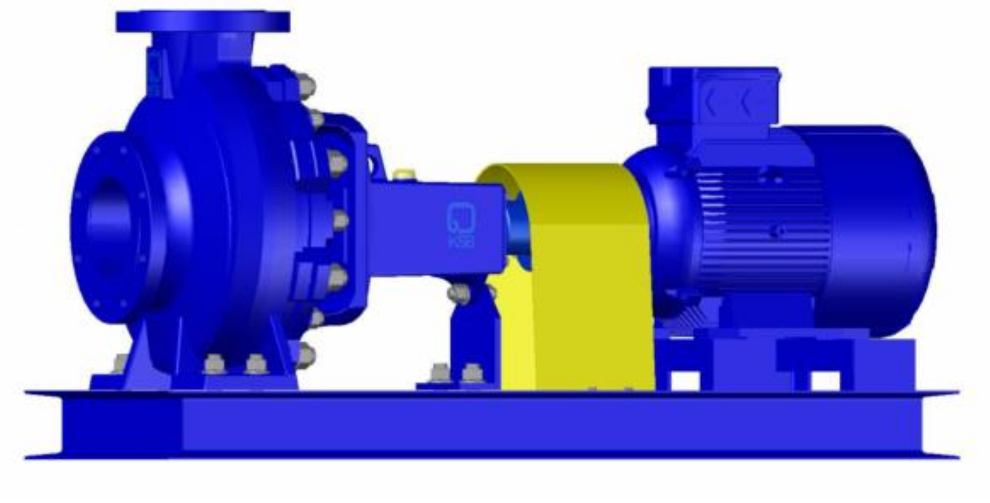


Detail of a Pelton wheel turbine. Source: Rickly Hydro

These are the turbines with greater presence in the market but they are not the only ones. As regards to the hydraulic infrastructures in operation, it is possible to access to other technologies usually for very specific uses, as the turbines based on screw of Archimedes, of gravitational vortex, the waterwheels or the pumps as turbines (PATs). The PATs are pumps that act as turbines, generating electricity instead of consuming it. It's simpler and more compact than traditional turbines devices and usually are designed to work on pipes. They are more sensitive to variations in flow and pressure, making as ideal applications those where the flow of incoming water conditions does not vary too much. Its advantages are its low cost and easy maintenance.

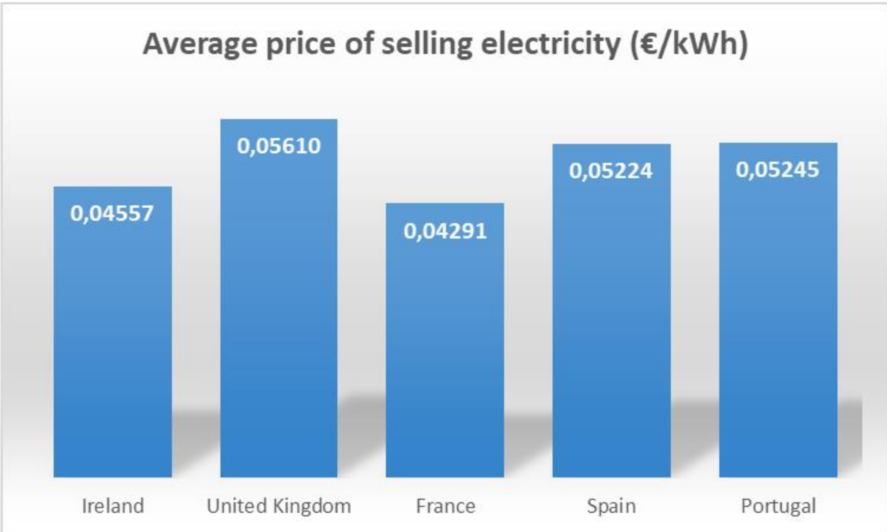
The choice of machine doesn't depend only on the technical criteria (conditions of the location, head and flow), but also economic criteria such as investment, operation and maintenance costs.

Therefore, as stated, the power generation capacity of a MHP and, therefore, revenue production, is influenced by the head; by the flow rate which also influences the number of operating hours; and by the technology that defines its performance.



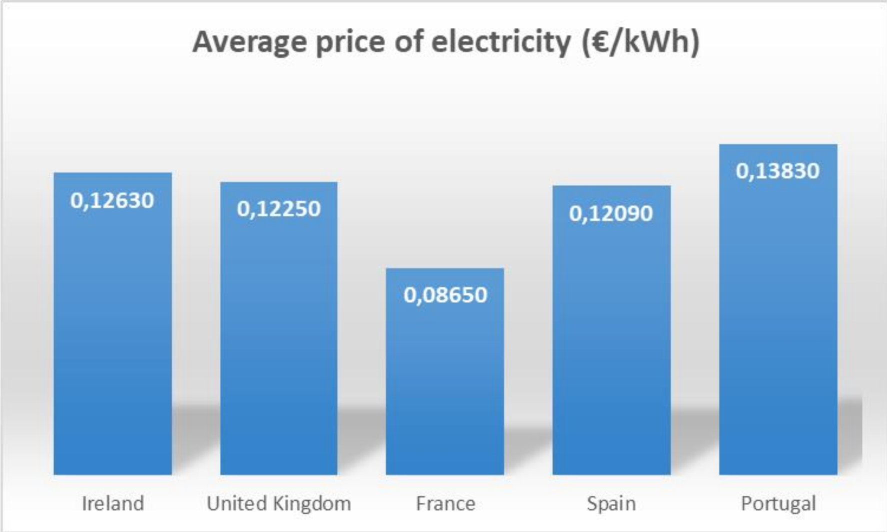
3D model of a PAT

To quantify the level of income, the analysis is different depending on the concept proposed for the use of energy. If the option is a grid-connected MHP, the income is the result of the sale of electricity to the grid. The selling price of this energy is different depending on the market in which it is traded. The average values of these prices are shown in the graphic below with the different markets in the Atlantic Area (year 2017):



Average price of selling electricity (without taxes) by country

In case of self-consumption, the introduction of MHP devices into hydraulic infrastructures contributes to the reduction of their energy operating costs. The income from the energy generated is counted as a reduction in the variable costs of the electricity acquired from the grid. The billing of this energy term will depend on the consumption and price of the kWh set in the contracted rate. As for the price of kWh, these are the average rates of the countries of the Atlantic Area (year 2017):



Average price of electricity (without taxes) by country

It shouldn't be forgotten that electricity tariffs introduce a fixed term linked to the contracted power which does not depend on the operating regime of the installations and which, usually, it is not possible to reduce by self-consumption. This fact means that the share of reduction in the costs that it is possible achieve with a MHP with self-consumption is lower than the share of reduction in the consumption of energy.

We must take into account that the previous assessment considers only the direct economic benefits of the installation of a MHP in a water network but, in some cases, there are other indirect benefits. Some of these additional benefits that could be evaluated as potential incomes are mentioned below:

- A reduction of investment costs in reducing press valves and similar equipment because these devices can act as pressure-reducing elements.
- Electrification of water networks that allows the access to the electricity in isolated areas. In this way, it is possible the use of sensors and electrical devices of control that allows the monitoring and remote operation of the network and, in this way, an increase in the quality of the water and an optimization in the consumption of water. Some of the services provided are leak detection, monitoring of hydraulic parameters, pressure regulation, demand measurement, reading of water quality parameters (chlorine, PH), water chlorination… This allows to improve the control strategy by quickly identifying network failures, evaluating their causes, offering an immediate resolution and preventing future problems before they can happen. The optimization in the operation of the network means a reduction in the consumption of water and in the maintenance tasks what will mean a reduction in the energy demand and operational and maintenance costs. Taking into account the results of other best practices, these benefits could be estimated in 3-5% reduction in consumption of water; 15-20% reduction in energy consumption and 5-7% in operational costs of the network (source: EFINET project).

For the expenses to be assessed, the costs presented by an MHP are the operating and maintenance costs and the depreciation cost of the equipment. In relation to operating costs, it should be noted that MHPs are currently fully automated, not demanding the presence of specific personnel for their control. The required actions are limited to occasional operations and monitoring of energy levels generated, electrical billing and other administrative tasks. That is why it is not necessary to hire additional staff, so the costs attributable to the operation are considered despicable.

In terms of maintenance, MHPs must follow a preventive maintenance schedule to ensure acceptable performance throughout their lifetime. This program defines a series of operations and recurrences. Usually, the maintenance service is contracted externally to a specialized company.

Related to the depreciation costs, like other equipment, the devices of the MHP have an annual depreciation that it must be taken into account in the economic assessment of the feasibility of the installation. The period of depreciation will be different depending of the depreciation rules of each country but a period of 10 years could be reasonable.

Known the profit obtained from the balance between income and expenses, the economic viability of the plant can be evaluated by calculating the payback on the initial investment. With regard to this investment, it should be kept in mind that it depends on the chosen technology, the conditions of the settlement and the equipment required. A typical distribution of investment costs for a medium-sized plant is as follows:

- Turbo generator group: 30%
- Rest of electrical equipment: 22%
- Civil works: 40%
- Engineering and construction management: 8%

When it comes to technologies, the Kaplan are the most expensive and the Pelton and PAT, due to their simplicity, the most economical.

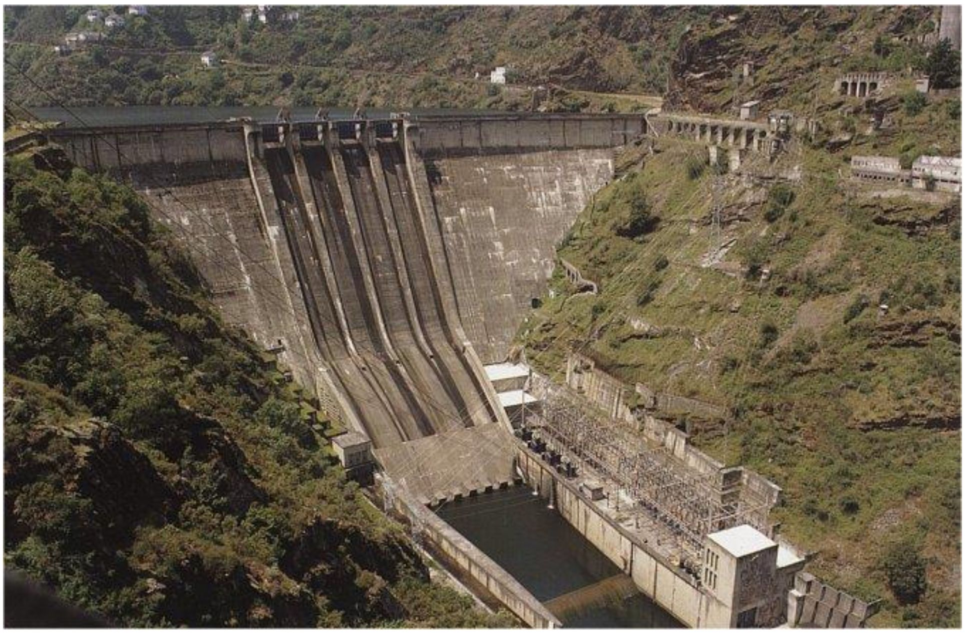
The conditions of the settlement define the volume of work to be carried out and, with it, the cost of the project.

In general, the setting up or construction phase in a “traditional” hydro plant includes the following actions:

1. Conditioning of roads.
2. Mulching and earthworks (depending on work size).
3. Placement of pipes and construction of manholes.
4. Laying of electrical line.
5. Filling of excavation holes.
6. Construction of buildings to house electromechanical equipment.
7. Transport, storage and assembly of electromechanical equipment.

The integration of an MHP plant into any hydraulic infrastructure only requires from the above steps 3 to 7 and in a much smaller dimension, which means lower expenses during the assembly phase. Costs are minimized as a result of reduced digging and earthmoving volume, and a reduced use of heavy machinery.

In addition, the type of use given to the MHP can conditioning the necessary equipment and thus the investment costs. The commitment to grid or self-consumption of the energy generated defines the need to invest in one kind of equipment or another. As an example, a self-consumption installation may require an accumulation system (batteries), which slightly makes the investment more expensive and it is not necessary in a grid connected installation.

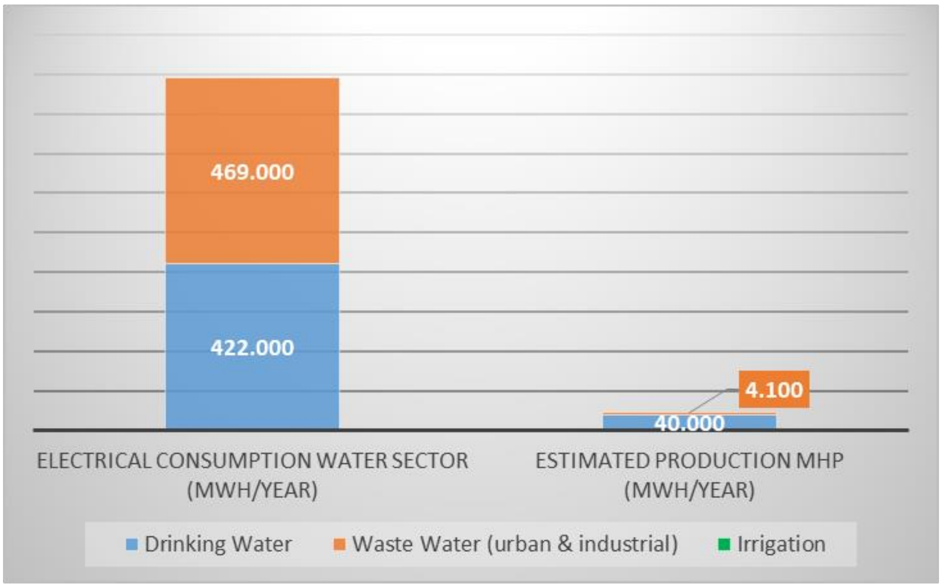


A traditional hydrodroelectric power station

4. Potential of economic benefits of MHP in water networks in AA

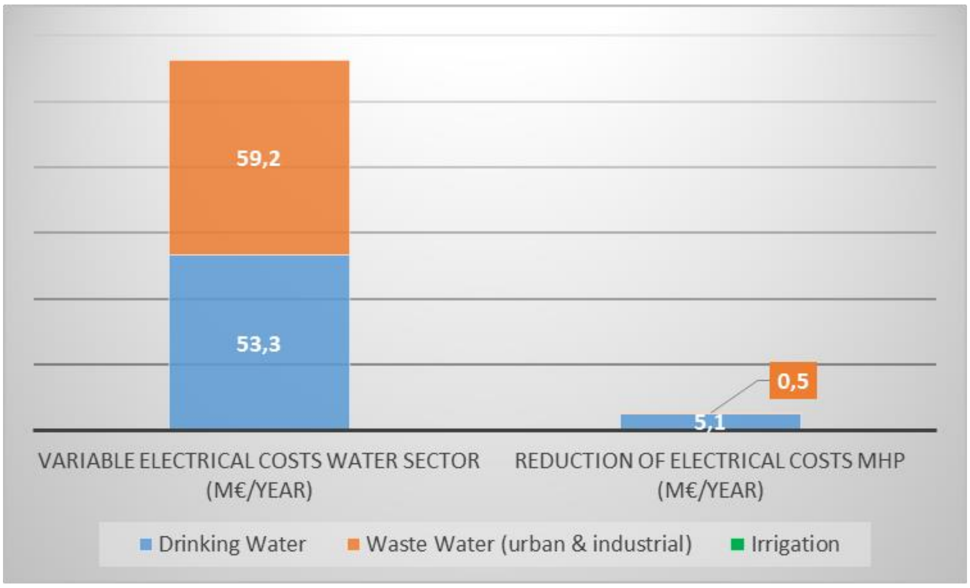
Taking into account the conditions for the economic analysis identified in section 3, assessed below is the reduction in costs for the water sector using the potential of MHP identified in section 2. In order not to introduce excessive complexity in the analysis, only the installation of MHP in self-consumption use is considered, which is also usually the most economically advantageous alternative.

4.1. Ireland



Electrical consumption in water networks of Ireland and estimated potential for electrical production as consequence of the installation of MHP (by infrastructure type)

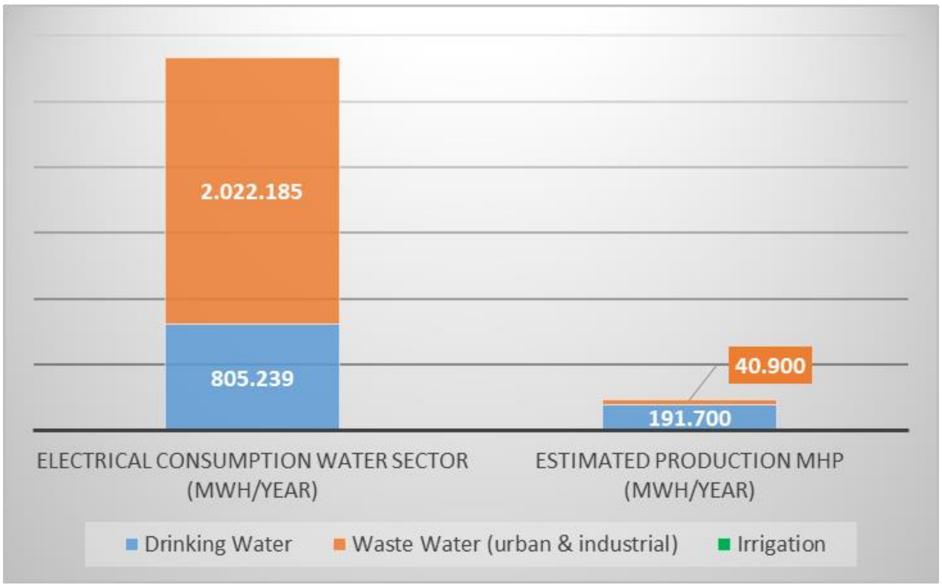
The sources of the electrical consumption and water volume data have been mainly the Sustainable Energy Authority of Ireland (SEAI) and Irish Water (info detailed in the Redawn report “Enviromental Impact Assessment”). The cost values used are presented in the section 3 of this document.



Costs of electricity in water networks of Ireland and their estimated reduction as consequence of the installation of MHP (by infrastructure type)

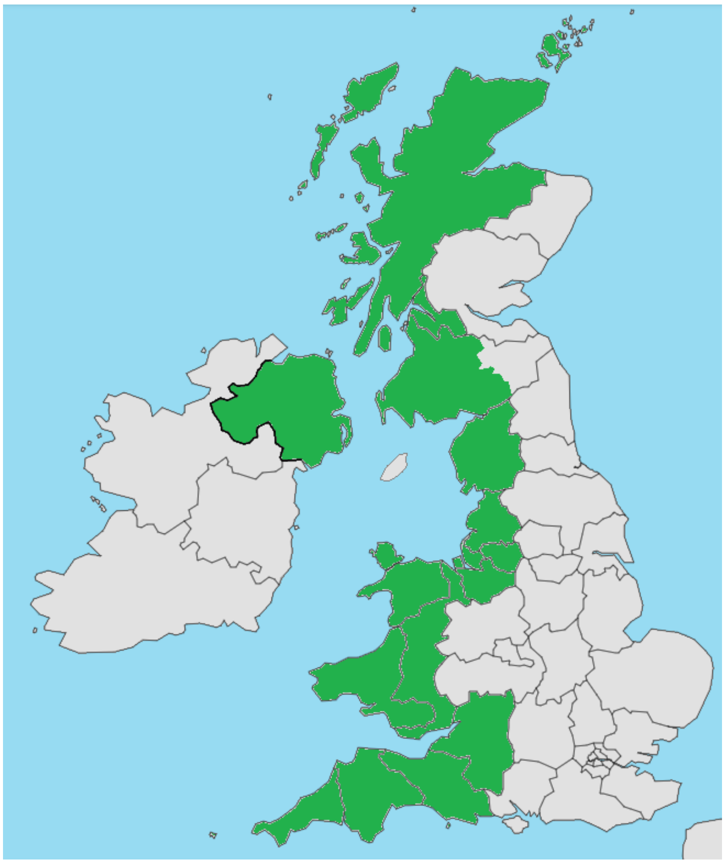
In Ireland, the highest electrical costs take place in wastewater networks. The country's climate conditions make irrigation of crops unnecessary, so there is no potential to exploit this type of infrastructure. In this case, the greatest potential for cost reduction lies in water supply networks, according to the detected MHP potential.

4.2. United Kingdom



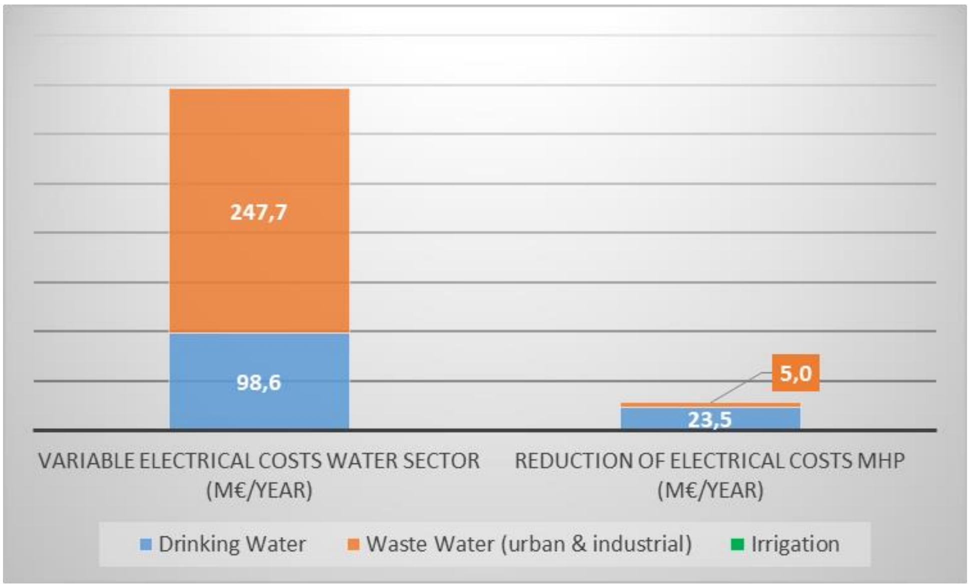
Electrical consumption in water networks of AA UK and estimated potential for electrical production as consequence of the installation of MHP (by infrastructure type)

The Atlantic Area (AA) in UK includes entire North Ireland and Wales and the following departments of England and Scotland (according to Eurostat NUTS-2): Cornwall and Isles of Scilly; Devon; Dorset and Somerset; Gloucestershire, Wiltshire and Bristol/Bath Area; Cheshire; Greater Manchester; Merseyside; Lancashire; Cumbria; Highlands and Islands; West Central Scotland and Southern Scotland (excluding Scottish Borders).



Atlantic Area in UK (green)

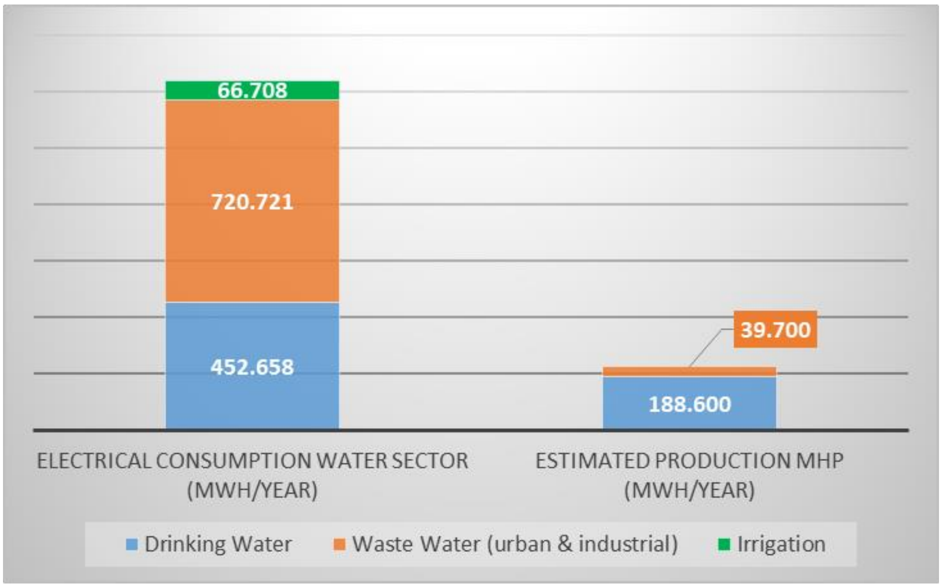
The sources of the electrical consumption and water volume data have been mainly the Office for National Statistics (ONS) and Water UK. The AA consumption data have been estimated from available population figures (national and regional) obtained from Eurostat and ONS. This info is detailed in the Redawn report "Enviromental Impact Assessment". The cost values used are presented in the section 3 of this document.



Costs of electricity in water networks of AA UK and their estimated reduction as consequence of the installation of MHP (by infrastructure type)

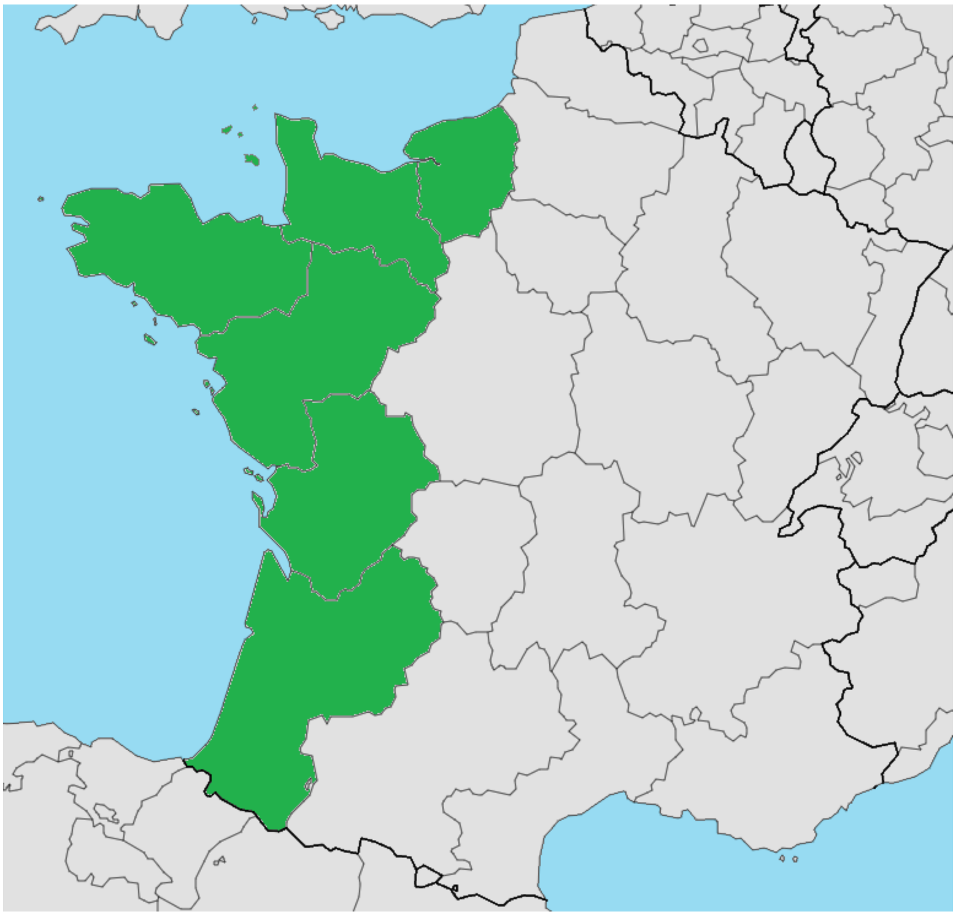
In the AA of UK highlights the high electrical costs in wastewater processes. Consumption and costs on this sector are the highest among all the countries analyzed. The climate conditions of the country make the irrigation of crops unnecessary, so there is no potential to exploit this type of installations. In this case, the greatest potential for cost reduction lies in water supply networks, according to the detected MHP potential.

4.3. France



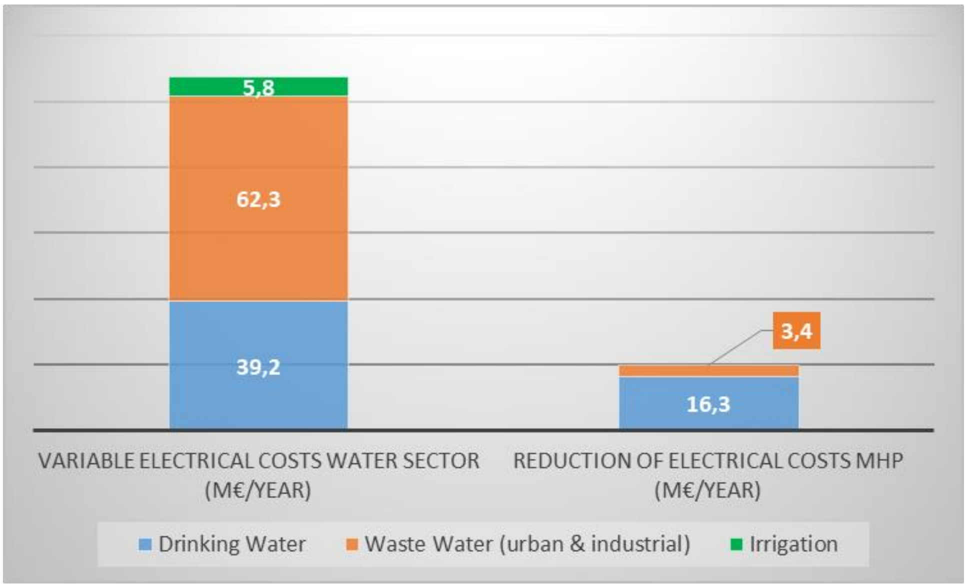
Electrical consumption in water networks of AA France and estimated potential for electrical production as consequence of the installation of MHP (by infrastructure type)

The Atlantic Area (AA) in France includes the following departments (according to Eurostat NUTS-2): Aquitaine, Poitou-Charentes, Pays de la Loire, Bretagne, Basse Normandie and Haute Normandie.



Atlantic Area in France (green)

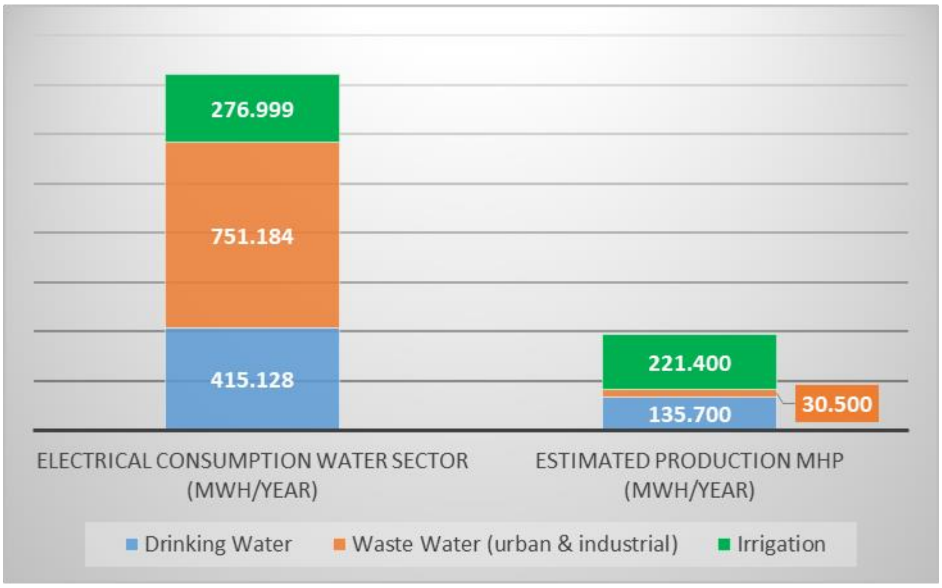
The source of the electrical consumption and water volume data has been mainly Eurostat. The AA consumption data have been estimated from available population figures (national and regional) obtained from Eurostat and L'Institut National de la Statistique et des Études Économiques (drinking water and wastewater). In the case of irrigation systems, the reference has been the irrigated agricultural area (source: Eurostat). This info is detailed in the Redawn report "Enviromental Impact Assessment". The cost values used are presented in the section 3 of this document.



Costs of electricity in water networks of AA France and their estimated reduction as consequence of the installation of MHP (by infrastructure type)

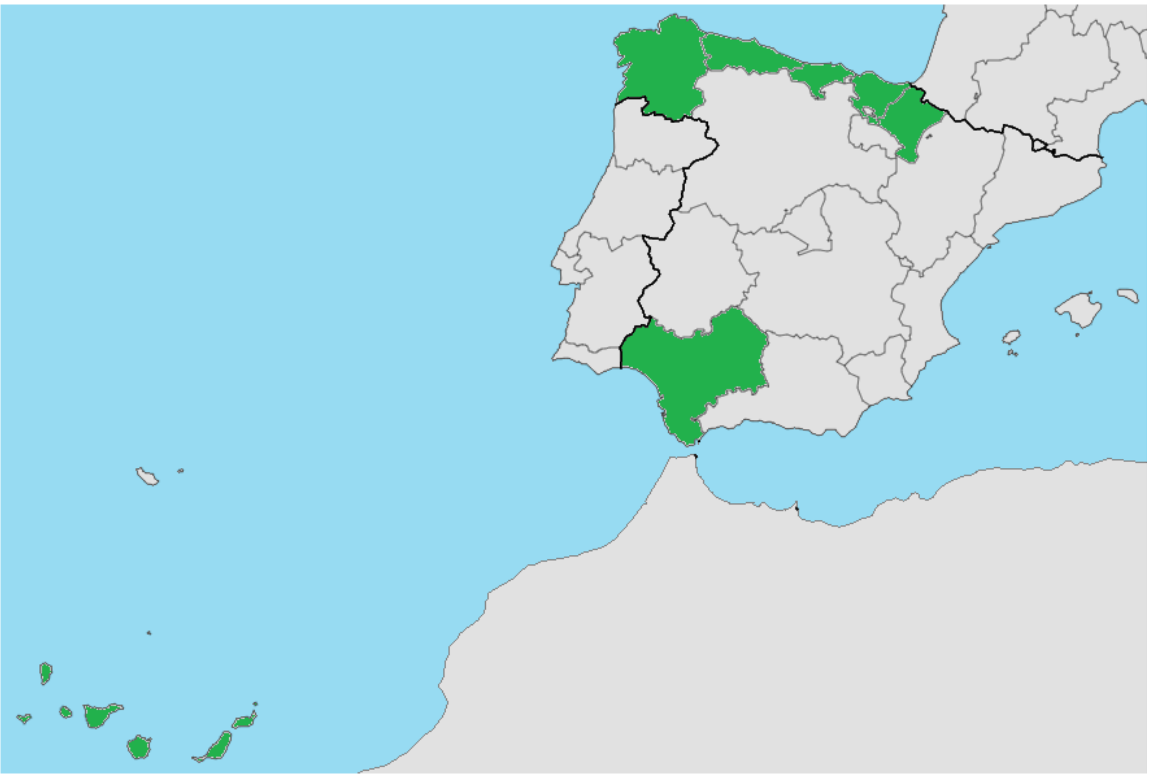
In the AA of France the highest electrical costs take place in wastewater networks. According to what was commented in section 2, the estimation for the irrigation sector was not finally included for France. In this case, the greatest potential for cost reduction lies in water supply networks, according to the detected MHP potential.

4.4. Spain



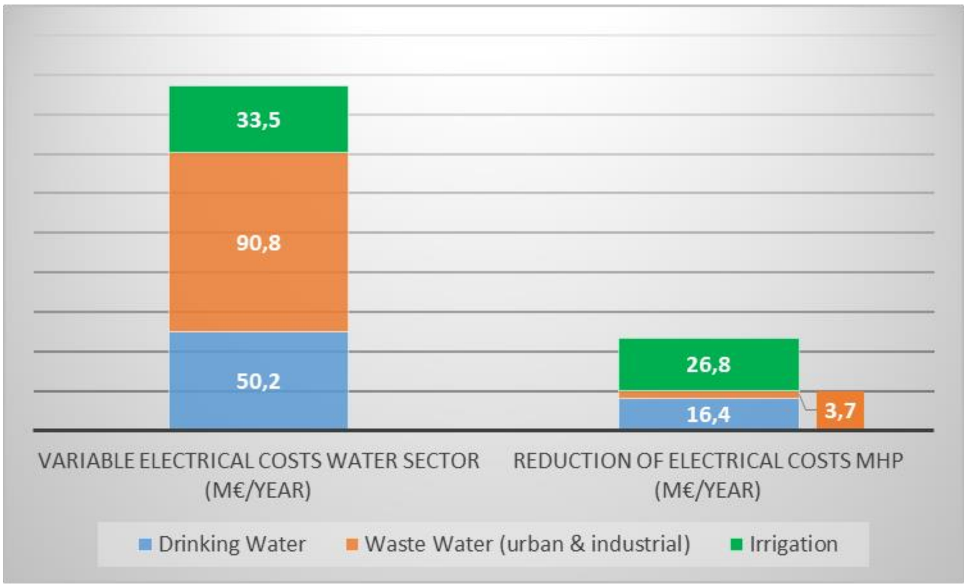
Electrical consumption in water networks of AA Spain and estimated potential for electrical production as consequence of the installation of MHP (by infrastructure type)

The Atlantic Area (AA) in Spain includes the following departments (according to Eurostat NUTS-2): Galicia, Principado de Asturias, Cantabria, País Vasco, Comunidad Foral de Navarra, Canarias and Andalucía (only Huelva, Sevilla, Cádiz and Córdoba provinces).



Atlantic Area in Spain (green)

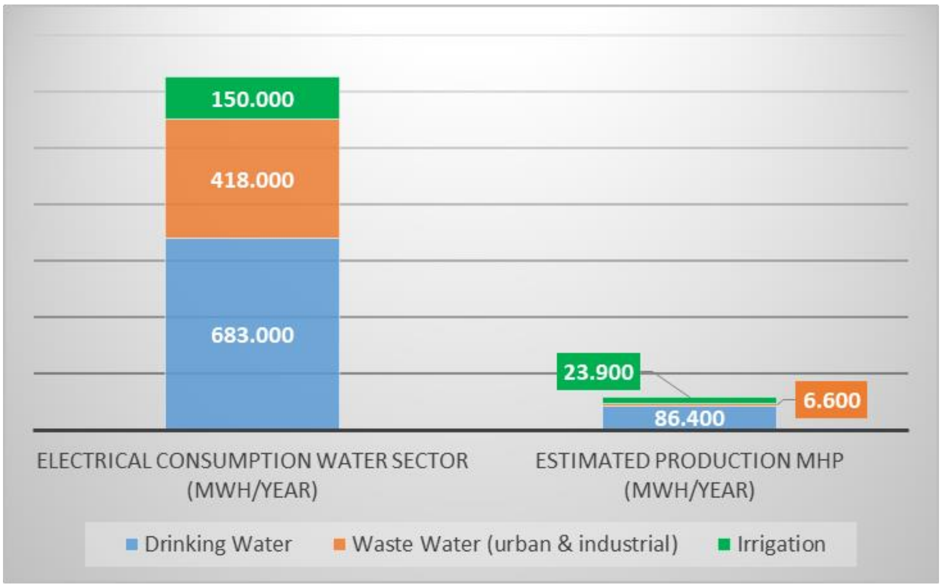
The sources of the electrical consumption and water volume data have been mainly Instituto Nacional de Estadística (INE), Instituto para la Diversificación y Ahorro de la Energía (IDAE) and Universidad de Córdoba. The AA consumption data have been estimated from water consumption figures in regional drinking water, wastewater and irrigation systems obtained from INE. This info is detailed in the Redawn report "Enviromental Impact Assessment". The cost values used are presented in the section 3 of this document.



Costs of electricity in water networks of AA Spain and their estimated reduction as consequence of the installation of MHP (by infrastructure type)

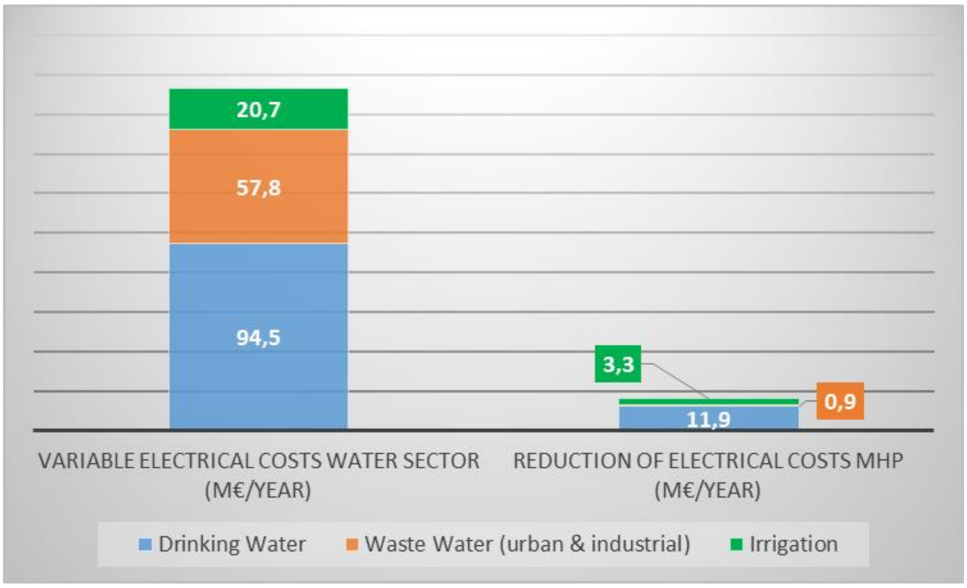
In the AA of Spain the highest electrical costs take place in wastewater networks. In this case, the greatest potential for cost reduction lies in irrigation systems. This seems logical given that Spain is the country with the greatest potential for MHP integration into irrigation infrastructures.

4.5. Portugal



Electrical consumption in water networks of Portugal and estimated potential for electrical production as consequence of the installation of MHP (by infrastructure type)

The sources of the electrical consumption and water volume data have been mainly Entidade Reguladora dos Serviços de Águas e Resíduos (ERSAR) and Eurostat (info detailed in the Redawn report “Enviromental Impact Assessment”). The cost values used are presented in the section 3 of this document.

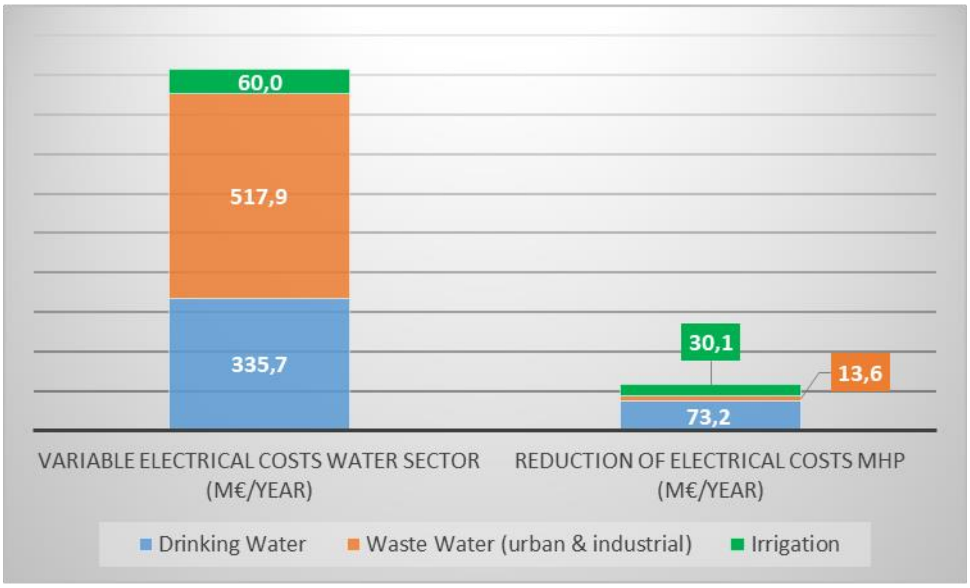


Costs of electricity in water networks of Portugal and their estimated reduction as consequence of the installation of MHP (by infrastructure type)

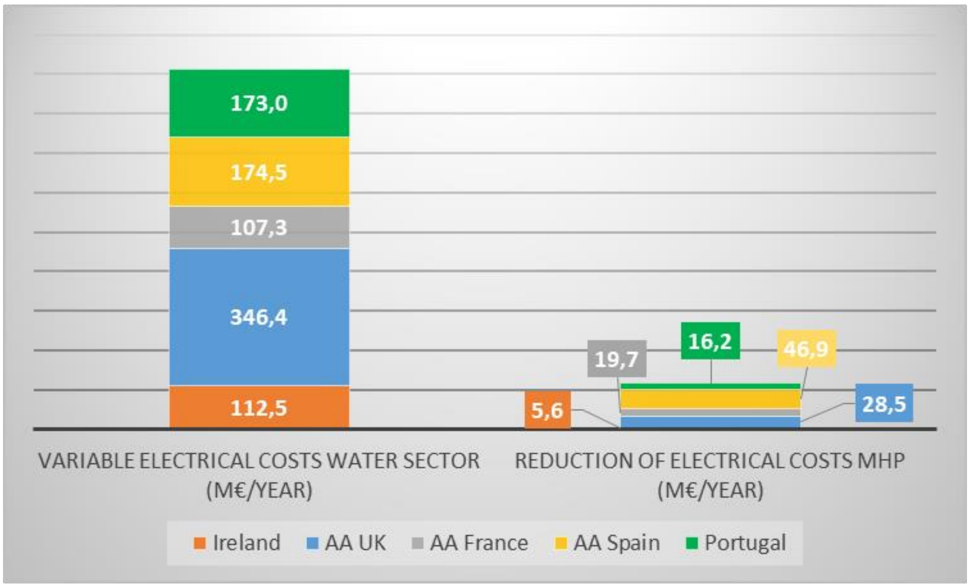
In Portugal the highest potential for cost reduction lies in water supply networks, which is precisely the sector that presents the largest electrical costs.

4.6. Atlantic Area

Summary graphic with the collection of the data obtained for the Atlantic Area that includes the data from the 5 countries is shown below:



Costs of electricity in water networks of Atlantic Area and their estimated reduction as consequence of the installation of MHP (by infrastructure type)



Costs of electricity in water networks of Atlantic Area and their estimated reduction as consequence of the installation of MHP (by country)

If we compare the potential of reduction of costs resulting from the implementation of MHP in the identified sites, considering the variable electrical costs estimated for the water sector in the Atlantic Area, the total reduction obtained is -12,8% (-21,8% in DW, -2,6% in WW and -50,1% in irrigation).

5. Conclusions

Like in other activities, water management has its economic impact. The main costs in water networks in operation is the one corresponding to electricity consumption.

The installation of MHP that generate electricity in the operational water networks can mean a significant reduction in the operating costs. Depending on the benefit provides by the MHP, it is possible to calculate the payback period of the investment required and, therefore, the viability of the installation. The benefit will be the result of the difference between the incomes and costs of the installation. It should be noted that income refers to the economic revenue for the electricity generated, either for sale to the grid or as a reduction of energy consumption costs (self-consumption). The capacity of generation of electricity of a turbine or PAT depends on the head and flow of the location and the performance of the generator. In addition to this direct reduction in energy costs, there are another important indirect economic benefits obtained as a result of the electrification and monitoring of water networks in isolated areas. This can improve water quality and competitiveness in network management by reducing the operating costs (energy + water). According to figures from the EFFINET Project (7th EU Framework Program) it can be possible to reduce these costs about 5-7%.

By other hand, the costs are not only the operation and maintenance costs but also the depreciation costs of the equipment.

The characteristics of the water networks (supply, wastewater treatment, industrial water and irrigation) in the regions of the Atlantic Area have an estimated energy use of 1.009,5 GWh/year. The country where the greatest potential is identified is Spain (387,6 GWh/year). UK is the country with the greatest potential in supply networks (191,7 GWh/year) and wastewater networks (40,9 GWh/year) and Spain in irrigation (221,4 GWh/year).

Having into account that the energy costs for the end-user do not differ excessively in the 5 countries (except France, where they are substantially lower), it can be concluded that the potential for cost-cutting by the introduction of MHP is practically proportional to the energy-use potential defined in the previous paragraph. In this sense, the estimated value for the entire Atlantic Area is around 116,8 million euros/year, what could mean the reduction of operating costs due to electricity consumption of these infrastructures in around 13 %.

In the Atlantic Area, the highest potential for costs reduction lies in water supply networks. In percentual terms, the greatest potential is detected in irrigations systems (> 50% of their costs).

The region in which the greatest potential is identified is the AA of Spain with a figure of more than 46 million euros/year. The AA of UK is the region with the greatest potential in supply networks and wastewater networks, while Spain is in irrigation. In percentual terms, the largest potential is detected in the AA of Spain (> 26% of their costs). Contrary, Ireland is the country with the smallest potential.

REDAWN – Reducing Energy Dependency in Atlantic area Water Networks

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