Energy Efficiency in the Management of the Integrated Water Service. A Case Study on the White Certificates Incentive System

Maria Macchiaroli, Luigi Dolores, Luigi Nicodemo(✉), and Gianluigi De Mare

University of Salerno, Via Giovanni Paolo II, 132, Fisciano, SA, Italy
lnicodemo@unisa.it

Abstract. Energy Efficiency Certificates (TEEs, also called White Certificates) are tradable certificates certifying the achievement of energy savings in energy end-use through energy efficiency improvement measures and projects. Electricity and natural gas distributors (obliged parties) can achieve their energy efficiency improvement targets either by implementing energy efficiency projects (and earning TEEs) or by purchasing TEEs from other parties. Voluntary actors can also participate in the mechanism, typically Energy Service Companies (ESCo) or companies that have appointed an energy management expert (EGE). Voluntary actors are those operators who freely choose to carry out energy end-use reduction measures.

In this work, the TEE mechanism is applied to the Integrated Water Service to reduce energy consumption. To date, it is noted that few projects relating to the Integrated Water Service have been presented for the issue of TEEs. The proposed application aims at verifying the financial convenience in using the tool both for the service provider and for those external subjects (e.g., ESCo) that support the provider in carrying out an energy efficiency intervention. The results show the impact of TEEs on the financial sustainability of projects in the water sector.

Keywords: Economic evaluation of projects · Financial sustainability · Energy efficiency certificates · Discounted cash-flow methods · Integrated urban water management

1 Introduction

The European Union has addressed the issue of energy efficiency since 2006 with the first “Action Plan for Energy Efficiency” (COM 2006/0545). The aim of the action plan was to mobilize civil society, policy makers, and market participants to transform the internal energy market, to provide EU citizens with high levels of energy efficiency in relation to:

- Infrastructures, through distribution systems and building performance.

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- Products, through appliances, automobiles, and machinery.
- Territorial systems, through connected networks, organization, and territorial governance [1].

The first Energy Efficiency Directive (2012/27/EU) imposed requirements and the Member States and entered into force in December 2012. The directive requires the definition of indicative national energy efficiency targets to ensure the overall objective of reducing energy consumption by 20% by 2020. This means that the EU's total energy consumption should not exceed 1483 million tonnes of oil equivalent (Mtoe) of primary energy or 1086 Mtoe of final energy. Member States are free to adopt stricter minimum requirements to promote energy-saving and establish legally binding rules for end-users and energy suppliers. The first amendment was the "Clean Energy for All Europeans" package. Under the amending directive, countries can achieve new energy savings of 0.8% each year of final energy consumption for the period 2021–2030, except for Cyprus and Malta which is achieved 0.24% annually. The Commission has pledged to review existing legislation to meet the 2030 greenhouse gas emissions target. "The Green new deal", in the impact assessment accompanying the Communication on the Climate Target Plan, proposes an emission reduction target of at least 55% net.

Italy, to align itself with the European objectives, adopted two measures in 2014, inserting energy-saving objectives set for 2020:

– Legislative Decree no. 102/2014, which transposes the EU directive and establishes a framework of measures for the promotion and improvement of efficiency aimed at reducing primary energy consumption by 20 million tonnes of oil equivalent (Mtoe) by 2020.
– Action Plan for Energy Efficiency (PAE), which from a strategic and regulatory point of view aims to remove the barriers that delay the spread of energy efficiency, both nationally and locally.

The action plan for energy efficiency imposes a mix of fiscal, economic, regulatory, and programmatic instruments, calibrated mainly by sectors of intervention and typology of recipients. However, the plan will favour the integration of energy efficiency into policies and measures with main purposes to optimize the relationship between costs and benefits of the actions. From this point of view, the great potential for efficiency of the construction sector can be better exploited with interventions that pursue energy redevelopment together with seismic improvement and the aesthetic renovation of buildings and neighbourhoods, in line with the real estate redevelopment strategy at 2050. Italy intends to pursue an indicative target of reducing consumption by 2030 equal to 43% of primary energy and 39.7% of final energy compared to the PRIMES 2007 reference scenario[1]. 2030, Italy pursues a target of 132 Mtoe of primary energy and 103.8 Mtoe of final energy, with the trajectory shown in Fig. 1, starting from the estimated consumption in 2020 [2].

[1] As a partial equilibrium model for the European Union energy markets, PRIMES is used for forecasting, scenario construction and policy impact analysis.

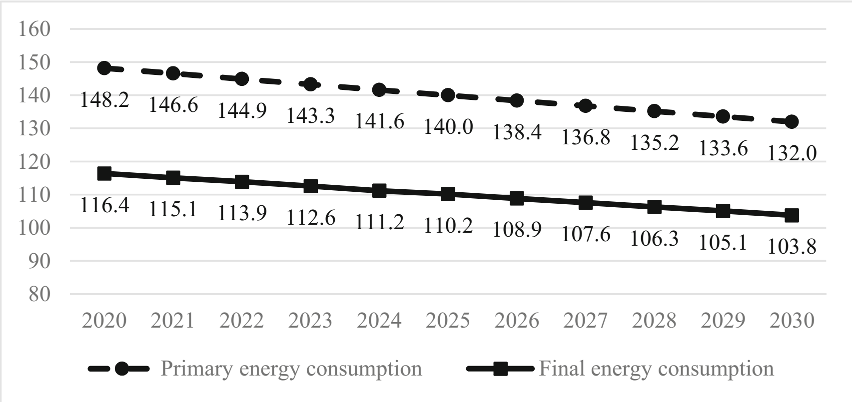

Fig. 1. Expected trend of primary and final energy consumption 2020–2030. Source: Action Plan for Energy Efficiency (PAE).

Therefore, to fulfil the obligation, the plan promotes a reduction in final energy consumption from active policies of approximately 9.3 Mtoe/year by 2030, with the annual objectives shown in Table 1 [3].

Table 1. Savings to be achieved in 2020–2030. Source: Ministry of Economic Development (MISE).

Year	Annual saving	Annual energy savings										Tot
2021	0.80%	0.935										0.935
2022	0.80%	0.935	0.935									1.870
2023	0.80%	0.935	0.935	0.935								2.805
2024	0.80%	0.935	0.935	0.935	0.935							3.740
2025	0.80%	0.935	0.935	0.935	0.935	0.935						4.675
2026	0.80%	0.935	0.935	0.935	0.935	0.935	0.935					5.610
2027	0.80%	0.935	0.935	0.935	0.935	0.935	0.935	0.935				6.545
2028	0.80%	0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.935			7.480
2029	0.80%	0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.935		8.415
2030	0.80%	0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.935	9.350
Total Cumulative saving 2021–2030												51.425

To achieve the 2021–2030 energy-saving objectives, pursuant to article 7 of the Energy Efficiency Directive - EED (and estimated at 51.4 Mtoe), Italy makes use of various support tools, such as:

– The mechanism of White Certificates.
– Tax deductions for energy efficiency interventions and recovery of existing buildings (Ecobonus DL 104/2020).
– The National Energy Efficiency Fund.
– Measures contained in the "Thermal Account" incentives.

This paper focuses on the first line of action, namely the White Certificate mechanism for financing energy efficiency projects.

The European Directive on Energy Efficiency in End-Use and Energy Services (2006/32/EC) of 5 April 2006 introduces and defines White Certificates as documents issued by independent certification bodies that certify the energy savings of market players because of measures to improve energy efficiency.

According to Italian laws, the obliged actors of the White Certificate mechanism are the distributors of electricity and natural gas with more than 50,000 registered customers; these utilities can achieve their energy efficiency improvement objectives both by implementing energy efficiency projects and earning TEE (direct interventions) and by purchasing TEE from other subjects (indirect interventions) [4, 5]. White Certificates must certify the amount of savings achieved and can be purchased by obliged subjects to fulfil the obligations imposed by law because these companies often consider a direct intervention not advantageous.

In addition to energy distributors, other voluntary subjects can also participate in the mechanism, typically energy service companies (ESCos) or companies that have appointed a certified energy management expert (EGE). The voluntary subjects are all the operators who freely choose to carry out interventions to reduce consumption in the final uses of energy, and who are granted the right to receive the corresponding quantity of White Certificates.

The operating rules of White Certificates were updated with the decrees of January 2017 and May 2018; instead, with the decree of April 2019, the "Operating Guide to promote the identification, definition, and presentation of projects within the framework of the White Certificates mechanism" was approved. The Guide, drawn up by the GSE (Head of Energy Services), contains useful information for the preparation and presentation of requests for access to incentives as well as indications on the potential for energy savings deriving from the application of the best technologies available in the main production sectors. The system introduced in January 2017 caused the price of White Certificates to rise during the first year of adoption. Therefore, the government tried to limit the price of the certificates by implementing further constraints and, after the publication of the corrective decree in May 2018, the price of the certificates stabilized at 250 ÷ 260 €/TEE [6].

The civil sector is the main actor of efficiency interventions, with a reduction in energy consumption of about 5.7 Mtoe compared to the BASIC scenario in 2030. In particular, the residential sector contributes 3.3 Mtoe to this reduction, while the tertiary sector its consumption projections are reduced by 2.4 Mtoe thanks to building redevelopment and installation of heat pumps, as well as a strong efficiency of end-use devices [7–9].

As for the Integrated Water Service (SII), it is one of the most energy-intensive systems. Based on the data collected by Terna for the year 2019, only the activities of the Integrated Water Service consumed 5,964 GWh of electricity, approximately 2% of the total national energy requirement equal to 301,803 GWh [10]. As regards the aqueduct service, in Italy an average of 0.45 kWh is consumed per cubic meter of water introduced into the pipeline: 9.9 kWh per km of network and 58.5 kWh per inhabitant. As the population density of the areas served increases, the energy consumption per km of piping tends to increase, while the unit consumption per cubic meter of water introduced into the pipeline decreases. The highest energy consumption is recorded in the South of the country, unlike what happens instead for the sewing service. Finally, as regards the purification service, the average energy consumption is equal to 0.29 kWh per cubic meter treated [11, 12].

In this work, the White Certificate mechanism is applied to the Integrated Water Service to reduce energy consumption. They could generate TEEs by financing interventions on the water network or the replacement of machinery.

This document compares the cost of TEE in the virtual market with the possibility of earning TEE by investing in the energy efficiency of the water service [13]. The results show the impact of TEE on the financial sustainability of the project in the water sector and the range of acceptable value for project financing.

Among the volunteers, to date, it is noted that few projects relating to the Integrated Water Service have been presented for the issue of White Certificates. The proposed application, therefore, has the objective of verifying the financial convenience in using the tool both for the service managing body and for those subjects (for example energy service companies) who possibly support the operator in carrying out an energy efficiency intervention.

2 White Certificate Mechanism in the Integrated Water Service

The Integrated Water Service (SII) represents the set of public services for the collection, supply, and distribution of water for civil use, sewerage, and wastewater purification. So, it is the set of complex processes that provide a service such as water delivered to the user or wastewater treatment returned to the environment[2]. These services are associated with directly connected services (quality of drinking water or discharged wastewater, quantity, and continuity of service), indirectly connected services (service information, billing, customer care), and other services for the community (improvement of hygienic-sanitary conditions, protection of the environment from civil and industrial discharges, etc.) [14–16]. The energy consumption of the water service is essentially related to:

- Pumping systems. Energy consumption depends on numerous variables such as the flow rates, the orography of the territory, the types of pipelines, the type of operation, the interconnections between the pipelines, the number, and type of collection tanks, and the distribution.
- Wastewater treatment plants. Energy consumption depends on the influence of the qualitative characteristics of the water (higher or lower concentration of substances to be removed, presence of micropollutants), on the complexity of the treatment plant.

[2] Art. 142, co. 2, Legislative Decree n. 152/06.

– Drinking water systems. Energy consumption is independent of the qualitative characteristics of the water subjected to purification, as they are identical for all users of the service.

Electricity, which represents one of the main cost items for water operators, is between 10% and 30% of the total costs of the water service. The average value of the incidence of electricity costs on turnover can be considered equal to 15%[3]. From the analysis of the water service data collected by the ARERA (Authority for Energy, Networks, and the Environment) in 2020, it is noted that 30% of the energy consumption of the SII is attributable to purification systems alone [17].

The interventions aimed at improving energy efficiency in the Integrated Water Service, and which can therefore allow the obtaining of TEE, can be grouped into 3 categories:

1. Punctual interventions. Punctual interventions consist of the replacement of specific components or machinery within networks or systems with components that guarantee greater energy efficiency under the same plant and engineering conditions.
2. Interventions on processes. Process interventions consist of increasing the energy efficiency of a plant section that performs a specific function. The effectiveness of the intervention is evaluated based on the comparison between the post-intervention energy consumption and a baseline made up of other similar plant components used to carry out the same process.
3. System interventions. System interventions consist of intervening on different processes or functional parts of the system, improving its general energy efficiency. The effectiveness of the intervention is evaluated based on the comparison of the energy consumption of the entire system before and after the intervention.

The first approach to evaluate an investment in energy efficiency is the analysis of basic consumption. There can be two different situations: installation of a new system or renovation of an existing system. In the case of the construction of a new plant, the reference consumption is obtained from the market analysis, or from the most common systems in the period considered. In the case of renovation of an existing plant, the reference baseline is the performance before the intervention, obviously considering the condition of maximum efficiency of the plant and the regulations in force.

As previously stated, according to ARERA the most energy-consuming part of the system is wastewater treatment. Considering that half of the purification plants use traditional aeration technologies[4], attributing 50% of the total consumption of the wastewater treatment plants to the energy consumption of the aeration, we obtain that the savings of the sector at the national level are equal to:[5]

$$Re = 7062\ GWh \times 0.30 \times 0.50 \times 0.50 \times 0.40 = 211.5\ GWh \quad (1)$$

[3] ENEA, "White Certificates - Operational Guide for the Integrated Water Service", 2014.
[4] GSE, "White Certificates - Sectoral Guides: The Integrated Water Service", 2019.
[5] ENEA, "White Certificates - Operational Guide for the Integrated Water Service", 2014.

Treated wastewater often has a variability of flow rate and concentration of pollutants that must be made as persistent as possible. The correction of the variability of the flow is called equalization, while homogenization is the concentration of pollutants. To ensure these conditions and to avoid the sedimentation of suspended solids in the wastewater, large storage tanks equipped with agitation and mixing devices are required. For old plants, which have installed low-yield machines, it is possible to replace the mixers present in the homogenization, equalization, and activated sludge treatment phases to obtain primary energy savings that can be translated into White Certificates [18].

This article analyses two mixer replacement interventions, within two different wastewater treatment plants.

The study estimates the achievable energy savings, the resulting TEEs, and the profitability of the proposed project solutions through the main economic performance indicators: the net present value (NPV) and the internal rate of return (IRR).

3 Materials and Methods

In this paper, we intend to make the wastewater disposal system more efficient from an energy point of view through appropriate plant investments. The sector under analysis has multiple similarities with that of gas distribution (it is no coincidence that they share the same regulator, the Regulatory Authority for Energy, Networks, and the Environment - ARERA) [19–21]. For this reason, the project managers for the purification service can evaluate the investment performance through methods like those used for the gas sector.

To make the wastewater disposal system energy-efficient, it is assumed that the mixer must be replaced in a purification plant. The evaluation of the energy efficiency project is based on 4 phases:

– Analysis of the energy absorption of the plant installed before the project (calculation of the consumption baseline, monitoring of consumption with two daily measurements for 3 months).
– Calculation of the average absorbed energy and the average absorbed power of the systems and analysis of the standard deviation for the measurement data.
– Evaluation of the total energy saving.
– Calculation of the TEE generated by the system.

The study considers two plants:

1. Plant A - the system has 7 mixers divided as follows:

   – 5 mixers with 2.9 kW absorbed power from data sheet.
   – 2 mixers with 1.5 kW.

The analysis of the previous years (2017 and 2018) shows that the energy absorbed by the set of 7 mixers represents approximately 28% of the total electrical consumption of the system. During the monitoring period, there was an average daily flow in the plant of 2.08 m^3 of wastewater and 3.5 mm of average daily precipitation.

2. Plant B - the system has 5 mixers divided as follows:

   – 3 mixers with 5.5 kW absorbed power from data sheet.
   – 2 mixers with 2.8 kW.

The analysis of the previous years (2017 and 2018) shows that the energy absorbed by the set of 5 mixers represents approximately 31% of the total electrical consumption of the system. During the monitoring period, there was an average daily flow in the plant equal to 1.74 m^3 of wastewater and 3.1 mm of average daily precipitation.

As for the new mixers to be installed, it is assumed that the water operator has identified two possible estimates from suppliers, or two alternative types of mixer:

- Solution 1 - Adaptive compact submersible mixer, IE4 class efficiency. This permanent magnet synchronous motor can be used in all tanks from the plants in question, allowing a lower capital investment in parts and spare parts (see Table 2).

Table 2. Solution 1. Power installed plant A and plant B.

PLANT A	Power installed by each machine [kW]			Absorbed power [kW]
	Mixer 1	Mixer 2	Mixer 3	kW
Equalization	0.35	0.35	0.35	1.05
Model 1	0.30	0.30		0.60
Model 2	0.41	0.41		0.82
Total absorbed power				2.47
PLANT B	Power installed by each machine [kW]			Absorbed power [kW]
	Mixer 1	Mixer 2	Mixer 3	kW
Equalization	1.07	1.07	1.07	3.21
Model 1	0.49			0.49
Model 2	0.79	0.79		1.58
Total absorbed power				5.28

- Solution 2 - Compact submersible mixers, IE3 class efficiency. This solution involves the installation of permanent magnet motors controlled by a frequency converter (VFD) with nominal powers between 3 and 5 kW (see Table 3).

Table 4 shows the installation cost for the two plants.

For the calculation of the reference baseline, the legislation provides for a period of monitoring consumption before the intervention of at least 12 months, with daily measurements. In some cases, however, it is possible to submit projects that have a shorter monitoring period to the GSE, demonstrating that this is sufficient and representative of

Table 3. Solution 2. Power installed plant A and plant B.

PLANT A	Power installed by each machine [kW]			Absorbed power [kW]
	Mixer 1	Mixer 2	Mixer 3	kW
Equalization	1.87	1.87	1.87	5.61
Model 1	1.87			1.87
Model 2	3.64			3.64
Total absorbed power				11.12
PLANT B	Power installed by each machine [kW]			Absorbed power [kW]
	Mixer 1	Mixer 2	Mixer 3	kW
Equalization	2.39	2.39		4.79
Model 1	1.35			1.35
Model 2	3.64	3.64		7.28
Total absorbed power				13.42

Table 4. Cost of installation (€).

	Solution 1	Solution 2
PLANT A	61,011 €	26,343 €
PLANT B	52,295 €	34,577 €
TOTAL	113,306 €	60,921 €

actual consumption. In this case, a period of about 3 months was considered, sufficient for the definition of a reliable consumption baseline.

For the calculation of the saved energy (RISP) the equation used is the following:

$$RISP = P_{pre} \cdot h_{post} - E_{post}[kWh] \tag{2}$$

with:

- P_{pre}: Basic power before surgery in relation to daily monitoring.
- h_{post}: Operating time in hours after installation.
- E_{post}: Total amount of energy absorbed by the mixers in each system, measured after replacement.

The conversion factor used for the TEP assessment is shown in the following equation:[6]

$$fe = 0.187 \cdot 10^{-3}\ tep/kWh \tag{3}$$

Following the analysis of the technical data, the two investment proposals (Solution 1 and Solution 2) are evaluated through the Discounted Cash-Flow considering three different scenarios [22]:

- Scenario 1: Sustainability of the investment project for the Integrated Water Service operator. The NPV and IRR performance indicators are estimated according to the point of view of the Managing Body (public or private entity).
- Scenario 2: Sustainability of the investment project for the eventual purchaser of the TEEs. In this scenario, it is assumed that an Energy Service Company (ESCo) or another private investor will finance the energy efficiency project. It is assumed that the necessary capital is disbursed to the operator of the Integrated Water Service by means of a French loan. Another source of income for the investor consists in the sale of White Certificates earned by making the service more efficient.
- Scenario 3: direct involvement of investors (ESCo or other private entity) with sharing of costs and risk. Assuming that the operator of the Integrated Water Service is a public body, for example, a Municipality, it is assumed that the latter entrusts it to a private person through a public-private partnership, sharing risks, costs, and cash flows with it. In this scenario, we intend to evaluate the convenience of the investment for both actors involved [23–27].

In all three scenarios, the analyses are conducted without considering the effects of positive and negative externalities on the environment and the social context. The analysis conducted focus solely on the financial, or monetary, aspects of the hypothesized investments, neglecting further economic assessments.

4 Results and Discussion

As previously anticipated, the first step of the energy efficiency project is to monitor consumption and define the power of the two plants. The following table shows the value of the average installed power before the intervention and the results of the consumption monitoring (Table 5).

The second phase is the calculation of the installed power after the intervention for both solutions. These data are based on information certified by suppliers and simulations of the application of technologies on the two plants considered in analysis with the aid of specific technical software for energy calculations. It is assumed that the pre-intervention working conditions are the same as the post-intervention ones (Table 6).

Total amount of savings estimated for each plant are reported in Table 7. The number of TEEs obtainable for each solution is evaluated using Eq. (2). The results are shown below.

[6] Resolution EEN 3/08 of 20 March 2008.

Table 5. Consumption analyses (MWh/year) and power installed (kW).

	Power installed	Annual consumption
PLANT A	17.5 kW	130.3 MWh/year
PLANT B	22.1 kW	164.5 MWh/year
TOTAL	39.0 kW	294.8 MWh/year

Table 6. Post intervention data, powers estimated by the suppliers applied on plant system.

	Solution 1	Solution 2
PLANT A	2.47 kW	11.12 kW
PLANT B	5.286 kW	13.42 kW
TOTAL	7.98 kW	24.53 kW

Table 7. Total amount of savings estimated for each plant.

	Solution 1	Solution 2
PLANT A	111.91 MWh	67.14 MWh
PLANT B	90.95 MWh	46.96 MWh
TOTAL	7.98 MWh	24.53 MWh

$$\mathrm{RISP}_1 = 37.93\ \mathrm{TEP/year} \cong 38\ TEE \tag{4}$$

$$\mathrm{RISP}_2 = 21.33\ \mathrm{TEP/year} \cong 21\ TEE \tag{5}$$

For the estimate of the NPV, a time horizon of $n = 5$ years is considered[7], with a discount rate i = 4%, as suggested by the European commission and other authors for similar investments in the Integrated Water Service sector [28, 29]. For each year it is assumed that the energy-saving remains constant without changing the characteristics of both the plant and the reference area.

The cost of energy is estimated at Cee = € $0.16/kWh$ for the first year, equal to the average cost of electricity in 2019 for non-domestic consumers. The tariff is made up of the sum of the sales tariff (TV), the network services (SR), the system charges (OS), and the taxes (I):

$$TEE = TV + SR + OS + I \tag{6}$$

[7] SACE, Table attached 1 types of interventions. https://www.sacee.it/wp-content/uploads/2019/02/Tipologie-di-interventi-per-certificati-bianchi.pdf.

If the volumes of water treated are approximately constant over the years, the consumption of electricity can be considered constant for each year of the reference time horizon.

Below are the NPV and IRR obtained for each scenario.

Scenario 1. In the scenario in which the sustainability of the investment project is assessed for the Integrated Water Service operator, the values of the performance indicators shown in Table 8 are obtained:

Table 8. Financial assessment from the point of view of the Service Operator.

	Solution 1	Solution 2
NPV	€ 29,988	€ 19,574
IRR	13%	11%

Scenario 2. In the scenario in which the sustainability of the project is assessed for the lender who obtains the White Certificates, the efficiency of the investment depends on the number of TEEs acquired and their market value. Table 9 shows the NPV and the estimated IRR considering the same time horizon and a discount rate of Scenario 1.

Table 9. Financial assessment from the investor's point of view (ESCo or another lender).

	Solution 1	Solution 2
NPV	€ 55,260	€ 33,771
IRR	23%	18%

Scenario 3. Finally, we consider the case in which both the managing body and the private entity (ESCo) finance the energy efficiency interventions. It is assumed that the operator invests directly in the project covering 30% of the initial costs and that the ESCo finances the remainder with a French mortgage as in the previous scenario. Table 10 shows the investment performance indicators estimated for the first mixer solution selected with respect to both economic actors involved.

Table 11 shows the investment performance indicators estimated for the second solution of the selected mixer.

Also, in this case the discount rate and time horizon are assumed to be similar to those of the previous scenarios. For all three scenarios, a decrease in the price of energy of 2% per year is assumed (a more conservative and high-risk situation). For the first year, the price of the White Certificates is set at € 250/TEE (market value 2019 according to ARERA resolutions 270/2020/R/EFR). For the following years, a decrease of 2% per

Table 10. SOLUTION 1, financial evaluation for a shared project.

	Operator	ESCo
NPV	€ 24,309	€ 16,661
IRR	24%	11%

Table 11. SOLUTION 2, financial evaluation for a shared project.

	Operator	ESCo
NPV	€ 21,160	€ 11,302
IRR	29%	13%

year is considered. The impact generated by the reduction of both the energy price and the TEE on the sustainability of the project is therefore considered.

The comparative analysis of the three scenarios shows that for the water service operator the most advantageous solution is the first of scenario 1. Instead, for a possible external investor, the best solution is the first of scenario 2. However, solution 2 of scenario 3 allows the service provider to obtain a much higher expected return of the discount rate than the other possible solutions, even though the NPV is slightly lower than that of solution 1 of scenario 1.

The convenience of directly financing the project (scenario 1) may depend on various parameters, such as the virtual market price of White Certificates (subject to monthly variation), the mortgage interest rate, the forecast of energy costs, and the lack of skills in the management. To avoid that these parameters have a negative impact, it is advisable that the Integrated Water Service operator opts for the risk-sharing solution (scenario 3) to obtain levels of NPV and IRR that are acceptable for both economic actors.

5 Conclusions

To promote energy efficiency interventions, several operational tools have recently been introduced in the community. Among these, an important role is assumed by the Energy Efficiency Certificates (TEE), also called White Certificates. In this case, these are negotiable securities that certify the achievement of savings in the final uses of energy through interventions to increase energy efficiency. One certificate is equivalent to saving one Ton of Oil Equivalent (TOE). In addition to energy distributors, other voluntary subjects can also participate in the mechanism, including the operators of the Integrated Water Service. The aim of this paper is to clarify the operating mechanism of the White Certificates in the case of investments in energy efficiency aimed at reducing consumption for the treatment of industrial and domestic wastewater. The incentive mechanism was then applied to a case study, providing for three investment scenarios.

In the first scenario, the financial sustainability of the investment project for the service operator is assessed. In the second, the convenience of the investment is assessed from the point of view of the investor (ESCo or another lender) who supports the service operator in the implementation of the energy efficiency project. Finally, the third scenario is assumed that the operator covers 30% of the costs and the remaining share is up to the ESCo, with a view to sharing both risks and benefits. For each scenario, two design alternatives are considered. In terms of net present value, the most advantageous solution for the managing body is alternative 1 of scenario 1 (NPV = € 29′988). Instead, alternative 1 of scenario 2 is the most advantageous for the investor. However, by resorting to solution 1 of scenario 3, which provides for the sharing of the risk with the investor, the service operator is entitled to a slightly lower NPV than that of the first solution of scenario 1. And in fact, in this case, the operator obtains the highest IRR among the different scenarios and possible solutions. In this scenario, it would be desirable to implement risk management models [30, 31] that could be used to evaluate investments in energy efficiency considering all the critical variables related to the project, such as the price of energy and the variability of the value of the TEEs.

Although in practice, market operators tend to be more involved in direct investments (generally to have energy savings of 5–10%) rather than resorting to the exchange of White Certificates on the virtual market, the model demonstrates the validity of a shared project between the managing body of the service and the Energy Service Company.

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