LocalRES

Empowering local renewable energy communities for the decarbonisation of the energy systems

D1.4 – Cost-benefits analysis (methodology and results)

09 June 2023

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30/09/2022	V1.1	RINA-C	First complete draft
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Executive summary

Deliverable 1.4 provides the outcomes of the analysis led in *Task 1.4.- Cost-benefit analysis of project Use Cases.* The report illustrates the quantification of the use cases previously defined in Task 1.2 and based on the Reference Scenarios (Ref-SC) modelled in Task 1.3.

The cost-benefit analysis (CBA) is a systematic approach to estimate the strengths and weaknesses of alternatives (David, Ngulube, & Dube, 2013). The CBA is used to determine options which provide the best approach to achieving benefits while preserving savings in, for example, transactions, activities, and functional business requirements.

In Task 1.4, the CBA is developed considering two different methodologies: one based on the Joint Research Centre (JRC) framework for Smart grid CBAs (Giodano, 2012) and one based on consultation of local stakeholders.

In the *CBA based on the JRC framework*, the methodological approach includes the development of detailed calculation to derive achievable revenues and costs for the defined assets implemented identified for the use cases. For this, specific cost elements (investment cost resulting in capital and operational expenditures) are determined.

The Smart grid CBA by JRC is a step-by-step assessment framework based on the work performed by EPRI (Electric Power Research Institute) with several additions and modifications to fit the European context. The main idea behind the EPRI methodology is that assets provide a set of functionalities that can, in turn, enable benefits which can be quantified and eventually monetised.

Furthermore, the results of a *CBA based on consultation of local stakeholders* are presented to complete the analysis providing insights on a set of priority services identified by each demo. This integration to the JRC methodology, commonly based on technological benefits, was additionally addressed, as the results are expected to facilitate the design of business cases for different stakeholders that will be investigated in Task 1.5.

The two CBAs should been seen as complementary due to the fact that they will allow to have a more clear picture of both technologies and services that could be have the most high potential in terms of replicability, as well as better to understand the needs for future investments. Considering that the JRC framework was dedicated to smart grid projects, the methodology was adapted to better reflect the use cases of LocalRES demo sites.

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BAU	Business As Usual
CAPEX	CAPital EXpenditure
CBA	Cost Benefit Analysis
DHN	District Heating Network
DH&CN	District Heating and Cooling Networks
DR	Demand Response
DSM	Demand-Side Management
DSO	Distribution System Operator
EMS	Energy management system
EPRI	Electric Power Research Institute
ESSs	Energy storage systems
EU	European Union
EV	Electric vehicle
H2P	Heat-to-power
ICT	Information and Communication Technologies
JRC	Joint Research Center
MEVPP	Multi Energy Virtual Power Plant
OCPP	Open Charge Point Protocol
OPEX	OPerational EXpenditure
ORC	Organic Ranking Cycle
P2H	Power to heat
P2P	Peer-to-peer
PV	Photovoltaics
REC	Renewable Energy Community
RES	Renewable Energy Sources
ROI	Return on investment
RTO	Research and Technology Organisation
TFM	Targeted Flow Management
TRL	Technology Readiness Level
TSO	Transport System Operator
V2G	Vehicle-to-grid
WH	Waste Heat

1/ Introduction

1.1. Purpose of the report

This report represents Deliverable 1.4 of the project LocalRES. In particular, Deliverable 1.4 reports the methodology and the outcomes of the analysis led in *Task 1.4.- Cost-benefit analysis of project Use Cases* aiming to provide a quantification of the use cases previously defined in Task 1.2 with the help of a CBA based on the scenarios identified in Task 1.3. The CBA is developed considering different stakeholders and different desired returns on investment for each of them.

In particular, the methodological approach includes the development of detailed calculation models based on the JRC framework and its extension to derive achievable revenues and costs for the defined use cases. Those revenues are then combined with the resulting implementation cost to perform a detailed CBA resulting in the identification of the most crucial parameters of developed solutions. For this, specific cost elements (investment cost resulting in capital and operational expenditures) will be determined.

Furthermore, the results of a CBA based on the consultation of local stakeholders are presented to complete the analysis providing insights on a set of priority services identified by each demo. This integration to the JRC methodology, commonly based on technological benefits, was additionally addressed, as the results will facilitate the design of business cases for different stakeholders that will be investigated in Task 1.5.

1.2. Contribution of partners

The structure and main contents of this report have been prepared by RINA-C as the lead partner. AIT, R2M and GRID joined the discussions around the definition of the CBA methodology. AIT has provided the data required for the CBA thanks to the modelling exercise elaborated in Task 1.3. Table 1 shows the main contributions from participant partners in the development of this deliverable:

Table 1: Contribution of participant partners

Partner	Contribution
RINA-C	Elaboration of the CBA methodology and implementation. Preparation of the Deliverable.
AIT	Collaboration in the CBA under the different use cases and data inputs for all the demo sites. Support RINA-C in the CBA methodology definition.
R2M	Support RINA-C in the CBA methodology definition.
GRID	

1.3. Relation to other Tasks

Deliverable 1.4 leverages on the results of Task 1.2 (LocalRES, Task 1.2 - Definition of REC-driven services and Use Cases, 2022), where the use cases of all demo site were identified, and Task 1.3 (LocalRES, Task 1.3.- Decarbonization scenarios assessment under REC, 2022), where several decarbonisation scenarios were modelled based on the use cases. The outcomes of the analysis performed in D1.4 will support Task 1.5 (LocalRES, Task 1.5 - Business model development, 2022), focusing on the business model definitions.

2/ Methodology

Deliverable 1.4 presents the results of two CBA exercises: (1) based on the JRC framework for technological benefits and (2) based on interviews integrating the JRC methodology for a set of prioritized services identified by each demo. The two methodologies are illustrated in the following paragraphs.

2.1. CBA based on JRC framework

In Task 1.4, the quantification of the use cases previously defined in Task 1.2 and later transformed and modelled as specific scenarios in Task 1.3 is performed with the help of a **cost-benefit analysis** (**CBA**). The CBA is a systematic approach to estimating the strengths and weaknesses of alternatives (David, Ngulube, & Dube, 2013). The CBA is used to determine options which provide the best approach to achieving benefits while preserving savings in, for example, transactions, activities, and functional business requirements.

The methodological approach, implemented in Task 1.4, included the development of detailed calculation models based on the JRC framework for Smart grid CBA (Giodano, 2012) and its extension to derive achievable revenues and costs for the defined use cases. The Smart grid CBA by JRC is a step-by-step assessment framework based on the work performed by EPRI (Electric Power Research Institute) with several additions and modifications to fit the European context. The main idea behind the EPRI methodology is that **assets provide a set of functionalities that can, in turn, enable benefits which can be quantified and eventually monetised**.

This methodology provides guidance in the identification of externalities and social impacts that can result from the implementation of projects, but that cannot be easily monetised, and factored into the cost-benefit computation. The proposed approach, shown in Figure 1, recognises that the impact of the use cases, as in the LocalRES context, goes beyond what can be captured in monetary terms. Therefore, the general approach aims at integrating **an economic analysis** (monetary appraisal of costs and benefits on behalf of society) **and qualitative impact analysis** (non-monetary appraisal of non-quantifiable impacts and externalities, e.g. social impacts, contribution to policy goals).

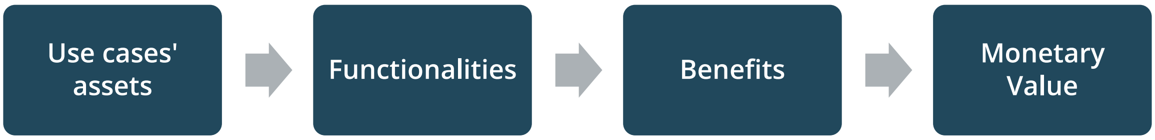

Figure 1: CBA general approach adapted from (Giodano, 2012)

The methodological approach is structured around 7 steps as follows:

- **Step 1.** Review and describe the technologies, elements and goals of the project;
- **Step 2.** Map assets onto functionalities;
- **Step 3.** Map functionalities onto benefits;
- **Step 4.** Establish the baseline;
- **Step 5.** Monetise the benefits and identify the beneficiaries;
- **Step 6.** Identify and quantify the costs;
- **Step 7.** Compare costs and benefits.

It is worth mentioning that the JRC framework is specific for Smart Grids Projects, so in Task 1.4, this methodology was adapted to reflect the LocalRES demo sites' use cases. The first step is enclosed in the outcomes of Task 1.2, which identified the use cases considering the technologies, the stakeholders and the main goals of the LocalRES projects. Leveraging on the results provided in the deliverable D1.2 and data collected or estimated in Task 1.3, in Task 1.4, the steps from 2 to 7 were performed.

2.1.1. Step 1: Review and describe the technologies, elements and goals of the project

In Step 1, the use case has to be identified, describing the main assets and goals of the project. In the LocalRES context, the use cases were defined in collaboration with local stakeholders in Task 1.2 (deliverable D1.2), and were quantified through specific scenarios in Task 1.3 (deliverable D1.3), which implied the collection of data. The missing data were estimated based on the best available information.

In particular, the following information were collected:

- scale and dimension of the interventions (e.g. consumers served, energy consumption per year);
- assets (e.g. technologies adopted and the functionalities of the main components);
- local characteristics of the demo sites;
- relevant stakeholders;
- a clear statement of LocalRES objectives and its expected socio-economic impact;
- regulatory context and its impact on the project.

2.1.2. Step 2: Map assets onto functionalities

In Step 2, the functionalities activated by the assets proposed were identified. In particular, the assets identified for each use case were mapped into functionalities according to the list of 33 ones reported in the JRC framework (Giodano, 2012) and the specific assets identified in Task 1.3. The assets are divided into two main categories: *infrastructure* and *information systems*.

2.1.3. Step 3: Map functionalities onto benefits

The purpose of Step 3 is to link the functionalities identified in Step 2 to the (potential) benefits they provide. The links between assets and benefits through functionalities are not straightforward and might require several assumptions. The benefits identified leverage on the 22 reported in the JRC framework (Giodano, 2012) and the specific solutions identified in Task 1.2.

2.1.4. Step 4: Establish the baseline

The objective of Step 4 is to define the project baseline that reflects the system condition which would have occurred if the interventions had not taken place. This is the baseline situation against which all other scenarios of the analysis are compared. Indeed, the CBA of any investment is based on the difference between the costs associated with the "business as usual" (BAU) scenario and those associated with the project implementation. In the LocalRES project, the scenarios were identified and modelled in Task 1.3 according to the demo-sites needs and preferences. As in Task 1.3, the 2030 timeline was considered for the CBAs too.

2.1.5. Step 5: Monetise the benefits and identify the beneficiaries

In Step 5, once the baseline and the project scenarios have been identified, the data required for the quantification and monetisation of the benefits are identified and collected. The first challenge is to determine the type of data required for the quantification of each benefit. Since the benefits categories reported in the JRC framework (Giodano, 2012) are strictly related to smart grid projects, in Task 1.4 the benefits were adapted to the LocalRES project context.

In this step, according to the data availability, the benefits that can be monetised are identified. It is worth mentioning that not all benefits can be monetised; for the ones excluded, qualitative considerations are provided.

This step entails monetising, i.e. expressing, in economic terms, the benefits identified and allocating them to the different stakeholders. Indeed, the results of CBAs are likely to vary across different stakeholder groups.

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2.1.6. Step 6: Identify and quantify the costs

In Step 6, the costs required for implementing the project are identified in line with the assets considered in Task 1.3. This Step allows for estimating the cost-effectiveness of the project. The data required were provided by AIT in the context of Task 1.3. It has to be remarked that taxes are not incorporated into the CBA as suggested in (Giodano, 2012). In addition, it is assumed that the selected stakeholders can have access to the benefit totally. A differentiation between stakeholders in terms of benefit share is proposed in the *CBA based on consultation of the local stakeholders*.

2.1.7. Step 7: Compare costs and benefits

Since costs and benefits have been estimated earlier, in Step 7, they are compared in order to evaluate the cost-effectiveness of the project. The cumulative comparison method is adopted for the assessment of the payback time. The cumulative comparison consists of estimating the sum of initial investment, expenditures for operation and maintenance and benefits.

2.2. CBA based on consultations

In task 1.2 the key services that could be potentially provided by a REC were identified based on 3 layers of analysis: i) member-focused services (e.g. community-based optimization of self-consumption, energy sharing and trading); ii) REC services to the markets and the grid in the normal operation mode and iii) REC grid services in the grid alert state (e.g. during a high risk of a blackout).

This analysis allows considering a set of potential services that can be deployed within the LocalRES framework. In order to further investigate the potential of these services from an economic prospective, the team took a round of interviews with each demo to identify a set of priority services that they would like to implement.

On the basis of data collected, a CBA based on services has been done. This CBA should been seen as complementary to the previous one due to the fact that it will allow to have a more clear picture of both technologies and services that could have the highest potential in terms of replicability, as well as better to understand the needs for future investments.

Consultation-based CBA follows most of steps forecasted by the JRC methodology. This had been possible by combining the data collected from the previous tasks (tasks 1.2 and 1.3), the results of the CBA based on JRC Methodology and the additional information deriving from the interviews conducted with the demos.

Keeping in mind that the JRC methodology was dedicated to smart grid projects, all the necessary measures were put in place in order to adapt it and to reflect the LocalRES demo sites' use cases.

3/ Description of the use cases

In this section, a description of the use cases elaborated in Task 1.2 and reported in deliverable D1.2 is presented, where the services and stakeholders that are considered in the CBA are highlighted.

3.1. Kökar

Kökar is a small archipelago municipality of Åland Islands with a total land area of 64 km^2. The population of Kökar Island is officially 234 persons (2018), but politically speaking, the island is a full-scale municipality. In reality, 160-170 persons live in Kökar wintertime, almost 1,000 in the summertime, and the island is visited by some 18,000 tourists per year. This results in high volatility and puts extra demand on the flexibility of the infrastructure.

The creation of a REC in the area is meant to be achieved thanks to the community engagement in Kökar by making use of the distributed energy resources (PV, micro-wind turbines, heat pumps). This will favour grid flexibility and self-reliance on the island. As ultimate targets, there will be a better adaptation of RES and a proper exploitation of the demand response (DR) mechanisms.

A diagram illustrating the description of the Kökar use case is shown in Figure 2.

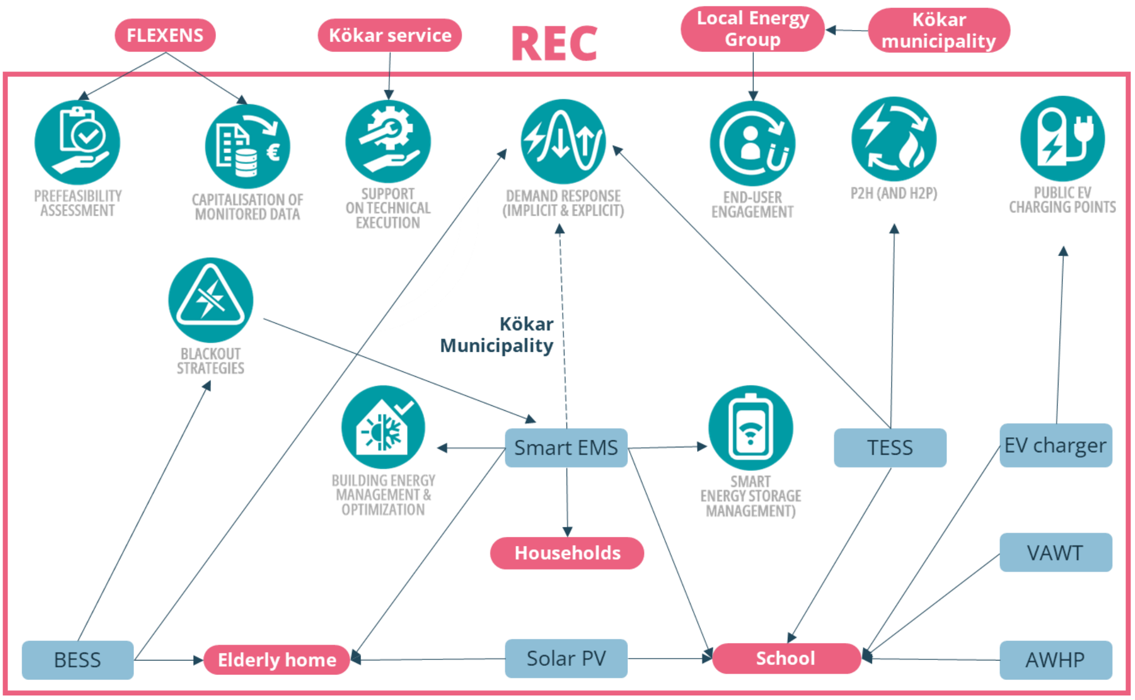


Figure 2: Diagram of Kökar use case (D1.2)

The main **services** identified for Kökar are:

Thermal:

- Power to Heat (P2H)
- Building energy management & optimisation

Electrical:

- Demand response (implicit and explicit)
- Blackout strategies
- Public Electric Vehicles (EV) charging stations
- Smart Storage Management System

Non-technical:

- Capitalisation of monitored data
- Preliminary feasibility assessment
- End-user engagement
- Support on technical execution

The main **stakeholders** identified for Kökar are:

FLEXENS: Demo site coordinator and responsible for the energy management system for the households. FLEXENS will be continuously in connection with the information part of the REC or the municipality. They will keep the information always updated on the island (during these years and in the future), and they will be responsible for the user interface.

Kökar service: It's a local company for installation works. They provide the service for the power and data network. They are certified for cooling machines and are in charge of the maintenance works and heat installation. They ensure the technical equipment is up-to-date and have the responsibility to make the correct operation of the REC. They own the unique e-car that is currently on the island.

Local energy group: There are four people, one for each small group on the island. They are the gateway to the local community, so they contact the citizens. They are technical engineers in FLEXENS. The local energy group is the contact with the citizens and the Kökar municipality

Kökar Municipality: They are in charge of the installation of the new assets and energy management systems. The person in charge in Kökar municipality has the energy system information, and this tool could be handed over to other stakeholders such as Kökar service and could be useful also for the school.

VTT is in charge of the research actions of the project.

DSO: Ålands Elandelslag, ÅEA

Consilia Solutions AB: All the consumption data measured in the smart meters are sent via both cell radio and fibre cables to a datahub operated by this entity.

Single Wing Energy Oy is developing Small Scale Single-blade wind turbine (TRL6) and is providing one for the Kökar School.

Polar Night Energy: The technology provider for the novel TESS for Kökar's school.

Local citizens: will participate in the participatory processes and engagement activities associated to the REC, and will benefit directly or indirectly from the different actions and services provided by the REC. In particular, the users of the school, the elderly home and the households included in the REC will be directly benefited.

Additionally, there is a **technician** in charge of the works in the local school and elderly home, and there is no organisation acting as **aggregator**.

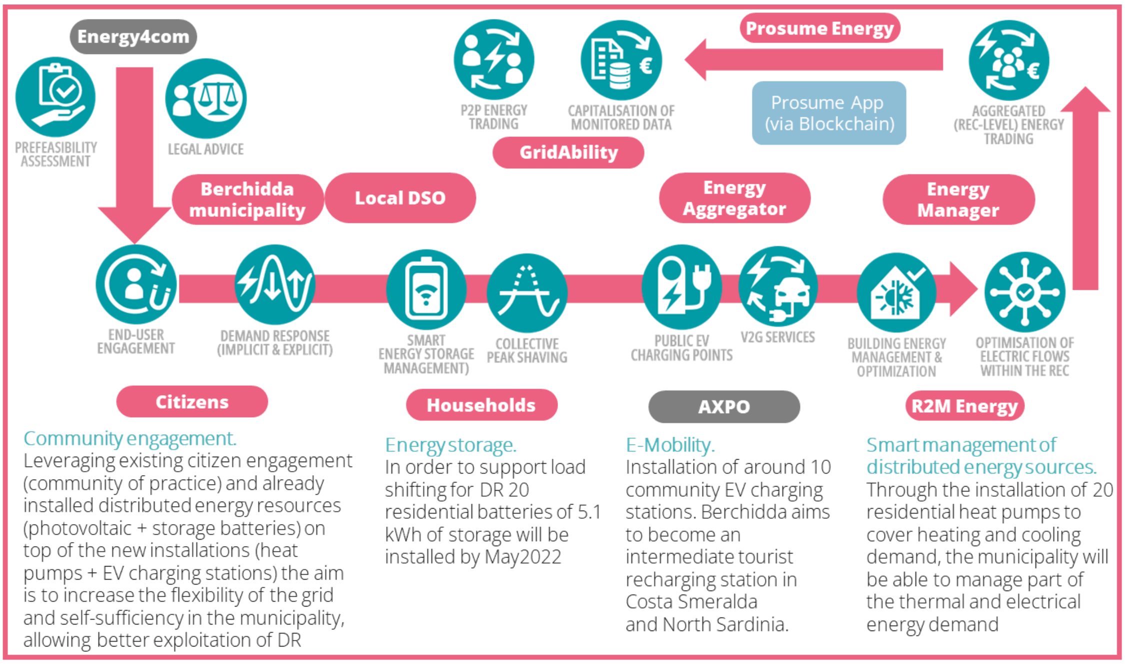
3.2. Berchidda

Located on the Southern slopes of Mount Limbara, in the North of Sardinia Island, Berchidda is a village with three thousand inhabitants. The land covers approx. 201 $km^{2,}$ and it is located at an average altitude of 300 m, with a wide hilly area in a radius of almost 20 km. The anthropic structures, vegetation and climatic conditions are typical for the inland areas of Sardinia, with average temperatures of 15°C. Berchidda adhered to the Covenant of Mayors to achieve energy independence and reduce energy dissipation, regain and strengthen the local economy, also through the enhancement of its excellent food and the environment and increase the resident population, recovering in this way also the homes in decay.

The development of local PV production has been prompted by individual emulation rather than a collective, coordinated move. The access to PV load curve data will be made possible within LocalRES with the installation of the smart meters and the associated local radio transmitter and gateway. The electric network is owned by the Municipality of Berchidda and operated by AEC - Azienda Elettrica Comunale (Public Energy Office). It is a smart grid, ready for remote management and control, smart billing, and balancing.

Currently, there is no gas grid connection in Berchidda. There's a program in the region to bring a gas network. On the other hand, there is a clear trend towards electrification (to make the grid smarter). People are used to getting heated with domestic stoves fed with biomass, diesel, or gas hobs.

A diagram illustrating the description of the Berchidda use case is shown in Figure 3.



Community engagement. Leveraging existing citizen engagement (community of practice) and already installed distributed energy resources (photovoltaic + storage batteries) on top of the new installations (heat pumps + EV charging stations) the aim is to increase the flexibility of the grid and self-sufficiency in the municipality, allowing better exploitation of DR

Energy storage. In order to support load shifting for DR 20 residential batteries of 5.1 kWh of storage will be installed by May2022

E-Mobility. Installation of around 10 community EV charging stations. Berchidda aims to become an intermediate tourist recharging station in Costa Smeralda and North Sardinia.

Smart management of distributed energy sources. Through the installation of 20 residential heat pumps to cover heating and cooling demand, the municipality will be able to manage part of the thermal and electrical energy demand

Figure 3: Diagram of Berchidda use case (D1.2)

The main **services** identified for Berchidda are:

Thermal:

- P2H: Installation of around 20 air-to-air heat pumps (HP) for heating, cooling and DHW production based on existing or new photovoltaic systems.
- Building energy management & optimisation

Electrical:

- Collective Peak shaving
- Optimisation of electric flows within the REC
- Demand response (implicit and explicit)
- V2G services
- P2P energy trading (planned activities within the scope of NEON project)
- Aggregated energy trading
- Public EV charging stations
- Smart Storage Management System
- REC-level/Collective self-consumption
- P2H: Installation of around 20 air-to-air HPs for heating, cooling and DHW production based on existing or new photovoltaic systems.

Non-technical:

- Capitalisation of monitored data
- Preliminary feasibility assessment

- End-user engagement
- Legal advice

The main **stakeholders** identified for Berchidda are:

R2M: In charge of the installation of the HPs and the community EV charging points.

GridAbility: In charge of providing information for the services to be integrated in the MEVPP and for the responsible for the overall physical implementation in the demo site. In charge of the installation of smart meters in the households where the heat pumps will be installed. Responsible for the installation of 20 residential batteries having 5.1 kWh storage each in the scope of Hestia project. Responsible for the installation of the smart management platform that will connect all the community users. Stakeholder in charge of the citizen engagement. Responsible for the provision of the prosumer platform in the scope of "Berchidda 2.0" local plan (developed by Prosume Energy, who is one of their associated partners).

AEC: Grid manager (DSO-TSO) that will offer local know-how, including support to the energy system sizing and legal documentation that may be required.

Energy4com is a private non-profit company connected to Gridability that is supporting the community of Berchidda in setting up the legal entity.

Axpo: energy supplier in the area (not involved in LocalRES). They are helping to create smart contracting also to manage the storage capacity and the surplus of energy that would be monetised somehow. AXPO has the role of energy aggregator within Berchidda.

Berchidda municipality is the local distributor.

Local citizens: will participate in the participatory processes and engagement activities associated to the REC, and will benefit directly or indirectly from the different actions and services provided by the REC.

3.3. Ispaster

Ispaster is a small village with 740 inhabitants (350 in the main urban area or district) in a municipal area of 22 km^2, located on the coast of Bizkaia, in the north of Spain. The demo site is located in the Eleixalde district, a neighbourhood with 350 inhabitants, the site of the Town Hall, public school, cultural centre and most of the public services. There is no relevant industry area near the demo site, but some small services/industries. The expected range of inhabitants that potentially would become part of the REC is 50-150 inhabitants.

The main goal in the mid to long term is to become an autonomous and isolated energy island based on 100% renewable. In line with this goal, Ispaster signed the Programme for the Further Implementation of Agenda 21 in 2008 and the Covenant of Mayors (Adapt, 2016).

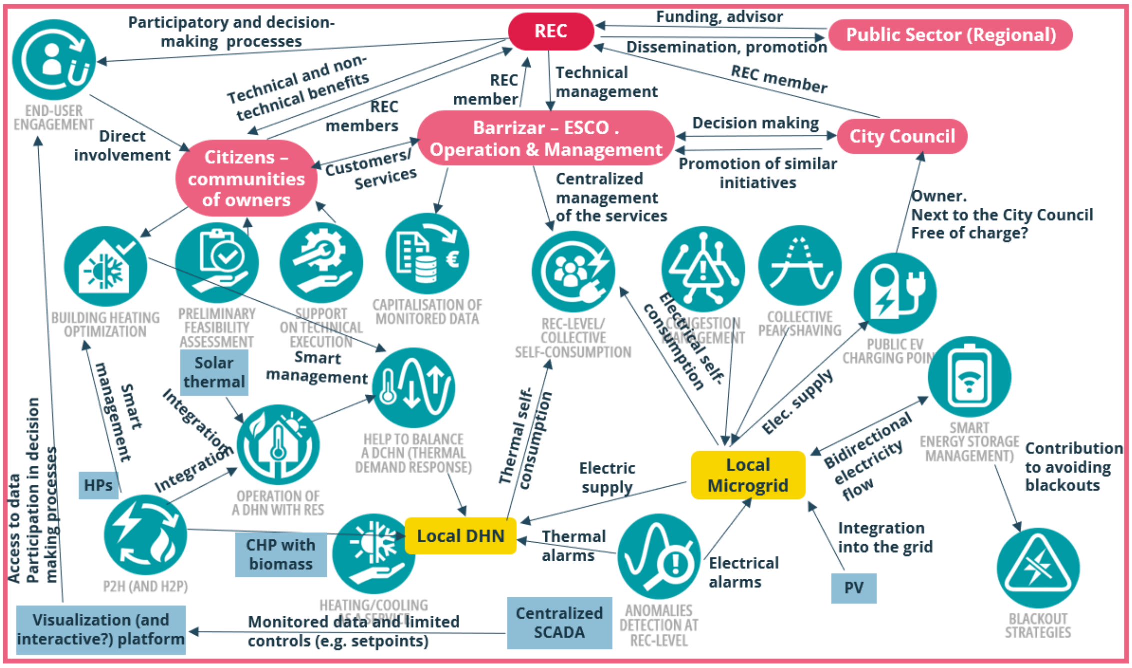


Figure 4: Diagram of Ispaster use case (D1.2)

A diagram illustrating the description of the Ispaster use case is shown in Figure 4.

The main **services** identified for Ispaster are:

Thermal:

- Operation of a DHN (District Heating Network) with RES (Renewable Energy Sources)
- Help to balance a DH&CN (thermal DR)
- Heating/Cooling as a service
- P2H
- Building energy management & optimisation

Electrical:

- Collective Peak shaving
- REC-level/Collective self-consumption
- Blackout strategies
- Public EV charging stations
- Smart Storage Management System
- Congestion management
- Anomalies detection at REC-level

Non-technical:

- Capitalisation of monitored data

- Preliminary feasibility assessment
- End-user engagement
- Support on technical execution

The main **stakeholders** identified for Ispaster are:

Ispaster town council: It's a public body which has the ownership of the installation

Barrizar is a small cooperative, more specifically, an ESCO with 5 people. They are in charge of the operation and management at the technical and financial level of the REC and its services. They have the leadership over the REC and provide thermal and electrical energy to the Ispaster town council.

Public sector (Regional): Support of the REC. Funding of different interventions in the REC

Aiguasol provides support on technical execution and the preliminary feasibility assessment service.

Local citizens: will participate in the participatory processes and engagement activities associated to the REC, and will benefit directly or indirectly from the different actions and services provided by the REC.

3.4. Ollersdorf

Ollersdorf is in the South-East of Austria and has about 1,800 inhabitants, whereas 200 inhabitants are already part of several activities in order to further increase the integration of RES. The area is mostly agricultural, with no industries settled there. The municipality of Ollersdorf is part of the Klimate and Energy Model Region (KEM) "KEM Golf und Thermenregion Stegersbach". KEM is a program of the Austrian Klimate and Energy Fund. Ollersdorf is also part of the *Innovation Lab act4.energy*, which is an initiative of the Austrian Ministry of Transportation, Innovation and Technology in the program "City of Tomorrow" as such, Ollersdorf has a clear strategy to focus on renewable energy and smart municipality.

A diagram illustrating the description of the Ollersdorf use case is shown in Figure 5.

The main **services** identified for Ollersdorf are:

Thermal:

- P2H

Electrical:

- REC-level/Collective self-consumption
- Optimisation of electric flows within the REC

This project has received funding from the European Union's Horizon 2020 Programme under the Grant Agreement no. 957819

- Blackout strategies
- P2P energy trading
- Public EV charging stations

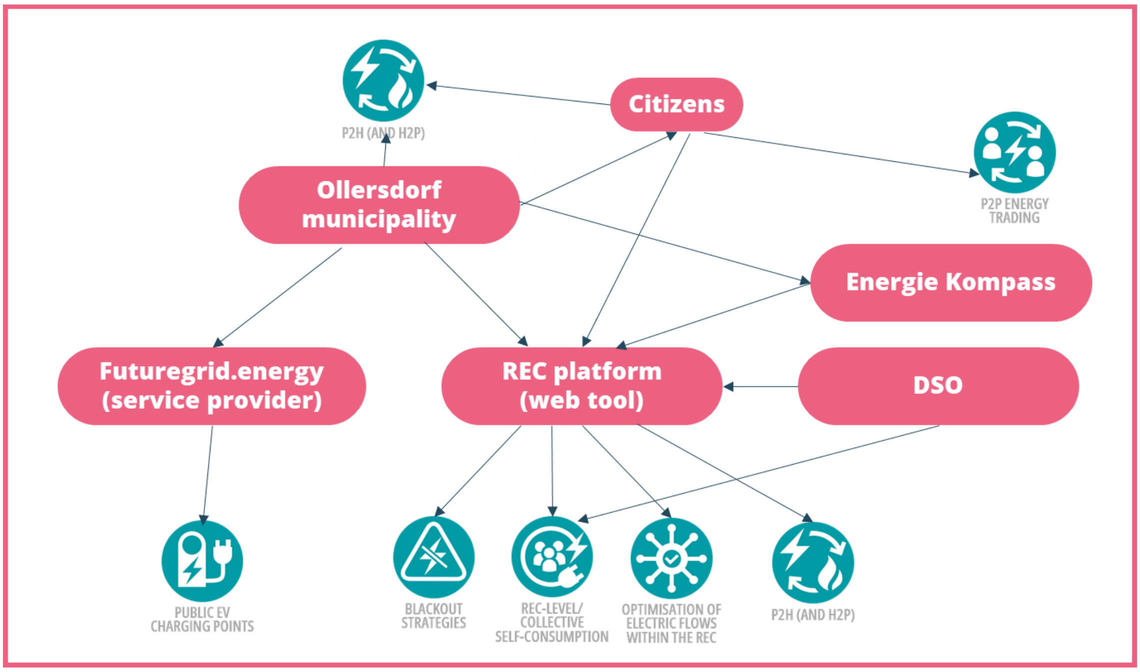


Figure 5: Diagram of Ollersdorf use case (D1.2)

The main **stakeholders** identified for Ollersdorf are:

AIT: Demo site coordinator. AIT is also in charge of the smart converter installation and deployment for local control and integration with the MEVPP.

OLLERSDORF Municipality is in charge of the management and interaction with local stakeholders.

University of PASSAU will be in charge of the design and development of the black-out strategies' integration in the MEVPP.

Local citizens: will participate in the participatory processes and engagement activities associated to the REC, and will benefit directly or indirectly from the different actions and services provided by the REC.

4/ CBA based on JRC framework

In the following section, the results of the CBA based on the JRC framework are reported. Firstly, the scenarios are analysed, and the assets are identified. Secondly, the functionalities and the related benefits are determined. The map of functionalities to benefits is created. Afterwards, the main stakeholders for the benefits are assessed. Finally, the initial investment of the assets is calculated and compared to the benefits, and the return on investment (ROI) is calculated for the different stakeholders.

4.1. Scenario and calculations

The CBA is performed for the demo sites considering the Reference Scenarios (Ref-SC) modelled in Task 1.3, as reported in Table 2.

Table 2: Scenarios (Source: Task 1.3)

Technologies	Ispaster	Kökar	Ollersdorf	Berchidda
PV	Up to 330 kWp	50% More	Up to 8.7 MW	Up to 3 MW
Wind turbines		50% More		
Electric Batteries	YES	YES	Up to obtain Energy Balance	Up to 1MWh
Thermal solar	18 kW		No change	YES
HPs	Replace 10% of current boilers	Replace 100% of fossil fuel boilers	Current growth	Replace 50% of fossil fuel boilers
DSM	50% of HP capacity	50% of HP capacity	50% of HP capacity	50% of HP capacity
E-vehicles	22% of vehicles	10% of vehicles and 10% of boats	Current growth	10% of vehicles
Type of e-charge	Smart charging	Smart charging	Smart charging	Smart charging
Trans. Capacity National grid	112 kW (80% max current peak)	1.5 MW	5.0 MW	1.5 MW
DHN	72% of heat demand		No change	
Biomass CHP	5 kW_e/55kW_{th}			
Geothermal HP	Up to 30 kW			
Thermal solar	YES			
Biomass Boiler	YES			

Table 3: Capacity increase [MW] (Source: Task 1.3)

Technologies	Ispaster	Kökar	Ollersdorf	Berchidda
PV	0.230	0.025	8.700	0.300
Wind turbines	-	0.265	-	-
Electric Batteries	0.023	0.080	-	1.000
Thermal solar	0.018	-	-	-
HPs	0.016	0.161	0.010	1.390
Geothermal HP	-	0.006	0.040	-

The initial investment is estimated considering the CAPEX and OPEX values for the baseline and the scenario considered as identified in Task 1.3 and reported in Table 4. The CAPEX and OPEX are assumed to be the same for the BAU 2030 and the Scenario 2030.

Table 4: CAPEX and OPEX (Source: Task 1.3)

Technologies	CAPEX [M€/MW]*	OPEX [k€/MW]*
PV	0.95	17.36
Themal Solar	0.47	1.60
Wind	0.99	18.00
Biomass CHP	1.84	40.95
Biomass boiler-powered DHN	0.30	5.00
Electric batteries	0.25	3.75
Thermal Storages	0.04	0.00
Air HP	0.66	13.30
Geothermal HP	0.96	6.65

*same value for all demo sites as assumed in T1.3

In particular, the initial investment is estimated based on the capacity foreseen in the Scenarios and the CAPEX, respectively reported in Table 2 and Table 4, as per Eq. (1):

$$\boldsymbol{Initial\ Investment}\ [€] = \boldsymbol{Capacity}\ [\boldsymbol{MW}]\ \boldsymbol{x}\ \boldsymbol{CAPEX}\ \left[\frac{€}{\boldsymbol{MW}}\right] \quad \text{Eq. (1)}$$

Similarly, the operational cost is estimated based on the capacity foreseen in the Scenarios and the OPEX, respectively reported in Table 2 and Table 4, as per Eq. (2):

$$\boldsymbol{Initial\ Investment}\ [€] = \boldsymbol{Capacity}\ [\boldsymbol{MW}]\ \boldsymbol{x}\ \boldsymbol{OPEX}\ \left[\frac{€}{\boldsymbol{MW}}\right] \quad \text{Eq. (2)}$$

The map of functionalities to benefits is elaborated for all the demosites according to the JRC framework as reported in Table 5.

Table 5: Map of Functionalities to Benefits

FUNCTIONALITIES \\ BENEFITS	Security of supply	Avoid energy waste	Decrease electricity & thermal consumption	Balance supply & demand of energy	Major control for power companies during the peak demands	Major control for DHN companies during the peak demands*	Promote the use of EVs	Increase local renewables self-consumption	Promote peak shaving	Citizens can manage their consumption behaviour	Monitoring of data (energy generation & consumption)
Adequacy of energy supply & related infrastructure	x										
Increased efficiency	x										
Increase the use of RES	x										
Increase production flexibility	x										
Protection from price increasing	x										
Energy savings		x									
Increased efficiency			x								
Reduce the cost of electricity				x							
Financial incentives					x	x					
Reduction of CO_2 emission				x			x				
Revenues from charging station	x						x				
Reduce the cost of electricity /energy								x			
Benefit from arbitrage, i.e.price fluctuations in energy markets									x		
Lower electricity bill										x	
Lower heating bill						x					
Revenues from selling data											x

*only for Ispaster demo

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Based on the available data to implement the calculations, the following five quantifiable benefits were selected:

1. Energy savings;
2. Reduction of CO_2 Emission;
3. Savings from the grid;
4. Revenues from the Electricity Export
5. Cost Reduction from the grid due to the Demand-Side Management (DSM).

The **Energy Savings** are estimated considering the fuel consumption variations between the business-as-usual (BAU) 2030 and the modelled scenario 2030, reported in Table 6 and Table 7 respectively, as per Eq. (3). The fuel prices are assumed to be the same for the BAU 2030 and the Scenario 2030.

$$\begin{gathered}\boldsymbol{Energy\ Savings}[€] = (\boldsymbol{Fuel\ Consumption}_{\boldsymbol{BAU\ 2030}} - \\ \boldsymbol{Fuel\ Consumption}_{\boldsymbol{Scenario\ 2030}})[\boldsymbol{MWh}] \\ \boldsymbol{x\ Fuel\ Price}\ [€/\boldsymbol{MWh}]\end{gathered} \qquad \text{Eq. (3)}$$

Table 6: Fuel Consumption Variations (Source: Task 1.3)

	Kökar		Berchidda		Ispaster		Ollersdorf	
Fuel	**BAU 2030**	**Scenario 2030**	**BAU 2030**	**Scenario 2030**	**BAU 2030**	**Scenario 2030**	**BAU 2030**	**Scenario 2030**
Coal							23	22
Gasoline	2,119	1,946	2,255	2,029	429	335	2,448	2,448
Diesel	8,235	8,136	1,875	1,687	1,199	1,009	3,415	3,415
Fuel oil	537	-	2,005	1,003	53	19	1,440	1,433
Natural Gas							5,382	5,367
Biomass	1,115	1,117	9,090	9,090	147	26	5,061	5,040
LPG			2,960	1,466	948	182		
Biodiesel							392	392
DH					170	938	85	85
Electricity	2,955	3,171	5,366	5,993	760	917	7,025	7,208

Table 7: Fuel Prices for BAU 2030 and Scenario 2030 (€/MWh) (Source: Task 1.3)

Type of fuel	Fuel	Kokar, Berchidda, Ollersdorf	Ispaster
Fossil	**Natural Gas**	1.55	1.55
	Coal	0.83	0.83
	Fuel Oil	5.23	5.23
	LPG	4.97	4.97
Renewable	**Wood**	1.75	2.93
	Biodiesel	4.62	4.62

The **Reduction of CO_2 Emission** is estimated based on the emission factors and the fuel consumption variation, reported in Table 6 and Table 8 respectively, as per Eq. (4):

$$\boldsymbol{Emission\ Reduction}[€] = (\boldsymbol{Consumption}_{\boldsymbol{BAU\ 2030}} - \boldsymbol{Consumption}_{\boldsymbol{Scenario\ 2030}})[\boldsymbol{MWh}] \\ \boldsymbol{x\ Emission\ Factor}[\boldsymbol{t}_{\boldsymbol{CO_2}}/\boldsymbol{MWh}]\ \boldsymbol{x\ Emission\ Price}[€/\boldsymbol{t}_{\boldsymbol{CO_2}}] \qquad \text{Eq. (4)}$$

The Emission Price is 50 €/tCO_2 for all demo sites as provided by Task 1.3.

Table 8: Emission Factor (t_{CO2}/MWh)

Fuel	Emission Factor
Coal	1.054
Gasoline	0.064
Diesel	0.038
Fuel oil	0.038
Natural Gas	0.986
Biomass	0.106
Biodiesel	0.106
DH	0.106
Electricity*	0.118

**EU27 average (Source EEA[1])*

The **Savings from the grid**, the **Revenues from the Electricity Export** and the **Cost Reduction from the grid due to the DSM** were provided from Task 1.3 as reported in Table 9, Table 10 and Table 11, respectively.

Table 9: Savings from the grid (Source: Task 1.3)

Ispaster	Kökar	Ollersdorf	Berchidda
25,295 €	97,260 €	282,941 €	118,560 €

Table 10: Revenues from the Electricity Export (Source: Task 1.3)

Ispaster	Kökar	Ollersdorf	Berchidda
5,449 €	19,801 €	89,009 €	16,832 €

Table 11: Cost Reduction from the grid due to the DSM (€) (Source: Task 1.3)

Ispaster	Kökar	Ollersdorf	Berchidda
34 €	206 €	121 €	2,057 €

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[1] https://www.eea.europa.eu/data-and-maps/indicators/overview-of-the-electricity-production-3/assessment

4.2. Kökar

The initial investment and operation costs of the new assets for Kökar, as reported in Table 3, amount to around 439,109 € and 7,642 €, respectively, as reported in Table 12.

Table 12: Initial Investment and Operation Cost for Kökar

Asset	Investment (€)	Operation cost (€/year)
PV	35,899 €	600 €
Wind turbines	286,200 €	4,770 €
HPs	111,492 €	2,233 €
Geothermal HP	5,518 €	38 €
Total	**439,109 €**	**7,642 €**

Kökar's main assets, functionalities and benefits are reported in Table 13, and the map of functionalities to benefits is created as shown in Table 5. Table 14 reports the main stakeholders identified in Task 1.2 and the CBA boundaries for Kökar in light of the map of stakeholders onto benefits. In Table 15, Kökar's main stakeholders are identified and associated with the benefits.

Table 13: Assets, Functionalities and Benefits, Kökar

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Infrastructure	Polar Night Energy TESS	Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	Air-to-water HPs		
	Distributed energy resources *(BESS, microgrids, combined heat and power (CHP) systems, rooftop solar installations, backup power generators, and battery storage systems)*		
	EV charger or electric vehicle	Promote the use of EVs as a clean alternative to traditional fuelled vehicles	✓ Reduction of CO_2 emission ✓ Revenues from charging station
Information system	Building energy consumption optimisation	Avoid wasting energy	✓ Energy savings
		Decrease electricity and thermal consumption	✓ Increased efficiency
	Demand response programs	Balancing supply and demand of energy	✓ Reduce the cost of electricity
		Major control for power companies during the peak demands	✓ Financial incentives
			✓ Lower electricity bill
	Smart Storage Management System	Balancing supply and demand	✓ Reduction of CO_2 emission
		Increase local renewables self-consumption	✓ Reduce the cost of electricity /energy
		Promote peak shaving	✓ Benefit from arbitrage, i.e. the price fluctuations in the energy markets
		Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	Capitalisation of monitored data	Citizens can manage their consumption behaviour	✓ Lower electricity bill
		Monitoring of data regarding energy generation and consumption process	✓ Revenues from selling data
		Avoid wasting energy	✓ Reduce the cost of electricity/energy

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Table 14: Kökar's Main Stakeholders and CBA Boundaries

Main Stakeholders identified in *Task 1.2*	CBA Boundaries
Local citizens	Local citizens
FLEXENS (Energy utility)	FLEXENS (Energy utility)
Kökar service (craftsmen/workers)	Kökar service (craftsmen/workers)
Kökar Municipality (public staff)	Kökar Municipality (public staff)
Local energy group	
VTT (RTO)	
Ålands Elandelslag (DSO)	
Consilia Solutions AB (datahub entity)	
Single Wing Energy Oy (Tech. provider)	
Polar Night Energy (Tech. provider)	
Technicians	

Table 15: Kökar's Map of Stakeholders onto Benefits

BENEFITS	MAIN STAKEHOLDERS
Adequacy of energy supply and related infrastructure	Polar Night Energy TESS Ålands Elandelslag (DSO) Grid operator **Local citizens** **Kökar Municipality**
Increased efficiency	
Increase the use of RE resources	
Increase production flexibility	Ålands Elandelslag (DSO) Grid operator
Protection from price increasing	**Local citizens**
Energy savings	Prosumer
Increased efficiency	Operator or provider to manage the building optimisation **Flexens**
Reduce the cost of electricity	**Local citizens**
Financial incentives	Grid operator
Reduction of CO_2 emission	**Local citizens**
Revenues from charging station	Kökar service **Kökar Municipality**
Reduce the cost of electricity /energy	**Local citizens**
Benefit from arbitrage, i.e. the price fluctuations in the energy markets	Single Wing Energy Oy (Tech. provider) PV installer
Lower electricity bill	**FLEXENS** Grid operator
Revenues from selling data	Consilia Solutions AB **Local citizens**

The benefits that can be quantified are identified and calculated for the main stakeholders: (1) local citizens, (2) Kökar municipality and (3) Flexens. The quantified benefits are calculated as reported in Table 16, and the return on investment is estimated for the main stakeholders as shown in Figure 6, Figure 7 and Figure 8, respectively for (1) local citizens, (2) Kökar municipality and (3) Flexens.

Table 16: Quantifiable Benefits for Kökar

	Local Citizens	Kökar Municipality	Flexens
Energy savings	-2,459 €	-2,459 €	-2,459 €
Savings from the grid	97,260 €	97,260 €	97,260 €
Reduction of CO_2 emission	470 €		
Revenue Export	19,801 €	19,801 €	
DSM Cost Reduction from the grid	206 €		
Total	**115,277 €**	**114,601 €**	**94,800 €**
Return on Investment (years)	***4***	***4***	***4.9***

According to the results of the CBA, the benefits resulting from the assets installed in Kökar can provide very short payback times and the ROI for the main stakeholders is:

- 4 years for the Local Citizens;
- 4 years for the Kökar Municipality; and
- 4.9 years for Flexens.

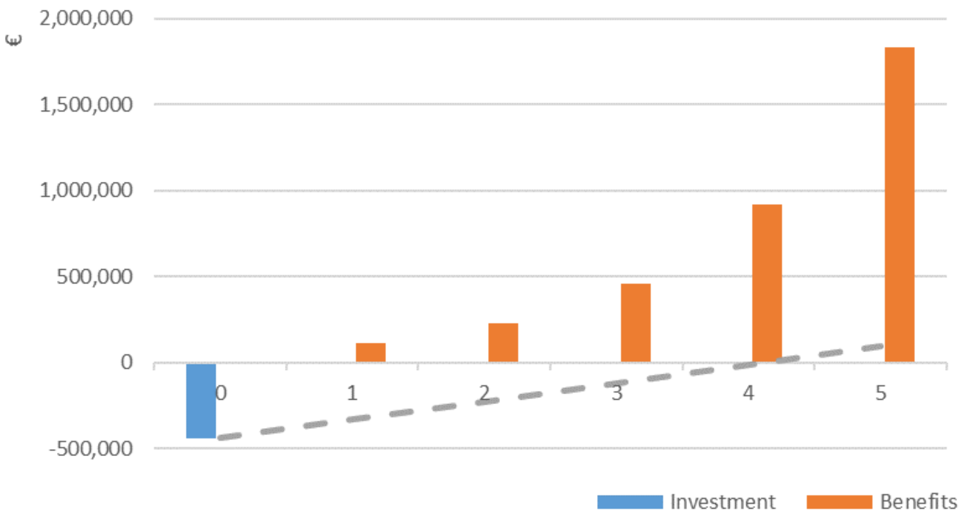

Figure 6: CBA for Kökar's local citizens

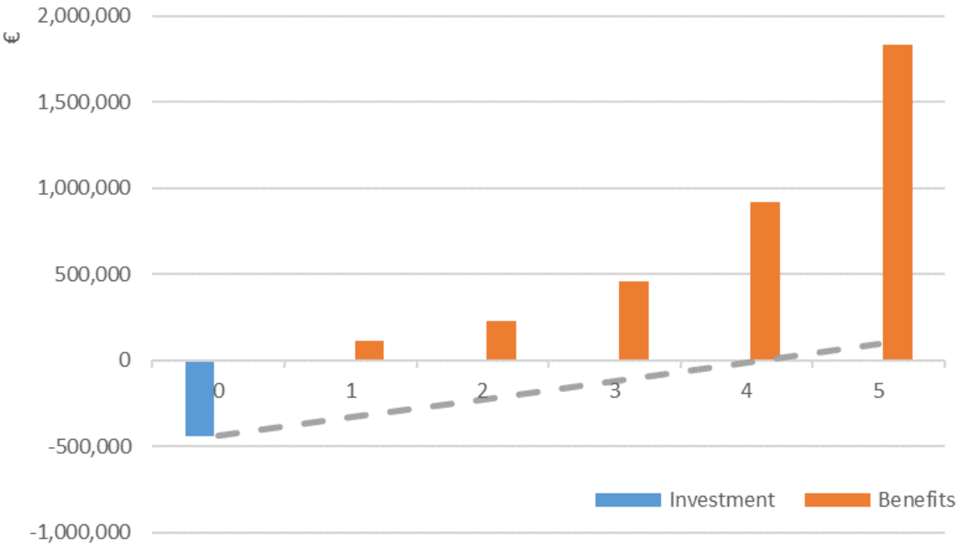

Figure 7: CBA for Kökar Municipality

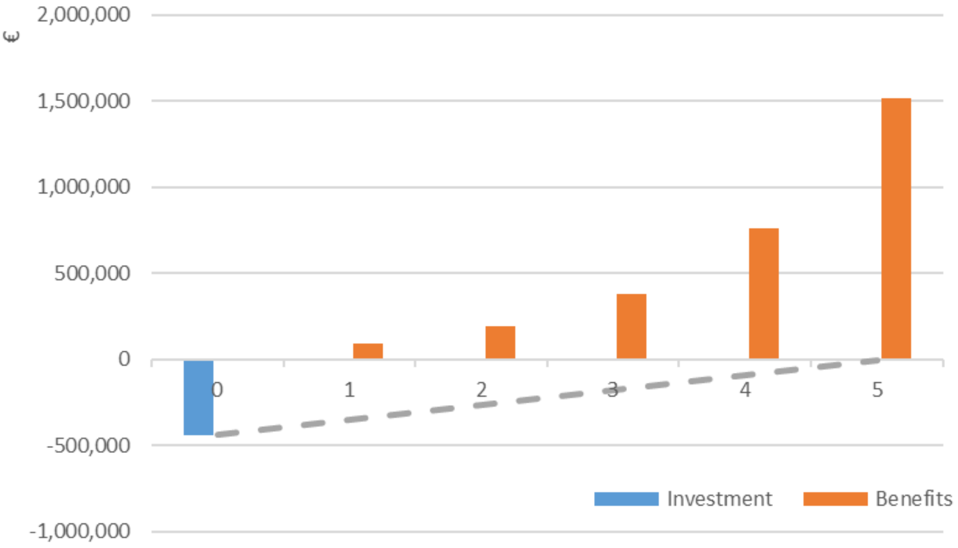

Figure 8: CBA for Flexens (Kökar)

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4.3. Berchidda

The initial investment and operation costs of the new assets for Berchidda, as reported in Table 3, amount to around 2,004,239 € and 36,798 €, respectively, as reported in Table 17.

Table 17: Initial Investment and Operation Cost for Berchidda

Asset	Investment (€)	Operation cost (€/year)
PV	439,579 €	7,352 €
Electric Batteries	600,000 €	10,125 €
HPs	964,660 €	19,321 €
Total	**2,004,239 €**	**36,798 €**

Berchidda's main assets, functionalities and benefits are reported in Table 18, and the map of functionalities to benefits is created as shown in Table 5.

Table 20 reports the main stakeholders identified in Task 1.2 and the CBA boundaries for Berchidda in light of the map of stakeholders onto benefits. In Table 19 Berchidda's main stakeholders are identified and associated with the benefits.

Table 18: Assets, Functionalities and Benefits, Berchidda

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Infrastructure	Air-to-air HP	Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	EV charger or electric vehicle	Promote the use of EVs as a clean alternative to traditional fuelled vehicles	✓ Reduction of CO_2 emission ✓ Revenues from charging station
Information system	Building energy management & optimisation	Avoid wasting energy	✓ Energy savings
		Decrease electricity and thermal consumption	✓ Increased efficiency
	Demand response programs	Balancing supply and demand of energy	✓ Reduce the cost of electricity
		Major control for power companies during the peak demands	✓ Financial incentives
			✓ Lower electricity bill
	Smart Storage Management System	Balancing supply and demand	✓ Reduction of CO_2 emission
		Increase local renewables self-consumption	✓ Reduce the cost of electricity /energy
		Promote peak shaving	✓ Benefit from arbitrage, i.e. the price fluctuations in the energy markets
	Optimisation of electric flows within the REC, V2G services, P2P energy trading, Aggregated (REC-level) energy trading	Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	End-user engagement, Preliminary feasibility assessment	Increase local renewables self-consumption	✓ Reduce the cost of electricity /energy
	Capitalisation of monitored data	Citizens can manage their consumption behaviour	✓ Lower electricity bill
		Monitoring of data regarding energy generation and consumption process	✓ Revenues from selling data
		Avoid wasting energy	✓ Reduce the cost of electricity/energy

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Table 19: Berchidda's Map Stakeholders onto Benefits

BENEFITS	MAIN STAKEHOLDERS
Adequacy of energy supply and related infrastructure	**AEC** **Local citizens** **Berchidda Municipality**
Increased efficiency	
Increase the use of RE resources	
Increase production flexibility	**AEC** Grid operator
Protection from price increasing	**Local citizens**
Energy savings	Prosumer
Increased efficiency	Operator or provider to manage the building optimisation
Reduce the cost of electricity	**Local citizens**
Financial incentives	Grid operator
Reduction of CO_2 emission	**Local citizens**
Revenues from charging station	**Berchidda Municipality**
Reduce the cost of electricity /energy	**Local citizens**
Benefit from arbitrage, i.e. price fluctuations in energy markets	Tech. provider PV installer
Lower electricity bill	Grid operator
Revenues from selling data	**AXPO** **Local citizens**

Table 20: Berchidda's Main Stakeholders and CBA Boundaries

Main Stakeholders identified in *Task 1.2*	CBA Boundaries
R2M	AEC
GridAbility	AXPO
AEC	Berchidda Municipality
Energy4com	Local citizens
AXPO	
Berchidda Municipality	
Local citizens	

The benefits that can be quantified are identified and calculated for the main stakeholders: (1) local citizens, (2) AEC and (3) Berchidda Municipality. The quantified benefits are calculated as reported in Table 21, and the return on investment is estimated for the main stakeholders as showed in Figure 9, Figure 10 and Figure 11, respectively, for (1) local citizens, (2) AEC and (3) Berchidda Municipality.

Table 21: Quantifiable Benefits for Berchidda

	Local citizens	AXPO	Berchidda Municipality
Energy savings	-16,957 €	-16,957 €	-16,957 €
Savings from the grid	118,560 €	118,560 €	118,560 €
Reduction of CO_2 emission	10,934 €		
Revenue Export	16,832 €		16,832 €
DSM Cost Reduction from the grid	2,057 €	2,057 €	
Total	**131,427 €**	**103,660 €**	**118,435 €**
Return on Investment (years)	***22***	***30***	***25***

According to the results of the CBA, the benefits resulting from the assets installed in Berchidda can provide short payback times and the ROI for the main stakeholders is:

- 22 years for Local citizens;
- 30 years for AXPO; and
- 25 years for Berchidda Municipality.

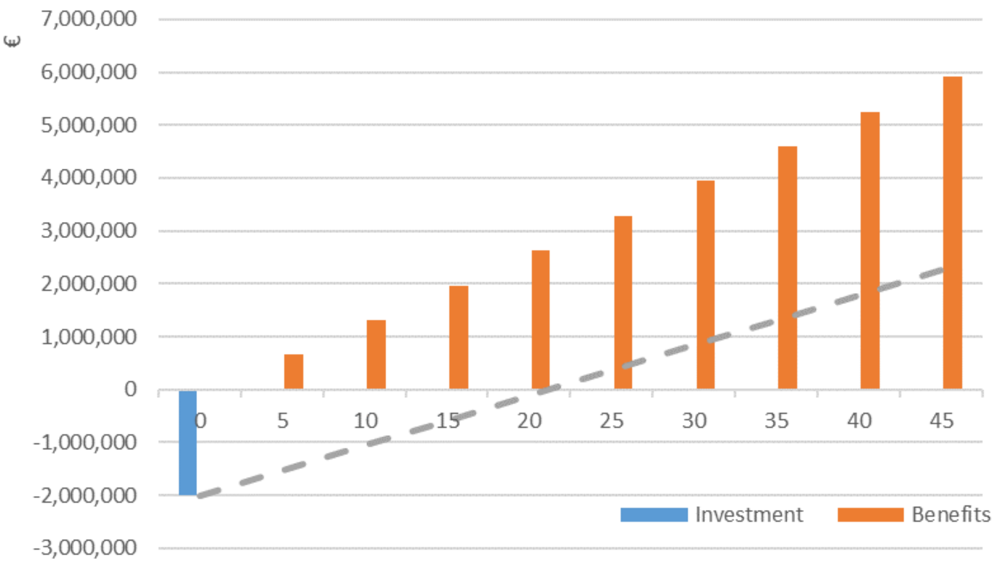

Figure 9: CBA for Berchidda's local citizens

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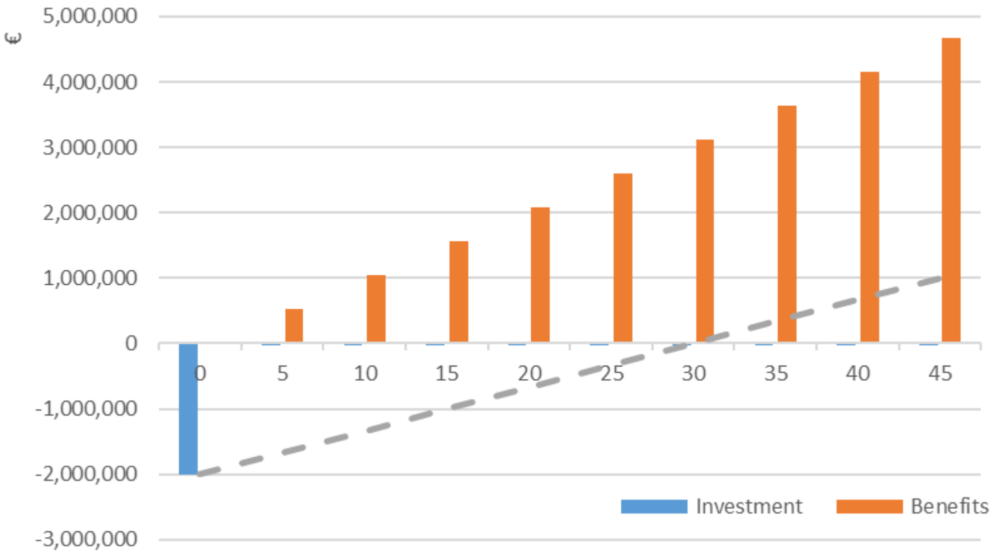

Figure 10: CBA for AXPO (Berchidda)

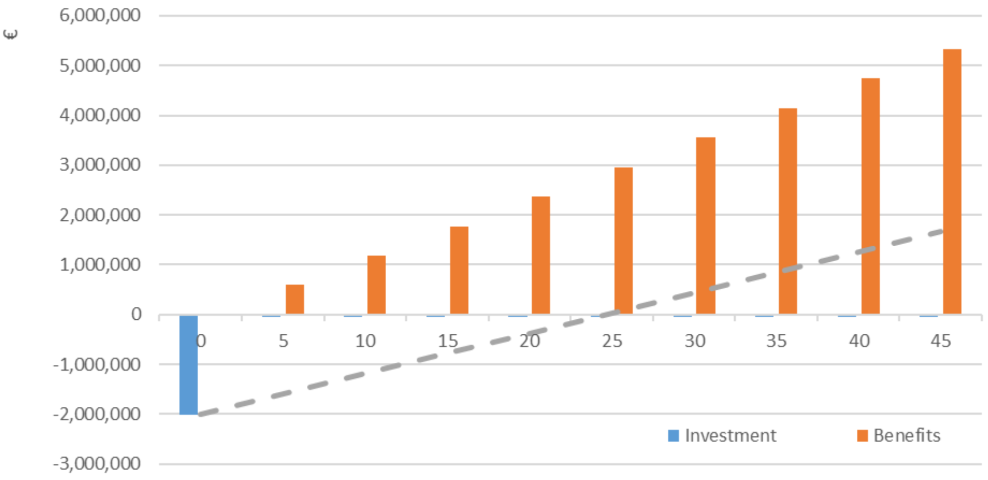

Figure 11: CBA for Berchidda Municipality

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4.4. Ispaster

The initial investment and operation costs of the new assets, as reported in Table 3, for Ispaster amount to around 516,991 € and 8,542 €, respectively, as reported in Table 22.

Table 22: Initial Investment and Operation Cost for Ispaster

Asset	Investment (€)	Operation cost (€/year)
PV	483,537 €	8,087 €
Electric Batteries	13,800 €	233 €
Thermal solar	8,550 €	0 €
HPs	11,104 €	222 €
Total	**516,991 €**	**8,542 €**

The main assets, functionalities and benefits for Ispaster are reported in Table 23, and the map of functionalities to benefits is created as shown in Table 5. The tables highlight how the security of supply is one of the functionalities that relates to more benefits.

Table 23: Assets, Functionalities and Benefits: Ispaster

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Infrastructure	HP	Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	Public EV charging stations	Promote the use of EVs as a clean alternative to traditional fuelled vehicles	✓ Reduction of CO_2 emission ✓ Revenues from charging station
Information system	Building energy consumption optimisation	Avoid wasting energy	✓ Energy savings
		Decrease electricity and thermal consumption	✓ Increased efficiency
	Collective Peak shaving, REC-level/Collective self-consumption, Blackout strategies	Balancing supply and demand of energy	✓ Reduce the cost of electricity
		Major control for power companies during the peak demands	✓ Financial incentives
		Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
	Operation of a DHN with RES, Help to balance a DH&CN (thermal DR), Heating/Cooling as a service	Major control for DHN companies during the peak demands	✓ Financial incentives ✓ Lower heating bill
	Smart Storage Management System, Congestion management, Anomalies detection at REC-level	Balancing supply and demand	✓ Reduction of CO_2 emission
		Increase local renewables self-consumption	✓ Reduce the cost of electricity /energy
		Promote peak shaving	✓ Benefit from arbitrage, i.e. the price fluctuations in the energy markets
		Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	Support on technical execution, Preliminary feasibility assessment, End-user engagement	Increase local renewables self-consumption	✓ Reduce the cost of electricity /energy
	Capitalisation of monitored data	Citizens can manage their consumption behaviour	✓ Lower electricity bill
		Monitoring of data regarding energy generation and consumption process	✓ Revenues from selling data
		Avoid wasting energy	✓ Reduce the cost of electricity/energy

Table 24 reports the main stakeholders identified in Task 1.2 and the CBA boundaries for Ispaster in light of the map of stakeholders onto benefits. In Table 24, the main stakeholders are identified and associated with the benefits.

Table 24: Ispaster's Main Stakeholders and CBA Boundaries

Main Stakeholders identified in *Task 1.2*	CBA Boundaries
Ispaster town council	Ispaster town council
Barrizar	Public sector (Regional)
Public sector (Regional)	Local citizens
Aiguasol	
Local citizens	

Table 25: Ispaster's Map Stakeholders onto Benefits

BENEFITS	MAIN STAKEHOLDERS
Adequacy of energy supply and related infrastructure	TSO/DSO Grid operator **Public sector (regional)** **Ispaster town council** **Local citizens**
Increased efficiency	
Increase the use of RE resources	
Increase production flexibility	TSO/DSO Grid operator
Protection from price increasing	**Public sector (regional)** **Ispaster town council** **Local citizens**
Energy savings	Prosumer **Local citizens**
Increased efficiency	Operator or provider to manage the building optimisation
Reduce the cost of electricity	**Public sector (regional)** **Ispaster town council** **Local citizens**
Financial incentives	Grid operator
Reduction of CO_2 emission	**Public sector (regional)** **Local citizens**
Revenues from charging station	**Public sector (regional)** **Ispaster town council** **Local citizens**
Reduce the cost of electricity /energy	**Public sector (regional)** **Ispaster town council** **Local citizens**
Benefit from arbitrage, i.e. the price fluctuations in the energy markets	Tech. provider PV installer
Lower heating bill	**Public sector (regional)** **Ispaster town council** **Local citizens**
Lower electricity bill	Grid operator **Local citizens**
Revenues from selling data	TSO/DSO **Public sector (regional)**

The benefits that can be quantified are identified and calculated for the main stakeholders: (1) local citizens, (2) the public sector (regional) and (3) the Ispaster town council. The quantified benefits are calculated as reported in Table 26, and the return on investment is estimated for the main stakeholders, as shown in Figure 12, Figure 13 and Figure 14, respectively, for (1) local citizens, (2) the public sector (regional) and (3) the Ispaster town council.

Table 26: Quantifiable Benefits - Ispaster

	Local citizens	**Public sector (regional)**	**Ispaster town council**
Energy savings	-40,718 €	-40,718 €	-40,718 €
Savings from the grid	97,260 €	97,260 €	97,260 €
Reduction of CO_2 emission	427 €		
Revenue Export	16,832 €		16,832 €
DSM Cost Reduction from the grid	2,057 €	2,057 €	
Total	**75,857 €**	**58,599 €**	**73,374 €**
Return on Investment (years)	***7.5***	***10.2***	***7.8***

According to the results of the CBA, the benefits resulting from the assets installed in Ispaster can provide very short payback times and the ROI for the main stakeholders is:

- 7.5 years for the local citizens;
- 10.2 years for the Public Sector; and
- 7.8 years for the Ispater town council.

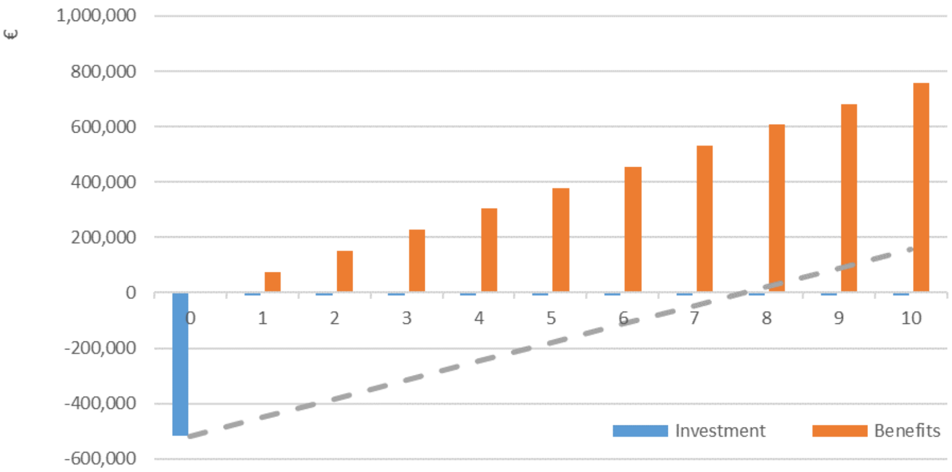

Figure 12: CBA for Ispaster's local citizens

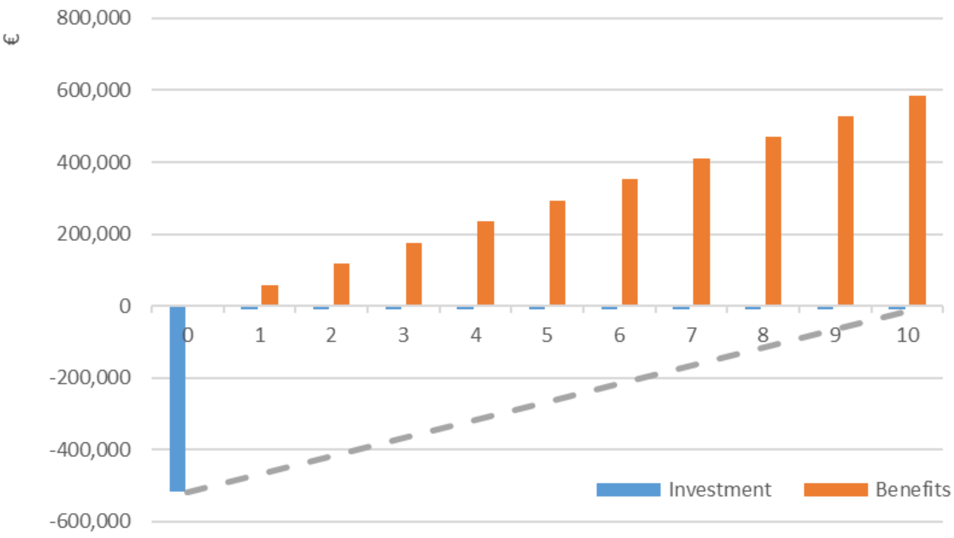

Figure 13: CBA for public sector (regional; Ispaster)

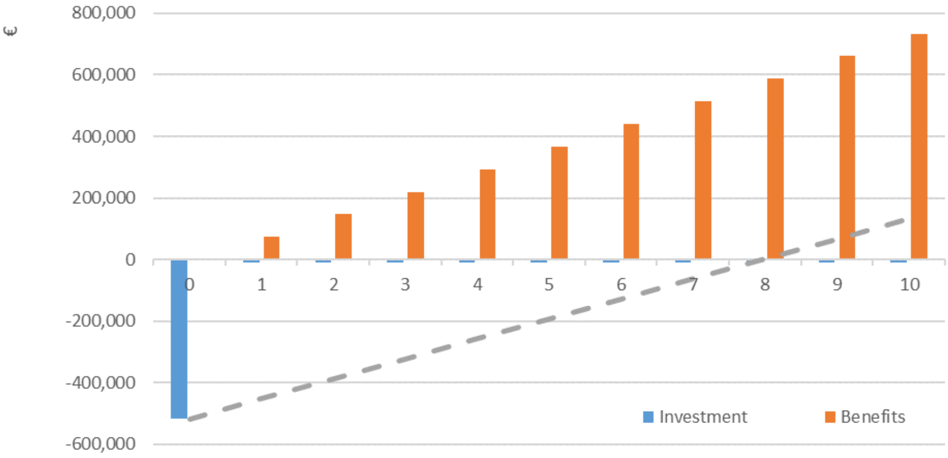

Figure 14: CBA for Ispaster town council

This project has received funding from the European Union's Horizon 2020 Programme under the Grant Agreement no. 957819

4.5. Ollersdorf

The initial investment and operation costs of the new assets, as reported in Table 3, for Ollersdorf amount to around 12,840,990 € and 214,419 €, respectively, as reported in Table 27.

Table 27: Ollersdorf's Initial Investment and Operation Cost

Asset	Investment (€)	Operation cost (€/year)
PV	12,747,798 €	213,204 €
Wind turbines	0 €	0 €
Electric Batteries	48,000 €	810 €
Thermal solar	0 €	0 €
HPs	6,940 €	139 €
Geothermal HP	38,251 €	266 €
Total	**12,840,990 €**	**214,419 €**

The main assets, functionalities and benefits for Ollersdorf are reported in Table 28, and the map of functionalities to benefits is created as shown in Table 5.

Table 28: Assets, Functionalities and Benefits:Ollersdorf

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Infrastructure	Air-to-water HPs	Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	EV charger or electric vehicle	Promote the use of EVs as a clean alternative to traditional fuelled vehicles	✓ Reduction of CO_2 emission ✓ Revenues from charging station
Information system	Building energy management & optimisation	Avoid wasting energy	✓ Energy savings
		Decrease electricity and thermal consumption	✓ Increased efficiency
	Collective Peak shaving, Optimisation of electric flows within the REC, V2G services, P2P energy trading, Aggregated (REC-level) energy trading	Balancing supply and demand of energy	✓ Reduce the cost of electricity
		Major control for power companies during the peak demands	✓ Financial incentives
		Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing

This project has received funding from the European Union's Horizon 2020 Programme under the Grant Agreement no. 957819

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
	Demand response programs	Major control for power companies during the peak demands	✓ Financial incentives
	Smart Storage Management System	Balancing supply and demand	✓ Reduction of CO_2 emission
		Increase local renewables self-consumption	✓ Reduce the cost of electricity /energy
		Promote peak shaving	✓ Benefit from arbitrage, i.e. the price fluctuations in the energy markets
		Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	Preliminary feasibility assessment, End-user engagement	Increase local renewables self-consumption	✓ Reduce the cost of electricity /energy
	Capitalisation of monitored data	Citizens can manage their consumption behaviour	✓ Lower electricity bill
		Monitoring of data regarding energy generation and consumption process	✓ revenues from selling data
		Avoid wasting energy	✓ Reduce the cost of electricity/energy

Table 29 reports the main stakeholders identified in Task 1.2 and the CBA boundaries for Ollersdorf in light of the map of stakeholders onto benefits. In Table 30, the main stakeholders are identified and associated with the benefits.

Table 29: Ollersdorf's Main Stakeholders and CBA Boundaries

Main Stakeholders *identified in Task 1.2*	**CBA Boundaries**
AIT	Ollersdorf Municipality
Ollersdorf Municipality	Local citizens
University of PASSAU	
Local citizens	

Table 30: Ollersdorf's Map Stakeholders onto Benefits

BENEFITS	MAIN STAKEHOLDERS
Adequacy of energy supply and related infrastructure	TSO/DSO Grid operator Local citizens Ollersdorf Municipality
Increased efficiency	
Increase the use of RE resources	
Increase production flexibility	TSO/DSO Grid operator
Protection from price increasing	Local citizens Ollersdorf Municipality
Energy savings	Prosumer
Increased efficiency	Operator or provider to manage the building optimisation
Reduce the cost of electricity	Local citizens Ollersdorf Municipality
Financial incentives	Grid operator
Reduction of CO_2 emission	Local citizens
Revenues from charging station	Local citizens Ollersdorf Municipality
Reduce the cost of electricity /energy	Local citizens Ollersdorf Municipality
Benefit from arbitrage, i.e. the price fluctuations in the energy markets	Tech. provider PV installer
Lower electricity bill	Local citizens Ollersdorf Municipality
Revenues from selling data	Grid operator

The benefits that can be quantified are identified and calculated for the main stakeholders: (1) local citizens and (2) Ollersdorf municipality. The quantified benefits are calculated as reported in Table 31, and the return on investment is estimated for the main stakeholders as showed in Figure 15 and Figure 16, respectively, for (1) local citizens and (2) Ollersdorf municipality.

Table 31: Quantifiable Benefits - Ollersdorf

	Local Citizens	Ollersdorf Municipality
Energy savings	-7,727 €	-7,727 €
Savings from the grid	282,941 €	282,941 €
Reduction of CO_2 emission	-226 €	
Revenue Export	89,009 €	
DSM Cost Reduction from the grid	121 €	121 €
Total	**364,118 €**	**275,335 €**
Return on Investment (years)	***87***	***207***

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According to the results of the CBA, the benefits resulting from the assets installed in Ollersdorf provides very long payback times and the ROI for the main stakeholders is:

- 87 years for the Local Citizens; and
- 207 years for the Ollersdorf Municipality.

It is indeed suggested to include more services and benefits in the assessment in order to investigate shorted payback times.

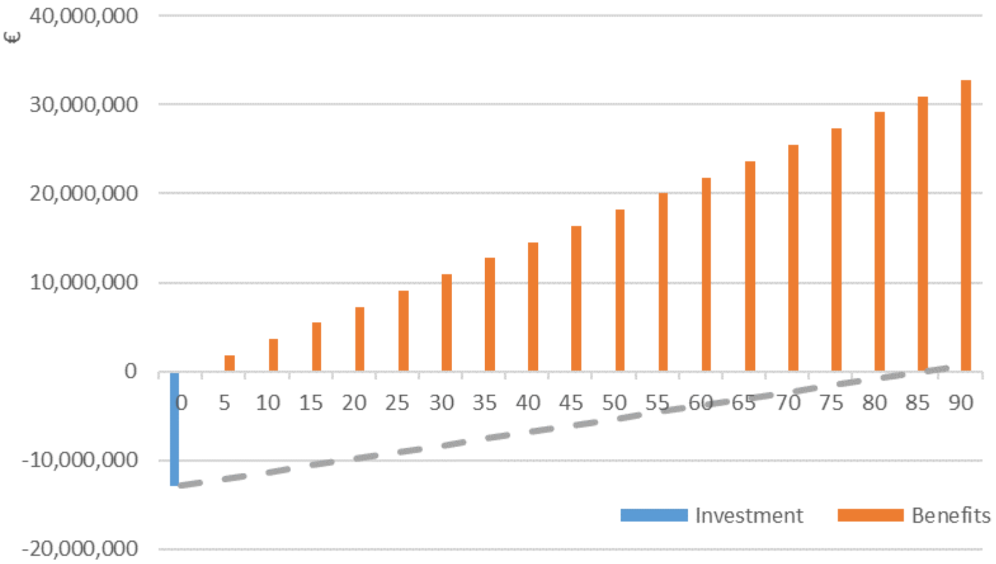

Figure 15: CBA for local citizens

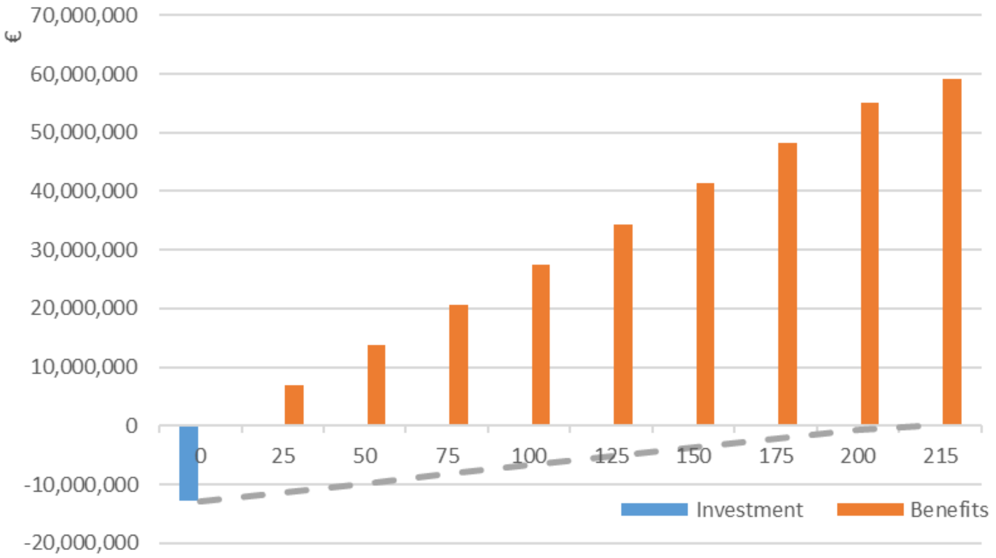

Figure 16: CBA for Ollersdorf Municipality

This project has received funding from the European Union's Horizon 2020 Programme under the Grant Agreement no. 957819

5/ CBA based on consultation of local stakeholders

In the following section, the results of the CBA based on interviews local stakeholders of the project demos is reported.

This CBA follow partially the JRC Methodology and reports some changes in order to adapt it to our LocalRES project. The approach followed is reported below.

Per each demo a set of priority services are identified, as well as the initial investment that the community should face. The key stakeholder of the LocalRES project is the community so the focus is placed on two principal actors: citizens and the municipality. For this reason, the CBA has been calculated for those two stakeholders.

Moreover, a share is reported per each type of investment, that shows to whom the investment belongs to: citizens or municipality.

Following the JRC methodology assets, functionalities and related benefits have been mapped.

Thanks to the interviews with demos, monetarized yearly operational costs have been quantified and considered, as well as monetarized yearly benefits.

Costs and benefits are assumed to be allocated to each stakeholder in accordance with the share of the investments.

The benefits are the results of the comparison of the baseline in 2030 without the deployment of LocalRES project (Business as Usual) and the scenario in 2030 with the presence of the local energy community.

The CBA have been performed following the cumulative method without considering any inflation and discount rate. The cumulative comparison consists of estimating the sum of initial investment, expenditures for operation and maintenance and benefits (cash flow). On the basis of this calculation the return of the investment has been identified, considering its payback period. The payback period is the length of time required for an investment to recover its initial outlay in terms of profits or savings. According to the instruction given by JRC methodology for energy project, the timeframe consider, for the deployment of the project is 23 years.

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5.1. Kökar

The key services identified are: building heating optimization, DR and blackout strategies. In detail, within LocalRES framework for this demo next assets are assumed in terms of building optimisation: TESS, Aiir-to-water HPs, Vertical Axis Micro-Wind Turbines, PV systems and Building automation; for DR: Smart Energy Management Systems and for the Blackout Strategies: the BESS. The total amount of the initial investment is equal to 515,700 € (Table 32) and the share of the investment is splitted as follows: 2% for the citizens (~10,000€) and 98% for the Municipality (~505,700 €).

Table 32: Initial investment -Services, Kökar

Service	Asset	Investment
Building heating optimization (systems & electricity consumption optimization)	TESS	205,000 €
	Air-to-water HP	40,000 €
	Vertical Axis Micro-Wind Turbines	55,000 €
	Solar PV systems	110,700 €
	Building automation	30,000 €
	Subtotal	*440,700 €*
DR (implicit and explicit)	SEMS	10,000 €
Blackout strategies	BESS	65,000 €
	Total	**515,700 €**

On the basis of the set of services identified as a priority by the demo, the JRC methodology is applied, which allows mapping assets, functionalities and relative benefits by service, as shown below in Table 33 and Table 34.

Table 33: Assets, Functionalities and Benefits – Services, Kökar

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Information system	Building energy consumption optimisation	Avoid wasting energy	✓ Energy savings
		Decrease electricity and thermal consumption	✓ Increased efficiency
	Demand response programs	Balancing supply and demand of energy	✓ Reduce the cost of electricity
		Major control for power companies during peak demands	✓ Financial incentives
			✓ Lower electricity bill
	Blackout strategies	Security of supply	✓ Adequacy of energy supply & related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing

Table 34: Map of Functionalities to Benefits – Services, Kökar

FUNCTIONALITIES \\ BENEFITS	Security of supply	Avoid energy waste	Decrease electricity & thermal consumption	Balance supply & demand of energy	Major control for power companies during peak demands
Adequacy of energy supply and related infrastructure	X				
Increased efficiency	X				
Increase the use of RE resources	X				
Increase production flexibility	X				
Energy savings		X			
Increased efficiency			X		
Reduce the cost of electricity				X	
Financial incentives					X
Reduction of CO_2 emission				X	

In order to complete the CBA, several interviews were conducted to monetarized costs and benefits related to the set of services per each stakeholder, respectively: citizens and municipality.

Concerning the costs, costs for operation and maintenance associated to the building heating optimization are considered, and costs for maintenance for the blackout strategies services. No relevant costs have been identified for the DR service (Table 35).

Table 35: Quantifiable Costs – Services, Kökar

OPEX	Total amount	Stakeholders share	Amount according to the share
Operation for Building heating optimization	26,922 €	2%	584 €
Maintenance (see services above)	2,700 €	98%	29,538 €
Maintenance of Blackout strategies	500 €		
Total	**30,122 €**		

In addition, a set of benefits have been monetarized, that are listed and quantified in the table below (Table 36). Benefits are the result of the comparison of the baseline (2030, BAU) against the scenario in 2030 (with the hypothetical presence of a local energy community). As done for the costs, also the benefits have been allocated in accordance with the share of the investment.

After collecting the relatives' costs and benefits, the CBA cumulative method has been adopted in order to find out the return on investment. For both stakeholders the payback period is more than 23 years as per Table 37.

Table 36: Quantifiable Benefits – Services, Kökar

REVENUES/BENEFITS	Baseline 2030 BAU	Unit	Baseline vs Scenario 2030	Stakeholders share	Amount according to share
Saving from the reduced use of electricity	60,303.0	€/year	15,173.84 €	2%	412 €
Savings from the grid	0	MWh/year	3,190.68 €	98%	20,812 €
Reduce use of fuel		MWh/year	1,521.93 €		
Selling of energy	0	€/year	1,336.83 €		
		Total	***21,223 €***		

Table 37: CBA based on consultation of local stakeholders, Kökar

	Citizens			Municipality		
Year	**Costs**	**Benefits**	**Cash Flow**	**Costs**	**Benefits**	**Cash Flow**
0	-10,000 €		-10,000 €	-505,700 €		-505,700 €
1	-584 €	412 €	-10,173 €	-29,538 €	20,812 €	-514,426 €
2	-584 €	412 €	-10,345 €	-29,538 €	20,812 €	-523,153 €
3	-584 €	412 €	-10,518 €	-29,538 €	20,812 €	-531,879 €
4	-584 €	412 €	-10,690 €	-29,538 €	20,812 €	-540,605 €
5	-584 €	412 €	-10,863 €	-29,538 €	20,812 €	-549,332 €
6	-584 €	412 €	-11,035 €	-29,538 €	20,812 €	-558,058 €
7	-584 €	412 €	-11,208 €	-29,538 €	20,812 €	-566,784 €
8	-584 €	412 €	-11,380 €	-29,538 €	20,812 €	-575,511 €
9	-584 €	412 €	-11,553 €	-29,538 €	20,812 €	-584,237 €
10	-584 €	412 €	-11,726 €	-29,538 €	20,812 €	-592,964 €
11	-584 €	412 €	-11,898 €	-29,538 €	20,812 €	-601,690 €
12	-584 €	412 €	-12,071 €	-29,538 €	20,812 €	-610,416 €
13	-584 €	412 €	-12,243 €	-29,538 €	20,812 €	-619,143 €
14	-584 €	412 €	-12,416 €	-29,538 €	20,812 €	-627,869 €
15	-584 €	412 €	-12,588 €	-29,538 €	20,812 €	-636,595 €
16	-584 €	412 €	-12,761 €	-29,538 €	20,812 €	-645,322 €
17	-584 €	412 €	-12,934 €	-29,538 €	20,812 €	-654,048 €
18	-584 €	412 €	-13,106 €	-29,538 €	20,812 €	-662,774 €
19	-584 €	412 €	-13,279 €	-29,538 €	20,812 €	-671,501 €
20	-584 €	412 €	-13,451 €	-29,538 €	20,812 €	-680,227 €
21	-584 €	412 €	-13,624 €	-29,538 €	20,812 €	-688,953 €
22	-584 €	412 €	-13,796 €	-29,538 €	20,812 €	-697,680 €
23	-584 €	412 €	-13,969 €	-29,538 €	20,812 €	-706,406 €

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5.2. Berchidda

The key services identified are: P2H, Building heating optimization and Public EV charging stations. In detail, within the LocalRES framework for this demo next assets are assumed: for the P2H service, to subsitute 20 gas boilers with 20 electric boilers; to provide building heating optimization for 100 families (devices that will support the control of electrical loads are considered under this service) and to install 6 double charging points 7.6 kW - 20 kWh /100 km - 6 points with 1EV/week (3h charging time) – 60 kWh/VE-51Weeks - 0.5€/kWh.

Considering the above assumptions, the total amount of the initial investment is equal to 106,000 € (Table 38) and the share of the investment is splitted as follow: 66% for the citizens (70,000€) and 34% for Municipality (36,000 €).

Table 38: Initial investment -Services, Berchidda

Service	Investment
P2H	20,000 €
Building heating optimization	50,000 €
Public EV charging stations	36,000 €
Total	**106,000** €

On the basis of the set of services identified as a priority by the demo, the JRC methodology is applied, which allows mapping assets, functionalities and relative benefits by service, as shown below in Table 39 and Table 40.

Table 39: Map of Functionalities to Benefits – Services, Berchidda

FUNCTIONALITIES \\ BENEFITS	Security of supply	Avoid energy waste	Decrease electricity & thermal consumption	Promote the use of EVs
Adequacy of energy supply and related infrastructure	X			
Increased efficiency	X			
Increase the use of RE resources	X			
Increase production flexibility	X			
Protection from price increases	X			
Energy savings		X		
Increased efficiency			X	
Reduction of CO_2 emission				X
Revenues from charging station				X

Table 40: Assets, Functionalities and Benefits – Services, Berchidda

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Infrastructure	Air-to-air HPs	Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
	EV charger or electric vehicle	Promote the use of EVs as a clean alternative to traditional fuelled vehicles	✓ Reduction of CO_2 emission ✓ Revenues from charging station
Information system	Building energy management & optimisation	Avoid wasting energy	✓ Energy savings
		Decrease electricity and thermal consumption	✓ Increased efficiency

Table 41: Map of Functionalities to Benefits – Services, Berchidda

FUNCTIONALITIES \\ BENEFITS	Security of supply	Avoid energy waste	Decrease electricity & thermal consumption	Promote the use of EVs
Adequacy of energy supply and related infrastructure	X			
Increased efficiency	X			
Increase the use of RE resources	X			
Increase production flexibility	X			
Protection from price increases	X			
Energy savings		X		
Increased efficiency			X	
Reduction of CO_2 emission				X
Revenues from charging station				X

In order to complete the CBA, several interviews were conducted to monetirized costs and benefits related to the set of services per each stakeholder, respectively: citizens and municipality.

Concerning the costs, costs for operation and maintenance associated to all the three services were identified. In dateil: electric losses as operation costs derived form building optimisation, and consumption as operation costs derived from charging points (Table 42).

This project has received funding from the European Union's Horizon 2020 Programme under the Grant Agreement no. 957819

Table 42: Quantifiable Costs – Services, Berchidda

OPEX	Total amount	Stakeholders share	Amount according to the share
Operation and maintenance of P2H	1,000 €	66%	9,044 €
Maintenance of building optimisation	10,000 €	34%	4,651 €
Operation of building optimisation	1,000 €		
Operation of charging points	1,095 €		
Maintenance of charging points	600 €		
Total	**13,695 €**		

In addition, a set of benefits have been monteirisezed, that are listed and quantified in the table below (Table 43). Benefits are the results of the comparison of the baseline (2030 BAU) against of the scenario in 2030 (with the hypothetical presence of a local energy community). As done for the costs, also the benefits have been allocated in accordance with the share of the investment

Table 43: Quantifiable Benefits – Services, Berchidda

REVENUES/BENEFITS	Unit	Baseline vs Scenario 2030	Stakeholders share	Amount according to share
Reduction of use of electricity (P2H)	€/year	7,300.00 €	66%	13,181.52 €
Reduction of use of electricity (building optimisation)	€/year	9,000.00 €	34%	6,790.48 €
Selling kWh per years for charging vehicles	€/year	3,672.00 €		
	Total	**19,972.00 €**		

After collecting the relatives' costs and benefits: the CBA cumulative method has been adopted in order to find out return on the investiment. For both stakeholders the payback period is 14 years as per Table 44.

Table 44: CBA based on consultation of local stakeholders, Berchidda

	Citizens			Municipality		
Year	**Costs**	**Benefits**	**Cash Flow**	**Costs**	**Benefits**	**Cash Flow**
0	-70,000 €		-70,000 €	-36,000 €		-36,000 €
1	-9,044 €	14,393 €	-64,651 €	-4,651 €	7,415 €	-33,236 €
2	-9,044 €	14,393 €	-59,301 €	-4,651 €	7,415 €	-30,473 €
3	-9,044 €	14,393 €	-53,952 €	-4,651 €	7,415 €	-27,709 €
4	-9,044 €	14,393 €	-48,602 €	-4,651 €	7,415 €	-24,946 €
5	-9,044 €	14,393 €	-43,253 €	-4,651 €	7,415 €	-22,182 €
6	-9,044 €	14,393 €	-37,904 €	-4,651 €	7,415 €	-19,418 €
7	-9,044 €	14,393 €	-32,554 €	-4,651 €	7,415 €	-6,655 €
8	-9,044 €	14,393 €	-27,205 €	-4,651 €	7,415 €	-13,891 €
9	-9,044 €	14,393 €	-21,855 €	-4,651 €	7,415 €	-11,128 €
10	-9,044 €	14,393 €	-16,506 €	-4,651 €	7,415 €	-8,364 €
11	-9,044 €	14,393 €	-11,156 €	-4,651 €	7,415 €	-5,601 €
12	-9,044 €	14,393 €	-5,807 €	-4,651 €	7,415 €	-2,837 €
13	-9,044 €	14,393 €	-458 €	-4,651 €	7,415 €	-73 €
14	-9,044 €	14,393 €	4,892 €	-4,651 €	7,415 €	2,690 €
15	-9,044 €	14,393 €	10,241 €	-4,651 €	7,415 €	5,454 €
16	-9,044 €	14,393 €	15,591 €	-4,651 €	7,415 €	8,217 €
17	-9,044 €	14,393 €	20,940 €	-4,651 €	7,415 €	10,981 €
18	-9,044 €	14,393 €	26,289 €	-4,651 €	7,415 €	13,745 €
19	-9,044 €	14,393 €	31,639 €	-4,651 €	7,415 €	16,508 €
20	-9,044 €	14,393 €	36,988 €	-4,651 €	7,415 €	19,272 €
21	-9,044 €	14,393 €	42,338 €	-4,651 €	7,415 €	22,035 €
22	-9,044 €	14,393 €	47,687 €	-4,651 €	7,415 €	24,799 €
23	-9,044 €	14,393 €	53,036 €	-4,651 €	7,415 €	27,563 €

5.3. Ispaster

The key services identified are: Building heating optimization, self-consumption and Public EV charging stations. In detail, within the LocalRES framework for this demo next assets are assumed: for Building heating optimization, additional 100 kWp of PV on roofs of private buildings, 200 kWh of storage and HPs (50-70 kW) in public spaces; for self-consumption, 3 additional public thermal consumption points, plus six private points and two restaurants and to install one double charging point of 7.4 kW, one simple charging point of 3.6 kW and to buy an electric car for the Municipality.

Considering the above assumptions, the total amount of the initial investment is equal to 350,200 € (Table 45) and the share of the investment is splitted as follow: 41% for the citizens (145,200€) and 59% for Municipality (205,000 €).

Table 45: Initial investment -Services, Ispaster

Service	Investment
Building heating optimization (systems and electricity consumption optimization)	160,000 €
Self-consumption	147,000 €
EV/Public charging stations	43,200 €
Total	**350,200 €**

On the basis of the set of services identified as a priority by the demo, the JRC methodology is applied, which allows mapping assets, functionalities and relative benefits by service, as shown below in Table 46 and Table 47.

Table 46: Assets, Functionalities and Benefits – Services, Ispaster

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Infrastructure	Public EV charging stations	Promote the use of EVs as a clean alternative to traditional fuelled vehicles	✓ Reduction of CO_2 emission ✓ Revenues from charging station
Information system	Building energy consumption optimisation	Avoid wasting energy	✓ Energy savings
		Decrease electricity and thermal consumption	✓ Increased efficiency
	REC-level/Collective self-consumption	Balancing supply and demand of energy	✓ Reduce the cost of electricity
		Major control for power companies during the peak demands	✓ Financial incentives
		Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing

Table 47: Map of Functionalities to Benefits -Services, Ispaster

FUNCTIONALITIES \\ BENEFITS	Security of supply	Avoid energy waste	Decrease electricity & thermal consumption	Balance supply & demand of energy	Major control for power companies during peak demands	Promote the use of EVs	Increase local renewables self-consumption
Adequacy of energy supply and related infrastructure	x						
Increased efficiency	x						
Increase the use of RE resources	x						
Increase production flexibility	x						
Protection from price increases	x						
Energy savings		x					
Increased efficiency			x				
Reduce the cost of electricity				x			
Financial incentives					x		
Reduction of CO_2 emission				x		x	
Revenues from charging station						x	
Reduce the cost of electricity /energy							x

In order to complete the CBA, several interviews were conducted to monetarized costs and benefits related to the set of services per each stakeholder, respectively: citizens and municipality.

Concerning the costs, costs for operation and maintenance associated to all the three services were identified (Table 48).

Table 48: Quantifiable Costs – Services, Ispaster

OPEX	Total amount	Stakeholders share	Amount according to share
Operation and maintenance of HPs	1,800 €	41%	11,112 €
Operation and maintenance of Storage	1,800 €	59%	15,688 €
Operation and maintenance of rooftop PV	2,800 €		
Operation costs (see services above)	18,000 €		
Operation and maintenance of charging stations	400 €		
Operation and maintenance of public EV	2,000 €		
Total	**26,800 €**		

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In addition, a set of benefits have been monetarized, that are listed and quantified in the table below (Table 49). Benefits are the result of the comparison of the baseline (2030, BAU) against the scenario in 2030 (with the hypothetical presence of a local energy community). As done for the costs, also the benefits have been allocated in accordance with the share of the investment.

Table 49: Quantifiable Benefits – Services, Ispaster

REVENUES/BENEFITS	Unit	Baseline vs Scenario 2030	Stakeholders share	Amount according to share
Savings from reduced electricity consumption- Building optmisation	€/year	500 €	41%	2,194 €
Savings from reduced electricity consumption derived from Self-consumption	€/year	1,538 €	59%	3,098 €
Selling kWh for charging vehicles	€/year	3,000 €		
savings from the reduction consume of diesel (1 car)	€/year	254 €		
	Total	**5,292 €**		

After collecting the relatives' costs and benefits: the CBA cumulative method has been adopted in order to find out the return on the investiment. For both stakeholders the payback period is more than 23 years as per Table 50:

Table 50: CBA based on consultation of local stakeholders, Ispaster

	Citizens			Municipality		
Year	**Costs**	**Benefits**	**Cash Flow**	**Costs**	**Benefits**	**Cash Flow**
0	-145,200 €		-145,200 €	-205,000 €		-205,000 €
1	-11,112 €	2,194 €	-154,117 €	-15,688 €	3,098 €	-217,590 €
2	-11,111 €	2,194 €	-163,034 €	-15,688 €	3,098 €	-230,180 €
3	-11,112 €	2,194 €	-171,951 €	-15,688 €	3,098 €	-242,770 €
4	-11,112 €	2,194 €	-180,869 €	-15,688 €	3,098 €	-255,360 €
5	-11,112 €	2,194 €	-189,786 €	-15,688 €	3,098 €	-267,950 €
6	-11,112 €	2,194 €	-198,704 €	-15,688 €	3,098 €	-280,540 €
7	-11,112 €	2,194 €	-207,621 €	-15,688 €	3,098 €	-293,130 €
8	-11,112 €	2,194 €	-216,538 €	-15,688 €	3,098 €	-305,720 €
9	-11,112 €	2,194 €	-225,456 €	-15,688 €	3,098 €	-318,310 €
10	-11,112 €	2,194 €	-234,373 €	-15,688 €	3,098 €	-330,900 €
11	-11,112 €	2,194 €	-243,291 €	-15,688 €	3,098 €	-343,490 €
12	-11,112 €	2,194 €	-252,208 €	-15,688 €	3,098 €	-356,080 €
13	-11,112 €	2,194 €	-261,125 €	-15,688 €	3,098 €	-368,670 €
14	-11,112 €	2,194 €	-270,043 €	-15,688 €	3,098 €	-381,260 €
15	-11,112 €	2,194 €	-278,960 €	-15,688 €	3,098 €	-393,850 €
16	-11,112 €	2,194 €	-287,878 €	-15,688 €	3,098 €	-406,440 €
17	-11,112 €	2,194 €	-296,795 €	-15,688 €	3,098 €	-419,030 €
18	-11,112 €	2,194 €	-305,713 €	-15,688 €	3,098 €	-431,620 €
19	-11,112 €	2,194 €	-314,630 €	-15,688 €	3,098 €	-444,210 €
20	-11,112 €	2,194 €	-323,547 €	-15,688 €	3,098 €	-456,800 €
21	-11,112 €	2,194 €	-332,465 €	-15,688 €	3,098 €	-469,390 €
22	-11,112 €	2,194 €	-341,382 €	-15,688 €	3,098 €	-481,980 €
23	-11,112 €	2,194 €	-350,300 €	-15,688 €	3,098 €	-494,570 €

5.4. Ollersdorf

The key services identified are: P2H, REC-level/Collective self-consumption, Optimisation of electric flows within the REC and blackout strategies. In detail, within the LocalRES framework for this demo next assets are assumed: for the P2H, HPs in 20 households; while for the other three services, to invest in measuring and IoT devices Web Server and Database setup.

Considering the above assumptions, the total amount of the initial investment is equal to 450,000 € (Table 51) and the share of the investment is splitted as follow: 88% for the citizens (395,000€) and 12% for Municipality (55,000 €).

Table 51: Initial Investment – Services, Ollersdorf

Service	Investment
P2H	395,000 €
Collective self-consumption (REC level)	55,000 €
Optimisation of electric flows within the REC	
Blackout strategies	
Total	**450,000 €**

On the basis of the set of services identified as a priority by the demo, the JRC methodology is applied, which allows mapping assets, functionalities and relative benefits by service, as shown below in Table 52 and Table 53.

Table 52: Ollersdorf's Assets, Functionalities and Benefits – Services

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Infrastructure	Air-to-water HPs	Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
Information System	Optimisation of electric flows within the REC	Balancing supply and demand of energy	✓ Reduce the cost of electricity
		Major control for power companies during the peak demands	✓ Financial incentives
		Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing
		Balancing supply and demand of energy	✓ Reduce the cost of electricity

TYPOLOGY	ASSET	FUNCTIONALITIES	BENEFIT
Information System	REC-level/Collective self-consumption	Major control for power companies during the peak demands	✓ Financial incentives
Information System	Blackout strategies	Security of supply	✓ Adequacy of energy supply and related infrastructure ✓ Increased efficiency ✓ Increase the use of RE resources ✓ Increase production flexibility ✓ Protection from price increasing

Table 53: Map of Functionalities to Benefits – Services, Ollersdorf

FUNCTIONALITIES \\ BENEFITS	Security of supply	Decrease electricity & thermal consumption	Balance supply & demand of energy	Major control for power companies during peak demands	Increase local renewables self-consumption	Promote peak shaving
Adequacy of energy supply and related infrastructure	X					
Increased efficiency	X					
Increase the use of RE resources	X					
Increase production flexibility	X					
Protection from price increase	X					
Increased efficiency		X				
Reduce the cost of electricity			X			
Financial incentives				X		
Reduction of CO_2 emission			X			
Reduce the cost of electricity /energy					X	
Benefit from arbitrage, i.e. price fluctuations in energy markets						X

In order to complete the CBA, several interviews were conducted to monetarized costs and benefits related to the set of services per each stakeholder.

However, due to the fact that the investments for REC-level/Collective self-consumption, Optimisation of electric flows within the REC and blackout strategies convey in an only total investment amount and that for these specific services only qualitative benefits can be provided, it was decided to calculate only their costs. Therefore, only for P2H a full CBA was performed, for which it was possible to monetarized both costs and benefits. Concerning the costs, we identified costs for operation and maintenance that comes from all the four services. The quantified costs and benefits are presented in Table 54 and Table 55, respectively.

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Table 54: Quantifiable Costs – Services, Ollersdorf

OPEX	Total amount	Stakeholders share	Amount according to share
Operation and maintenance of HPs	36,745 €	88%	36,368 €
Operation and maintenance of Collective self-consumption (REC level)	272 €	12%	4,959 €
Operation and maintenance of storage & PV	300 €		
Operation costs of the server and license fees	510 €		
Server operation (annual)	1,000 €		
Maintenance and support	2,500 €		
Total	**41,327 €**		

Table 55: Quantifiable Benefits – Services, Ollersdorf

REVENUES/BENEFITS	Unit	Baseline vs Scenario 2030	Stakeholders share
Savings from fuel costs for natural gas and fuel oil	€/year	25,338 €	100%
	Total	**25,338 €**	

As mentioned before, the interviews conducted allowed monetarizing only benefits associated to P2H. Benefits are the results of the comparison of the baseline (2030 BAU) against the scenario in 2030 (with the hypothetical presence of a local energy community). Costs and benefits for these services belong to the citizens which are the owner of the investment.

After collecting the relatives' costs and benefits for the P2H the CBA cumulative method has been adopted in order to find out the return on the investment. The payback period is more than 23 years, as per Table 56.

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Table 56: CBA based on consultation of local stakeholders, Ollersdorf

	Citizens		
Year	**Costs**	**Benefits**	**Cash Flow**
0	-395,000 €		-395,000 €
1	-36,745 €	25,338 €	-406,407 €
2	-36,745 €	25,338 €	-417,814 €
3	-36,745 €	25,338 €	-429,221 €
4	-36,745 €	25,338 €	-440,629 €
5	-36,745 €	25,338 €	-452,036 €
6	-36,745 €	25,338 €	-463,443 €
7	-36,745 €	25,338 €	-474,850 €
8	-36,745 €	25,338 €	-486,257 €
9	-36,745 €	25,338 €	-497,664 €
10	-36,745 €	25,338 €	-509,072 €
11	-36,745 €	25,338 €	-520,479 €
12	-36,745 €	25,338 €	-531,886 €
13	-36,745 €	25,338 €	-543,293 €
14	-36,745 €	25,338 €	-554,700 €
15	-36,745 €	25,338 €	-566,107 €
16	-36,745 €	25,338 €	-577,515 €
17	-36,745 €	25,338 €	-588,922 €
18	-36,745 €	25,338 €	-600,329 €
19	-36,745 €	25,338 €	-611,736 €
20	-36,745 €	25,338 €	-623,143 €
21	-36,745 €	25,338 €	-634,550 €
22	-36,745 €	25,338 €	-645,958 €
23	-36,745 €	25,338 €	-657,365 €

6/ Conclusions

In all the LocalRES demo cases, the CBA is developed considering different stakeholders and different desired returns on investment for each of them, aiming to provide a quantification of specific scenarios defined in Task 1.3 based on the use cases previously defined in Task 1.2.

The methodology implemented included the development of detailed calculation models based on the JRC framework for Smart grid CBA (Giodano, 2012) and its extension to derive achievable revenues and costs for the defined use cases.

In particular, the methodological approach includes the development of detailed calculation models based on the JRC framework and its extension to derive achievable revenues and costs for the defined use cases. Those revenues are then combined with the resulting implementation cost to perform a detailed CBA, resulting in an identification of the most crucial parameters of developed solutions. For this, specific cost elements (investment costs resulting in CAPEX and OPEX) are determined.

Moreover, the **CBA based on JRC framework** assessed that the use cases analysed are advantageous for Kökar (around 4-5 years), Berchidda (around 27-43 years) and Ispaster (around 7-10 years) as they have short payback times. In Ollersdorf, a longer payback time (over 87 years) is required due to larger investments. However, it is worth mentioning that the CBA considers a set of benefits and functionalities that can be enlarged with further investigation. In addition, in Task 1.4, the social benefits are included in the assessment but not monetised as they require specific consultations. If the social benefits are quantified, the CBA might provide different results.

As far as the **CBA based on consultation of local stakeholders**, it has emerged that, apart from the case of Berchidda, most demos have an initial investment between €350,000 and €500,000. Monetizable costs and benefits were identified and compared through a cumulative methodology. However, from the CBA it clearly emerges that for the demos it is necessary to resort to forms of external financing (e.g., subsidies, loans, grants, etc.) in order to be able to cover, even only partially, the initial investment and to be able to guarantee a return on the investment in shorter times.

It should be noted that the drafting of the CBA was completed in a moment of the project in which demos are in a preliminary phase of implementation. Only at the end of the project, having a more information at disposal, it would be possible to expand the reasoning made so far.

Finally, it is worth mentioning that also this CBA considers only those benefits that can be monetarized, but there are also qualitative benefits that would influence positively the implementation of the Local Energy Community. In this analysis we have been able to analyzed a portfolio of potential benefits (quantitative and qualitative) and functionalities, that can be enlarged for further investigation.

To conclude, this CBA exercise aims to provide an overview of the benefits and encourage the demo cases to embrace the REC. The monetary results are strictly related to the selected benefits that are quantified. The demo case shall consider these results as a starting point to further develop according to the prioritised benefits.

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