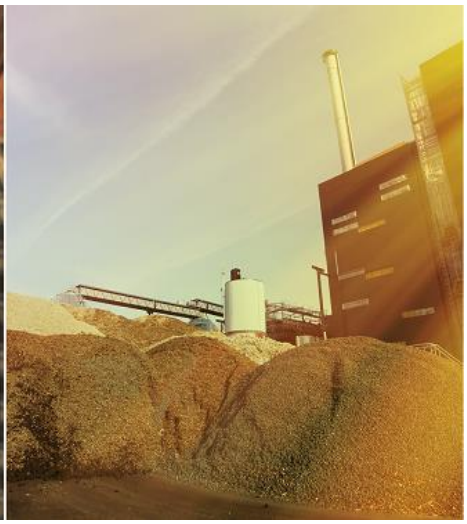
UNLOCKING THE COMMUNITY BIOENERGY POTENTIAL

D4.1. Co-definition of community bioenergy heating roadmaps

APRIL 2022





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Legal Notice

About

Over the last years, the EU has witnessed some remarkable steps in Renewable Energy (RE) deployment. However, at the same time, we see an increasingly uneven penetration of RE across the different energy sectors, with the heating and cooling sector lagging behind. Community bioenergy schemes can play a catalytic role in the market uptake of bioenergy heating technologies and can strongly support the increase of renewables penetration in the heating and cooling sector, contributing to the EU target for increasing renewable heat within this next decade. However, compared to other RES, bioenergy has a remarkably slower development pace in the decentralised energy production which is a model that is set to play a crucial role in the future of the energy transition in the EU.

The ambition of the EU-funded BECoop project is **to provide the necessary conditions and technical as well as business support tools for unlocking the underlying market potential of community bioenergy.** The project's goal is to make community bioenergy projects more appealing to potential interested actors and to foster new links and partnerships among the international bioenergy community.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952930.

Project partners

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Abbreviations

AVG	Vitoria/Gasteiz city council (Ayuntamiento Vitoria/Gasteiz)
BiPV	Building integrated PV (photovoltaics)
CHP	Combined heat and power (cogeneration)
DH	District heating
DHW	Domestic hot water
GHG	Greenhouse gases
NIMBY	Not in my backyard
OBS	Oborniki Slaskie (PL)
REC	Renewable energy community/communities
SH	Space heating
TSSE	Twin Screw Steam Expander
WS	Workshop

Executive Summary

T4.1 provides support to communities and local key stakeholders of the four pilot areas to agree on and co-define with local communities the most promising path for the development of the BECoop RESCoops, by further building on the challenges and needs identified in Task 1.4.

The output of T4.1 will be used for the deployment of T4.2, 4.3 and 4.4 that mainly aim to investigate the techno-economic feasibility of the BECoop RESCoops' vision in each of the project pilots.

The task leader, Fiper, supported by the pilot and consortium partners, led the development of the present consolidated report, which describes the following main activities carried out within T4.1:

- ✓ ***Conversion of challenges and needs into a RESCoop vision***, according to each pilot's conditions and characteristics. This activity has been carried out through bilateral meetings involving the task leader, Fiper, and the pilot partners;
- ✓ ***Pre-assessment of quantitative and qualitative information*** that will be used for the future implementation of each BECoop RESCoop's vision. This step has been accomplished by sharing and discussing with pilot partners a data collection template;
- ✓ ***Co-development of BECoop RESCoop roadmaps.*** Fiper has supported pilot partners in the definition and organization of co-creation workshops (WS). Workshops' aim was to stimulate collaboration between pilot partners and local stakeholders in order to define the most suitable vision for the implementation of a BECoop RESCoop in their territory.

All pilot partners have successfully accomplished the activities foreseen in T4.1.

Pilot partners with the support of Fiper organized the co-creation workshops and filled in the reporting template shared by the task leader to capture and report the required information. Based on each WS output, a complete RESCoop roadmap has been developed for each pilot case, enlisting actions and interventions both up until the end of the BECoop project but also towards 2030, providing a realistic and solid perspective to the project results.

Note: This report includes references to names of organisations, municipalities, NGOs, local authorities, universities and associations that - under this theoretical examination phase and within the framework of the project - may potentially serve as stakeholders strongly interested in the project's mission or members of the under-development BECoop RESCoops.

Pilot partners, responsible for organising the co-creation workshops performed all necessary actions (incl. following informed consent procedures, according to the principles of GDPR[1]) so that the engaged representatives of each organisation are well aware and do give their consent for this type of data to be published and reported to the EC.

It has to be emphasized that workshops' participants, respective organisations and entities potentially identified as BECoop RESCoop members are not, by any means, linked to a binding role or any contractual or legal obligation in this regard. They are voluntarily engaged to the project's planned activities and investigations and may withdraw of them at any given time.

[1] Regulation (EU) 2016/679 of the European parliament and of the council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32016R0679.

1 Introduction

1.1 Task objective

The main activity of T4.1 is to assist communities and local key stakeholders of the project's four pilot areas to jointly agree on and **co-define the most promising path for switching from fossil fuels to bioenergy, along with a local vision and roadmap towards bioenergy heating**. To this end, local communities of the four pilots involved have been invited in **one co-creation WS per area** to identify the bioenergy heating vision that they consider more appropriate for their needs and challenges. At the end of the process, the local pilot partners helped the communities to translate the co-creation WS results to **roadmaps**. To this aim, they supported them to define a plan of actions and timing, to include their overall vision, specific targets and objectives, and targeted areas of intervention.

1.2 Background information

In order to achieve a co-developed vision per pilot region and to translate it into a roadmap, inputs from the following previous deliverables have been considered.

D1.2: Regional and EU framework and value chain conditions affecting community bioenergy uptake

D1.2 provides an initial mapping of the local framework and value chain conditions that affect the community bioenergy uptake at the regional and EU level. Political, legal, economic, environmental, social and technical aspects were examined through a thorough literature review and a series of interviews with all major types of project-relevant stakeholders both at the pilot and EU level.

D1.4: Definition of community bioenergy heating uptake needs and challenges

D1.4 provides an overall analysis of the bioenergy uptake challenges and needs both at the BECoop pilots and EU level. Workshops have been organised and carried out within Task 1.4 in which the pilot partners together with the local stakeholders have analysed the main barriers and drivers for the establishment of a RESCoop. Indicative intervention areas were preliminarily defined.

D2.2: Self-assessment tool for evaluating current regional status and future potential

This deliverable presents and describes the project-developed self-assessment tool. The tool consists of an evaluation methodology and self-assessment forms that can be used by stakeholders and entrepreneurs to track and assess the status of their community bioenergy projects. The tool helps the user to understand the current status, but also offers a "future itinerary" with recommended technical and business actions for the uptake of the local RESCoop features.

D3.1: Mobilisation actions for the development of community bioenergy projects

This deliverable describes the community mobilisation activities around local bioenergy heating projects and the structure of the developed bioenergy communities in the four target areas. Moreover, it provides a preliminary identification and definition of a pool of BECoop RESCoops.

1.3 Overview of the task actions

During T4.1 (M12 to M18), pilot partners were involved – with Fiper's support - in the definition of the most suitable scheme for developing a roadmap for each local BECoop RESCoop. To this end, the following steps were carried out:

- **A first round of virtual meetings** with pilot partners for sharing progress, information and experience from previous tasks and for defining the further information needed for the development of the roadmaps;
- **Data collection phase**, in which pilot partners were asked to provide quantitative and qualitative information about the pilot areas (such as biomass potential, existing facilities involved in the RESCoop vision, potential users of the community, etc.) in a dedicated template;
- **Second round of virtual meetings** with pilot partners for gathering information and sharing ideas and needs regarding the organization of the co-creation workshops (WSs);
- **Development** and review **of the co-creation WSs guidelines document** for each pilot;
- **Development** and review of the **co-creation WS reporting template document** for each pilot;
- **Implementation of the co-creation WSs**;
- **Analysis of the co-creation** workshops' results and **development of the roadmap** for each BECoop RESCoop.

1.4 Expected outputs

The activities described in the present deliverable are meant to collect useful information and experiences from other tasks and project's activities and to provide a systematic approach for a future effective establishment of the BECoop RESCoop in the pilot areas. The main output of this task is the development of the **roadmaps for the BECoop RESCoop** that will be supported by the project through a collaborative process with pilot partners and local stakeholders. The results of T4.1 will be used in other WP4 tasks.

Considering this, the main results and how they will be used in the following tasks are summarised as:

- *Which* needs will be satisfied by the development of the RESCoop (by a quali-quantitative approach);
- *Which* bioenergy sources will be exploited by the development of the RESCoop (by a quali-quantitative approach);
- *Which* stakeholders will support the implementation of the RESCoop in the pilot area, *in which* part of the supply-chain and *how*;
- According to the specific needs of the pilot partners and the stakeholders involved, *which* can be the most suitable scheme and vision of the RESCoop in the pilot area (T4.3);
- Investigation of the local supply-chain that is already in place or under development, and plan for its support within the following tasks of WP4 (T4.2);
- Targets to be achieved for an optimal implementation of the pilot vision and list of the demonstration activities for the BECoop project development (T4.4);
- Final roadmaps for each BECoop RESCoop.

2 Methodology

The approach, adopted by Fiper, for supporting the pilot partners in the definition of the RESCoop roadmaps was articulated into **three main phases**. (i) In a first preliminary phase, the proper information and outputs from the previous tasks and deliverables were acknowledged and discussed with pilot partners to agree on the most suitable and feasible solutions for the uptake of a bioenergy community according to the specific characteristics of each pilot area. This step was supported by a **data collection template.** (ii) Afterwards, through further consultations with pilot partners, co-creation WSs were organised with the aim of involving local stakeholders and communities in the definition of the features and the main steps for the establishment of the RESCoop. To this end, two documents (**WS guidelines, and co-creation WS reporting template**) were drafted by Fiper and reviewed by pilot partners to support the organisation of the co-creation WSs in the pilot area. (iii) Lastly, by analysing the WSs' output for each pilot area, the RESCoop vision of each partner was translated into a roadmap, main output of the present task. The method adopted in T4.1 is described in Figure 1.

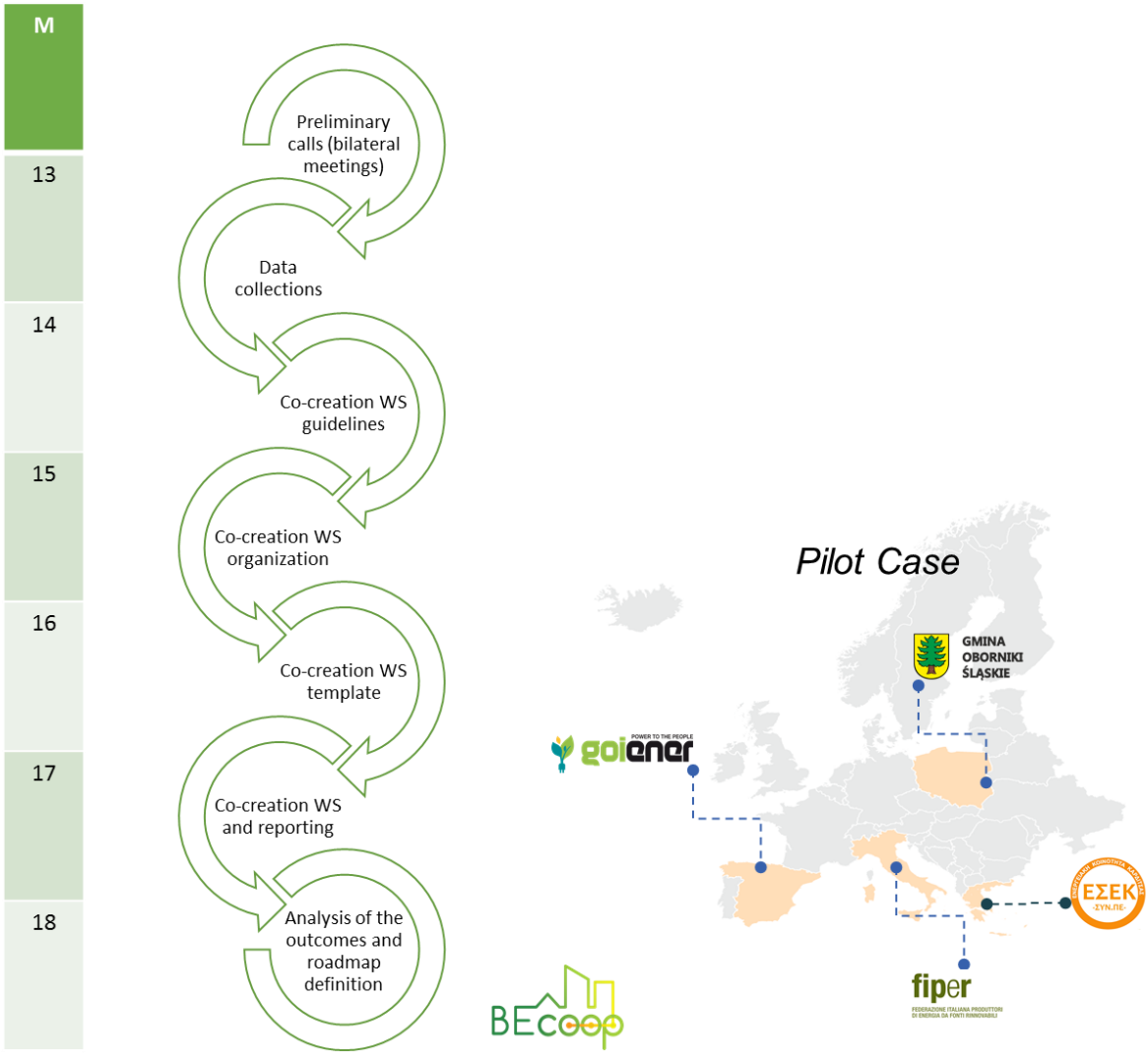

Figure 1. Scheme of the method adopted for the Roadmap definition.

2.1 Preliminary phase

As first step in T4.1, the state of the art of each pilot vision was assessed by Fiper by analysing the results and deliverables of previous tasks. Relevant information for each pilot was identified and reviewed in the perspective of supporting pilot in the definition of the most suitable RESCoop vision for each pilot area. Through the revision of the previous BECoop documents, Fiper highlighted the main criticalities and points to be further investigated.

2.1.1 Bilateral meetings with the pilot partners

Starting from this first analysis, a round of bilateral virtual meetings for each pilot with the involved BECoop partners was carried out, in which the following points were addressed:

- Presentation of the current status of the RESCoop vision;
- Discussion about the criticalities identified by Fiper;
- Organization of next steps towards the definition of a representative and feasible roadmap for each partner.

In such meetings, pilot partners were asked to present their vision for the RESCoop -at the moment- by considering former tasks, in particular T1.4, and to update the available information.

2.1.2 Data collection

In order to assess the status of each pilot by a quantitative approach and to allow Fiper to effectively support pilot partners in the definition of the RESCoop roadmaps, a data collection template was drafted and shared with pilot partners. In this phase, pilot partners were asked to provide:

- General information about the national context, energy market and system;
- Information and data related to the targeted users (energy demand side);
- Data related to the local biomass potential;
- Information about the resource collection and treatment/transformation and distribution.

Data collected was analysed by Fiper in order to assess the feasibility of the actions foreseen and further clarification calls have been scheduled.

2.2 Co-creation workshops organisation

One of the core activities of T4.1 was the organisation of the co-creation workshops (WSs). The workshops aimed at involving the local stakeholders into a co-development process to define the most suitable RESCoop vision in each pilot area and the actors to be involved in the supply chain.

A second round of virtual meetings was carried out with BECoop partners involved in each pilot. During these meetings the partners discussed, clarified and completed the information shared through the data collection template and agreed on the most interesting aspects to be faced during the co-creation WSs.

These meetings included the following sections:

- Summary of the previous WSs and updates from the pilots;

- Q&A about the data collection proposed by Fiper;
- Aims and targets of the co-creation WSs and progresses from the consultation WSs;
- Definition of support expected from Fiper.

2.2.1 Workshops guidelines and reporting template definition

Based on the results from the bilateral meetings, the discussion and the analysis of the data collected, the objectives and main topics to be faced in each of the co-creation WS were defined. In order to support the pilot partners in the design and organisation of the WS, two documents were drafted and shared:

- **Guidelines for co-creation WS organization:** this document contains a brief summary of the information and data collected from the pilot partners and elaborated by Fiper, organizational aspects, the specific objectives and expected output for each WS, considering the peculiarities of each pilot.
- **Reporting template:** this document provides a general structure for the co-creation WSs in order to guide pilot partners in the organization and reporting of the WS and the development of the final roadmap.

3 Co-creation workshops implementation

The following section briefly presents the way with which the co-creation WSs were implemented in each pilot case.

3.1 Greek pilot workshop

Due to the nature of activities and the biomass feedstocks that will be investigated in the Greek pilot (ESEK), two WSs (see Figure 2 and Table 1), instead of one, were organized in **Karditsa**, Greece. In the first WS, stakeholders related to the forest residues exploitation were invited, whereas for the second WS, stakeholders related to the exploitation of urban pruning and coffee residues (city biomass) were invited. In the first co-creation WS, ESEK along with CERTH, demonstrated to local authorities and stakeholders (the University of Thessaly, the Municipality of Lake Plastiras etc.), the need and potential of forest residues exploitation in the area. **A vision and roadmap for bioenergy projects** at the local level were discussed with local actors, focusing on the exploitation of the untapped forest residues towards the area's transition to energy independence from fossil fuels and rural development. In the same logic, a second WS was organised to discuss with relevant stakeholders the exploitation of local city biomass, such as urban pruning and coffee residues towards community bioenergy production. Both meetings allowed Government representatives and Ministries and local key-stakeholders to interact, exchange ideas, provide suggestions and plan a BECoop pilot community that would exploit the forest and coffee residues and urban pruning for heating purposes.

Figure 2. Co-creation WS in Karditsa.

Table 1. Main organisational details of the Greek pilot WS.

WS's details	Description
Date	23/02/2022
Physical/Virtual	Physical
Pilot partner	Energeiaki koinothta Karditsas ESEK
Pilot supporting partners	CERTH, Q - PLAN
Audience	21 participants (1st group: 12; 2nd group: 9)
Duration (hours)	2 hours per WS: ● WS1: 13:30 - 16:00 ● WS2: 19:00 - 21:00

In both WSs, an introduction was made by the facilitator and the structure of the event was introduced. Continuously, a round table was performed for everyone to present himself/herself. In both WSs, a presentation of the BECoop project and its objectives were presented. In addition, a brief presentation of the new activities of ESEK, as a RESCoop, were presented. Moreover, the success case of Lehovo, a northern Greek village was presented. There, a biomass boiler, which is operated by the municipal district heating operator, is used to cover the thermal demands of two schools, by using vine pruning chips and sunflower husk pellet. This case was presented in order for everyone in the WSs to realise that the new activities, for ESEK as a RESCoop exploiting new biomass feedstocks and selling heat, are feasible when scheduled properly. Continuously, several rounds of discussions ignited, where the need for the implementation of a bioenergy community and its positive impact were highlighted. The views of all stakeholders were expressed and a first dialogue took place between the participants/ key-stakeholders.

In order to maximize the effectiveness of the WS, the involved pilot and national supporting partners carried out the following **preparatory actions**:

- physical meeting with the deputy mayor of Karditsa for the city tree cuts, with the aim of better fine tuning and coordinating the urban pruning transportation to the biomass plant of ESEK as a demonstration activity;
- physical meeting with the president of coffee houses of Karditsa prefecture in order to better fine tune and coordinate the next steps for the collection of coffee residues;
- physical meeting with representatives of the University of Thessaly where the exploitation of forest residues was discussed along the coordination of the drafting of a letter, in cooperation with the municipality, that would address the ministry of environment. This letter concerns the implementation of a pilot project in the area, for the harvesting and treatment of forest residues;
- internal calls with CERTH in order to better coordinate the WS and its scope;
- field visit (ESEK - CERTH) in Lehovo village in order to record a biomass heating success case - biomass boiler that covers the heating demands of two schools in Lehovo, operated by the local district heating company- and present it to the WSs.

3.2 Italian pilot workshop

Thanks to the relationships that Fiper has with the mountain municipalities of the Lombardy region, it was possible to have primary exchanges with some small towns of Valtellina (Province of Sondrio, northern Italy), located in the same territorial area of successful experiences of forest biomass district heating (DH) systems (e.g., TCVVV of Tirano).

In particular, Fiper has initiated the dialogue with the mayor of the municipality of **Tovo Sant'Agata**, a non-methanised municipality located 8 km from the municipality of Tirano (Valtellina area) and presented the BECoop initiative to evaluate the interest in starting a community of renewable energy.

The first meeting took place on the 8th February 2022, with the mayor of Tovo Sant'Agata and a non-profit association involved in forestry management. The mayor showed interest in the initiative, which follows the strategy implemented by the municipality to replace oil boilers or wood stoves with biomass systems (pellets and chips). Indeed, the municipality has a small chip district heating micro-network that heats the municipal users.

The mayor suggested to involve also local companies in the REC initiative, in particular, Melavì, a historic apple processing cooperative, affected by the drastic increase of the electricity and heating

bills, to assess the feasibility of starting a biomass-fuelled co-generative mini-district heating network combined with the installation of photovoltaic panels.

After the preparatory actions, the co-creation WS took place at the Melavì plant in Tovo Sant'Agata on 22nd February 2022 (see Figure 3 and Table 2).

After the reciprocal introduction of the participants and of their goals, a preliminary evaluation of the feasibility of the Italian BECoop RESCoop was discussed. The active presence of key stakeholders contributed so that the WS succeeded in meeting the planned objective and a network of collaboration has been created. Participants were satisfied with their participation in the WS and were interested for the further development of the BECoop RESCoop, thinking also of synergies with other planned projects.

Figure 3. Co-creation WS in Tovo Sant'Agata.

Table 2. Main organisational details of the Italian pilot WS.

WS's details	Description
Date	22/02/2022
Physical/Virtual	Physical
Pilot partner	Fiper
Pilot supporting partners	Fiper
Audience	12 participants
Duration (hours)	10:00 - 13:30 + local tour during the afternoon

Another meeting was held at Melavì on 18 March 2022 concluding that, **for an optimal exploitation of the local available biomass, a combined heat and power (CHP) system can be the most promising solution.**

3.3 Polish pilot workshop

OBS organized two WSs for **two groups of stakeholders** (see Figure 4 and Table 3). The first group consisted of residents of the local commune, farmers, entrepreneurs, local activists, investors, representatives of scientific institutions, while on the second day representatives of local authorities were invited: village leaders, representatives of village councils, town council members.

This approach was selected i) to **build from scratch a local biomass supply chain**, facilitating the development of bioenergy cooperatives in the region, ii) identify experiences in the use of biomass for energy purposes, and iii) overcoming barriers to the creation of local initiatives. After a reciprocal presentation, introducing the BECoop project and the idea for the development of the BECoop RESCoop initiatives, many issues were discussed. During the meetings, the goals and objectives of the BECoop project were presented, clarifying the participation of the Oborniki Śląskie commune, the contributions by energy cooperatives, the commune's potential in terms of biomass use for energy purposes. Attention was paid to identify the best dissemination channels to involve citizens, local entrepreneurs, local authorities and residents in discussions around energy issues and the possibility of establishing this type of projects.

Figure 4. Co-creation WS in Oborniki Śląskie.

Table 3. Main organisational details of the Polish pilot WS.

WS's details	Description
Date	16/03/2022 and 17/03/2022
Physical/Virtual	Physical
Pilot partner	OBS
Pilot supporting partners	WUELS
Audience	31 participants (1st meeting: 20; 2nd meeting: 11)
Duration (hours)	3 and half hours per each meeting

Farmers showed a great deal of interest in energy communities but are still hesitant due to unsuccessful previous projects. They also expressed the concern that with a further increase in fertilizer costs, they would be forced to leave biomass on agricultural land in order to enrich the soil with nutrients. Consequently, this would result into reduced amount of biomass that could be transferred to cooperatives. Another problem may be the increase in the price of straw, which may translate into an increase of the price of the produced pellet for the cooperative.

The Oborniki Śląskie Commune was recognized as the **pivotal element** in defining the structure and features of the RESCoop, as well as the creation and support of a local biomass supply chain.

The **Polish regulation** was discussed underlining the constraints in developing the BECoop RESCoop, the absence of funding mechanisms for the creation of energy cooperatives and the current situation of the energy market: electricity prices have increased by 30-50%, gas by 80-100% or more.

It was discussed that Poland as a country, as well as the Oborniki Śląskie Commune, have not invested enough in the energy transformation mainly because coal burning still paid off more than new investments in renewable energy. Local self-government representatives showed their willingness to support the vision of the BECoop project. Each group showed the need to be self-sufficient in the region, and all agreed that without the possibility of **financial support** it may be unrealistic and difficult to create an energy cooperative.

During the discussions, the use of biomass for energy purposes was introduced, knowledge and experiences on the use of renewable energy sources were exchanged, and **the potential of the commune in terms of the use of biomass in heating systems was examined.** An important issue was also to identify barriers to the creation of local social initiatives as part of their independence from the supply of fossil fuels (coal, gas, fuel oil).

3.4 Spanish pilot workshop

Before the WS, the involved pilot partners carried out the following actions, to maximise the effectiveness of the co-creation WS:

- Work with the energy team from **Vitoria/Gasteiz city council (AVG)**, on the preliminary action plan (road map) for **Aberasturi** BECoop RESCoop;
- Meeting with the energy and rural development groups of AVG in order to follow-up on project initiatives and progress, present the scope of the co-creation event and discuss the preliminary accompaniment actions;
- Work with the energy team from AVG, on the topics and dates for the co-creation event;
- Preparation of the invitation/presentation fact sheet for the board members from the small rural village (Aberasturi BECoop RESCoop) dependent on the AVG;
- Internal meeting with CIRCE regarding the scope and material to be shared during the event.

During the WS: After introducing each of the participants, the BECoop concept was presented alongside with the accompaniment activities foreseen for the Aberasturi BECoop RESCoop. Also, the reasons for selecting Aberasturi were presented, supported by preliminary information collected at the beginning of T4.1. To close this first part, general concepts about bioenergy value chain were explained and how the level of involvement of the community will affect this structure and involved group of interest.

An exercise of open discussion was then carried out to rank the most important aspects to be achieved, obtaining results such as **the reduction of the current energy bills, advantages related to DH for final users, community building, benefits related to the energy and economic self-sufficiency and decarbonization**. During these first steps of accompaniment activities, available resources identification and consumption data collection tasks were performed, as a part of the roadmap defined during this co-creation event.

The **end users** were identified as 49 dwellings out of 56, which represents almost the entire village, in addition to two buildings of the Aberasturi Administrative Council.

The **energy sources** were identified as: 1,000 tonnes of straw available at the end of summer (currently it is managed free of charge by an external company to be valorised in a big thermoelectric plant located 150 km away from Aberasturi); 9 tonnes of wood biomass per house. At this moment, both raw materials should be considered in the study.

According to this, **small DH systems fed by local biomass resources have been identified as a proper solution.**

Table 4. Main organisational details of the Spanish pilot WS

WS's details	Description
Date	16/02/2022
Physical/Virtual	Physical
Pilot partner	GOI
Pilot supporting partners	CIRCE
Audience	12
Duration (hours)	2 hours and half

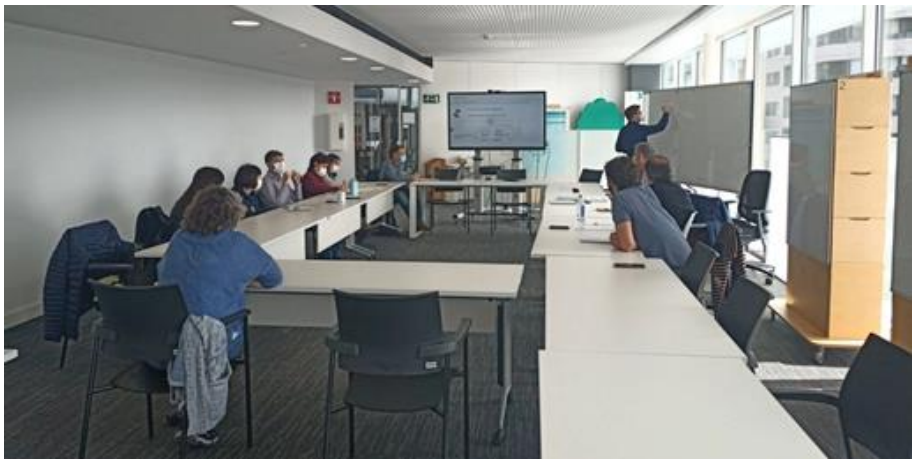

Figure 5. Co-creation WS in Aberasturi.

The template of the co-creation WS properly compiled including also the relationships among the activities of T 4.1 and of T 4.2 and T 4.3.

GOIENER selected the hamlet of Aberasturi as the main BECoop RESCoop to which most of the accompaniment efforts from T4.2, T4.3 and T4.4 will be dedicated.

However, in order to have a broader base for developing the pilot, beyond the bioenergy services to be offered in the Aberasturi energy community, the Spanish partners will support **a second, smaller BECoop RESCoop in the village of Murgia**, which is expected to offer an additional replication potential in the region. These main activities are related to conducting a preliminary business plan for deploying a biomass solid fuel production and a retail service under the umbrella of an energy community. In that second case, the entire bioenergy value chain from forest to heat will not be covered as in the Aberasturi BECoop RESCoop, but focus will be placed on the first stages of the biofuel production cycle.

4 BECoop RESCoop Roadmaps

4.1 Greek BECoop RESCoop Roadmap

4.1.1 Introduction

Karditsa is a city in western Thessaly in mainland Greece with around 39,000 inhabitants. Currently, the main resources used for thermal purposes are oil (53%), electricity (22%) and natural gas (18%), while **biomass represents only the 6%, despite the great untapped potential** quantified in:

- ✓ 14,000 t/y[2] of wet biomass that can be collected from urban pruning in the whole prefecture of Karditsa; the pruning deriving from city trees are either left in the open-space or burned in open fires or disposed in landfills;
- ✓ 4,400 ha of forests (owned and managed by the municipality of Plastira, 35 km from Karditsa), i.e. about 5,000-8,000 t/y[3] (dry) as biomass residue, that is left inside the forests, without being exploited;
- ✓ 300 t/y (dry) of coffee residues that are disposed in landfills.

Despite fossil fuels are mainly used for energy purposes in the region, one of the most important levers to foster the use of biomass is the **prices in the current market**. In the last months of 2021 the prices of natural gas, oil and electricity raised by, respectively, 160%, 56% and 47% (prices in November 2021 were: 98 €/MWh for natural gas, 233.8 €/MWh for electricity, 110 €/MWh for oil and 65 €/MWh for wood pellet); further increasing have happened due to the recent energy crisis at the beginning of 2022. **Such fluctuations of the energy market seem to have a lower effect on biomass fuels**, since they are produced locally, and whose prices are mainly affected by the collection and treatment costs.

Aim of the BECoop project and T4.1 is to expand the activities of an existing energy community in Karditsa, ESEK, towards the production of community bioenergy. **ESEK already owns a pellet production facility in Karditsa.** The pellet plant is currently operating by transforming sawdust and wood residues into pellet with a capacity of 1,200 t/y. **The goal of BECoop activities is to expand the currently sources of biomass that are used by ESEK to new local feedstocks that remain untapped, such as forest/agricultural residues, urban pruning and coffee residues**. Furthermore, the aim for the Greek BECoop pilot is **to also expand its existing activities into producing alternative biomass fuels e.g. pellets from such residual biomass sources, and the operation of ESEK as an ESCO by installing and operating biomass boilers in public buildings and by selling heat to customers**.

During the co-creation WSs that were held in Karditsa with various key-stakeholders, the abovementioned concept of bioenergy community was presented and the following main aspects were defined regarding the Greek BECoop pilot:

- Energy exploitation of city pruning and reduction of the amount that end up in illegal landfills;
- Energy exploitation of the forest residues and reduction of fire events due to such residues;
- Energy exploitation of coffee residues and reduction of the amount that end up to landfills while reducing disposal waste cost for the municipality;
- Reduction of the current fossil energy consumption and CO_2 emissions;
- Energy resilience and energy independence for the region;

[2] INTENSSS- PA. H2020 Project, Integrated Sustainable Energy Plan RLL of Karditsa (2018)
[3] Filippou, V. and I. Philippou. 2014. Harvesting methods of logging residues. 10th. National Congress on Renewable Energy. 26-28 November, 2014, Thessaloniki.

- Need to promote the concept of local circular economy, bioeconomy, environmental consciousness, bioenergy, tackling energy poverty.

A synoptic overview of the Greek BECoop community is presented in Figure 6. The figure presents the existing activities of ESEK and the new BECoop activities that are investigated through the project.

Figure 6. Overview of the RESCoop to be investigated (Greek pilot).

4.1.1.1 Involved stakeholders

In order to develop a BECoop pilot case a variety of stakeholders should be involved. A group of involved stakeholders during the WSs were consulted with regards to the new activities. The thematic list of involved stakeholders in the Greek BECoop community is reported in Table 5.

Table 5. List of stakeholders (Greek pilot).

Stakeholder	Role
ESEK	(BECoop partner) Energy cooperative – biomass facility operator, responsible for storage and treatment of collected biomass.
Municipality of Karditsa	Provides the urban pruning, potential end- user of biomass fuels (e.g., public buildings, swimming pools, schools etc.).
Municipality of Plastiras lake	Contribution at the exploitation of the forest residues (municipal forest), potential end user of biomass fuels (e.g., public buildings, swimming pools, schools etc.).
CERTH	(BECoop partner) Technical consultancy on new biomass-based activities.
University of Thessaly - Department of forestry wood sciences and design	Provide academic support for the production of biofuels and the exploitation of forest residues.
Oksigono Agrafon (NGO)	Possible contribution at the exploitation of the forest residues.
Ecoperativa (NGO)	Possible contribution at the exploitation of the coffee residues.
Agency development of Karditsa AN.KA	Networking and consultancy.
Biomass boiler manufacturers	Provide support in the installation and operation of biomass boilers in the local area.

Stakeholder	Role
Citizens, farmers, forest cooperatives, coffee shops	Provide feedstock, end-users, general role in the community.
Local hotels and industries	Potential end users of biomass fuels.

4.1.1.2 Community concept and structure

A pivotal element of the Greek RESCoop vision is the expansion of the products and services of the already existing ESEK's pellet production facility.

First of all, the new feedstocks that are investigated in the Greek BECoop are (Figure 7):

- ✓ **Residual urban biomass from the city tree cuts (pruning):** the municipality of Karditsa performs city tree cuts and produces, according to the Integrated Sustainable Energy plan of Karditsa[4] in 2018, 14,000 tons of residuals annually; however, the actual quantities that can be exploited are expected to be smaller and will be estimated within the following WP4 activities. Currently, city pruning ends up in illegal landfills and many times they cause fires, producing smog and health problems. During the WSs, the municipality of Karditsa proposed to process together with ESEK the obtained residual biomass. It was also mentioned that to avoid that city tree cuts residuals are disposed with various other wastes, such as plastics, iron etc. that makes the biofuel production impossible, citizens should be trained and informed. Furthermore, it was also added that the municipal staff should be trained in order to collect only the pruning and no other wastes, when harvesting urban pruning. **During the WSs, it was highlighted that the municipality could procure a wood-chipper and process the produced pruning on the spot. Thus, in the BECoop community, the city pruning will be performed by the municipal workers, along with the transportation of city pruning to ESEK biomass plant. Then, ESEK will store the city pruning and treat them into chips or pellets.**
- ✓ **Wood from the maintenance of the local forests**: In the mountainous area of Lake Plastira, around 20 km from the city of Karditsa, there is an untapped source of biomass that remain unexploited. The second new feedstock stream that will be investigated for the Greek BECoop pilot is the forest residues, that currently are mainly left inside forests. **During the WSs, the municipality of Lake Plastira (through its mayor) showed their strong support and committed to participate in a pilot project for harvesting local forest residues for the production of bioenergy.** Special mention was made for the current legal framework that hinders forest residues exploitation and that need to be revised. Another challenge mentioned, is the unknown assessment of local forest residues. In this light, during the BECoop project, it is suggested to perform on-field measurements to local forests in order to determine the quantities of the residual forest biomass. **In the BECoop community, the management of municipal forest and the forest operations could be performed by the forest cooperatives, along with the forestry state office, that could also be responsible for the transportation of forest residues. ESEK will be responsible for their treatment.**
- ✓ **Residual of coffee from the rural coffee houses**: in the region of Karditsa there are around 800 coffeehouses that produce 450 t/y (dry) of residual coffee (300 dry t/y are located at the city of Karditsa). Coffee residues are currently disposed in landfills and burden the municipalities with waste disposal costs. Thus, the third feedstock stream to be investigated in the Greek BECoop pilot is that of coffee residues. The concept is that the coffee residues from each coffee

[4] INTENSSS- PA. H2020 Project, Integrated Sustainable Energy Plan RLL of Karditsa (2018)

houses are collected once per week (ESEK or a municipal worker would be responsible for the transportation) and transported to ESEK biomass plant for storage and treatment. There should be extensive discussions with the management of each coffee house in order to determine and end up with the most effective way of residual coffee collection, as well as the timeline of the collection of the residues, in order not to create other problems such as storage and biodegradation. **During the WS, it was mentioned that the municipality could also provide a motivation to the participating coffee shops by reducing their municipal taxes and providing a green label to participating coffee houses.**

Further to the new feedstocks, the RESCoop will have two main activities (Figure 8):

- ✓ The production of "alternative" biomass fuels such as pellets from the new feedstocks. Based on the new feedstocks and the existing pellet plant, which can currently produce up to 0.5 t/h of pellets, ESEK will be able to expand its supply chain and produce new mixtures of alternative and cheaper solid biofuels.
- ✓ The operation of ESEK as an ESCO by installing (by ESEK or by third parties such as collaborating boiler manufacturers) biomass boilers to public buildings, local industries etc. and by selling heat to the customers. In this way, ESEK will provide the biomass fuels to the end-user, operate the biomass boilers that are installed and get revenues by selling heat (per kWh), whereas the end-users will only have to pay for their heat consumptions.

The second activity regards the promotion of a **new turnkey service for space heating (SH)**, including biomass supply, pellet production, boiler installation and operation and sale of thermal energy. In this frame, ESEK could install biomass boilers to public buildings, local industries etc. and sell heat to the customers. Thus, the end-users will only have to pay for their heat consumptions and not bother with the maintenance of the boilers and their fuel supply. An issue regards the identification of suitable biomass boilers and manufacturers for the produced biofuels to properly and efficiently burn the biofuels (pellet/wood chips). In this light, during WP4 activities, the identification of suitable boilers will be performed, along with combustion tests with the new produced fuels at suitable boilers.

As reported above, Figures 7 and 8 present the RESCoop concept for ESEK with the investigation of the new feedstocks (urban pruning, forest residues and coffee residues), the new products/activities and logistics details. Furthermore, Figure 9 provides an overview of the location of ESEK's plant, the sourcing distances of the new feedstocks from the plant and the distance to the potential end-users.

Figure 7. Scheme of the new feedstocks available (Greek pilot).

Figure 8. Scheme of the new products and activities (Greek pilot).

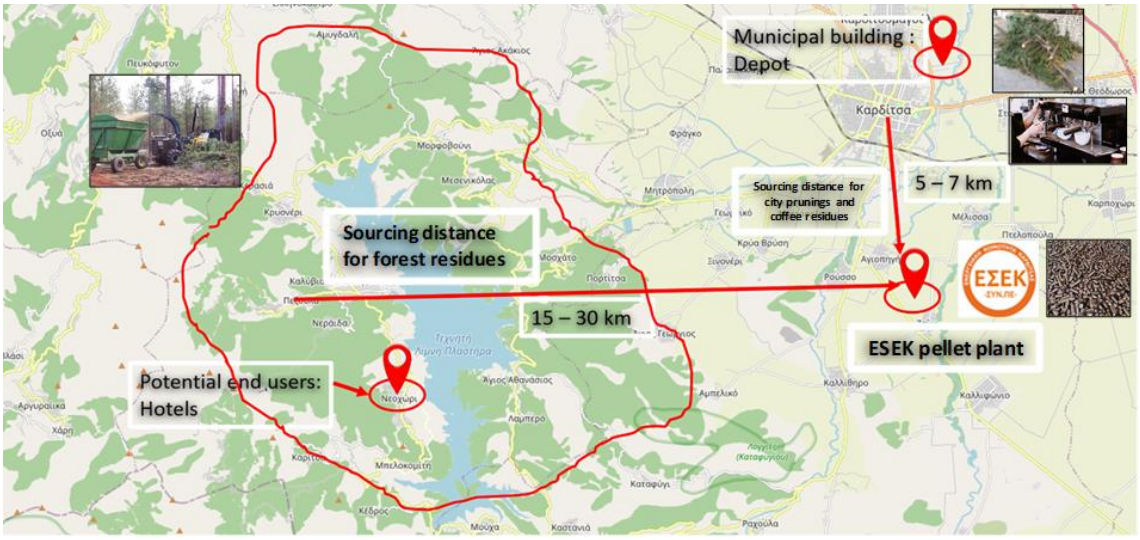

Figure 9. Locations of ESEK pellet plant, of new feedstocks and of potential end users (Greek pilot).

4.1.2 Challenges and opportunities

The challenges and opportunities that arise for the complete implementation of the Greek RESCoop vision in the pilot area are summarised below.

4.1.2.1 Challenges

- ✓ **Identification of end users for the new services.** Due to the nature of the solid biofuels, to make viable such new activities, the end use of the produced fuels should be secured. For these new activities, a pilot application is crucial to convince the municipality that the exploitation of the local residual biomass and the conversion to biofuels, such as pellet, could be a sustainable and reliable way to switch from fossil fuels to renewable energy sources (RES). After considering available information about local public buildings, it was agreed that more detailed estimations of heating demand of potential end users have to be performed in the following WP4 activities;

- ✓ **Legal framework for the harvesting of the forest residues**. The Greek legislation for the exploitation of forest residues is dated and modifications are needed to make the harvesting of forest residues a viable solution for the forest cooperatives. Examination of the existing legal status for the harvesting of forest residues and proposal of changes should be performed in the following activities;
- ✓ **Unknown forest residues potential in the local forests and lack of harvesting mechanisms.** To tackle such challenge, field measurements of forest residues in the mountainous area of the municipality of Plastiras Lake should be performed in the following WP4 activities for a more accurate assessment. Furthermore, during the upcoming tasks of WP4, the determination of the most suitable methods for the harvesting of forest residues that suit the local conditions (territorial morphology, biodiversity, etc.) would be performed along with field visits of local people to successful cases of forest residues exploitation;
- ✓ **Sorting of pruning.** It is very often that after the city tree cuts, the products collected contain various other wastes, such as plastics, iron etc., thus the process and biofuel production is not possible. Citizens should be educated and informed that the pruning are not waste but they can be used as raw material for energy production. Also the municipal staff should be trained in order to collect only the pruning and no other wastes, when transporting them to ESEK's plant;
- ✓ **Identification of residual coffee collection methods**. The collection could be a significant obstacle since each coffee house has its own way of collecting their wastes according to their design, available space, even the way (habit) that the employees have adopted. Some coffee houses express their unwillingness to keep their coffee wastes for more than a week at their shops due to odor, space unavailability etc. There should be extensive discussions with the management of each coffee house in order to determine the most effective way of residual coffee collection, as well as the timeline of the collection of the residues, in order not to create other problems such as storage and biodegradation;
- ✓ **Identification of suitable biomass boilers and manufacturers for the produced biofuels.** Since the raw materials come from residues, they are a non-uniform biofuel in terms of the quality and grain size. The identification of the properties of the produced biofuels, as well as the identification of suitable biomass boilers and manufacturers should be performed in order to properly and efficiently burn the biofuels (pellet/wood chips). In this light, combustion tests with the produced fuels at suitable boilers and emissions testing would help in dealing with such criticality;
- ✓ **Investment costs and finding funding opportunities.** Costs such as for biomass boiler installations in public buildings is a challenge and should be explored.

4.1.2.2 Opportunities

- ✓ **Exploitation of currently untapped local biomass resources (forest residues, urban pruning, coffee residues).** The new feedstocks to be investigated in the region are either disposed in landfills or burned in open fires, without being exploited. Thus, the main opportunity is the vast availability of local (residual) biomass;
- ✓ **Existing facilities of ESEK and ESEK itself.** As there is the experience and the facilities in handling biomass in the area, there is no need to start from scratch. Moreover, there are biomass logistics mechanisms in place;

- ✓ **Presence, in the region, of various potential end users for biomass heating** such as public buildings, schools, swimming pools, local industries. For instance, the municipality of Karditsa owns about 38 kindergartens, 25 elementary schools and 21 high schools, without considering the other municipal buildings. Furthermore, interest of hotels and resorts in the mountainous area of Lake Plastira will be investigated through the upcoming tasks of WP4, along with local industries and other public buildings in the pilot area. Regarding the municipality of Plastiras Lake, it should be mentioned that the mountainous area is the most developed tourism municipality in the prefecture of Karditsa. Thus, there are many hotel complexes/resorts in the area (47 hotels/1016 rooms) with heating needs.
- ✓ **Fuel prices of fossil-based products.** Recent severe fluctuations of the energy market, especially on fossil fuels, seem to have a lower effect on biomass fuels, whose prices are mainly affected by the collection and treatment costs;
- ✓ **Rural development and create new jobs in the local area.** This is possible due to the activities needed for the collection and treatment of biomass (employers, machineries etc.);
- ✓ **Positive environmental impact**. By exploiting the abovementioned feedstocks, it would decrease the use and dependency on fossil fuels and would tackle fire-hazard risks from burning residual biomass in open fires or leaving forest residues inside local forests;
- ✓ **Reduction of energy poverty.** The community bioenergy would support the reduction of energy poverty in the local area.
- ✓ **New energy paradigm**. By implementing a community bioenergy concept, a democratized and decentralized energy system is supported, that depends on local citizens and secures energy safety in the local area.

4.1.3 Community's roadmap

A detailed **action plan** for the next months of the project is presented herein (see also Table 6) and based on that, ESEK will investigate the proposed BECoop activities to further elaborate on its own future roadmap. In the next months the following activities will be accomplished:

- Retrieval of more information within the following tasks of WP4 for identifying the potential end users;
- Identification of appropriate boilers for the alternative fuels and combustion tests;
- Identification of the business model for each activity;
- Field measurements of residues of municipal forests and other biomass (coffee houses, city pruning estimation etc.);
- Training of the involved stakeholders on the activities suitable for the development of the pilot (municipal staff, coffee houses staff, citizens, etc.);
- Definition of memorandum of collaboration between the municipality and ESEK, and of contracts between ESEK and the coffee houses plus ESEK and the end users;
- Establishment of regular meetings in order to consolidate the involvement of the mentioned stakeholders.

Table 6. RESCoop action plan (Greek pilot).

Months /Actions		M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32
• Co-creation WS																		
City Tree Pruning	• Recording of the existing equipment of Municipality of Karditsa that can be used in the collection and transportation of city tree pruning • Training of the municipal staff for the correct sorting of pruning (separation from garbage, plastics, waste, etc.) • Transportation of city tree pruning, through municipal trucks, to ESEK • Recording data of the process (time, costs, etc.) and process optimization suggestions • Identification of business model/provision of financial services • Memorandum of cooperation with the municipality of Karditsa for the exploitation of city tree pruning																	
Coffee Residues	• Identification of residual coffee collection methods and formation of logistics supply chain • Pilot collection of residual coffee from coffee houses • Recording of the problems created by the collection of the residual coffee in coffee houses • Inform and train the staff of the coffee houses for the optimal collection of the residual coffee																	

Months /Actions		M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32
	• Identification of business model/provision of financial services																	
Forest Residues	• Examination of the existing legal status for the harvesting of forest residues and propose changes • Pilot case: Field measurements of forest residues of municipal forest; Study of the available quantities of forest residues in the mountainous area of the municipality of Plastiras Lake • Determination of the most suitable methods for collection of forest residues that would suit the local conditions (territorial morphology, biodiversity, etc.) • Field visit for knowledge transfer regarding the collection and exploitation of forest residues in other countries (e.g. Italy) • Identification of business model/provision of financial services • Preparation of an official document written by the Municipality of Lake Plastira, University of Thessaly and ESEK, to the Ministry of Environment for a pilot program of energy utilisation of local forest residues																	
Production of "alternative" solid biofuels	• Processing and production of solid biofuels from coffee residues, forest residues and urban pruning (and mixed)																	

Months /Actions		M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32
	• Identification of the properties of the produced biofuels • Combustion tests of biofuels produced in an suitable biomass boiler and measurement of emissions and particles																	
Space heating supply	• Assessment of the state of heating systems of municipal buildings • Identification of potential end users (municipal buildings, industries, hotels etc.) for the produced biofuels • Identification of suitable biomass boilers and manufacturers for the produced biofuels • Identification of business model/provision of financial services for the selling of heat and/or of the produced biofuels (from coffee residues, forest residues and urban pruning)																	

4.1.4 Community's vision towards 2030

The vision towards 2030 implies the implementation of the overall project, including the possible **increase of the ESEK plant capacity and expansion of its activities**. Based on the accumulating experience of the BECoop community in handling the new feedstocks and through its new business activities, the community would continuously develop. The Greek BECoop community's plan in the following years, after the end of BECoop project, can be presented as a timeline with the following general objectives/milestones:

- ✓ **2023 (end of BECoop project):** Successful demonstration of value chains regarding the exploitation of new feedstocks (coffee residues, forest residues, urban biomass) and production of biofuels;
- ✓ **2025:** Production of 200 t/y of pellets from coffee, forest and urban residues;
- ✓ **2026:** Installation of 20 biomass boilers in 20 public buildings. Covering of about 3,500 MWh of thermal needs in the area;
- ✓ **2027:** Increase of the productive capacity of ESEK pellet plant. Expansion of business activities in nearby areas and selling biofuels to public buildings and industries in neighbouring regions;
- ✓ **2028:** Building on the accumulating experience in handling the new feedstocks, and by acquiring the required equipment, the BECoop community will be able to harvest 3,000 dry t/y of forest residues, 4,000 dry t/y of urban pruning and collect 300 dry t/y of coffee residues from the local area;
- ✓ **2030:** Investment on a biomass plant of 1 MW of electric power, fueled with local biomass.

The scheme of the roadmap is drawn in Figure 10, while Table 7 shows the main element characterizing the vision of the future community, underling also the relations to T4.2, 4.3 and 4.4.

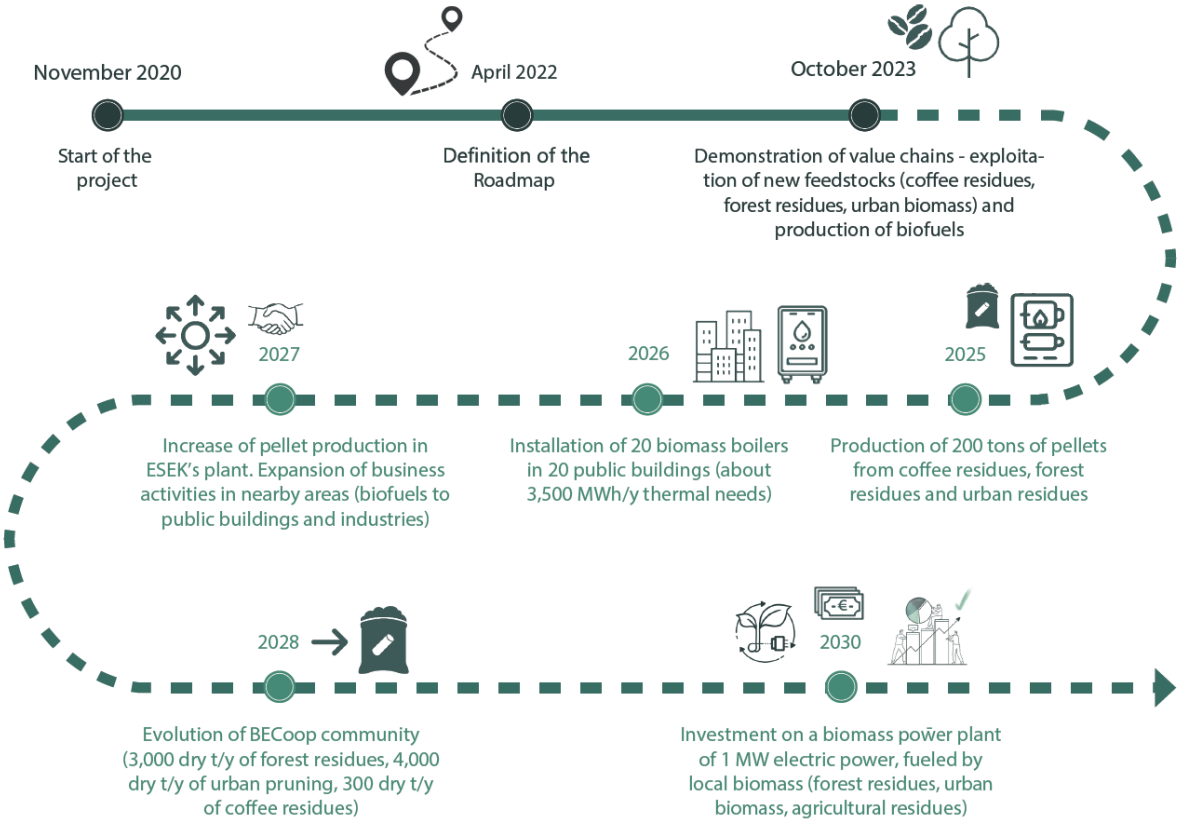

Figure 10. Scheme of the roadmap (Greek pilot).

Table 7. Stakeholders involved and vision of the BECoop RESCoop (Greek pilot).

MAIN STAGES	FEED-STOCK AND COLLECTION			TREATMENT/ TRANSFORMATION AND DISTRIBUTION	OPERATION, MANAGEMENT AND EVOLUTION
Mobilizing new biomass feedstocks/exploring new business models	Spent coffee grounds Challenges: ● Establishing a working collaboration with the local coffee shops ● logistics regarding the collection of coffee residues and their storage	Green waste / urban pruning Challenges: ● Establishing a working collaboration with the local municipality	Forest residues Challenges: ● Establishing a working collaboration with the local municipality & forest cooperative ● Current legislation framework on exploiting forest residues ● Technical solutions for forest residue extraction in local conditions (e.g. slopes)	Production of alternative biomass pellets / fuels Challenges: ● Defining appropriate feedstock mixtures (saw dust/ wood residues, coffee residues, forest residues, agricultural residues, urban pruning etc.)	Evolution to an ESCO / heat sales Challenges: ● Defining suitable equipment providers ● Identifying suitable clients ● Establishing a business model
Stakeholders Involved/ Potential roles	● Local coffee houses: provide the residual coffee ● ESEK: storage and treatment of coffee residues. Also potential stakeholder in charge of coffee residues transportation from coffee shops to ESEK plant. ● Citizens ● NGO such as in Common / Kafsimo project: already does coffee residues collection in two Greek cities. Transfer know-how/ consultancy ● Municipality of Karditsa: Could provide municipal tax reductions to local coffee shops that participate in such initiative. Also potential	● Municipality of Karditsa: perform city pruning and transportation to ESEK plant. ● ESEK: storage and treatment of city pruning ● Citizens	● Municipality of Limni Plastira ● Forest Cooperative: Management of municipal forest. Along with forestry state office and forest cooperatives, perform forest operations ● ESEK: storage and treatment of city pruning ● Ministry of Environment and Energy (forest service) and Policy Makers: Update current legislation for supporting the forest residues collection and exploitation	● ESEK: Pellet production unit ● University/ Research Organisation for supporting appropriate feedstock mixtures and the pelletization process ● End User / Customer identification: municipal/ public buildings, schools, swimming pools, hotels/ resorts in mountainous area, local industries	● Biomass Boiler Manufacturers ● ESCOs ● Municipality of Karditsa ● End User / Customer identification: municipal/ public buildings, schools, swimming pools, hotels/ resorts in mountainous area, local industries

MAIN STAGES	FEED-STOCK AND COLLECTION			TREATMENT/ TRANSFORMATION AND DISTRIBUTION	OPERATION, MANAGEMENT AND EVOLUTION
	stakeholder in charge of coffee residues transportation from coffee shops to ESEK plant				
Service already in place?	● There are about 450 t (wet) of residual coffee in the prefecture of Karditsa. Until now, coffee residues are not exploited and are disposed in landfills	● Each year the municipality of Karditsa perform tree cuts. Until now, city tree pruning are left in open spaces (illegal landfills) or burned in open fires, remaining unexploited	● There is a municipal forest of 4440 ha. Currently forest residues are most commonly left inside forests and not exploited	● Pellet production	n.a. – to be explored
BECoop (potential) Activities	● T4.2: Technical services – identification of collection methods ● T4.3: Financial services – business model & financing ● T4.4: Small-scale demo for collection of local coffee residues (planning, monitoring, data collection)	● T4.2: Technical services – optimization of collection method. ● T4.3: Financial services – business model & financing ● T4.4: Small-demo – collection and treatment of urban pruning collected biomass. Quantification of city tree biomass that can be exploited.	● T4.2: Technical services – identification of harvesting methods ● T4.3: Financial services – business model & financing ● T4.4 (small-scale demo): On field measurements on local forest residues production and/or field trip with local stakeholders (forest cooperative, municipality) to successful cases of forest residues exploitation (knowledge transfer on harvesting technologies etc.) ● T5.3: Policy change recommendations on forest residues harvesting and exploitation	● T4.2: Technical services – mixed pellet fuel analysis. End User / Customer identification ● T4.3: Financial services – business model & financing ● T4.4 (small-scale demo): Pilot mixed pellet production	● T4.2: Technical services – identification of boiler manufacturers. End User / Customer identification ● T4.3: Financial services – business model & financing ● T4.4: Small-demo – combustion validation tests with new “alternative” fuels

4.2 Italian BECoop RESCoop Roadmap

4.2.1 Introduction

In a first step, several municipalities in northern Italy, suitable for the implementation of a biomass energy community, were evaluated. Among them, the pilot case of **Tovo Sant'Agata** was selected, as it was the most promising for implementing a RESCoop within the timeframe of the BECoop project. The site is framed in the context of the non-methanised area of Valtellina (Province of Sondrio, northern Italy), where successful experiences of forest biomass DH systems (e.g., TCVVV of Tirano) and of wood biomass uses in domestic boilers and stoves are available.

During the arranged WSs, **many boundary conditions emerged that make this BECoop RESCoop promising for the project**, such as:

- The wide local biomass potential from forest residues and pruning of apple trees and vineyards (apple and wine are two important local products in Valtellina);
- The absence of the natural gas grid: without natural gas, the adoption of biomass heating systems could substitute oil systems that are less competitive under the economic and environmental point of view;
- The presence, in Tovo Sant'Agata and in the next Lovero and Mazzo municipalities, of households currently heated by oil boilers and obsolete wood stoves. Due to the habit of local people of adopting wood biomass as heat source in their home, a low risk of NIMBY effect can be expected in regard to biomass DH;
- The presence of Melavì, a cooperative involved in local apples commercialization rooted in the territory, promoter of energy efficiency and energy consciousness initiatives. Due to its activities. Melavì has very high electric needs and also thermal needs, an essential prerequisite for developing efficient CHP systems;
- The presence of other companies and factories operating in the food and medical product sectors;
- The co-presence of climatic conditions characterised by rigid winters and households with low energy performance, therefore the expectation of high heating needs to be satisfied, despite the not high density of the built environment;
- The high replicability potential of the initiative;
- The high interest and strong dynamism shown by the mayor of Tovo Sant'Agata;
- The possibility to develop further local economic activities exploiting local resources and traditional products;
- The possibility to enhance the local tourism due to the attractiveness of Mortirolo (which involves a mountain bike circuit quite famous in Italy).

The municipality of Tovo Sant'Agata, sensitive to sustainability issues at community level as demonstrated by projects already accomplished and in progress, has confirmed the intention of developing a biomass DH system, with the possibility to involve also other neighbouring municipalities such as Lovero and Mazzo (Figure 11). This project could contribute to decrease fossil fuels consumption, greenhouse gas (GHG) emissions and particle's emissions derived from the wood combustion in obsolete domestic systems, and to increase price stability for the citizens.

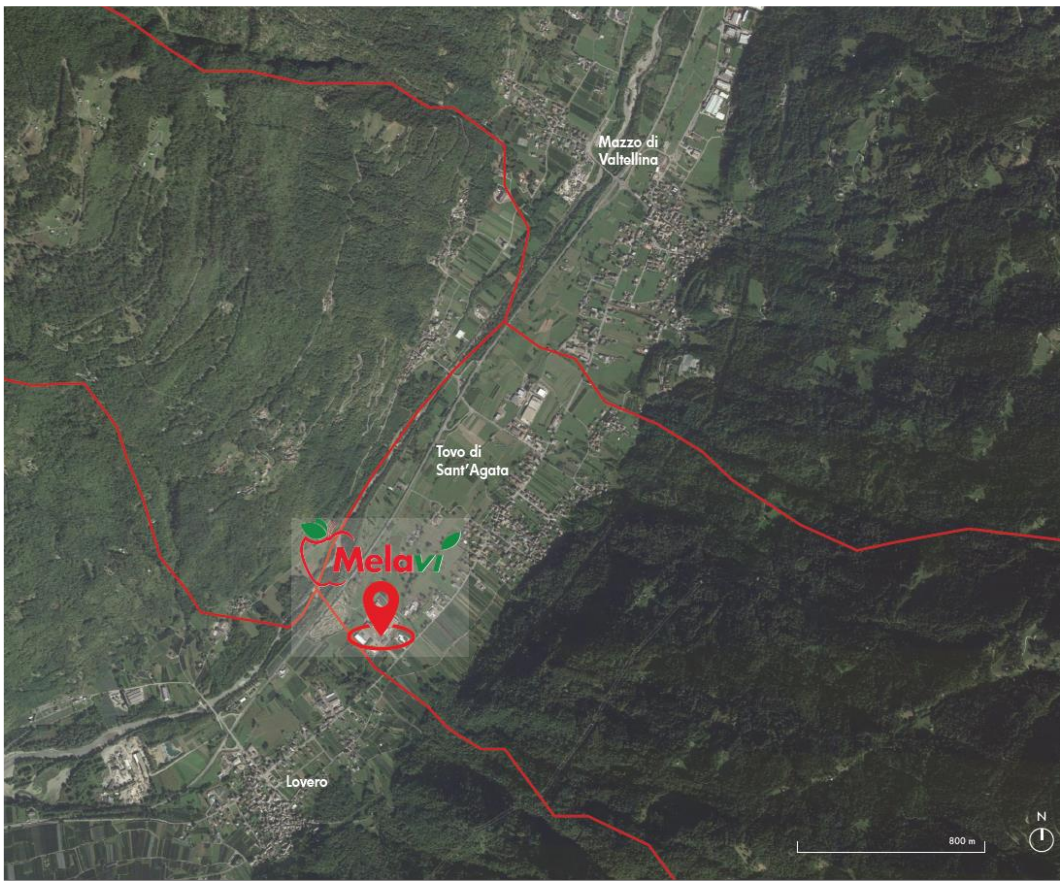

Figure 11. Map of the municipalities potentially involved (Italian pilot).

In addition, an accurate **analysis of the energy consumption and expenses of Melavì** has been carried out, stressing the need of a new lighthouse example to promote self-generation and self-consumption, and to present opportunities related to existent initiatives oriented to a general industrial energy efficiency improvement. The synoptic overview of the community is reported in Figure 12.

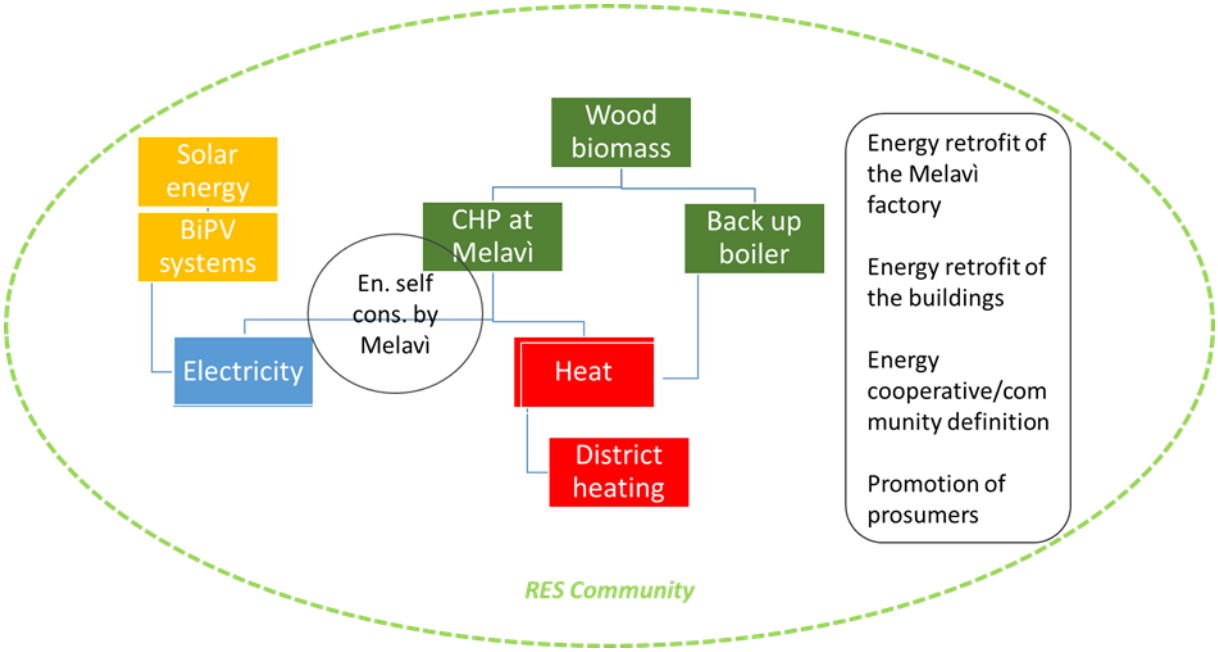

Figure 12. Overview of the Italian pilot.

4.2.1.1 Involved stakeholders

The stakeholders involved represent the different part of the supply chain, from the resource to the final uses. The list is reported in Table 8.

Table 8. List of stakeholders (Italian pilot).

Stakeholder	Role
Fiper	(BECoop partner) Expert for development of biomass DH and biomass CHP systems.
Local engineering office	Expert of the buildings and heating plants features and performance, promoter of other local projects for biomass to heat mainly by boilers.
Local forestry companies	Promoter of the management activities for organizing the exploitation of local forest biomass, including contracts.
Melavì	Cooperative operating in the collection, packaging and distribution of local apples, with the plant in Tovo Sant'Agata and other two plants (in Ponte di Valtellina and Villa di Tirano) for apples processing in Valtellina. Promoter of the management activities for organizing the exploitation of local biomass from apple trees pruning. Pivotal element for the development of the RESCoop due to the intention of realizing a biomass CHP system for electricity self-consumption and heat self-consumption and, mainly delivery, in addition to a PV systems mainly for electricity self-consumption.
Municipality of Tovo Sant'Agata	Local environmentally conscious municipality, promoter of a biomass DH system and other initiatives for enhancing the energy self-sufficiency also reducing energy poverty.
Other municipalities, e.g. Lovero (*)	Promoter of biomass uses and other initiatives for energy sustainability.
Politecnico di Milano	An internationally renowned university, with a strong expertise on biomass DH and CHP.
Ambiente Valtellina Onlus	Operating in biomass collection from local forest and vineyards pruning.

(*) Contacted in a follow up meeting on 18 March 2022 after the co-creation WS. The meeting was held at Melavì and consolidated the conclusions and the agreement of the co-creation WS.

4.2.1.2 Community concept and structure

During the co-creation WS and follow up activities, the biomass potential was preliminarily estimated, the stakeholders to be involved were defined, and the supply chain and the best forms of collaboration were examined (consortium, association etc.).

Considering the large availability of the biomass source, starting from the pivotal presence of the Melavì plant, an estimation of the electric and thermal needs to be satisfied was presented, supported by the identification of the most proper solutions (**cogeneration system plus biomass boiler plus PV systems**) and sizes.

For the definition of the potential RESCoop structure in the pilot area, the following information must be considered:

Tovo Sant'Agata

- About 650 people, 280 households and 11 km^2;
- Draft estimation of energy needs: 700-800 MWh/y (electric) and 5.000 MWh/y (thermal).

Melavì

- Draft estimation of energy needs: 2 GWh/y (electric) and 0.3 GWh/y (thermal); the electric consumption is equivalent to about 600-700 households, while the thermal one is equivalent to about 60 households;
- Electric price has been increased of more than 100% in the last months;
- A PV system of 50 kWp is already in operation, with an electricity production of about 60 MWh/y.

Since the municipality of **Lovero** has the same people and households, the energy needs could be doubled as first estimation, reaching about 1.5 GWh/y (electric) and 10 GWh/y (thermal).

Exchanges are in progress to also involve the municipality of **Mazzo**, with about 1,200 people, increasing the heating needs to be satisfied by the potential DH plant.

In both cases, electric needs are quite constant during a year while, a part domestic hot water (DHW), thermal needs are concentrated during winter season.

In order to satisfy the mentioned needs, even if the thermal ones have to be further examined, different strategies can be considered, also by a modular approach. These may imply the necessity of maximum 6,000 – 8,000 t/y of wood chips (without considering Mazzo), surely **available in a small range of forests nearby**.

According to the RESCoop vision in the pilot area, the **action plan** has to include the information to:

- Develop the biomass supply chain from the forests/apple trees/vineyards to the CHP system, all steps included;
- Clarify how to involve the final users and to forecast the number of expected costumers;
- Sketch of the possible technological solutions and DH network (length, pipes etc.) after the definition of the municipalities really involved;
- Find out possible investors and supporting mechanisms.

Fiper will support all the mentioned steps that are summarized in Figure 13.

Figure 13. Main steps of the process (Italian pilot).

4.2.2 Challenges and opportunities

In the sections below can be found the challenges and opportunities for the successful establishment of the BECoop RESCoop and the realization of its vision.

4.2.2.1 Challenges

Different forms of cooperation will be evaluated for the supply chain and for the realization and management of the new energy system.

Currently, the collective self-consumption incentives within the renewable energy communities (REC) are recognized only for electricity, therefore it is important to include electricity generation in the initiative.

The possible reticence of local people and the instability of the energy market should be faced to that end, also considering the effect of the recent Russia-Ukraine crisis, still in progress, and the consequences on the Italian energy market.

A precise definition of the logistic framework including i) the connection between users' demand and biomass potential and ii) the involvement of other municipalities is fundamental. To this aim, surveys and campaigns will be implemented with the support of Fiper.

One critical aspect is related to the role of Melavì. Therefore, an memorandum agreement should be signed in order to ensure its involvement in the initiative, even if other local companies can be also integrated in the initiative instead.

The overall investment costs, about 4-5 M€ of which about 2 for the DH network (very draft estimation, to be verified in the next steps by further deep investigations within other tasks of WP4) are relevant for small municipalities and for medium enterprises. The possibility to have public funding for the investment and/or incentives during the operation has to be explored accurately. A modular implementation of the new energy system can be considered, in order to defer the investment costs.

The technical features of the system have to be further explored. **Different available and suitable technologies should be investigated according to the expected size.** As an example of first evaluation, two alternatives for biomass use were investigated (Figure 14):

- ✓ A micro size (e.g., a Twin Screw Steam Expander of kW of electric power) CHP + a biomass boiler + BiPV;
- ✓ A mini size (e.g., an Organic Rankine Cycle with 300-500 kW of electric power) CHP + a biomass boiler (only as back up) + BiPV.

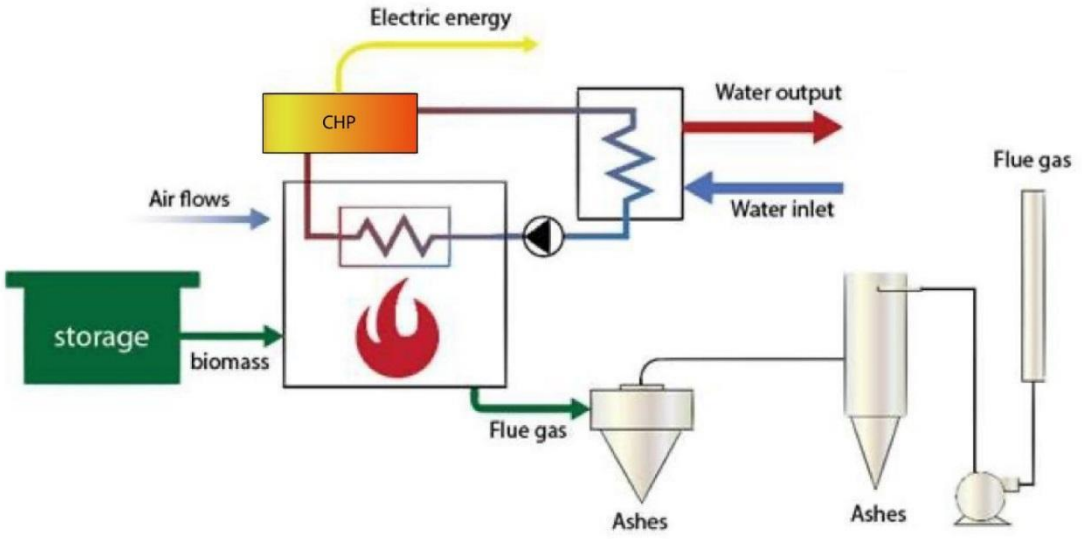

Figure 14. General scheme of the two CHP options (Italian pilot).

Overall, in order to overcome possible challenges, Fiper will constantly monitor the activities with dedicated meetings and surveys in the next months.

4.2.2.2 Opportunities

Due to the active presence of the key stakeholders, the WS succeeded in achieving the planned objectives and in developing a network of collaboration led by Fiper, in the framework of BECoop activities. Co-creation workshop attendants were satisfied with their participation in WS and were interested in further actions in the framework of BECoop project.

An interesting opportunity emerged considering the conditions of the built environment. Besides some exceptions, generally buildings have low energy performances (high surface to volume ratio, not well insulated walls, and roofs) and the heating density seems quite compatible with a DH network (2-3 floors above ground, low distance among the buildings, location along the same main road). The linear power density, i.e., the ratio of the connected power needs to the total length of the network, should be verified by accurate investigations since a minimum value of 1 kW/m has to be guaranteed for the energy and economic feasibility of the district heating network.

This opportunity has become even more important in the current energy market due to the evident increasing of the energy prices in Italy, a condition that, after the two years of Covid-19 pandemic, can lead enterprises to bankruptcy and families to energy poverty.

Recently, by official communications at national level[5], Fiper has underlined that, unlike users of natural gas or oil, the users of biomass DH have not been affected by the drastic increasing of the heat prices.

4.2.3 Community's roadmap

In the Italian BECoop RESCoop roadmap the following points are expected:

- ✓ Organization of the biomass supply chain;
- ✓ Definition of the most suitable components and technologies to be adopted in the CHP system;
- ✓ Approval and the pre-feasibility analysis of the biomass CHP DH plant;
- ✓ Official involvement of the Municipality of Tovo Sant'Agata (Lovero and Mazzo to be confirmed) as well as their citizens for the establishment of an energy cooperative towards energy self-sufficiency.

The energy retrofit of the Melavì plant and the installation of PV panels can make the roadmap even more economic effective. Indeed, the proposal is under the study of its President and of the Board of Directors of Melavì. If confirmed by evaluations by the company, the next actions may include also the transferring of the production process which requires a huge amount of energy (production of juices, drying apples and, maybe in the future, chestnuts) to the Tovo Sant'Agata plant.

In summary, the following steps have to be considered:

- Deep analysis of the context, from the point of view of the energy demand and supply, of the built environment features, etc.;
- Preliminary stages towards contracting for wood biomass supply (local owners, forestry agency and consortia);

[5] Many references are available about this topic in the recent Italian main stream, such as: https://www.fiper.it/wp-content/uploads/RS-articolo-Cavalese.jpg; https://www.fiper.it/wp-content/uploads/RS-2022-adige.jpg; https://www.fiper.it/wp-content/uploads/RS-2022-il-messaggero.pdf; https://www.ilgiorno.it/sondrio/cronaca/crisi-energetica-bisogna-puntare-sulle-biomasse-lappello-dei-produttori-da-fonti-rinnovabili-per-ridurre-la-dipendenza-dal-gas-naturale-1.7493867; https://www.canaleenergia.com/rubriche/digirinnovabili/le-biomasse-come-alternativa-sostenibile-alle-importazioni-di-gas/; https://www.fiper.it/wp-content/uploads/RS-2022-la-provincia-sondrio.pdf (in Italian).

- Survey aimed at defining the current electric and thermal needs and profiles for Melavì and other local entities (private buildings, public buildings, local enterprises) and their possible evolution towards 2030;
- Definition of the campaign for finding customers interested in being supplied by a biomass DH network. Within the campaign, the sustainability issues should be addressed properly: in addition to the environmental issues, the energy prices and their recent trend should be explained in order to underline the higher stability of the biomass market in comparison to the fossil one; further, the potentialities of new local economic activities should be stressed;
- Opportunities of funding (international national regional and local calls and other supporting initiatives) and scout of companies with expertise that can be interested in investments for the development of the plant;
- Accomplishment of proper meetings in order to consolidate the involvement of the mentioned stakeholders.

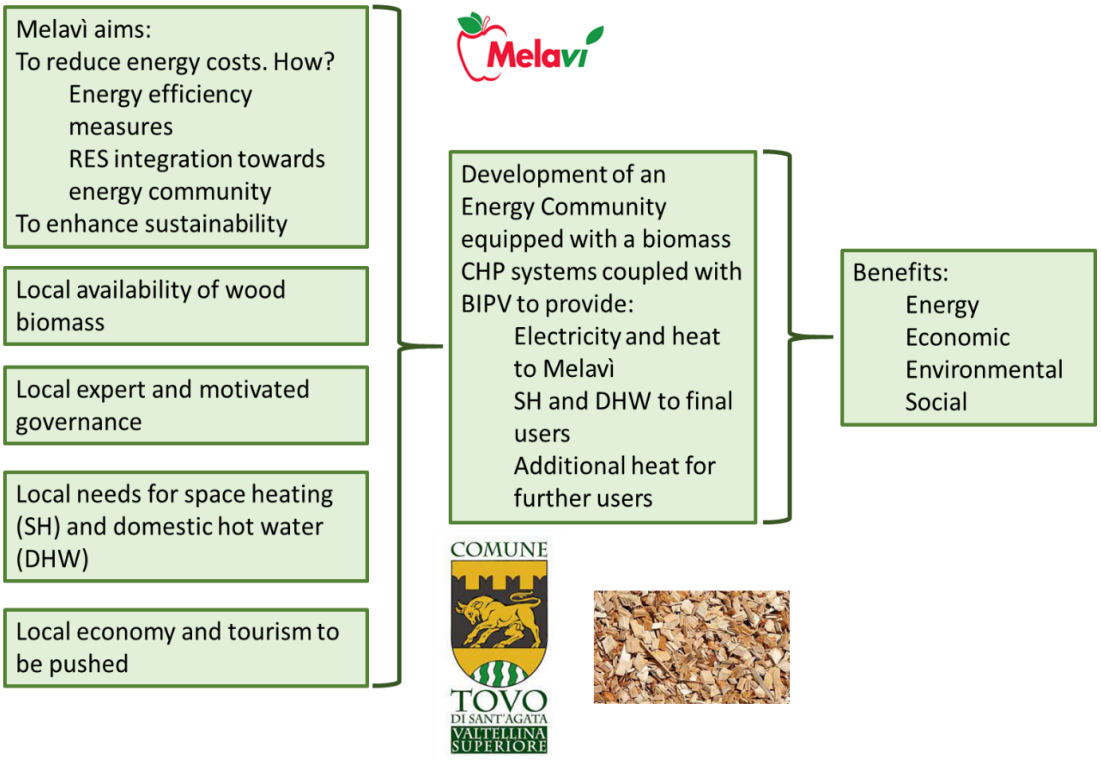

Figure 15. Sketch of the vision of the Italian pilot.

Table 9. RESCoop action plan (Italian pilot).

Months / Actions	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32
Co-creation WS and definition of the roadmap																	
Survey of context and stakeholders																	
Deepening of the available data about energy needs																	
Deepening of the available data about biomass availability, features and price																	
Agreement for the involvement of the local factories and possible localization of the CHP DH plant																	
Definition of the configuration of the CHP system to be realized																	
Final agreement for biomass supply																	
Definition of the main economic boundary conditions (prices, contributions, contracts, associates, investors etc.)																	
Campaign for the definition of the final users interested in biomass DH supply																	
Possible timing of the project to be implemented																	
Pre-feasibility study for the biomass CHP DH system																	
Final business plan																	
Definition of the conditions and stakeholders for starting preliminary design																	

4.2.4 Community's vision towards 2030

The vision towards 2030 implies the different stages of the design activities, the development of the overall project, the implementation of the biomass CHP system and of the DH network involving one or more municipalities next to the plant. These actions could include also the energy retrofit of Melavì plant and the initiation of new activities in Tovo Sant'Agata. An important element of the vision is the co-creation of a local RESCoop able to involve citizens as associated (e.g. some of them can sell wood to the plant and obtain heat for their uses). According to this vision, the area will be fossil free and self-sufficient.

The scheme of the roadmap is drawn in Figure 16, while the schematic vision of the RESCoop is provided in table 10.

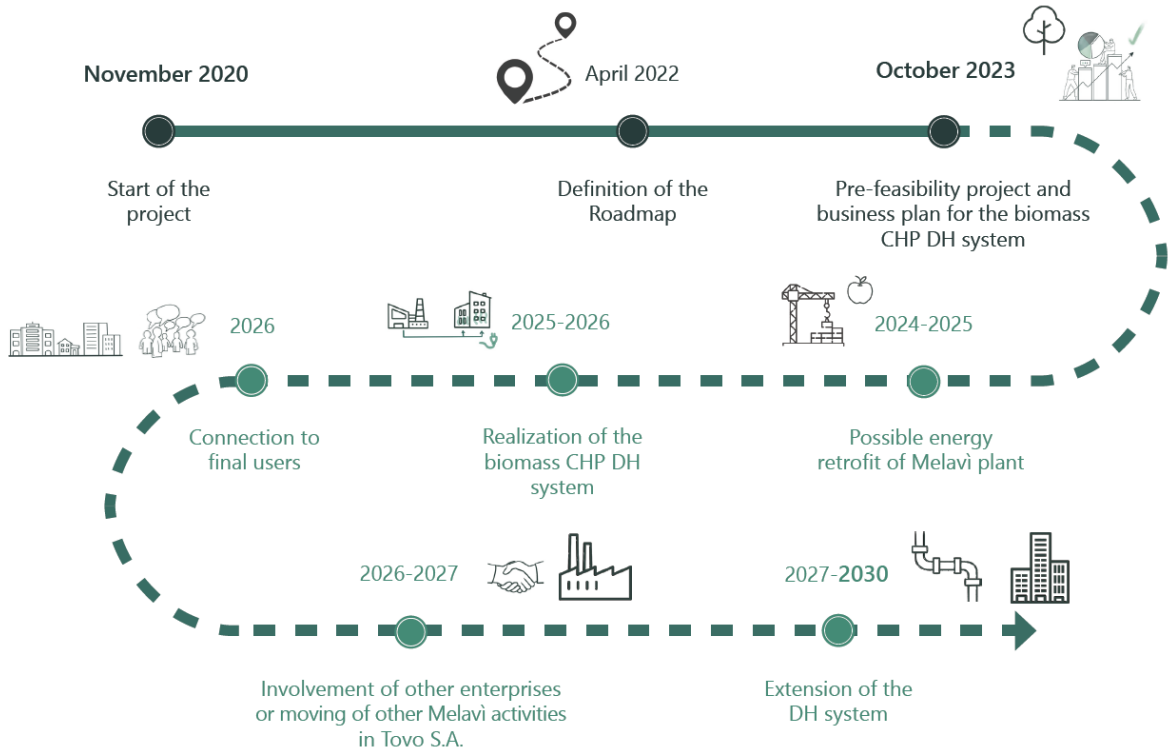

Figure 16. Scheme of the roadmap (Italian pilot).

Table 10. Stakeholders involved and vision of the BECoop RESCoop (Italian pilot).

MAIN STAGES	FEED-STOCK	COLLECTION	TREATMENT/ TRANSFORMATION	DISTRIBUTION	FINAL USERS (DH/INDIV. SOLUTIONS)	OPERATION AND MAINTENANCE (WASTE MANAGEMENT)
Entity in charge	n.a. / to be explored	Forest enterprises, Citizens	n.a. / to be explored	n.a. / to be explored	Owners of public and private buildings	n.a. / to be explored
Stakeholders involved	Forest enterprises, Farmers (apples), Citizens	Forest enterprises, Melavì, Municipalities, Citizens	Forest enterprises, Melavì	Melavì, Municipalities	Melavì, Municipalities, Citizens	Fiper, Melavì, Municipalities, Citizens, Responsible of small biomass DH systems
Service already in place?	These services are in place only for the individual use of biomass by boilers in some households and stoves and in a small DH system for few public buildings					
Estimation of investment (if service not in place)	n.a. / to be explored	n.a. / to be explored	4/5 million euros of which 1.5/2 million for the DH network (to be verified in the next steps by further deep investigations)			n.a. / to be explored
Location	Local forest and apples trees	Local	Local	Local	Municipalities of Tovo Sant'Agata and neighbouring	n.a. / to be explored

4.3 Polish BECoop RESCoop Roadmap

4.3.1 Introduction

The energy balance in Poland is based on **fossil fuels and mainly coal** (i.e., more than 50% of households are directly or indirectly heated by coal), which is often used in individual and deregulated devices since it can be found at low price. In the analysed area, **pellet** is often used as a bioenergy source, which is mainly imported from Lithuania and Ukraine. Biomass, used in a balanced way, could significantly contribute to the decarbonisation of the Polish heating sector.

In this framework, **Oborniki Śląskie (OBS) municipality** was selected as the most suitable area for the development of a biomass supply chain (from local biomass to SH). Oborniki Śląskie municipality is placed in the north-eastern part of the Lower Silesia Voivodeship, in the Trzebnica County; currently it is part of the Wrocław agglomeration. The municipality energy mix is made of coal for the 25.76%, wood for the 29.69%, natural gas for the 24.89%, liquid gas for the 6.99%, electricity for the 10.92%, eco-pea coal for the 0.44%, heating oil for the 0.87%, and briquette for the 0.44%. Oborniki Śląskie locates in a **rural context** characterized with a high availability of biomass (wood and straw based), with a low urban density and, as consequence, **low heating density**, despite of the quite **cold climatic conditions**. Indeed, there is no local DH and buildings use up-to-100 kW boilers based on fossil fuels. The biomass use is low and there is no inventory of related resources and based systems.

During the co-creation WSs, the following points to be tackled towards the RESCoop vision implementation were identified:

- To draw the **role of biomass** in the energy market framework, according to the evolution of prices and the targets for renewables;
- To assess the **regulation framework** in relation to the possibility of implementing a DH solution, the use of biomass in domestic devices in urban context, considering also the issue of emissions limits for pollutants etc.;
- To develop an **informative campaign** to citizens (see also the output of T3.1 and strong connection with T3.3);
- To define which **stakeholders** will manage the biomass supply chain;
- To clarify if there are **financial support schemes** for energy communities' implementation or bioenergy technologies' integration;
- To collect **quantitative data** concerning the pellet market, the capacity needed, the target users (in order to estimate the local heating demand), and the feedstock available;
- To draw the **action plan** and the first steps for the establishment of the RESCoop vision.

4.3.1.1 Involved stakeholders

OBS identified two groups of stakeholders. The first group consisted of residents of the commune, farmers, entrepreneurs, local activists, investors, representatives of scientific institutions, while the second one is represented by local authorities. During the WS, one goal was to increase social awareness, although, according to the information received, the process of stakeholders' networking has not yet been implemented. The list is reported in Table 11.

Table 11. List of stakeholders (Polish pilot).

Stakeholder	Role
Partners of the project	Meeting organizers, presenters, moderator
Representatives of farmers	Supply of biomass
Representatives of residents	End-users / Initiators
City councilmen/village administrators/municipal corporation	Initiators

4.3.1.2 Community concept and structure

Basically, the analysed concept consists of three components i.e. a grower of energy crops, a biomass processor, and an intermediary (e.g., a distribution or logistics company) as described in the following section.

Regarding the exploitation of biomass, farmers can rely on residues from a **5,400 hectares forest area** (the technical energy potential was estimated as 17,940 MWh/y of heat) and an **8,500 hectares agricultural area** (the technical energy potential was estimated as 66,110 MWh/y of heat).

For the resources collection step, farmers and forestry companies have the appropriate machinery for obtaining both agricultural and forest biomass. **There is no biomass pelletizing or briquetting company in the region.**

A solution boosting the creation of an energy cooperative could be the connection of the biomass suppliers with a production company in charge of transforming the biomass into good quality and then selling it to the end-users. Such a **short local logistic chain** should contribute to the reduction of energy poverty thanks to the lower price of biomass fuel and better access to energy resources. The production companies can be the **local existing sawmills**, which are interested in expanding their activities.

The potential distribution system could be based on local producers (e.g., sawmills, new SME) that would supply solid biofuel (pellets, briquettes) to the end-user. Considering the different available biomass sources, it is assumed to adopt about **half materials from agriculture (straw and other crop residues) and the remaining half from forests (chunk wood, waste wood in the form of trees, branches from pruning, bark waste). These sources will be used for heating purposes after the transformation in pellets or briquettes**. From a first estimation, a pellet production plant with a capacity of 1 t/h can be built in the region with a cost of about 150-300 k€ (depending on the degree of automation). However, further agreement is being held with potential suppliers of raw material for pellet production.

For the energy transformation, two sites were identified in the area.

The **Claudie Design chair factory** has a heating boiler room currently equipped with a 350 kW biomass boiler fired with sawdust and wood, producing energy for the existing buildings SH and domestic hot water demands. In order to cover the heating needs of the designed production and warehouse building, it is planned to add a 600 kW biomass boiler.

Further, in the framework of previous WSs, **the multi-family building at Kasztanowa Street in Lubnów**, currently heated by hard coal, will be equipped by a new pellet boiler of 120 kW; ultimately, the pellet boiler will heat 13 apartments.

In Figure 17, the involved stakeholders and locations of the expected pilot are presented.

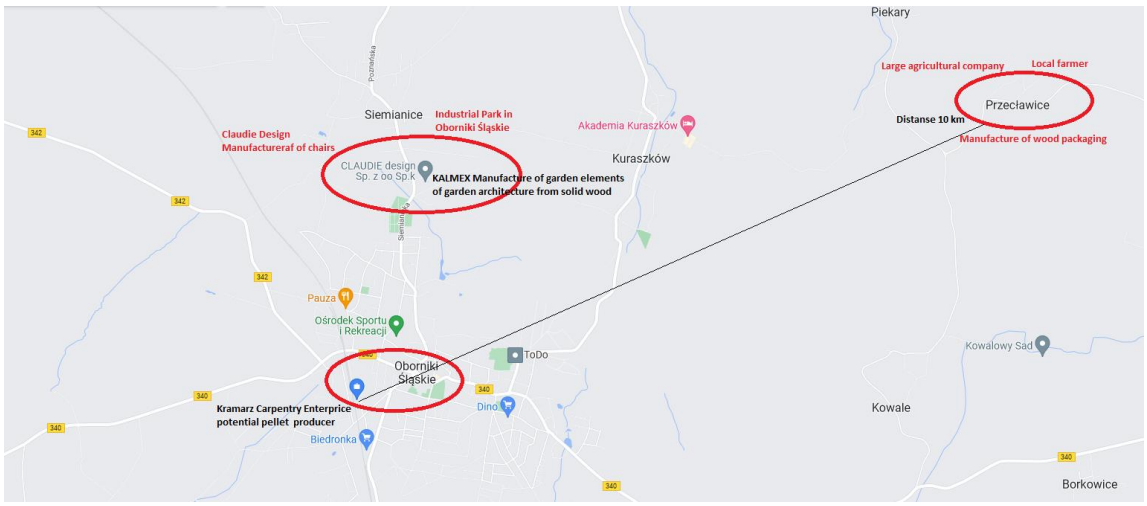

Figure 17. Location of the main element of the Polish pilot (Farmers, Chair factory Claudie design, garden furniture factory Kalmex, Carpentryand sawmills.

4.3.2 Challenges and opportunities

In the following sections, the challenges and the opportunities for the realisation of BECoop RESCoop's vision are presented.

4.3.2.1 Challenges

Poland as a country, as well as the Oborniki Śląskie Commune, have not invested enough in the energy transformation mainly because coal burning still paid off more than new investments in renewable energy. Biomass has a price of around 90 €/t while a high-quality pellet (Class A1-A2) can also reach 250 €/t.

From the beginning of 2022, the energy prices have increased significantly; an update of the energy prices is provided in Table 12, where it is possible to observe that the price of natural gas for households is very competitive since it is lower than the price of biomass pellet and briquettes. According to Table 12, **only wood logs and chips seem to be cost effective in the current market**.

Table 12. Energy carriers' average unit prices (Poland, Q1 2022).

Energy carrier	Average price [€/kWh]
Coal	3.8
Light oil	7.7
Gas (households)	4.5
Gas(entrepreneurs)	12.8
Electricity	16.6
Biomass Pellets	4.7
Wood (logs)	2.6
Biomass briquettes	5.5
Wood chips	1.9

Another issue is due to the **Polish regulations in force** that forbid the cooperatives to sell the energy or to store it. Cooperatives are only able to transfer their surplus to the common distribution grid. The requirement to guarantee 70% of coverage by RES for a cooperative member is a very challenging threshold.

Another problem is related to the drastic **increase in the price of fertilizers for agriculture.** This resulted in a significant reduction in the possibility of selling straw for energy purposes, due to the need to leave it in the fields to compensate for the deficiency of nutrients in the soil, which until now were provided by mineral fertilizers produced by the chemical industry.

In addition, **there are no bioenergy cooperatives in Poland;** this can be a new space for research (seen also as an opportunity). The lack of experience in this field in Poland is also an obstacle in convincing the local community to engage more deeply, especially in times of energy crisis and unstable political situation.

Further, there is no DH systems in the Oborniki Śląskie commune. Residential buildings, public utility buildings and production plants are supplied with heat by means of local individual heating systems.

There is a developed gas network in the city of Oborniki Śląskie and in rural areas to some extent. **Buildings that are not connected to the gas network are heated by individual heating systems, mainly with hard coal and firewood.**

Moreover, in the field of electricity, problems with connecting RES investments to the power grid are getting worse. The state of **the power grid** (high, medium and low voltage lines) in the rural region requires significant and serious investments. The above situation is a certain barrier to the development of renewable energy installations, as it requires **additional financial costs**, which are very limited in the Commune's budget for this purpose (as pandemic situation and economic crisis forced other expenditures in the last 2 years).

Other challenges regard the fact that, even if local government representatives expressed their willingness to cooperate in promoting the vision of the present project and each group of the participants understood the necessity of energy self-sufficiency in the region, all of them emphasized that **without the possibility of external financial support it may be very difficult to create an energy cooperative, especially in rural areas with a high energy poverty rate.** In this framework the cooperation of producers and end users within a short logistic supply chain of biomass (taking into account local market, environmental and organizational conditions) would be critical. To this aim, it is important to offer appropriate financial and technical support mechanisms.

Unfortunately, conversations with people from various social groups show that **cooperation** in the region between people with different professional profiles (non-agricultural), social status, time of residence in the region (people living for generations, people coming from e.g. the city) and way of thinking **is difficult.** This complicates the work of developing the energy community, which requires understanding and joint activity in this area (building mutual social trust and a sense of joint responsibility for the region).

Another issue regards the **regulation about the use of solid fuels for heating purposes**. In 2017, the Lower Silesian Voivodship Parliament adopted resolutions on the introduction of restrictions for systems fuelled by solid fuels to prevent negative impacts on human health and the environment. From 2018 these restrictions are related to the use of solid fuels included solid biomass with a moisture content over 20%. From 2018 newly commissioned boilers must meet Ecodesign requirements for particulate matter (dust) emissions; from 2024 systems that do not meet the requirements corresponding to class 3 boilers in terms of dust emission limits will be banned; from 2028, systems that do not meet the requirements corresponding to class 3 and 4 boilers in terms of dust emission limits will be banned, therefore only 5 class Ecodesign boilers are allowed to be used for heating purposes.

4.3.2.2 Opportunities

Energy cooperatives constitute a new phenomenon in the Polish energy sector with a great potential for development prospects. Besides economic benefits, energy cooperatives can also contribute to mitigate social problems e.g., issues of energy poverty. **In Poland, one third of people suffering from energy poverty live in rural areas** (e.g. villages). Energy cooperatives may be established in rural and semi-rural communes to counter this problem.

Assuming that a household can be affected by energy poverty if the expenses for SH are more than 10% of the incomes, in Poland approximately 45% of households are in this condition and almost 65% of these households are located in a rural area (villages)[6] . While, according to the definition of LIHC (Low Income High Costs), energy poverty affects 22-30% of households[7]. Therefore, among the available initiatives for mitigating energy poverty, energy cooperatives may play an important role, especially in rural and urban-rural communes.

For the local society, energy cooperatives are also an important element of the economy, as the involvement of entrepreneurs, farmers and craftsmen from a given region stimulates the economic activity of the region, which in turn translates into financial benefits for individual members of the cooperative and the entire local community.

Unfortunately, there are other social, economic and legal challenges and hurdles (defined in D1.2 of the BECoop project) that hinder the bioenergy community uptake. Reducing bureaucracy and access to incentives could be an important leverage involving biomass companies and investors in this area.

4.3.3 Community's roadmap

In the following, a detailed action plan for the next months of the project is reported. Being **an *ex-novo* project**, the analysis of the entire site area and its resources, included an extensive data collection, has to be deepened. It would then be possible to proceed with an economic assessment of the project's feasibility and the collection of declarations of willingness to join the initiative. At the same time, a strong educational and informative campaign with the end-users and farmers needs to be carried out (strong link with BECoop T3.3).

Considering the information collected during the Polish co-creation WS and other events, the action plan for the next months of the project is described in Table 13.

[6] https://www.cire.pl/pliki/2/2018/ubostwo_energetyczne_w_polsce_raport_03_09_2018.pdf.
[7] https://orka.sejm.gov.pl/opinie9.nsf/nazwa/801_20210618/$file/801_20210618.pdf.

Table 13. RESCoop action plan (Polish pilot).

Months / Actions	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32
Co-creation WS and definition of the roadmap																	
Education of the local community - promotional campaign																	
Analysis of potential resources																	
Concept finalisation (main idea of the project, possible conflicting interests etc.)																	
Expanding the available data																	
Development of technical conditions in the region (identification of possible end-users)																	
Economic analysis																	
Declaration of willingness to join the initiative																	

4.3.4 Community's vision towards 2030

For the Polish pilot, it is difficult to provide a long-term vision due to the lack of know-how for the actual formal establishment and operation of energy cooperatives in the national market, as well as of real experiences in energy cooperatives management. This may discourage the establishment of such projects in the sector at a national level. However, on this initiative, more effort is put on the **education of the local community and the promotion of bioenergy**. The BECoop raise-awareness campaigns developed under T3.3 will also contribute and fill in any knowledge gaps and misconceptions around bioenergy communities in the local region. Some outlines about the vision are reported in Table 14, while the scheme of the roadmap is drawn in Figure 18. The timing reported underlines that the creation of energy cooperatives in the region is a very long-term process and requires the initiative and agreement of many groups of stakeholders, mainly farmers, but also inhabitants, entrepreneurs, local government units, scientific institutions, specialists in the industry.

Despite of the recent geopolitical events and the two years of the ongoing Covid-19 pandemic, that have raised concerns about investing and spending spare funds, the Polish strategy is currently underway. OBS together with WUELS are actively working to enable the creation of a local short supply chain, which in the future could lay the foundation for the establishment of an energy cooperative in the region.

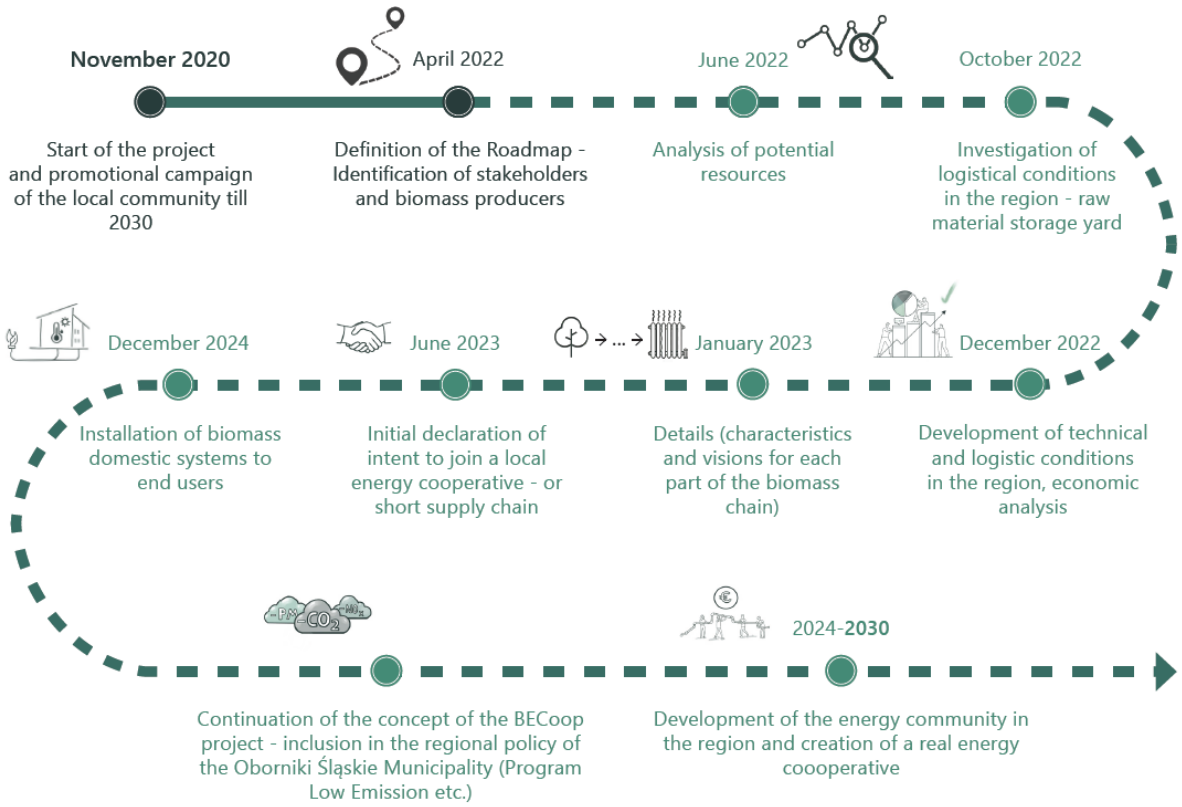

Figure 18. Scheme of the roadmap (Polish pilot).

Table 14. Stakeholders involved and vision of the RESCoop (Polish pilot).

MAIN STAGES	FEEDSTOCK	COLLECTION	TREATMENT/ TRANSFORMATION	DISTRIBUTION	FINAL USERS (DH/INDIV. SOLUTIONS)
Entity in charge	Farmers, Forest companies, National forests unit	Local companies	Local companies	Local company, End user	End user, RES installation owners, biomass boiler owners
Stakeholders involved	Farmer	Agricultural biomass producers, wood production companies, farmers, local companies	Local pellet manufacturer, briquette manufacturer	Local fuel companies	Public utilities, building - schools, village halls
Service already in place?	-	Service in place for agro-biomass; for forest biomass the technology is ready, but the service is not established	A local service is not established, but companies are interested in in this area	Service ready	Service in place
Estimation of investment (if service not in place)	Lack of economic and financial analysis Currently, OBS is working on an inventory of heat sources and the precise determination of resources that can be used for energy purposes	Investments not required	Investments in building the briquetting installation are highly recommended and required.	The logistics of the fuel within the Commune does not require significant investments, as there are companies selling coal with delivery to the end user	Difficulties in realizing new biomass installations
Location	Oborniki Śląskie Commune area				
Details	Local forest resources local farming biomass resources Interested parties	Defining how much and at what time it is possible to provide biomass by local farmers	The capacity of the pelletizing/briquetting installation is still to be defined	The logistics of the fuel will be organized by pellets/briquettes producers, local fuel seller or personally by end users	End users should cooperate with producers of pellets/briquettes based on an agreement and a declaration of fuel purchase

4.4 Spanish BECoop RESCoop Roadmap

The Spanish pilot case involves **two different BECoop RESCoops**: Aberasturi is the main case, while Murgia is the secondary case. Sections from 4.4.1 to 4.4.4 are devoted to the RESCoop of Aberasturi, while section 4.4.5 summarises the RESCoop of Murgia.

4.4.1 Introduction

The Spanish partners selected **Aberasturi** as the most suitable area for the development of a BECoop RESCoop. It is a small hamlet located in the municipality of Vitoria, in the province of Alava, in the Basque country.

Aberasturi is a small village of 133 inhabitants distributed in 56 houses dependent on the city council of Vitoria/Gasteiz. They enjoy some degree of autonomy because of historical regulations governing smaller rural local authorities, and this is the reason why they manage the aspects that fall within their competence through a local administrative board made up of two members and a president that work voluntarily and elected by the local inhabitants. They also hold administrative meetings with the rest of the neighbours from time to time.

In such area, after preliminary analysis of the heating systems, residential uses are mainly covered by fossil fuels such as oil (51%) and natural gas (12%), as presented in Figure 19.

Tipo de tecnología calefacción 1	Numero casa	Energia primaria total (kWh)	Emisiones (kg)	Número casa
Bomba de calor (Aerotermia /geotermia u otros)	9B	7.000,00	2.499,00	1
Caldera de gas natural	21	216,53	54,57	1
Caldera/estufa de Biomasa_Leña	17	15.832,50	284,99	1
Caldera/estufa de Biomasa_Leña	1A	5.988,00	107,78	1
Caldera/estufa de Biomasa_Leña	25	16.471,77	296,49	1
Caldera/estufa de Biomasa_Leña	26	18.900,00	340,20	1
Caldera/estufa de Biomasa_Leña	32	33.885,88	609,95	1
Caldera/estufa de Biomasa_Leña	4	48.600,00	874,80	1
Caldera/estufa de Biomasa_Leña	43	18.900,00	340,20	1
Caldera/estufa de Biomasa_Leña	45	21.600,00	388,80	1
Caldera/estufa de Biomasa_Leña	47	18.900,00	340,20	1
Caldera/estufa de Biomasa_Leña	54	24.261,00	436,70	1
Caldera/estufa de Biomasa_Leña	7	2.700,00	48,60	1
Caldera/estufa de Biomasa_Leña	9	14.626,47	263,28	1
Caldera/estufa de Biomasa_Leña	53	14.000,00	252,00	1
Caldera/estufa de Biomasa_Pellets	61	720,00	12,96	1
Caldera/estufa de gasoil	1	17.500,00	5.442,50	1
Caldera/estufa de gasoil	11	29.940,00	9.311,34	1
Caldera/estufa de gasoil	13A	19.960,00	6.207,56	1
Caldera/estufa de gasoil	14	19.960,00	6.207,56	1
Caldera/estufa de gasoil	15	21.956,00	6.828,32	1
Caldera/estufa de gasoil	27	9.980,00	3.103,78	1
Total		**732.212,53**	**150.035,39**	**43**

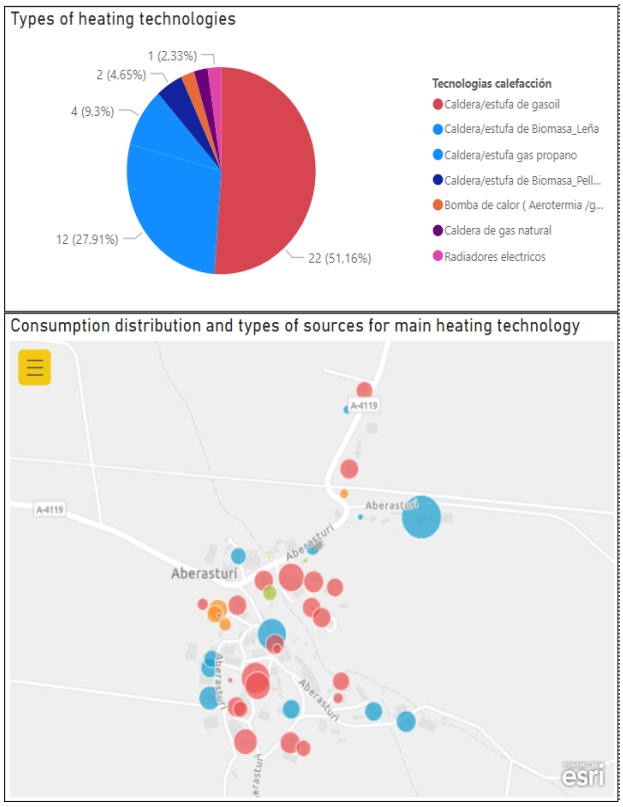

Figure 19. information about the consumption and the technologies adopted for heating purposes in the pilot area (Spanish pilot).

Aberasturi will be developed as an experiment to establish a BECoop RESCoop that locally covers the entire value chain. In the region, some scattered experiences of pellet and wood chips exploitation for thermal purposes are present, but no one has a RESCoop structure behind. Assigned wood

allotments from common land to residents are available which could affect the feasibility of the project. In addition, straw resources are available during the summer season that could be used as an input in the solid biofuel's mixture.

Main barriers identified in the area in developing a bioenergy community are **the high initial investment costs, the lack of infrastructures (for resource collection, treatment and distribution) and the challenging replacement of diesel boilers with biomass boilers.** On the other hand, most of the population in Aberasturi complain about the **high bills for heating**, due to increasing costs of oil. Moreover, **energy autonomy, circular economy, contrast to climate change and local benefits such as job opportunities have been identified as main drivers**.

The target area is composed of 2 public buildings and 47 residential buildings (mainly cottages), for a total heating and DHW demand around 0.68 GWh/y (14 MWh/y per house). Despite the availability of a cost-effective local resource, the low heat-demand density (around 45 MWh/ha/y) to be supplied by a future district heating facility makes it necessary to consider financial aid mechanisms as part of the business model, because of the high upfront cost of the DH infrastructure and of the consequent high payback time. Three biomass DH facilities are currently in place in neighbouring villages that could serve as reference cases. In all of them the DH is managed by the municipality, producing wood chips from local forest. In one of the cases, where harvesting and solid biofuel activities are outsourced, a price around 50-60 €/t is achieved, while the market price is around 120 €/t, i.e. 0.03 €/kWh. Such price (to be better evaluated in the case of Aberasturi) would be competitive also with other resources available in the area, as shown in the following list:

- Pellet: 0.06 €/kWh
- Natural gas: 0.12-0.13 €/kWh
- Oil: 0.09 – 0.10 €/kWh

In addition, also in this case, it must be taken into account that the price for woodchips or woody biomass is not as volatile as the one for fossil fuels. Such consideration represents an additional advantage which must also be included in the economical calculations/business plans to be carried out in the following WP4 tasks.

According to pre-WS implementation stage and the main vision of the Spanish pilot's, **the following uncertainties have been identified and tackled through the co-creation WS**:

- How to involve the final users and to forecast the number of new real customers?
- How to convince users to move toward a biomass solution for satisfying heating and DHW demand?
- Which would be the best option for the last part of the RESCoop chain, e.g. DH or individual solutions?
- Which can be the technical details about the new collection facility to be implemented (size etc.)?
- What should be the governance, organisation and management of the resource collection company/entity?
- Which are the main actors locally involved in the bioenergy market and how could they interact to lower the resource cost?
- How can be found the best match between heating demand and available biomass?
- How to ensure a sustainable exploitation of forest resources over the lifetime of the proposed thermal solution?

Thanks to the WS outcomes, the most important aspects to be achieved were ranked, as already explained in section 3.4, and most of the previous uncertainties solved.

4.4.1.1 Involved stakeholders

The list of stakeholders involved in the case of Aberasturi is reported in Table 15.

Table 15. List of stakeholders (Spanish pilot).

Stakeholder	Role
Goiener	(BECoop partner) Assistant in the creation of the RESCoop (development team) and possibly heat retailer
CIRCE - Technical support	(BECoop partner) Assistant in the creation of the RESCoop (development team)
AVG_Energy department - Energy focal point and BECoop focal point	Assistant in the creation of the RESCoop (development team)
AVG_ Rural zone department - biomass resource and local management focal point	Assistant in the creation of the RESCoop (development team)
AVG_ Rural zone department - Forest technician	Assistant in the creation of the RESCoop (development team)
Small Local Entity belonging to AVG (Aberasturi village) - End user and council chairperson - End user and council member	End user (Promoter group)

4.4.1.2 Community concept and structure

The members of the Aberasturi BECoop RESCoop are not defined yet, however it is foreseen that the local council will merely be one of the constituent parties, with the energy community being autonomous and independent from the council. First approach is that the owners of the facility/solution need to be the members of the community. Thus, the council, inhabitants, farmers (as straw providers), new or existing enterprises related to any step of the value chain could be part of the BE community.

Regarding the business model that will condition the structure of the RESCoop, **the following three approaches were identified to be analysed during the support services provided (T4.2 and T4.3):**

- Option A (All outsourced): The operations of collection and treatment of the biomass are subcontracted to specialised companies. The heat retailing activities will be done through an ESCO. The same scheme is expected for straw.
- Option B (All internal): Someone belonging to the community carries out these biomass collection and treatment activities, receiving economic compensation for it. The community retails and invoices BE heat.
- Option C (mix of the two above): certain operations subcontracted others carried out by members of the community. This is the approach followed by DH installations executed nearby.

The different actors and their role in the value chain have been captured during the co-creation WS and in Table 16.

4.4.2 Challenges and opportunities

In the following section, the obstacles affecting the implementation of the BECoop RESCoop of Aberasturi vision and the possible opportunities are reported.

4.4.2.1 Challenges

The first challenge is related to the **engagement activities**. Therefore, the future members of the RESCoop will receive , as a result of the project, a comparison between the current thermal technologies and the proposed most feasible solution. Thus, the business model defined will need to be cost-competitive with current energy costs in order to ensure a sufficient number of inhabitants joining the cooperative and associated heating delivery services. Nevertheless, it is hoped that not only economic motivations will promote a switch to the collective solution: considerations such as environmental protection, energy-independence, comfort, civic pride etc. are all expected to play their part.

More in detail, the level of involvement of the cooperative members, the structure and the type of services to be deployed will rely on the results obtained by T4.3 business model assessment activities and best practices from nearby cases. However, there is a concern about how to define a proper strategy in order to keep the inhabitants engaged over time and at the end with interest in joining the cooperative.

As **technical issues**, two different boilers will need to be considered in the case of exploitation of both biomass resources due to different physicochemical properties affecting the proper operation. Indeed, several technical/economic analyses will be performed in order to obtain different alternatives compared to the current baseline scenario.

Every year farmers have more and more problems in managing the straw residue, so the valorisation of both resources is desirable. In that case, **the forest biomass collection activities need to be done after the cereal harvesting** that generates the straw, in order not to damage the roads used.

In addition, there is an **environmental concern** about managing the residues, mainly ashes, that will be generated by the boiler. The same goes for emissions associated and how to avoid their effects on local air quality.

Regarding the size of the public land classified as "urban" that should be designated for the construction of the boiler and storage facilities, solutions were discussed in the WS.

In terms of **business model and financial support**, it is not allowed to make economic profit from the local forest wood allotments selling to consumers outside of the rural village and neither would it fit the approach of local valorisation of the resource that is proposed. However, other small villages willing to process their resources could use the RESCoop facilities to do so in exchange for a financial contribution to the cooperative.

Also due to **low heat-demand density** and high upfront cost of district heating civil engineering works, several financial supporting programs will need to be considered within economic assessment accompaniment activities.

4.4.2.2 Opportunities

The main opportunity is related to the potential to cover the entire value chain: from harvesting to local processing and storage and to heat delivery via district heating network.

In addition, there is the possibility of implementing an **innovative forest management model** that ensures the exploitation of the resource but is based on the diversity of the ecosystem, natural regeneration, minor interventions, thinning, and therefore going one-step further than the criteria established in RED II directive.

The experience could also enhance local inhabitants' **energy independence** by exploiting local forest and agricultural biomass resources, reducing energy cost and tackling energy poverty issues.
The level of involvement in the initiative is very high (**49 out of 54 houses have shown interest** in the proposed advisory) with the local administrative board and municipality really engaged.

Eventually, the project will contribute to building awareness around energy communities for heating in the local area.

4.4.3 Community's roadmap

T**he community's roadmap presented herein is related to the main BECoop RESCoop of Aberasturi,** which is the main one for the Spanish pilot (A draft action plan is also available also for the case of Murgia).

As presented in the following action plan (Table 16), within the upcoming months, the analysis of the exact quantity of resources to be exploited to meet the current heat demand will be carried out.

The co-creation WS was the first step for the implementation process of a bioenergy community in Aberasturi. The quantification of available resources and heat demand to be supplied, will be part of the first months' activities whereas nearby identified cases characteristics are going to be consolidated and shared. These results will feed the activities to define the proposed thermal solution in the following months.

In the same timeframe, first business model alternatives will be identified and will be grounded in the local case of Aberasturi. This information will be used to define the level of outsourcing based on the economic feasibility of each alternative in order to conclude on the cooperative's structure. Likewise, this input will be used to define the different short circuit logistic alternatives that could be implemented.

It is worth mentioning that, in parallel, the assessment on the cooperative creation process will take place. Also, demonstration experiments are foreseen mainly related to biofuel characterization and logistic alternatives.

Regarding future steps, there was an agreement to maintain **regular meetings to inform of noteworthy progress on BECoop assessment activities. Also, when any important decision is expected to be made, willingness to meet was shown.**

Table 16. RESCoop action plan (Spanish pilot).

Months / Actions	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32
T4.1. Bioenergy RESCoop projects vision and road map																	
Approximate feasibility study with preliminary data																	
Project design/Co-creation WSs																	
Milestone: Project planning = road map																	
T4.2. Technical accompaniment activities																	
Evaluation of the initial situation: Self-assessment tool+results of the co-creation process.																	
Compilation of information on existing cases																	
Milestone: Definition of the starting point and collection of existing cases' information in a template																	
Definition of the local biomass potential																	
Definition of necessary starting data for the resource study (forest and agricultural)																	
Providing information to evaluate forest and agricultural resources																	
Carrying out of the forest inventory by parcels and forest management plan																	
Milestone: Resource potential study and harvesting plans																	
Assess different logistics chains from biomass collection to distribution for each resource																	
Identify the initial or boundary conditions																	
Define alternative logistics chains for each resource to be valorised																	
Milestone: Definition of the most optimal value chain																	
Thermal demand study in the ELM																	
Definition of necessary data (preparation of data sheet to be filled in by users)																	

Months / Actions	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32
Identification of possible initial and future consumers																	
Collection of thermal demand data at the ELM, including visits where necessary																	
Milestone: Estimation of the minimum power and resource requirements of the proposed solution																	
Technical feasibility study of generation alternatives for each resource																	
Identify components of the solution and possible locations of components/network																	
Preliminary operation and maintenance (O&M) recommendations																	
Design, coordination and support activities related to RESCoop creation alternatives: Define preliminary structure, legal entity and process (guideline)																	
Milestone: Pre-feasibility of the solution compared to the current thermal solution based on the valorisation of biomass forest resource or/and straw																	
Demonstration activities																	
Laboratory characterisation of biomass																	
Biomass collection and treatment. Collection, treatment and logistics techniques depending on the type of boiler to be used																	
Visits to existing cases																	
Contact with ESCOs to request the development of a technical report in the case of obtaining favourable results																	
Milestone: Biofuel Quality Optimisation of collection, treatment, storage and distribution activities.																	
Economic accompanying activities																	

Months / Actions	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32
Economic feasibility study of generation alternatives: Collective or individual																	
Search and structuring of financing through the different aid programmes for Energy Communities and bioenergy																	
Determine business models and the role of each party, including the approach for the creation of RECs, identifying problems and benefits																	
CAPEX, OPEX, pay-back, feasibility analysis of the proposed solution																	
Milestone: economic feasibility study																	

4.4.4 Community vision towards 2030

Through the experiences obtained during the support of both Spanish cases (**primary case of Aberasturi** – introduced within sections 4.4.1 – 4.4.3 and **secondary case of Murgia** – presented in section 4.4.5), Goiener will gain knowledge on BE community heating and will deploy a renewable thermal assessment service among its members, and will assist the establishment of other RESCoops in Spain and Europe. Therefore, **renewable electricity** retail activities will be complemented with consultancy in **renewable thermal systems**.

The roadmap to the end of BECoop project and to 2030 is represented in Figure 20, while the synoptic vision for Aberasturi is described in Table 17.

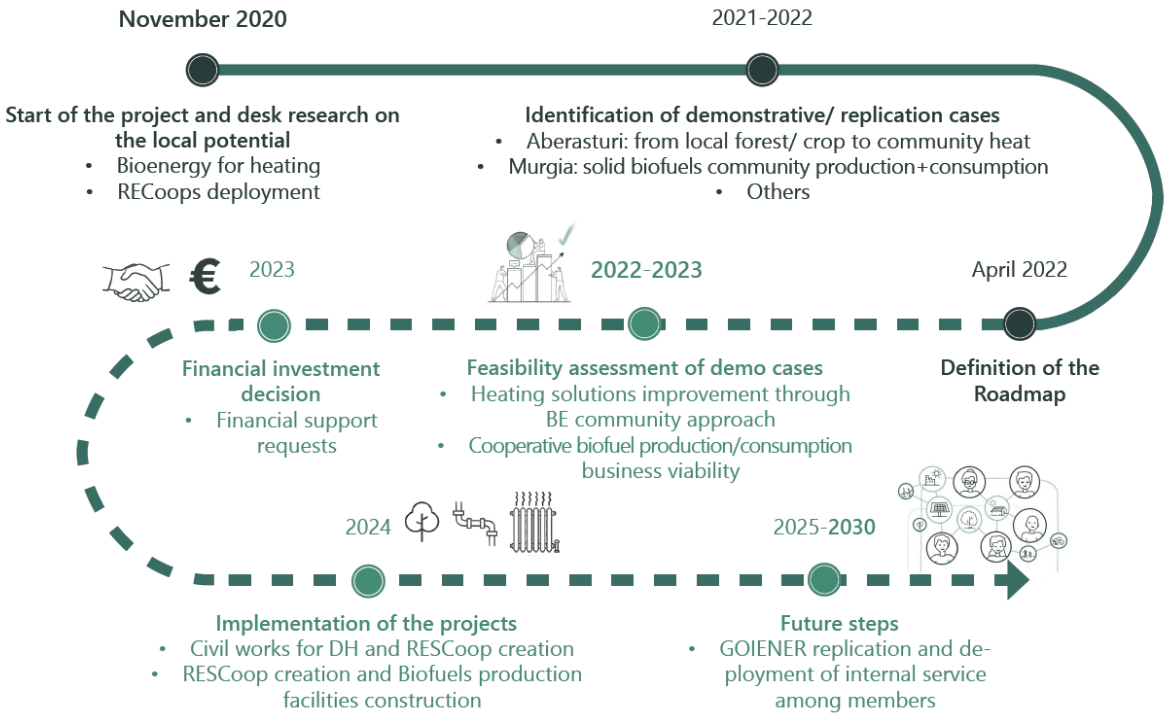

Figure 20. Scheme of the roadmap (Spanish pilot).

Table 17. Stakeholders involved and vision of the RESCoop (Spanish pilot - Aberasturi).

MAIN STAGES	FEED-STOCK	COLLECTION	TREATMENT/ TRANSFORMATION	DISTRIBUTION	FINAL USERS (DH/INDIV. SOLUTIONS)	OPERATION AND MAINTENANCE (WASTE MANAGEMENT)
Entity in charge	Inhabitants (Resource owner) or the RESCoop to be created.	The RESCoop to be created.	The RESCoop to be created.	The RESCoop to be created.	Inhabitants (Resource owner) or the RESCoop to be created as end consumer.	The RESCoop to be created as the owner of the installation.
Stakeholders involved	Aberasturi Management Board as data facilitator and management co-ordinator. AVG Rural Zone department as a resource information facilitator. Forest management consultants as participants in the resource inventory process.	Option A: Forestry services company / biomass collection: Subcontracting managed by the community to extract biomass from the forest and straw from the field to specialised service companies. Option B: the RESCoop to be created developing these services internally. Forest management consultancies as designers of the forest management plan.	Option A: Subcontract forestry services company managed by the community to produce the solid biofuel in the village. Option B: the RESCoop to be created developing these services internally. External processing centre where to transfer the product for treatment.	Option A: Subcontract the service to companies that have means for transport. Option B: to be managed by community members who have the means for transport or developed internally.	Option A: Subcontract the service to ESCO in order to do the retailing activities. Option B: The RESCoop to do these activities.	Option A:Subcontract the service to ESCO in order to do the O&M activities. Option B: The RESCoop to do these activities. Waste managers for handling the residues to be generated.
Service already in place?	Yes, there is a forest resource, but its use must be associated with a management plan to support it. Yes, there is a local straw resource.	Option A: Several Forestry services companies are based in Gasteiz/Vitoria. Option B: The service will need to be deployed by some of the RESCoop members. Also forest management consultancies are based in Gasteiz/Vitoria.	Option A: Several Forestry treatment services companies are based in the Gasteiz/Vitoria area. Option B: The service will need to be deployed by some of the RESCoop members. External processing centre such as Naparpellet	Option A: Several Forestry treatment services companies are based in the Gasteiz/Vitoria area. Option B: The service will need to be deployed by some of the	Option A: Several Energy Service Companies (ESCOs) companies are based in the Gasteiz/Vitoria area. Option B: The service will need to be deployed by some of the	

MAIN STAGES	FEED-STOCK	COLLECTION	TREATMENT/ TRANSFORMATION	DISTRIBUTION	FINAL USERS (DH/INDIV. SOLUTIONS)	OPERATION AND MAINTENANCE (WASTE MANAGEMENT)
				RESCoop members.	RESCoop members.	
Estimation of investment (if service not in place)	To do the exact inventory on the available resources will cost around 3000 € that will be assumed by AVG.	To be determined in T 4.2. As a reference, bales are sold at 39-50 €/t (transport included), so the cost should be less than that. In the case of woodchip, a chipper can charge 250 €/h, processing about 20 t/h, the chipping cost is 12.5 €/t, and the total cost of woodchip in the market must be equal or lower than 80-100 €/t (including transport) to be competitive. Aim to obtain below-market prices (including VAT).		Target to obtain prices below current technologies (2021).		
Location	Around 180 ha of common good forest surrounding Aberasturi (map here) (42.82655411094461, -2.5960329093544225)	The cut forest biomass and straw will be left in the field until the collection for treatment during the summer.	Pending to define the exact location of the facility depending on: Option 1: To store all the wood chips close to the boiler. Option 2: The silo (with the capacity for 15 days at full boiler capacity according to local regulations (RITE)) next to the boiler in a central location, and the rest in another building.		n.a.	n.a.

MAIN STAGES	FEED-STOCK	COLLECTION	TREATMENT/ TRANSFORMATION	DISTRIBUTION	FINAL USERS (DH/INDIV. SOLUTIONS)	OPERATION AND MAINTENANCE (WASTE MANAGEMENT)
Details (characteristics and visions for each part of the biomass chain)	Local forestry resource of 9 t per house, but pending definition of whether there would be enough resource over the service life of the proposed solution, for 56 houses. In the case of straw, 1000 t/y.	Define how the resource should be exploited in order to ensure enough resources over the service life of the proposed solution.	Woodchips from the Forest biomass. Straw balls from the agricultural resource.			

4.4.5 BECoop RESCoop of Murgia (secondary case)

Murgia is located in the Gorbeialdea mountain region, halfway between the cities of Bilbao and Vitoria and is composed of six small rural municipalities. The heat from some local public buildings is being supplied by boilers that use non-local (collected at more than 60 km of distance) forest biomass (wood chips and pellets), despite the availability of local resources. A new swimming pool and recreation centre will be built in the coming years and is expected to use biomass technology as a heating system.

The vocational-training institute at Murgia offers forest management classes and owns some equipment: tractor, woodchipper, storage and drying area. An initial small-scale test of producing wood chips from locally sourced forest biomass has been performed, but the level of quality reached is insufficient to be used in the boilers from the local municipalities.

Therefore, there is the need to improve the production process in order to promote a wood chips service, with local student-entrepreneurs to deliver to residents and municipalities of the Gorbeialdea area. Presently, municipal buildings consume 20 t/y and there is a room for expansion (sports hall) and ensure future biomass demand that could improve the viability of the project.

Currently, there are wood allotments for about 9 t/y per household, however the wood chips used in most of the public buildings are obtained from forests 50 km away from the consumption point. This situation creates the opportunity to supply this local boiler with local resources.

Eventually, there is an initiative in the French part of the Basque country called Sugarai that could be used as a reference for implementing a cooperative offering wood and wood chips retail services based on local biomass resources in the Murgia area.

The **stakeholders** expected to be involved are municipalities, the vocational training centre, final-year students as possible employees/entrepreneurs, local forest management company and other interested parties. All of them can be part of the cooperative.

For the RESCoop of Murgia, the main **challenges** can be:

- ✓ To understand the local biofuel consumption market and ensuring sustained consumption over time could be one of the most critical challenges;
- ✓ To ensure a standardised biofuels production process in line with regulatory requirements in terms of quality.

The main **opportunities** are related to implementing a short-circuit project that could valorise local resources for satisfying heating demand and creating economic/environmental/social positive impacts. Employees for local students could be promoted fighting depopulation and energy poverty due to cooperative effective control.

5 Discussion and conclusions

In the framework of T4.1, after a preliminary phase in which Fiper assessed the current development status of the pilots' visions, **four WSs were organised and carried out in each of the pilot area by the related involved BECoop partners**. Specifically, within each case, the following activities were carried out by pilot and their national supporting partners:

- Update the stakeholders, previously involved, about the BECoop activities and developments;
- Define the list of stakeholders that will support pilot partners towards the implementation of BECoop RESCoops;
- Discuss and co-develop with the invited stakeholders the most suitable structure of BECoop RESCoop according to each pilot's specificities;
- Organise next steps and define the output to be further explored in the next tasks of WP4;
- Draft each RESCoop's roadmap towards community bioenergy production.

Concerning **the Greek and the Spanish pilots**, a vision of energy community was already in place at the beginning of the project. In that case, BECoop can be seen as an accelerator for the implementation of a more complete vision for a pre-existing idea of energy community.

Conversely, in **the Polish pilot** area, the vision of the energy community to be implemented has been started from scratch, since no entity, company or municipality were organised in that sense before the participation in the project. Here, the support of the BECoop consortium has played an important role in the promotion of bioenergy among local stakeholders and favoured the development of a brand-new bioenergy community vision.

The Italian pilot had a more complex path due to the difficulties encountered in the selection of the most suitable case of study. At the end, the municipality of Tovo Sant'Agata has been identified as a BECoop RESCoop, in an area prone to develop from scratch a RESCoop vision and the related initiatives. Here, the BECoop project's support and the unstable energy market conditions have been considered as an opportunity by the municipality and a local agri-food company to co-operate for assessing the feasibility of an energy community.

The observed variations in terms of the RESCoop's implementation status in the 4 pilot regions could be potentially seen as a challenge for the homogeneous development of the BECoop initiatives. On the other hand, it can be seen as great opportunity to implement and support a unique vision in different contexts and development statuses. **The project's pilot cases represent diverse framework conditions, community bioenergy maturity, RE penetration in the heating and cooling market and socioeconomic environments, thus, providing a highly complementary synthesis of evidence across Europe. The project's activities and generated insights are, thus, expected to significantly enhance the existing know-how on ways to boost the uptake and establishment of community bioenergy.**

References

References of D4.1 are cited as hyperlinks and footnotes. Further references are reported in detail in the previous deliverables.