UNLOCKING THE COMMUNITY BIOENERGY POTENTIAL

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

JUNE, 2021

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 952930.

Project Acronym:	BECoop
Programme:	HORIZON2020
Topic:	LC-SC3-RES-28-2018-2019-2020
Type of Action:	Coordination and Support Action
Grant Agreement number:	952930
Start day:	01/11/2020
Duration:	36 months
Contact:	contact@becoop-project.eu

Document information

Document Factsheet	
Full title	D1.2 – Regional and EU framework and value chain conditions affecting community bioenergy uptake
Work Package	WP1
Task(s)	T1.2
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Reviewers (Organisation)	WR, IEECP, CBS
Date	June 2021

Document dissemination Level

Dissemination Level	
x	PU – Public
	PP - Restricted to other programme participants (including the EC)
	RE - Restricted to a group specified by the consortium (including the EC)
	CO - Confidential, only for members of the consortium (including the EC)

Document history

Version	Date	Main modification	Entity
v0.1	16/06/2021	Draft version shared for quality review	WUELS
v0.2	25/06/2021	Quality reviewers' input	IEECP, CBS, WR
v0.3	29/06/2021	Revised version sent to coordinator	WUELS
V1.0	30/06/2021	Final version submitted to the EC	WR

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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List of Abbreviations

AEBIG	– es. Asociación Española de Biogás; Spanish Biogas Association
ARERA	– it. Autorità di Regolazione per Energia Reti e Ambiente; The Italian Regulatory Authority for Energy
AVEBIOM	– es. Asociación Espanola de valorización energética de la biomasa; Spanish Association of Energy Valorization of Biomass
BAFA	– de. Bundesamt für Wirtschaft Und Ausfuhrkontrolle; Federal Office of Economics and Export Control
Bioenergy NoE	Bioenergy Network of Excellence
Bioplat	– es. Plataforma Española de la Biomasa; Spanish Biomass Platform
CAPEX	Capital Expenditures
CHP	Combined Heat and Power Plant
DH	District Heating
EAFRD	European Agricultural Fund for Rural Development
EC	Energy Community
EEA	European Environment Agency
ERDF	European Regional Development Fund
ESCO	Energy Service Company
ESF	European Social Fund
EU	European Union
EU-28	Abbreviation of European Union (EU) which consists of a group of 28 countries that operates as an economic and political block
EUCO27	Policy scenario, which depicts models for an energy efficiency target of 27% in 2030
EUROSTAT	European Statistical Office
EVE	– es. Ente Vasco de la Energía; Basque Energy Board
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FORBIO	– se. Forskerskole i Biosystematic; Research School in Biosystematics
GHG	Greenhouse Gases
GIZ	The German Agency for International Cooperation
ICA	International Cooperative Alliance
IEMD	International Electric Machines and Drives
IHOBE	– es. Sociedad Pública de Gestión Ambiental del Gobierno Vasco; Environmental Management Public Agency of the Basque Government

IRENA	International Renewable Energy Agency
ISEP	Integrated Strategic Energy Planning
LRAs	Local and Regional Authorities
MCP	Medium Combustion Plant
MDF	Medium-density fibreboard
MS	Member States
NAPCP	National Air Pollution Control Plan
NASC	National Agricultural Support Centre
NECP	National Energy and Climate Plan
NSRF	National Strategic Reference Framework
O&M	Operation & Maintenance
ORC	Organic Rankine Cycle
PATSTAT	European Patent Office
PET	Polyethylene terephthalate
PM10	Particulate matter that is 10 microns or smaller in size
PM2.5	Particulate matter that is 2.5 microns or smaller in size
PNRR	– it. Piano Nazionale di Ripresa e Resilienza; The Recovery and Resilience Plan
PV	Photovoltaic
R&D	Research & Development
RAE	Regulatory Authority for Energy
RDP	Rural Development Programme
RE	Renewable Energy
RED	Renewable Energy Directive
RESCoops	Renewable Energy Cooperatives
RHC	Renewable Heat and Cooling
RIS3	Regional Strategy for Innovation
RoT	Region of Thessaly
SCR	Selective Catalytic Reduction
SME	Small and medium-sized enterprises
SNCR	Selective Non-catalytic Reduction
SPV	Special Purpose Vehicle

Executive Summary

This report focuses on mapping and providing a comprehensive analysis of the framework conditions and value chain conditions affecting community bioenergy uptake at (i) the EU level as well as (ii) the BECoop 4 Pilot cases (Spain, Greece, Poland, and Italy). The work presented herein is based on an extensive literature and existing databases' (i.e., EUROSTAT, PATSTAT, etc.) review which was complemented by a set of interviews (5 at the EU level; 3 per pilot area). The synthesis of desk research and interviews further revealed regional/national and EU-level factors (such as socio-economic, legal, political, environmental and technical considerations) and value chain parameters that can influence the establishment of community bioenergy across the EU.

The main identified empowering factors at the local level include: the fast transposition (into national law) of the RED II Directive, further adopting the energy community concept officially introduced and defined under this legislative act; the consideration of bioenergy uptake in local development strategies; the country-level ambitious goals in the field of energy transformation; the competitive prices of biomass fuels as well as domestic biomass boilers and the increasing local activities and awareness raising events related to RES development at the local level.

Major hindering factors identified include: the varying and often low speed transposition of RED II into national law; limitations in terms of RESCoop operation (power, area, membership, scope of activity and ambition); and low levels of awareness related to bioenergy and biomass combustion.

The analysis of social aspects reflects a strongly positive attitude of local communities towards bioenergy heating projects. In addition, the study of technical and economic factors showed no significant barriers against their uptake

The key findings of this work shed light on aspects that need to be further inspected (social acceptance, supply chain coordination, legal and public framework conditions etc.) and contribute at identifying whether a series of crucial aspects is indeed addressed by local and EU relevant policies. This is vital information upon which BECoop can better target and fine-tune the project's foreseen actions.

Report's results may feed into various project's WPs and Tasks; indicatively:

- giving input to T1.4: contributing to the analysis and the development of a consolidated report where community bioenergy heating uptake needs, and challenges are defined.
- connection to WP2: findings here will serve as a reference for the development of the BECoop tools.
- connection to WP3: bringing insights and identifying barriers that could be used in the mobilisation process of stakeholders and further implementation of awareness raising and training events.
- contribution to T5.3: mapping and analysing existing policy frameworks in different agglomerations.

1 Introduction

This report presents and reflects upon the results of BECoop T1.2, which aimed to map at local and EU level the framework circumstances and the environment concerning the activation and development of community bioenergy heating. The task's specific goals included:

- investigation of the framework conditions for the community energy development considering the whole local/regional logistic chain related to bioenergy utilization for heat purposes (desk research),
- analysis of current strategy and vision from EU level related to community energy activity in Europe (desk research),
- review of literature as well as of EU and local quantitative databases (EUROSTAT, PATSTAT, etc.) to determine biomass potential, low carbon energy needs, supply chain characteristics, local resources, and current uses, energy prices, etc. (desk research),
- conducting interviews with local actors/institutions/companies belonging to the potential logistics chain focused on heat generation from bioenergy, and with policymakers at the EU level in terms of community energy vision and development,
- identification and defining crucial aspects/issues requiring deeper analysis to uptake the community energy in Europe.

A brief action plan for the organization, implementation, and reporting of T1.2 results from desk research and interviews at local and EU level was as follow:

1. Preparation and sending to the task partners the methodological guidelines and templates for the desk research and interviews to collect feedback from the regional/national and EU framework conditions.
2. Reporting back from task partners the results of Desk Research and Interviews at local and EU level.
3. Synthesis of desk research and interviews for the pilot/national and EU level conditions.
4. Identification of significant empowering/hindering factors for RESCoop creation at local and EU levels.
5. Drafting and submission of the deliverable.

2 Desk Research

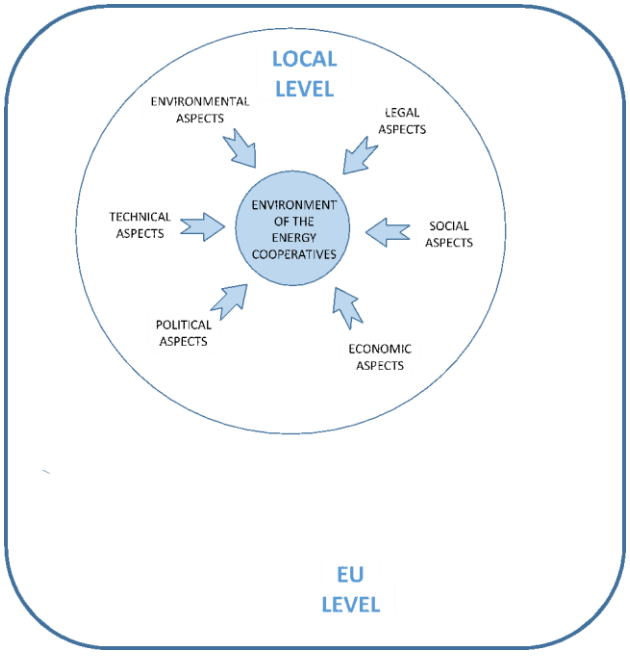
2.1 Desk Research Methodological Approach

In order to identify common and distinct empowering/hindering factors of RESCoop creation in the EU, the following aspects were analysed:

- political (e.g., identification of the assumed RES targets at the national and local level),
- legal (to identify legal limitations of RESCoop, support systems),
- environmental (to determine the differences in the implementation of Eco-design Regulation in pilot areas, identification of local air pollution problems),
- economic (to compare the market prices of biomass fuels with fossil fuels, to identify the RESCoop financing methods),
- social (related to ecological awareness of the society),
- technical (to outline the local opportunities to create a logistics chain for RESCoop).

For this purpose, the literature review based on scientific publications and local quantitative databases (EUROSTAT, PATSTAT, etc.) has been performed.

Figure 1 presents the scope of individual analyses at the local and EU level. Aiming to thoroughly assess the environment and framework conditions for the activation and uptake of bioenergy community, it is crucial to first understand the whole logistic chain of biomass utilisation process (*Figure* 2), as well as final targets defined by local authorities, national government and EU Directives. As community energy development varies between different EU countries, many actors can be involved; this can, therefore, be considered as a multifactorial equation.



Legend:

Local Level (flexible meaning): refers to the public administration at the lowest agglomeration level within government state, such as municipality of district. It entails local government units which, in turn, consist of local government institutional units and non-market institutions controlled at the local level.

Remark: Since community energy and renewable energy communities (RESCoop) can also include adjacent municipalities, if needed, the regional level is also acceptable and counts towards the local level

EU Level: includes the common vision, opinion and strategy of all the European Union Members

Figure 1. Aspects related to community energy development.

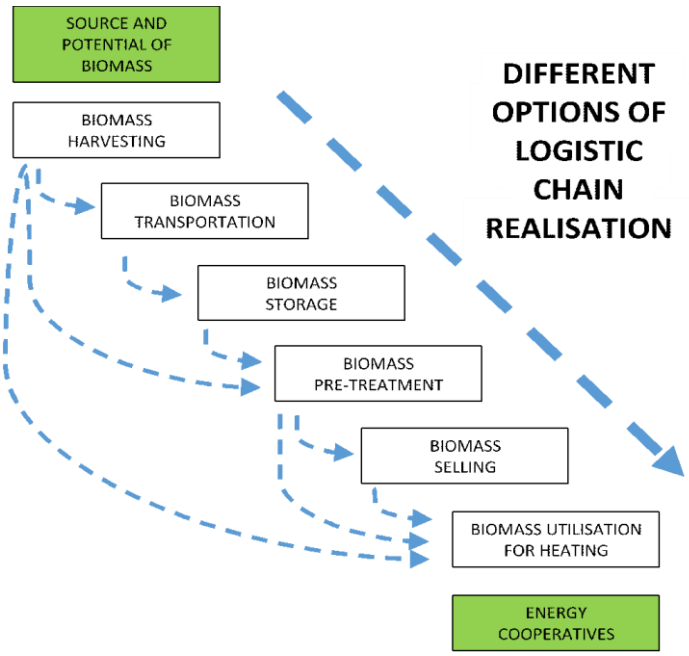


Figure 2. Logistic chain related to community energy functioning.

2.2 Results of Desk Research at the EU Level

A) POLITICAL ASPECTS

The establishment of energy communities relies on a wide variety of governance models that may encompass different patterns of organisational and contractual arrangements, local identities, and common interests [1]. It is, in fact, the blending of these factors combined together in a particular scheme that may eventually facilitate (or hinder) the successful creation of an energy or bioenergy community. While identity and interest are rooted in demographics and geography-specific cultures, **the organizational and contractual arrangements consist of political factors that can be adapted** [2]**.** In this context, EU, as well as policy at the national and regional level, should be flexible to adapt to this clean-energy transition era, establishing frameworks that empower the development of energy communities across Europe.

Supporting factors, driving the uptake of bioenergy community projects:

Projected increase in the production of renewable energy from biomass. The growth of bioenergy and renewable energy is mainly policy-driven, through targets and incentives. Nevertheless, biomass represents today more than 60% of current renewable energy production in the EU28 – the majority from solid biomass. Based on the [3], for the baseline policy scenario (EUCO27), it is expected that by 2030 the share of biomass will be around 50% of overall renewable energy production. In absolute terms, it is projected that final energy demand from biomass will stabilize to approximately 147 Mtoe by 2030, compared to 124 Mtoe in 2020.

There is a clear definition of the Renewable Energy Community provided by new RED II Directive [4], giving the legal entity for this type of organizations/associations. Renewable Energy Community means a legal entity: (a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity; (b) the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities;

(c) the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits.

Promotion of activities increasing the environmental awareness of society. Renewable Energy Directive (RED II (EU) 2018/2001) [4] and Energy Efficiency Directive (Directive 2012/27/EU) [5] promote the development of information, awareness-raising, guidance, and training programs for citizens on the benefits and practicalities of installing RE and undertaking energy efficiency measures and generally foresee both participative and leadership roles for LRAs.

RED II contains provisions that aim to facilitate the participation of individual prosumers and energy communities in the energy system (Art. 22) and to enable consumers to produce and self-consume energy individually or collectively (e.g. in multi apartment buildings) and ensure they are remunerated for the power they feed into the grid (Art. 21) [4].

Member States shall ensure that final customers, in particular household customers, are entitled to participate in a renewable energy community while maintaining their rights or obligations as final customers, and without being subject to unjustified or discriminatory conditions or procedures that would prevent their participation in a renewable energy community, provided that for private undertakings, their participation does not constitute their primary commercial or professional activity.

Member States shall ensure that renewable energy communities are entitled to [4]: (a) produce, consume, store and sell renewable energy, including through renewables power purchase agreements; (b) share, within the renewable energy community, renewable energy that is produced by the production units owned by that renewable energy community, subject to the other requirements laid down in this Article and to maintaining the rights and obligations of the renewable energy community members as customers; (c) access all suitable energy markets both directly or through aggregation in a non-discriminatory manner.

Member States shall ensure that renewables self-consumers, individually or through aggregators, are entitled [4]: (a) to generate renewable energy, including for their own consumption, store and sell their excess production of renewable electricity, including through renewables power purchase agreements, electricity suppliers and peer-to peer trading arrangements, without being subject: (i) in relation to the electricity that they consume from or feed into the grid, to discriminatory or disproportionate procedures and charges, and to network charges that are not cost-reflective; (ii) in relation to their self-generated electricity from renewable sources remaining within their premises, to discriminatory or disproportionate procedures, and to any charges or fees; (b) to install and operate electricity storage systems combined with installations generating renewable electricity for self-consumption without liability for any double charge, including network charges, for stored electricity remaining within their premises; (c) to maintain their rights and obligations as final consumers; (d) to receive remuneration, including, where applicable, through support schemes, for the self-generated renewable electricity that they feed into the grid, which reflects the market value of that electricity and which may take into account its long-term value to the grid, the environment and society.

The EU strives to promote international cooperation among energy communities. Member States may allow renewable energy communities to be open to cross-border participation (RED II Directive). Energy communities, especially during the last decade, established common communication channels and created groups of cooperation at the national and international levels to better safeguard their rights and promote their work. In Europe, a small group of RESCoops started to cooperate in 2009 and by 2013 officially set up RESCoop.eu [6]. RESCoop.eu aims to represent citizens and RESCoops towards European policymakers, support new RESCoops to start-up, and create a financial service that would facilitate European RESCoops [6].

Step by step RESCoops creation in the energy transformation of the region. Some locations, such as the pioneer town of Güssing in Germany, used local renewable projects to transform their communities and put them on a tourist map as an archetype and an inspiration for everyone interested in local sustainable development. From projects and small actions to community energy creation, the step-by-step approach enables the local citizens to get used to the transformation from passive to active participants of the energy market.

Calling to transpose the new directives into EU members national law within a period of 2 years, that is by 2021. Ever since RED II [4] and IEMD [5] were published, EU Member States MS were called to transpose the new directives into their national law within two years, that is, by 2021. In this context, MS needs to prepare their NECPs to specifically describe how they will fulfil their obligations according to the EU rules, thus reaching the EU climate objectives. MS should ensure a stable favourable national framework for the development of renewable energy communities. In the later stage, they should also present a progress report, evaluating their overall performance and assessing the transparency and efficacy of their respective measures (Directive (EU) 2018/2001-article 22).

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Difficulties for RESCoop to compete with centralized energy companies. One of the greatest challenges for energy communities is their volunteering structure. It is often hard for communities, relying on their members, to safeguard their rights compared to the means that a large, centralized energy company would have [7]. In addition, with the introduction of new financial schemes, such as auctions and tenders, it became evident that community energy projects face difficulties competing over more experienced energy companies, which might have a greater capacity to develop a project for the lowest amount of subsidies.

RESCoop development depends on national and regional governments policy. It is possible that during the next decade, due to the national evolving regulatory and legal choices, a heterogeneous development of energy communities will take place. Members States are responsible for supporting and legislate their national definition of community energy and further explain which already existing legal entities could fall under this definition (or even creating new entities that could adopt this role. Laws, however, are written in a way that leaves space for movement to each Member State; it is national governments who will choose to what extent energy communities will be supported. Furthermore, if a policy is put in place to foster the development of community energy, it is not always followed by good public financial schemes to encourage its implementation. In this context, for an effective RESCoops uptake, local governments need to be widely supported by national and European funds, and the lack of available resources remains a concern.

B) LEGAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Presence of organisations with experience in the functioning of the energy communities. In Europe, there are organisations having experience in the area of communities functioning, their role and activity (ICA [8]) as well as in the field of energy communities development, providing a range of services to support citizens, businesses and local authorities that want to work on community energy [9]. RESCoops lead the energy transition to energy democracy and respect several principles outlined by the International Cooperative Alliance, such as: voluntary and open membership, democratic member control, economic participation through direct ownership, autonomy and independence, education, training, and information, cooperation among cooperatives, concern for the community.

Legal EU support for project financing. In 2014, the European Commission published a *Communication on Unleashing the potential of Crowdfunding in the European Union* [10] which helps unleash crowdfunding in the EU. Also, a proposal that serves to amend the Regulation on European Venture Capital [11] and Regulation on European Social Entrepreneurship Fund [12] was published in July 2016. It mentions a common barrier to crowdfunding, and that is that some funds have a minimum investment which is often too high (compared to alternative renewable sources) to be combined with a citizen financed project.

SPV as a possible facilitation of the financing of a bioenergy project. German Federal Ministry for Economic Affairs and German development agency GIZ published a study on Community-based Renewable Energy Models [14] which analyses existing participation models and best practices for community-based renewable energy deployment in Germany and internationally. They report that most such projects are set up as a Special Purpose Vehicle (SPV), i.e., as a stand-alone legal entity, taking different shapes. It can, for example, be managed by highly participatory cooperatives or by more anonymous corporations less responsive to requests from non-institutional investors or affected tiers of the population, but it is an opportunity and a possibility for citizen financing, with legal models varying from country to country.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

In some countries, there are certain formal and legal restrictions regarding the operation of energy communities, the possibility of their connection to the grid or allowed power capacity. Even though all Member States provide some types of RE support mechanisms, including feed-in tariffs, feed-in premiums, or quota obligations, only some countries allow priority access to the grid for renewable energy or a simplified procedure for permitting small RE installations [15]. For further information, please check *Table 19* - Annex III.

Different level of bureaucracy and regulations across Member States related to the grid connection and registration. The non-technical barriers for RESCoops projects belong to the main inhibitors of this activity. The bureaucratic procedures, including permitting procedures, certification, formal restrictions, and access to the grid, are often more difficult and time-consuming than technical issues. As these barriers differ from one Member State to another (differences between the national support systems and their consistency), there is no expected level of confidence in the legitimacy of their development.

Lack of a common EU framework for crowdfunding in renewable energy projects. At a national level, the legal framework conditions for crowdfunding in renewable energy projects differ from country to country, and this lack of a common EU framework is one of the biggest hurdles in developing such projects. These local differences enhance the lack of transparency and legal uncertainty, thus hindering many projects and making it hard to have a coherent EU-wide market for crowdfunding with the same conditions for all market players.

The level of development of local bioenergy communities is not the same in all Member States (in some countries is considerably more advanced than in others) caused by significant differences defining energy communities in the national law. The different level of development of energy communities increases the uncertainty and distrust of this type of solution as not proven sufficiently in practice or as very individual with an uncertain guarantee of success. Energy communities' dispersion and range across Europe appear restricted until today, with 80% of them located in either Germany or Denmark. The concept remains relatively undeveloped in southern, central, and eastern Europe (e.g. in Poland, the national law strictly defines the concept of energy cooperative introducing a number of restrictions (e.g. power, location) [16].

C) ENVIRONMENTAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

The combustion of fossil fuels leads to a surplus of CO_2 emissions. If fossil fuels are burnt, a significant amount of direct and indirect CO_2 emissions to the atmosphere occurs. In the case of biomass combustion, there is only indirect CO_2 emission. Direct CO_2 emission is equal to zero as biomass burning only returns the amount absorbed during plant growth to the atmosphere. Consequently, there will be no net surplus CO_2 emissions if the cycle of growth and sustainable harvest continues in the future [17].

No negative impact of biomass harvesting on the carbon content in forests. The process of obtaining biomass for energy use is one of the many interacting factors that lead to an increase in carbon stocks in forests, also taking into account forest product markets, the structure and management of forest ecosystems, and natural conditions. Sustainable forest management and its strict harvesting requirements are coordinated across the forest landscape to ensure the forest is in good condition, with the synergy of wood supply to society and the maintenance/expansion of wood volume in the forest [17].

The use of waste biomass for energy production is in line with circular economy. In 2013, only 6% of the wood biomass used in the European Union for the production and electricity came from pellets [18]. In the case of forest biomass, most of the substrates converted to heat/electricity are waste and by-products originating from forest management and other processes using wood [17].

The GHG emission related to biomass logistics is lower in comparison to fossil coal. The use of traditional energy sources in the biomass logistics chain and the associated GHG emissions are generally low, even in the case of intercontinental biomass transport. The use of traditional fossil fuels for the cultivation and processing of wood pellets is associated with an increase in emissions from 2.5-15 $gCO_2 \cdot MJ^{-1}$. On the other hand, the transport of pellets between North America and Europe increases this value by only 5 g $CO_2 \cdot MJ^{-1}$ [19]. The standard life cycle of fossil coal, related to the supply to the energy centre and its combustion, is about 112 $gCO_2 \cdot MJ^{-1}$. Therefore, it is considered that the transport of biomass for energy purposes does not detract from its environmental performance and still offers significant climate benefits [20].

Biomass production on fallow and low-quality land reduces the use of other resources. Using the fallow and low-quality lands for biomass production to generate electricity and heat for sites that do not have a high nature value or high biodiversity leads to lower consumption of other resources such as water and pesticides, thus reducing the risk of water depletion. and GHG emissions [21].

Sustainable landscape and forest management to harvest biomass for energy purposes has a positive impact on biodiversity. Many species of organisms are adapted to open or semi-open conditions and therefore require exposure to the sun. Therefore, collecting solid biomass from these areas can support the construction of biodiversity in the areas where they occur. However, the management and regulation of biomass logging and harvesting is essential, as unregulated harvesting may have the opposite effect. In addition, the collection of biomass from contaminated sites would also have a positive effect on biodiversity with potentially high conservation values [22].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Threats to biodiversity resulting from storage and extraction of logging residues from forests. Wood residues and waste prepared in the forest for energy purposes are, for many organisms a breeding habitat,

shelter, or a substrate for lichen growth, which is destroyed (burned). The removed wood matter can also reduce the nutrients in the soil and protect the substrate or animals against extreme microclimate, mainly drought or high temperatures [23]. In addition, the removal of stumps and roots, as well as residues from tree felling for biomass, may also harm soil fauna and saproxylic species [24].

Lack of adequate protection of intensively used forests. According to a report by the EEA [25] are described as bad. the environmental conditions of European forests are described as bad. This is because many of them are intensively exploited, and there is a shortage of deadwood and older trees. It is estimated that almost two-thirds of forest habitats are in an unfavourable conservation status [26]. Intensifying the extraction of biomass from forests that are already under stress may be associated with the loss of biodiversity and an impact on other forest ecosystems in Europe [27].

The use of biomass for energy purposes may involve non-ecological production of biomass for other purposes. The use of both food and forest biomass to produce electricity and heat will increase the demand for these raw materials for other applications. Such action is related to the fact that, although biomass production for energy purposes is subject to strict sustainability criteria, the production of biomass for other purposes can still be produced through harmful practices and pathways, which in general may be associated with non-ecological activities [28].

Soil erosion related to the use of heavy machinery in forestry. Although mechanized harvesting of wood for energy purposes allows for a high yield of raw material, it is associated with the risk of severe damage to forest soils. As a result of deforestation carried out with heavy equipment, the topsoil is compacted, and the soil morphology changes. Such action is associated with soil compaction and reduction of soil porosity, which significantly reduces the supply of oxygen and water to soil microorganisms. The activity of heavy equipment, therefore, has negative consequences for the ecology of the soil, and at a later stage - the productivity of forests and the development of the most fertile parts of the soil [29].

Emissions from biomass combustion. The combustion of biomass is associated with a significant source of PM2.5, polycyclic aromatic hydrocarbons. In addition, depending on the plant's ability to accumulate nitrogen in the tissues, significant NOx emissions and various other pollutants related to the substances in the chemical composition of the biomass may occur. These emissions can have a degrading impact not only on the environment but also on the health of citizens [30].

Reduction of soil organic matter. Obtaining biomass for energy purposes is also associated with a negative impact on organic matter content in the soil and its production capacity. The appropriate content of this parameter is a crucial factor determining the ability to retain water in the soil, increase the retention of nutrients, prevent their leaching, and stabilize the soil to prevent erosion [31].

D) ECONOMIC ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Multitude of forms of non-institutional involvement in renewable energy projects. The GIZ report [14] explains four ways of non-institutional involvement in renewable energy projects: (i) The Open Investment Model, (ii) The Compensation Model, (iii) The Community Connected Model, (iv) The Community-based Model.

Existing supporting programs for the RES development in European countries. Especially in the eastern European countries there are national programs that co-finance the construction of the electricity production installation as well as provide subsidies to the amounts of energy produced [32].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lower heat and electricity final costs from fossil fuels. In many European countries, the useful electricity and heat from fossil fuels (especially coal) are still the cheapest (*Table 1*

), making them very competitive to renewable fuels, despite their negative impact on the environment. The electricity price is very often 3-4 times cheaper than the RES price.

Table 1. Cost analysis of some power plant types for EU area [33].

Type of power plant	Capital cost ($M/MW)	Utilization (%)	Fuel Cost ($/kWhe)	Electricity Price ($/kWhe)	Comment
Solar Photovoltaic Thermal	3-5 3-4	22 31	0 0	0.30-0.40 0.20-0.26	Day only Needs grid back-up
Wind	1.5	34	0	0.10-0.15	Windy only Needs grid back-up
Biomass	1.4	83	0.025	0.09	24 hr/day
Coal	1.2	85	0.024	0.08	24 hr/day

Phasing out of lucrative support programs in EU countries. Most recent research substantiates the importance of cooperatives in the energy transition. However, it is also evident that the role of energy communities has been shrinking recently since the lucrative support schemes are phasing out. For example, Germany witnessed an all-time high in cooperative creation, with 167 new cooperatives being set up, while since then, this growth continues to decrease at a rate of the app. 10% a year [34].

Nevertheless, regardless of the feed-in tariffs phasing out and being replaced by feed-in premiums and quota systems, biomass has always been a leading energy source. Historically, solid biofuels and hydro made up around 90% of all renewable sources. With the introduction of feed-in-tariffs, other renewables blossomed, especially wind and solar, but bioenergy also continued to grow, leaving the hydro behind. Such incentives resulted in biomass becoming a prominent renewable source in EU28 energy production (54%), including biomass (40%), biogas (7%), and liquid biofuels (7%) [35].

Fossil fuel power plants have the lowest investment costs. The investment costs for installations powered by fossil fuel are ca. three times cheaper than the RES installation (*Table 1*). Moreover, these installations are more stable in terms of heat and electricity production as they are independent of the external environment conditions like wind properties, solar radiation, etc.

E) SOCIAL ASPECTS

Social capital, civic-minded behaviour, environmental concerns, and trust are considered among the most important driving factors for empowering citizens' participation in energy communities [36], [37]. Community engagement often depends on a combination of social and moral goals, while economic profits constitute a crucial factor.

Supporting factors, driving the uptake of bioenergy community projects:

The vision of the financial benefits and improvement of the environment quality. The energy communities create a possibility to contribute to energy democracy and inhabitant's energy as well as trigger a wider consciousness among citizens and communities of energy issues. Citizens and energy communities will become active consumers or prosumers and gradually start participating in distribution grids, energy supply, and energy service companies. Such democratisation of the energy system can ensure wider acceptance and uptake of RE projects and lead to lower energy prices, especially for energy-poor consumers [38], [39]. Moreover, the locally centralized heating systems lead to better fuel quality control and the reduction of the pollutants emission to the atmosphere. Finally, energy communities contribute to the achievement of climate, energy, and environmental objectives. They can bring EU, national and regional policy goals closer to the citizens improving local acceptance for energy transition projects as well as participate in meeting climate policy goals due to the installation of RES, energy savings, and improvements of energy efficiency.

Growing popularity of community involvement models among the world. The GIZ report [14] concludes that: community involvement models are spreading internationally beyond high-income countries like Germany, Denmark, or the USA.

Help of RESCoop in strengthening the social capital. The German Federal Ministry for Economic Affairs and GIZ study on Community-based Renewable Energy Models [14] argues that Community-based renewable energy is desirable not only for straight forward benefits, but also for strengthening the social capital through developing participants' skills such as teamwork, cooperation, bargaining and knowledge to deal with administrative procedures and technology. These skills help the community even in other sectors. Finally, the report concludes that the community-based projects integrate people in the creation of a sustainable low carbon society and is therefore an important social pillar of energy system transformation. This report groups community-involvement models based on four criteria that correspond to different purposes for the inclusion of the community: (i) Openness to non-institutional, non-local investment (equity or debt) can be a means to enhance access to new forms of financing and allows individuals to benefit financially from renewable energy projects, (ii) The creation of Wider Community Benefits (e.g. through community donations or job creation) can improve local acceptance of energy projects, (iii) Openness to or active mobilization of non-institutional local investment can improve the local acceptance of renewable energy (RE) projects but also reflects the notion of getting a fair share from the exploitation of their natural resources, (iv) Making decisions locally through communities combines the notion of fairness towards the local community to benefit from RE projects with an empowerment of the community who takes the lead in the development in their area. Profits stay within the community and create local value-added cycles. Based on these criteria, four types of community involvement models were identified.

Gaining jobs by local community through a distributed energy model. IRENA 2018 report on *Renewable Energy and Jobs* [40] inform that in 2017 there were 3.06 million jobs in bioenergy globally, surpassed only by solar photovoltaic with 3.37 million jobs. When looking at total global renewable energy employment, bioenergy accounted for 35% of the jobs in 2017. This percentage decreased from 42% in 2010 due to the fast development of other renewables. However, there is constant growth in jobs, with 500,000 jobs created in bioenergy globally since 2010. Most jobs were generated with liquid biofuels, which took second place right after solar, employing almost 2 million people in 2017 worldwide. Europe accounts for 10% of total jobs in biofuels (200,000), and with the recast of RED II [4], there is a significant nudge to increase these numbers. When looking only at the EU, the situation is even more advantageous towards bioenergy.

Trust between local community and people leading the initiatives can boost participation in energy community projects. Trust is an essential ingredient in cooperative communities [36]. Trust between the local community and people leading the initiatives is fundamental for the development of the project, the outcomes and, of course, for the involvement of the local society and their desire to get engaged in the process. There is also evidence that communities with trust result in strongly participatory processes and these processes, in turn, lead to a further building of social capital [41]. More specifically, higher levels of trust empower a higher participation rate in community energy. Trust is a key element; it does not only serve as a requirement for the creation of a community but it is also an outcome of the community's establishment [42].

Will for energy independence and alleviation of energy poverty. Willingness for energy independence, away from large companies, constitutes an essential factor in empowering participation in energy communities [43]. Energy communities are characterized by energy autonomy by the centralized energy system, and they are self-sufficient as they can produce the energy they consume [44]. Therefore, energy communities could empower local citizens to reach energy self-autonomy, improve the local economy, and significantly contribute to alleviating energy poverty. Many energy communities use a part of their gained profits to alleviate energy poverty and help socially disadvantaged populations or even contribute economically to the local budget when it is reduced due to government cuts [45]. It should also be noted that energy communities often use their profits to finance other local energy projects (reinvestment of benefits), supporting activities such as improving local residences' insulation or renewable energies home installations [46]. In addition, in some cases, energy community members are motivated to donate their surplus energy to pay for the energy bills of the poorest or share their membership with other individuals [16].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lack of promotion of energy communities in individual EU Member States that would reach the local community, especially those living in rural areas. In many countries, the inhabitants have no idea about this kind of initiatives. As a result, the local community is not optimistic about new solutions, especially those requiring mutual cooperation and sharing of property.

Civic minded behaviour and memories from the community's past can shape citizens perceptions. Another important aspect that plays a crucial role in Eastern European countries is the negative social perception regarding cooperative structures and centrally planned economies due to negative memories from the past. As a result, eastern European citizens may show hesitation and scepticism towards the engagement in cooperative projects, which could be explained by the Soviet past of the populations [16], [47].

Capital availability and investment risk influencing willingness to be involved. The economic differences and especially citizens' income plays a significant role in community energy development. It is known that countries with higher income have a bigger number of energy communities in their territory than lower-income countries. This is also depicted geographically in the European Union as northern countries such as Germany and Denmark are the leading actors in the European energy community while southern and eastern countries lag behind. These differences due to income could be explained by the lack of capital to invest in the energy sector in more impoverished countries [16]. On the other hand, the economic factor is one of the most important reasons to engage in an energy community project. Citizens are expecting to reduce their energy expenses by producing and consuming their own energy. In rarer cases, people would also look at energy production as an additional source of income, and they would expect to have some profit from their involvement in the project.

Note: *BECoop T1.3 will offer a solid understanding on the current general public perceptions, intensions and behavioural aspects around community bioenergy. Captured information will shed more light on social factors that may act as drivers or barriers to the establishment of RESCoops.*

F) TECHNICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

There is a wide range of machines and devices available on the market, at every stage of the logistics chain, necessary for the operation of energy communities based on solid biofuels. There are machines for collecting forest and agricultural biomass, which can even prepare a semi-final product for further processing, or a final product ready for direct delivery to the consumer/user, even at the place of its harvesting/acquisition. Considering the automation process of low and medium size heating units, there are technologies and devices (pelletizing and briquetting machines) for biomass valorisation and the production of fuel with specific physical-chemical parameters. Depending on the type and form of biomass fuel, there are heating units available on the market for its combustion or gasification to generate heat or electricity. Currently, the heating units do not have difficulties in meeting the emission requirements resulting from the European ECODESIGN Directive [48] related to biomass combustion, in solutions of up to 500 kW. In more powerful equipment, the MCP Directive [49] regulates the emission requirements from combustion plants with a thermal input between 1 and 50 MW. An upcoming review of the Eco-design Regulation for solid fuel boilers may introduce EU-wide emission limits for the "missing capacity gap between 500 and 1,000 kW.

Set of procedures, aspects and conditions that can facilitate (bio)energy project from being implemented. There are many valuable resources, such as the NOE-BIOENERGY NOE [50] or FORBIO [51] EU projects about overcoming the barriers to bioenergy.

Requirements and exploitation conditions for boilers fired by solid fuels. The final users must be conscious of exploitation conditions of boiler fired by solid fuels (biomass). Actually, only using well-developed boilers and very high-quality biomass pellets, it is possible to operate fully-automatically the heating unit. However, in other circumstances, the user must from time to time remove the ash, add fuel to the container and buy the fuel if necessary.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Solid biofuels require relatively large space for storage. Thermal units fed by biomass need storage space, depending on the capacity of the boiler it varies from 2-5 m^3 (for households) to hundreds of m3 (for commercial CHP). In case of the fuels change, from gas or oil, the final user has to ensure the space for its storage into the biomass.

Building a heating network in an existing infrastructure is complex. If it is necessary to connect the heating network to consumers in a densely built-up area, one must consider many technical difficulties, which are complicated, time-consuming, and costly.

The build a central heat and power plant is complex. Central Combined Heat and Power Plant with medium power (several dozen MW) is a complex energy unit in terms of technical and technological requirements, requiring 24/7 supervision. An energy community must be aware of the risks and many difficulties associated with the operation of such devices on a large scale.

2.3 Desk Research Findings at the Local Level

2.3.1 Spanish Pilot Area

A) POLITICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Strategic National Energy and Climate Frameworks takes into account the use of RES. In February 2019, the Government of Spain presented the Strategic Energy and Climate Framework, seeking to facilitate the modernization of the economy and move towards a sustainable and competitive model which helps slow down climate change. The National Integrated Energy and Climate Plan 2021-2030 assumes [52]: 42% of renewables over final energy use, local establishes the lines of action to develop the appropriate regulatory framework that defines these legal entities and favours their development (measure 1.13), development of self-consumption with renewables and distributed generation, pointing out collective self-consumption as a starting point for the ECs (measure 1.4), framework for the development of thermal renewable energies with mechanisms to guarantee a minimum share of renewable energies in the thermal use sector and technical training at municipal level (measure 1.6), promoting the proactive role of citizens in decarbonisation, empowering citizens and their participation in the energy transition, promotion of the mobilisation of available funds by the public to contribute to financing the renewable energy transition and to manage their own energy (action 1.14), knowledge generation, dissemination and awareness raising to promote the proactive involvement of all parties in the energy transition (action 1.19), social innovation for the climate with a support for the realization of social and urban innovation projects (action 5.8).

Promotion of bioeconomy strategy to reduce depopulation of rural areas. Special emphasis on green job creation in rural areas, in line with the Spanish strategy on depopulation, by encouraging renewable energies like biomass or biogas, and by promoting the bio-economy strategy to generate economic value, local market activation for products and sub-products, and a review of the Spanish forest plan [53]. The public administrations of Navarre shall encourage local participation in renewable energy installations and promote the training of citizens, local renewable energy communities, and other civil society entities to promote their involvement in the development and management of renewable energy systems (article 25) [54].

Plan to establish a local regulatory, institutional and instrumental framework for climate action and to move to a low carbon energy model based on citizen participation and renewable energy. It is currently being debated and approved to establish in the Navarre Foral Community the regulatory, institutional, and instrumental framework for climate action and the transition to an energy model with a low-carbon economy based on citizen participation and renewable energies. It aims to include the coordination of related sectoral policies, compliance with GHG emissions mitigation targets, and facilitating adaptation by reducing the vulnerability of its population and territory.

Ambitious targets of local governments in the use of renewable energy. To reach targets in terms of use the RES, there are many supporting documents, such as:

- Climate Change Strategy of the Basque Country to 2050 [55] (Basque Country has set 40% renewable energy consumption out of the final consumption as the target for 2050),
- Energy policy 2030 [56] elaborated by Energy Agency of the Basque Government (increase of the use of renewable energy by 126% to achieve a utilization of 966,000 toe by 2030, which would mean achieving a 21% share of final consumption for renewable energy),

- 3E2020 & Navarre Energy Plan Horizon 2030 - PEN 2030 [54] (by 2050 all the energy supply electricity and heat - will be covered by renewable sources, by 2025 and 2030 to achieve a 35% and 50% contribution of renewable energies to total final energy consumption, from 1 January 2030 no fossil-fuel powered thermal systems may be installed in new residential and tertiary buildings),
- Basque Sustainability Law [57] (in 2019 the Basque Government approved the Sustainability Law, changing the overall vision and role of local municipalities, companies and households towards a faster adoption of RES - the promotion of a more local and community-based management of energy).

Support for creation Renewable Energy Communities (RECs). There is a support for the creation of RECs within innovation aid program: (i) EVE Basque energy agency (a program of aid for investments in biomass energy facilities 2020: Biomass driven boilers support programs) [58], (ii) LEADER program for rural development within LEADER zones (topic: Renewable energies, energy-saving, biomass and district heating) [59].

B) LEGAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Renewable energy communities concept defined at national legislation. Renewable energy communities have been defined by article 6 of the 24/2013 Electric sector law [60] and nowadays modified by Post Covid recovery Royal decree 23/2020 [61]. They are defined as subjects of the electricity system. This modification was performed based on the European energy renewable directive (UE 2018/2001) [4] but avoiding some articles concerning rights and the enabling framework. It is expected that renewable energy communities will follow the criteria set in the Integrated National Energy and Climate Plan 2021-2030: draft NECP [52].

Term of renewable energy communities is defined at local level. Navarre Energy Plan Horizon 2030 Annex: Energy Communities [62] defines Renewable Energy Communities as legal entities based on open and voluntary participation, autonomous and effectively controlled by partners or members which are located in the vicinity of renewable energy projects owned and developed by such legal entities, whose partners or members are natural persons, SMEs or local authorities, including municipalities, and whose primary purpose is to provide environmental, economic or social benefits to their partners or members or to the local areas where they operate, rather than financial gain, economic or social benefits to their partners or members or to the local areas in which they operate, rather than financial gain. These communities can therefore rely on installations of any energy carrier, as long as it is renewable.

Specified rules of the establishment of energy communities. The minimum requirements to be met when developing an energy community at the local level are defined as follow:

- a founding contribution of EUR 3,000 paid at the time of registration (in cash or property) in the presence of a Notary Public,
- through a public deed of incorporation, which will be registered in the Basque Cooperatives Register, need to define Basics Cooperative Bylaws that regulate the operation of the Cooperative and address the minimum contents set out in the Basque Cooperatives Act,
- the members - at the General Assembly - can and must freely determine their content within limits set by the Law,
- regime: they operate democratically and, therefore, each member has the right to one vote, regardless of the amount of capital contributed,
- it has a horizontal structure, with an equitable distribution of decision-making power,

- the guidelines by which co-operatives put their values into action and set the principles are: voluntary and open membership, democratic management by the members, economic participation of members, autonomy and independence, education, training and information, co-operation between co-operatives, concern for the community [62].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lack of full transposition of EU Directive defining energy communities into national law. The terms "Citizen Energy Communities and "Renewable Energy Communities defined in the European directive [5] have not been transposed yet to the national (Spanish) legal/policy framework.

C) ENVIRONMENTAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Lower emission of pollutants from biomass combustion in comparison to use of fossil fuels. The emissions associated to local bioenergy community projects can reduce substantially the emissions associated to fossil fuel traditional heating fuels (*Table* 2).

Table 2. Yearly emissions from fuels [63]

Emissions through a year			
Type of emission	**Heating oil**	**Natural gas**	**Wood chips & pellets**
CO (kg)	35	90	20
SO_2 (kg)	205	20	48
CO_2 (kg)	195	160	15
Particles (kg)	20	10	30

D) ECONOMIC ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Competitive prices of biomass fuels. The prices of biomass fuels are much lower than those of conventional fuels (*Table 3*).

Table 3. Unit fuel prices in Spain [64]

Fuel	**Woodchips**	**Firewood**	**Oil**	**Bagged Pellets**	**Domestic Natural Gas**	**Bottled LPG**	**Domestic Electricity**
Price, c€/kWh	3.18	3.19	3.23	5.66	6.87	7.52	14.03

Favourable installation prices based on domestic boilers (20x50 kW). Heating units based on some domestic boilers are several times cheaper than other energy solutions (*Table 4*).

Table 4. Unit CAPEX of energy plants in Spanish conditions [65] [66] [67] [68] [69] [70] [71] [72] [73]

Plant	**ORC**	**Biomass heat plant**	**Wind turbine**	**PV farm**	**Domestic boiler (20x50 kW)**	**Coal fired heat plant**	**Gas turbine**	**Diesel engine generator**
Unit CAPEX, M€/MW	2	0.4-1	1.5	0.7-0.8	0.06	1.7	0.5	0.45

E) SOCIAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Satisfactory level of ecological awareness of local community. In the year 2015, according to a survey and data prepared by Eurostat, Basque families achieve a score of 6.6 points out of 10 in the Environment Indicator (0.2 increase with respect to 2008) describing their degree of awareness and habits in behaviours with environmental impact [74]. In the area of climate change worries an average value of 7.8 points was obtained.

RESCoops as a help for vulnerable and low-income households. RESCoops through community integration reach out to vulnerable and low-income households. Thus, they can invest in ownership and affordable access to supply from renewables, participate in the collective wealth generated, invest in energy efficiency measures and building renovations to improve living conditions, and access advice.

Numerous local activities related to RES development. In Basque region there are some local activities related to RES development, such as: IHOBE (publicly-owned company of the Basque Government. Its mission is to support the Basque Government's Ministry for the Economic Development, Sustainability and Environment in implementing environmental policy and in spreading the green sustainability culture within the Basque Autonomous Community), The Basque Energy Board (EVE) [58], Fundación Sustrai (legal and technical response to unsustainable projects in Navarra) [75], AVERBIOM (Spanish Association for the Energy Recovery from Biomass [76], AEBIG:(Spanish Biogas Association) [77], Bioplat (The Spanish Technology and Innovation Platform 'Biomass for the Bioeconomy') [78], Cluster Energia Basque country [79].

F) TECHNICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

There are companies able to harvest and provide significant amounts of biomass. Different companies and associations could participate at the biomass harvestings stage. For example, the vineyards in Navarra or La Rioja Alavesa region could provide biomass pruning (30000 t/y) [58]. The companies in charge of the forests of the region could provide 2240000 tons of biomass in the form of dry chips [58]. Other biomass providers could be agro-industrial companies, small farmers and enterprises (i.e. Biotermiak already offers forest biomass).

There is a developed biomass transportation system in the region. Solid products in the form of pellets or chips can be easily transported by the logistics companies (i.e., company like Biotermiak, offers the logistics for the biomass they sell).

In the region, there are examples of biomass storage systems. There exist some district heating systems, where biomass is stored in silos. Other options may be warehouses.

There are examples of district heating systems using biomass. The government of the Region and an energetic local association (EVE) created in Bilbao 2014, different facilities for district heating purposes, such as heating a municipal sports centre or households (Orozko, Derio, Beizama). The most common boilers are based on pellets or forest biomass.

There exists many companies supplying boilers for different kinds of biomass. In the region operate biomass boilers suppliers, such as: Okofen/Ekienergia, Biocurve, SoliClima, or Geotermia Navarra Calderas de Biomasa y Leña in Navarre.

Strong position of pellets on the Spanish energy market. Based on the data from the last report of the biomass price Index prepared by AVEBIOM [81], the domestic pellet prices remain below 300 €/ton. Domestic pellets consumption is stable, or even with an increased tendency (in 2019, the production record with more than 700.000 tons was achieved). 100% of the ENplus certified pellet used in Spain comes from sustainably managed forests, which guarantees the growth of new trees instead of the trees used.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Insufficient control of pollutants emission from small capacity boilers. Regarding environmental issues, the manufacturers need to follow Eco-design (2015-1189) Directive and also EN 303 related to emissions limits (*Table 5*). In addition, some companies working in different European markets also try to meet BAFA (German standard).

Table 5. Limits of pollutants emission for small capacity boilers [48] [82]

Type of boiler	Power	Efficiency	CO mg/m³	OGC mg/m³	Particles mg/m³	NO_x mg/m³
Manual	≤20 kW	≥75%	700	30	60	200
	20 kW≤500 kW	≥77%				
	Class 5	87+logQ				
Automatic	≤20 kW	≥75%	500	20	40	200
	20 kW≤500 kW	≥77%				
	Class 5	87+logQ				

The main issue observed is that the air emissions rely on these periodical inspections performed by small service companies, and there is no solid public control on that if it is not a large installation (>1MW). No control at municipality levels.

G) OTHER ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

High biomass potential. Forest biomass is abundantly available [83].

High popularity of domestic biomass heating units. According to the data collected by AVEBIOM for more than ten years, there are more than 300.000 biomass heating units installed in the country. Most of them are small appliances, stoves, and boilers of less than 50 kW for domestic heating. It is estimated that there are more than 10.500 MW installed, which represents 12% of all heating systems in the country [81].

Existence of other RESCoops in the country. There are many RESCoops in Spain. In the considered pilot area, there are 3 other RESCoops: SOM energía/energía gara, GARES energia and Berrizar.

2.3.2 Greek Pilot Area

A) POLITICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Ambitious goals of the NECP in the field of energy transformation of the country. The NECP aims to achieve a minimum share of 35% RES in gross final energy consumption. The minimum share of RES per sector is as follows: 60% in gross final electricity consumption, 40% in heating and cooling needs, 14% in the transport sector. The NECP has also committed lignite phase-out in power generation by 2028, leading to a radical energy sector transformation. Furthermore, NECP aims to transform Greece into a regional energy hub [84].

Promotion of the energy use of biomass. In NECP, it is mentioned that "to promote bioenergy further, specialized support programs will be designed both for the development of efficient supply chains for residual biomass and biodegradable matter, as well as for the support and implementation of optimal environmental and energy-efficient bioenergy applications [84].

Plans to establish new energy communities in Greece. The NECP highlights the importance of the contribution of the Energy Communities schemes, as they will contribute to the implementation of RES and energy-saving technologies investments and contribute to the more active participation of the local community in energy affairs. In this context, the goal is to develop innovative energy offset schemes in energy production and consumption, thus supporting decentralized energy production and management [84].

The use of bioenergy considered in local development strategies. Regarding the local Integrated Strategic Energy Planning (ISEP), the main priority of the operational plans of the Region of Thessaly (RoT) is energy production through the activities of the primary sector (biomass exploitation, biogas produced by breeding activities). The reduction of the energy cost in the industry and the energy recovery of the waste produced by the primary sector are the top ambitions expressed in the Regional Strategy for Innovation (RIS3) of the RoT. The Regional Waste Management Plan (elaborated in 2016) identified the energy production by the livestock waste and the pellet production by biomass as recommended measures for the energy recovery of the regional waste, where: support will be provided and incentives for agricultural waste utilization for biofuels and pellets production.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lack of details about ways of implementing the goals of the country's energy transformation. Although the NECP seems promising regarding the biomass heating value chains, it lacks details on how these targets will be implemented (e.g., specific measures and support to be adopted) [84].

Underplayed potential of bioenergy in the heating sector. Regarding the final version of NECP, bioenergy's contribution is expected to remain stable, while solar and ambient heat and geothermal increase [84].

Expected decline in bioenergy use in urban areas. More specifically, in the residential sector, the increase in the use of bioenergy from 2020 to 2030 will be marginal. The NECP mentions that "its use will be reduced in urban areas at the regional level, with a significant decrease in absolute figures (over 5%) from the historic highs observed in 2012 [84].

Low interaction between forestry/agricultural, energy and environmental policy. There is a need for more significant interaction between forestry/agricultural, energy, and environmental policy. Up to now, the desired all-encompassing approach has left room for spot and non-integrated measures. For example, it is sufficient to consider that various plans for the methanisation of mountain areas have been presented within the regional energy plans, in territories with substantial renewable resources (including biomass, hydroelectricity).

B) LEGAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Renewable energy communities concept defined at national legislation. The term Energy Community has been recently introduced in the Greek legislation, by means of Law 4513/2018 [85]. An EC aims to promote a social and solidarity-based economy and innovation in the energy sector, address energy poverty, promote sustainability, and improve energy efficiency at the local and regional levels. With the pioneering Law 4513/2018 Energy Communities and other provisions, Greece became the first EU member state to acquire an integrated institutional framework for energy communities and their involvement in energy markets [85].

Specified rules of the establishment of energy communities. The minimum requirements to be met when developing an energy community at the local level are defined as follow:

- its mandatory activities are energy provision services, energy management and storage, production of raw materials for biomass,
- optional activities of the EC: management of funding programs, raising awareness of local people, and supporting vulnerable groups against energy poverty,
- the minimum number of members is 5 in case of public law legal entities (except for local authorities or private law entities or individuals), 3 in case the members are legal persons of public or private law or physical persons, as long as 2 at least are local authorities, 2 in case the members are only local authorities,
- the members shall contribute to the cooperative capital with a mandatory cooperative share, but they can also acquire one or more voluntary cooperative shares, which, nonetheless, cannot surpass the 20% of the total cooperative capital. The above cap is higher reaching up to the 40% of the total cooperative capital when the local authorities acquire such voluntary shares and in case of first tier local authorities of islands with less than 3,100 habitants, the above percentage rises to 50% of the cooperative capital,
- an EC can be dissolved if the required number of members or the locality criteria are not fulfilled anymore and the appropriate adjustments do not occur within a three-month period. Additionally, dissolution can also occur for an EC in case in its by-laws a specific duration is stated, which expires or after a general assembly decision [86].

Legal consent to create EC unions and federations. Energy communities can form unions and a Hellenic federation of energy communities. Both take the cooperative form and are subjected to the complementary application of relevant articles of Law 1667/1986 on civil cooperatives concerning their cooperative vertical integration [86].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Participation of energy communities in competitive processes. A big problem in the future development of the energy communities is article 160 of the law 4759/2020 by which from the 1 of January of 2022, each

energy community will have to participate in competitive processes, such as compete with private investors in bids to ensure the operational support of renewable energy projects [87].

Prohibition for the energy community to expand its activities. Except for the mandatory and optional activities listed in the law 1667/1986 on civil cooperatives, no further activity can be exerted by an EC; this limits its scope [86].

C) ENVIRONMENTAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Commitment to combat the smog problem. In February 2020, Greece - along with Romania and Malta - got a warning issued by the European Commission regarding air pollution. Greece has been urged by the EC to disclose information on the gravity of air pollution across its territory and take effective and immediate measures to reduce national emissions of air pollutants [88].

Quantitative targets for reduction on national emissions of certain air pollutants for the period 2020-2029 and for 2030. The quantitative targets for reducing national emissions of certain air pollutants for the period 2020-2029 and 2030 compared to 2005 (*Table 6*).

Table 6. Quantitative targets for reduction on national emissions of certain air pollutants for the period 2020-2029 and for 2030 compared to 2005 [84].

Air pollutants	Percentage of emission reductions compared to 2005	
	Period 2020-2029	2030
Sulphur dioxide (SO_2)	74%	88%
Nitrogen oxides (NOx)	31%	55%
Non-methane volatile organic compounds (NMVOCs)	54%	62%
Ammonia (NH_3)	7%	10%
Fine particulate matter (PM2.5)	35%	50%

Division of tasks related to emission control between national and regional governments. In Greece, competence is shared between the national government, which sets the limits and provides a framework, and regional authorities. Regions must monitor the quality of air and put in place measures to respect the limits.

Efficiency/ emission requirements of Eco-design Directive for wood boilers up to 500 kW and efficiency/ emission requirements of Class 3 / EN303-5 for new non-wood biomass boilers. Ministerial Decree 189533/2011 [89] established requirements for central heating boilers used in the residential and service sector, as well as for hot water / steam plants in service sector buildings. New biomass boilers have to comply with the requirements of Class 3 / EN303-5 as per the table below (for automatic feeding boilers) (*Table 7*).

The limits are less strict than the Eco-design Regulation requirements (equivalent to Class 5). Applicable fuels are anything within the scope of European standard EN 14961-1 [90] Regarding the wood boilers up to 500 kW, as of 1st January 2020, they have to comply with the efficiency/emission limits of the Eco-design Regulation.

Table 7. National limits for biomass central heating boilers [82]

Nominal Capacity, Q_n (kW)	Emissions (mg/Nm^3, @ 10 % O_2, dry)				Efficiency (%)
	CO	OGC[2]	PM	NOx	
<50	3,000	100	150	340	≥ 67 + 6×log(Qn)[3]
50 – 150	2,500	80	150		
150 - 300[1]	1,200	80	150		

[1] The 2012 revision of EN303-5 extends this range up to 500 kW
[2] Total Organic Gaseous Carbon
[3] EN303-5:2012 sets a lower limit of 82 % for the efficiency of boiler with capacity range between 300 – 500 kW

Multiple anti-emission solutions available in the market. There are multiple solutions available in the market (e.g., dust control systems such as cyclones, ESP or bag filters; SNCR and SCR technologies for NO_x abatement; and dry sorption systems for acidic flue gas constituents control) for the abatement of pollutants, such as particulate matter (dust), acidic gases and nitrogen oxide emissions.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Biomass as a source of PM10 emission. On 24th of June 2020, the Ministry of Environment and Energy launched a public consultation for the Greek NAPCP (National Air Pollution Control Plan). The consultation remained open until the 15th of July 2020 [91]. The draft document names biomass combustion in residential heating as a source of increased PM10 emissions in cold winter days. There are also some general references on agricultural residues, but not any quantification of the emissions caused by open-field burning, nor of the targets for their minimization.

Lack of conducted proper tests of biomass boilers . It should also be noted that up to now, enforcement of the law is rare, and many biomass boilers available on the Greek market have not undertaken proper type testing, even with wood biomass fuels [91].

No emission limits for (agro)biomass boilers for capacities ranging from 500 kW to 1 MW. There are no performance standards or emission limits in Greece for (agro)biomass boilers with capacities ranging from 500 kW to 1 MW.

Disputes over sustainability of the biomass feedstock and the carbon neutrality of bioenergy. In general, bioenergy is the recipient of environmental criticism, mainly based on two aspects. Firstly, the sustainability of the biomass feedstock and the carbon neutrality of bioenergy is disputed. There are several studies that support this concept and question whether biomass (mainly forest biomass) can be considered for renewable energy production [92]. Nonetheless, it should be also noted, that this aspect of bioenergy criticism is addressing mainly the large-scale biomass value chains and not local/small-medium scale value chains such as community bioenergy initiatives.

Another aspect of criticism on bioenergy is the environmental impact from burning biomass due to the emission of mainly particulate matter (PM) and other pollutants. The emission from burning biomass is a well-known aspect that its significance depends on many factors, such as the combustion technology that is applied, the emission abatement technology used, the quality of biomass used, or even the experience of the boiler operator. However, depending on the application, there are multiple solutions available in the market to abate pollutants. Though, both of the above factors are known and can be addressed, they have never been the reason for not developing a community bioenergy project.

Low ecological awareness of people. During the economic crisis in Greece, the phenomenon of smog was strongly observed, mainly in the big cities. The largest share of responsibility was given to the burning of biomass without giving the necessary clarifications. Some research shows that biomass burning in a fireplace or woodstove was responsible almost exclusively (over 90%) for the high concentrations at night [93]. On the other hand, specialists in wood science [94] indicated that the smog problem is mainly directed to uncertified biomass combustion systems and from biomass that is not suitable for combustion (burning old furniture or old particleboard, fibreboard (MDF), plywood or melamine products) which contain synthetic materials and chemicals and produce toxic fumes and hazardous exhaust fumes when burned.

D) ECONOMIC ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Competitive prices of biomass fuel. As the *Table 8* shows, the highest indicative price is characterized by electricity and gasoline (158.0 and 122.0 €/MWh respectively). Whereas the cheapest are biomass fuels such as exhausted olive cake or wood chips. The latter are used as industrial fuels and not for residential heating.

Table 8. Comparison of fuel properties [95].

Fuel comparison					
Fuel	**Moisture (a.r.)**	**Bulk density (kg/m³, a.r.)**	**NCV (MJ/kg, a.r.)**	**Indicative price (€/t)**	**Indicative price (€/MWh, excl. VAT)**
Wood pellets A1	≤ 10.0%	≥ 600	≥ 16.5	190 (wholesale) 260 (retail)	≤41.5 (wholesale) ≤56.7 (retail)
Wood pellets A2	≤ 10.0%	≥ 600	≥ 16.3	170 (wholesale) 210 (retail)	≤37.5 (wholesale) ≤46.4 (retail)
Exhausted olive cake	≤ 14.0 %	660	16.0	50- 80	11.2- 18.0
Olive stones	≤ 14.0	700	15.4	150	35.1
Sunflower husk pellets	10.0-12.0 %	540	15.7	80- 120	18.3- 27.5
Straw pellets	≤ 10.0%	650	16.5	180	39.3
Wood chips	≤ 30 %	200	12.2	30- 70	8.9- 20.7
Firewood	≤ 20%	425	14.7	160	39.1
Heating Oil			42.5		70.4
Natural Gas			47.2		37.4
Gasoline			44.3		122.0
Diesel			42.5		100.0
Electricity					158.0

It should be noted that the above costs are indicative and that the final heating cost depends also on the efficiency of each installation.

Competitive prices of domestic boilers. Plants based on some domestic wood/pellets boilers are several times cheaper than other energy solutions (*GREECE*).

Table 9. Comparison of installation costs for different technologies [96] [97] [98] [99] [100] [101].

GREECE		
No	**Type 1 MW installation**	**CAPEX**
1	Biomass Combustion Plant	0.8-1 M€
3	Biomass Gasification	4 M€
5	Agricultural Biogas Plant	2-3 M€
7	Onshore Wind Turbine	1.5 M€
9	Solar Park	0.8 M€
10	Steam Turbine	0.7- 0.85 M€
11	Gas Turbine	0.6-0.75 M€
12	Domestic pellet Boiler (50x20kW thermal)	125.000 €
13	Domestic wood Boiler (50x20kW thermal)	60.000 €
14	ORC Biomass Plant	4-5 M€

Allowances and exemptions resulting from the operation of the EC. Law 4513/2018 [85] defines financial incentives and support measures to ECs where: different treatment of ECs in RES and CHP tenders is foreseen, under the discretion of the Ministry of the Environment and Energy, ECs are exempted from the annual fee to maintain their RES and CHP stations electricity production licenses, applications of energy communities for new RES and RHC units to the RAE (Regulatory Authority for Energy) will be prioritized over other applications in the same region and tender-offer round, letters of guarantee amounts are reduced by 50% for energy communities RES and CHP plants.

EC support programs. On 11 of February 2021, the Secretary General of Energy and Mineral Raw Materials announced that, within 2021, a 2.5 M€ support funding scheme, through the Special Transitional Programme for the lignite phase-out period will be allocated from the Green Fund, targeting the energy communities in Western Macedonia, Greece [102]. The program will fund support actions of energy communities and pilot projects towards the decarbonization of the energy sector.

Another type of grants/programs that support the promotion of RES, and thus, promoting bioenergy and the creation of RESCoops indirectly is the "Saving at Home programme that aims to replace of old, inefficient installations with new, effective ones (i.e., natural gas/LPG burners/boilers, heat pumps, geothermal heat pumps, biomass/wood pellet boilers).

Other Operational Measures / National Strategic Reference Framework. Specific operational measures of the NSRF provide opportunities for substituting fossil fuel boilers that could promote bioenergy and empower the creation of RESCoops focusing on this field. The "Competitiveness toolkit for Small and Very Small Enterprises (Total budget 400 million EUR, investment plans from 20,000 to 200,000 EUR, funding rate 50-65%) includes as eligible costs - among many others - procurement and installation of new RES heating and hot water production systems (including biomass), as well as costs for a fuel switch. As of April 2020, 3,182 enterprises requesting almost 224 million EUR of public funds have been accepted in this scheme. However, the amount given for RES investments is not disclosed [103]. A more specific measure, "Promotion of RES heating and cooling systems and combined heat and power production for self-consumption with a total budget of 35 million EUR, with eligible investments ranging from 20,000 to 1,000,000 EUR per enterprise has been announced but not yet opened [104].

There is a Rural Development Programme. Rural Development is managed through the RDP, funded under the EAFRD and national contributions. The RDP 2014-2020 [105] includes 16 Measures and 37 Sub-measures, some of which are further refined in 29 Actions. The Managing Authority of RDP 2014-2020 is headed by the General Secretary of Agricultural Policy and Management of Community Funds of Rural Development and Food. No explicit measures are targeting the valorisation of biomass at the national or local level. However, some sub-measures of the RDP 2014-2020 offer this potential. The most relevant that have been identified include: sub-measure 4.1.3, providing support for the investment in RES at agricultural holdings, based on covering their energy demands, good practices for the handling of wastes and by-products and their utilization for energy production, or sub-measure 16.1-16.5, which promotes the establishment of cooperation for the development of new agricultural and production practices aiming to protect the environment and adapt to climate change. In addition, the list of actions includes the use of RES for the reduction of fossil fuel inputs.

Regional Funds. Regional Operational Programs co-financed by the European Union's Structural Funds, ERDF and ESF include support actions for renewable energy production and energy savings at residential sectors or buildings of the regional authorities (e.g. schools) [106]. In principle, such schemes can be used to support the installation of (agro)biomass boilers.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

VAT differences between fuels. Furthermore, although all of the above solid biofuels and fossil fuels have a VAT of 24%, Natural Gas and electricity have a VAT of 6%, thus affecting the final heating cost of each medium. In this sense, the promotion of natural gas can hinder the development of bioenergy community projects, where natural gas is easily accessible (inside natural gas network) [91].

No specific economic benefits for bioenergy based ECs. There are no significant specific benefits regarding heat production activities (from biomass or other sources) or biomass mobilization. The vast majority of Energy Communities already established target electricity production from photovoltaics or wind farms.

Complexity of the process of developing RES projects by energy communities. The National Energy and Climate Plan [84] sets a target for 2030 of over 600 MW for net metering energy schemes, but unfortunately, the promotion, support, and development so far is not satisfactory. Due to the above, the following phenomenon was observed in the market: private investors, who had the know-how and access to the required funds, took advantage of the energy communities' legislation. As a result, many energy communities currently registered in the General Commercial record are covert private initiatives.

Low starting capital for most ECs. Out of 409 ECs registered in Greece, 61% of them operate on capital of less than 10,000 EUR, 35% with a capital between 10,000 – 100,000 EUR, and the rest exceed 100,000 EUR [107]. It has been noticed that 25% of the ECs depend solely on their members for raising cooperative capital. The rest of cooperative capital is structured as follows; 31,5% on members contribution and 62,5% on lending. Some of them also rely partly on subsides. The low capital for ECs creates limitation to the EC's investments for energy production. With the majority of the ECs operating with a capital of less than 100.000 EUR, the investment at plant scales of 1 MW is complex. Thus, most ECs can invest in smaller capacity plants and projects, unless favourable funding opportunities are created.

Small biomass market. Regarding the biomass market in Greece, it is pretty small compared to other European markets. The consumption level per individual consumer is relatively low. Despite this, it seems

that the price of products such as wood pellets have remained mostly stable over the last years. The domestic biomass market is entirely driven by heat demand/weather. The Centre for Renewable Energy Sources report sets the total number of installed biomass boilers in the domestic sector (with capacities lower than 60 kW) to 30,700 [123]. Apart from the domestic market, there is also the industrial one. Some agro-industries (e.g., pomace mills) produce agro-industrial residues; after covering their own self-consumption needs, the remaining quantities are made available to the market for domestic or larger consumers. The level of production of these residues depends on the production level of the primary agricultural products. Bad years combined with cold weather may drive up the demand while minimizing the production; price increases are detected in such cases.

Solid biofuels that can be found in the Greek market are: firewood, wood pellets (mainly A1 and A2 quality), exhausted olive cake, olive stones, sunflower husk pellets, wood chips, and in smaller amounts cotton ginning residues, rice husks, peach kernels, and nutshells.

E) SOCIAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Younger people more ecological aware. A survey [108] was done in the pilot area about running a tourism business in the cities of Karditsa and Kalabaka, where it was noticed that: younger entrepreneurs are more informed about the regional dynamic for sustainability, young people are more likely to pay to make their business eco-friendly, women are more likely to be aware of options toward sustainable development, entrepreneurs have the willingness to adopt sustainable entrepreneurship plans, identified as necessary the creation of knowledge networks and web sites focused on sustainable business. Furthermore, younger people and the next generation seem more ecological aware, whereas entrepreneurs are willing to adapt sustainable plans for their businesses.

Noticed social benefits as a result of the development of RESCoops. Minimal evidence exist since the concept is relatively new in Greece, however the most valuable profits that have been noticed are [109]: 28 new jobs were created by ECs until August 2020; the creation of a positive attitude towards contributing to the local society; raising of environmental awareness; promotion of social acceptance to RES for energy production; reduction of energy costs; creating a local value chain; development of solidarity economy initiatives; promoting energy democracy and fighting energy poverty.

Problem of energy poverty in the country. Greece is facing one of the most serious problems of energy poverty due to the economic crisis that has existed in the country since 2009 and the continuous fluctuations in energy prices. Until 2010 there was no institutionalized definition of the problem in our country. A 2004 survey found that very low-income households needed to invest 120% of their income in meeting their thermal needs. 30% of all Greek households are unable to adequately heat their homes, while in vulnerable households, the percentage is 50% [110], [111]. From 2018, the energy communities started to be promoted so that there is more solidarity and innovation in the energy sector. The energy communities promote energy sustainability, production, storage, and self-consumption of energy. They enhance energy self-sufficiency and safety as well as improve end-use energy efficiency. The goal is energy efficiency in all phases of the energy cycle from production to final consumption and try to raise public awareness. Most of the existing ECs (72%) in Greece have contributed significantly to the reduction of energy poverty [112]. Approximately studies characterize their influence moderately to very important.

Local activities related to RES development. In the pilot area there is ANKA AE (Anaptixiaki Karditsas Anonimi Etaireia) [113], a development company that supports penetration and broader use of RES, development of

new collaborative structures and the social and general development of Karditsa regional unit and other areas in Greece. In addition, it is involved in actions such as providing technical support to local authorities and other legal persons, local cooperatives, and the legal forms in which they participate.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lack of trust to cooperative schemes due to their bad reputation. The vast majority of cooperatives schemes (especially farmer cooperatives) often went bankrupt, mainly under their own mismanagement. As a result, local communities have lost confidence in cooperatives schemes.

Increase of local people's knowledge on energy communities and bioenergy is needed. As it seems from the answers we received from the questionnaires (interviews of T1.2), the willingness of the stakeholders depends on the level of their knowledge about energy communities. There is a reluctance to participate due to the ignorance of some stakeholders about the purpose of energy communities, their operation, internal administrative structure, etc.

F) TECHNICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Significant possibilities to create a forest logistic chain for RESCoop at local level. Forest (Wood) biomass: The woody biomass in the area comes mainly through two different sources: 1) logging 2) industrial wood processing (sawmills). The products produced are solid fuels such as briquettes, pellets, woodchips, firewood.

The Greek region has a big possibilities to create a forest biomass logistic chain for RESCoop.

In its pilot area are located:

- 2 forestry offices (management and supervision of total over 55000 ha public forests)
- 5 municipalities (owners and managers of a total of over 23000 ha public forests)
- private forest owners (owners and managers of a private forest of 6390 ha,
- forest cooperatives (responsible for the exploitation of public/community forest areas, there were 14 active forest cooperatives active in the Karditsa Prefecture, with 222 active members),
- sawmills (involved in the transportation and processing of logging products, actually 5 sawmills are active in the Karditsa Prefecture),
- timber traders (involved in the marketing of logging products),
- transporters (involved in the transportation of logging products),
- foresters (Involved in the scientific support of forestry in the area and the preparation of management studies),
- solid biofuel producer who receives forest residues as fuel (ESEK),
- potential consumers (households/businesses / public bodies to meet thermal/cool needs).

Significant possibilities to create an agricultural logistic chain for RESCoop at local level. Agro biomass: The agricultural biomass in the area comes from two different sources: 1) crop residues (cotton, straw, corn), 2) energy crops. The products produced are balls or bales of straw or other grass biomass (seeds, shells).
In its area are located:

- farmers (owners and managers of private agricultural land),
- agricultural cooperatives (owners and managers of private agricultural land agricultural products of the members),
- local government (owners and managers of agricultural land),

- staff cutting/bundling/transport workshops (involved in the collection, baling, and transport of agricultural biomass from agricultural land),
- transporters (involved in the transport of high quantities of standardized agricultural biomass (balls or packages)),
- agriculturist (involved in the scientific support of agriculture in the region and the elaboration of relevant studies/analyses),
- potential consumers (households/businesses / public bodies to meet thermal/cool needs).

Significant possibilities to create an urban biomass logistic chain in the region of Karditsa. Urban Biomass: It comes from urban branching, the remains of gardens and green spots located inside or around the urban centres. From urban biomass, it can be produced low quality solid fuels for industrial use (pellets)
In its area are located:

- local government (managing urban pruning within the limits of their responsibility),
- plant/woody separation workshops (undertaking the separation of the plant/wood part),
- transporters (involved in the transport of high quantities of tree trimmings),
- solid biofuel producer, who receives urban branching residues as fuel (ESEK),
- potential consumers (industries to meet energy needs).

Growing popularity of wood pellets in Greece. Wood pellets have grown in popularity in Greece since 2011; their primary market is the domestic heating sector, but other enterprises also use them (e.g., bakeries, etc.). FAOSTAT estimates a domestic production of 40,000 tons in 2018, along with 20,332 tons of net imports. However, market players believe that the market size is much larger, in the range of 150,000 tons per year [114].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Outdated study regarding the energy consumption of the households in Greece. The latest detailed survey regarding the energy consumption of the households in Greece has been performed by the Hellenic Statistical Authority and concerns the heating period 2011 – 2012 [115].

G) OTHER ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

High bioenergy potential in the Karditsa prefecture. Biomass appears to have great perspectives under the prerequisite of sustainable resources management. Despite the conservative predictions for the renewable bio-energy potential of the Karditsa prefecture, bioenergy deriving from the local agricultural, forest, and industrial residues and animal waste can cover 1.7 times the current energy consumption (total energy consumption of Karditsa 2016: 1867.546 MWh) [117].

A lot of existing ECs. By March 18th 2021, 998 (966 active) energy communities have been registered nationally. From a total of 404 community projects of a total installed capacity of 280 MW in Greece, the 62.43 MW are installed in the Thessaly region (02/2021) [118].

2.3.3 Polish Pilot Area

A) POLITICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Plan of distributed energy development in Poland. The "National Plan for Energy and Climate for 2021-2030 [119] provides for the development of distributed energy. It is estimated that in 2030 there will be approximately 300 energy sustainable areas at the local level in the country. This task was included in the "Strategy for Responsible Development until 2020 (with a perspective until 2030) as one of the priorities in the field of energy and was also included in the Energy Policy of Poland until 2040 [120], [121].

Assumed increase in the share of renewable energy sources in energy production. The goal of the "Energy Policy of Poland until 2040 [121] is at least 23% share of renewable energy sources (RES) in gross final energy consumption in 2030. Not less than 32% in the power industry, 28% in heating.

Including the use of bioenergy in regional development strategies. Regarding the "Low-Emission Economy Plan for Integrated Territorial Investments of the Wroclaw Territorial Area - the Oborniki Slaskie commune [122], in the field of energy activities, the effective production and distribution of energy to reduce greenhouse gas emissions and other pollutants are being implemented, such as: application of individual low-emission heat sources in areas where the development of a heating network is unjustified. These sources should use renewable energy or low-emission fossil fuels (e.g., natural gas), maximum economically justified use of energy from renewable sources - in various forms (especially solar energy, geothermal energy, biofuels).

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lack of promotion and low awareness about RESCoop among the politicians at regional and national level. The policymakers do not promote the RESCoop development. As a result, there are no specific and targeted initiatives to encourage citizens for RESCoop creation.

B) LEGAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Energy co-operatives are regulated in Polish law. In terms of Art. 2 point 33a Act of 19 July 2019 [123] amending the Act on renewable energy sources and certain other acts, subject of activity of bioenergy community is the production of electricity or biogas or heat in renewable energy sources installations and balancing the demand for electricity or biogas or heat, only for the own needs of bioenergy community and its members, connected to an area-defined power distribution network with a rated voltage lower than 110 kV or a gas distribution network, or a district heating network.

Specific rules for the operation and control of community energy.
Simple administrative procedures - submitting an application to NASC with the required declaration and the statute of the cooperative, inclusion in the list of community energy, issue of a certificate by NASC.

Monitoring of the activity of an bioenergy community - the competence of NASC is to carry out inspections related to the subject of activity of an bioenergy community, keeping data of the amount of electricity or

biogas, or heat produced and consumed by members bioenergy community, analysis of annual reports (in terms of monthly) of bioenergy community.

Sanctioning system in case of irregularities – NASC imposes a financial penalty for:

- obstruction of the inspection (PLN 10,000);
- failure to submit the report on time, or to include it in the report;
- false information (PLN 1,000) [123].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Strict legal requirements for community energy. In Poland, the current regulations [123] dedicated to the bioenergy community constitute a set of restrictions that are difficult to explain: the number of cooperative members may not exceed 1000 participants, the total installed capacity is limited to 10 MW in the case of electricity, 30 MW in the case of heat, it has to be located in the area of no more than three rural or urban-rural communes directly adjacent to each other, in the area of one distribution system operator electricity or gas distribution network or heating Withdrawal from a bioenergy community as a result of termination may take place not earlier than at the end of a given accounting period.

Limitations in terms of energy communities' location. According to the Act of 19 July 2019, amending the Act on renewable energy sources and certain other acts [123], bioenergy communities cannot be located in municipalities. Therefore, it significantly reduces the potential of RESCoop development in Poland. This is also a disincentive to potential cooperative founders.

C) ENVIRONMENTAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

The need to implement remedial measures aimed at improving air quality. Based on the classification of zones in the Lower Silesia Voivodeship for 2018 and the state of the environment [124], the need to implement remedial measures aimed at improving air quality in order to protect human health was found for all zones of the voivodeship, including the Lower Silesia zone, where the Oborniki Slaskie commune is located. This need was identified due to exceeding the permissible/target levels of PM10 suspended dust, ozone, benzo(a)pyrene, and arsenic.

The introduction of the act of anti-smog resolution. In 2017, the Lower Silesian Voivodeship Council, pursuant to Art. 96 of the Act of 27 April 2001 Environmental Protection Law (Journal of Laws of 2018, item 799) [125], adopted the so-called Anti-smog Resolution [126] (Resolution No. XLI / 1407/17 of November 30, 2017, on the introduction of restrictions and bans on the operation of installations in which fuel combustion occurs in the Lower Silesian Voivodeship territory, excluding the Commune of Wroclaw and health resorts). Furthermore, in connection with the above resolution, from July 1, 2018, the use of: sludge and coal flotation concentrates and mixtures produced with their use, lignite and solid fuels produced with the use of this coal, loose hard coal with a grain size of less than 3 mm, solid biomass with humidity in the working condition above 20% is forbidden.

Efficiency/ emission requirements of Eco-design Directive for biomass boilers up to 500 kW. According to the Regulation of the Minister of Entrepreneurship and Technology of February 21, 2019 amending the regulation on the requirements for solid fuel boilers [127], from March 11, 2019 only solid fuel boilers could be marketed in Poland, including non-wood biomass boilers and boilers for the preparation of domestic hot

water, meeting the requirements of class 5 in terms of energy and emission efficiency specified following the standard PN-EN 303-5: 2012 Heating boilers. Part 5: Solid fuel heating boilers with manual and automatic fuel charging with nominal power up to 500 kW [82].

The subsequent tightening of the regulations took place on January 1, 2020 . From that moment, solid fuel boilers available on the EU market had to meet the requirements of the EU Commission Regulation 1189/2015 of April 28, 2015 (ECODESIGN)[48]. A comparison of requirements of PN EN 303 5:2012 standard and ECODESIGN directive is presented in *Table 10*.

Table 10. Comparison of class 5 emission requirements according to the PN EN 303 5: 2012 standard and the Eco-design requirements specified in the Commission Regulation (EU) 2015/1189 of April 28, 2015 for solid fuel boilers.

Emission requirements for solid fuel boilers	**Type of pollution**	**Manual fuel feeding, $mg \cdot m^{-3}$**	**Automatic fuel feeding, $mg \cdot m^{-3}$**
Class 5 according to the PN EN 303 5: 2012 standard	Carbon monoxide	700	500
	Organic gaseous compounds	30	20
	Dust	60	40
	Nitrogen oxides (NO_x) expressed as nitrogen dioxide (NO_2) equivalent	Not applicable	
ECODESIGN	Carbon monoxide	700	500
	Organic gaseous compounds	30	20
	Dust	60	40
	Nitrogen oxides (NO_x) expressed as nitrogen dioxide (NO_2) equivalent	For biomass boilers: 200 $mg \cdot m^{-3}$	
		For fossil fuel boilers: 350 $mg \cdot m^{-3}$	

Raising the ecological awareness of Poles by broadcasting ecological programs on TV. There are more and more scientific publications and popular science programs where researchers consider the current state of the natural environment and suggest possible solutions for its improvement (analysing their advantages and disadvantages) i.e. Play Green broadcast on Polish Television [128].

The utilisation of ash from biomass combustion as a fertiliser. If only biomass is burnt in the boiler, the ash produced in this process can be used as fertilizer in the field. It is a good element of zero-waste strategy and circular economy [129].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

The ecological awareness of society is still insufficient. The inhabitants have a minimal knowledge of solid fuels and how to burn them properly in the heating boiler. Little is known about the emission of pollutants into the atmosphere from coal-fired boilers, incredibly poisonous and hazardous compounds. No broad education related to the energy-saving techniques in the household.

Citizens do not prioritise environmental protection. Inhabitants appear not to be ecological aware and often burn very low-quality fuels or simply rubbish in domestic boilers (tires, PET bottles, MDF furniture boards, etc.).

Emissions of toxic compounds into the atmosphere. Although the biomass combustion is neutral in terms of CO_2 release, there is still emission of other pollutants, such as [130], [131]: dust, NOx, CO, dioxins, and furans (in case of burning biomass contaminated with pesticides), that can influence on the drop of the interest in solid biofuels utilization for energy purposes.

Risk of biodiversity reduction. There is a potential risk of reducing biodiversity with the introduction of energy plant monocultures in case of the significant increase in biomass usage for energy production and lack of control of energy crops development [132].

Problem with processing of raw biomass material. The lack of sufficient ecological awareness or knowledge by final biomass users regarding its proper processing and utilization leads to the combustion of wet biomass and significant pollutants emissions to the atmosphere. This is due to the unappropriated processing and storage of biomass [133].

Extensive deforestation. The biomass harvesting should be realized sustainably. The uncontrolled woody biomass acquisition from forests due to the increase of biomass demand can lead to the deforestation [134].

D) ECONOMIC ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Competitive prices of biomass fuels. Considering the fossil fuels and biomass fuels used for heating purposes, the biomass (as a source of energy) belongs to the relatively cheap sources of energy (*Table 11*).

Table 11. Fuel prices in Polish Pilot Area [135].

Type of fuel	Fuel price	LHV	Energy price
Eco-pea coal	0.22 EUR/kg	23 MJ/kg	9.56 EUR/GJ
Culm	0.13 EUR/kg	21 MJ/kg	6.19 EUR/GJ
Hard coal	0.19 EUR/kg	23 MJ/kg	8.26 EUR/GJ
Pellet class 1	0.21 EUR/kg	19 MJ/kg	11.05 EUR/GJ
Pellet class 2	0.17 EUR/kg	17 MJ/kg	10 EUR/GJ
Pellet class B	0.13 EUR/kg	13 MJ/kg	10 EUR/GJ
Briquette	0.13 EUR/kg	17 MJ/kg	7.65 EUR/GJ
Wood	60 EUR/m^3	10.5 GJ/m^3	5.71 EUR/GJ
Gas (methane)	0.3 EUR/m^3	34 MJ/m^3	8.82 EUR/GJ
LPG	540 EUR/m^3	25 GJ/m^3	21.6 EUR/GJ
Oil	570 EUR/m^3	36.1 GJ/m^3	15.79 EUR/GJ
Electricity	0.13 EUR/kWh	3.6 MJ/kWh	36.1 EUR/GJ

Favourable prices for the installation based on domestic boilers. Based on data from "Updated comparative analysis of electricity generation costs in nuclear, coal and gas power plants as well as renewable energy sources [136] elaborated by Energy Market Agency (*Table 12*), the installation costs of 1 MW unit for domestic boilers are the lowest. Therefore, it can encourage the use of biomass for heating purposes, especially in rural areas.

Table 12. Costs of 1 MW installation [136].

Type of installation	Price, mln EUR/MW
Biomass heat plant	2.4
ORC plant	3.5-5.5
Wind turbine	1.4
PV farm	1.1

Domestic boiler (20 kWx50 units)	0.3
Coal fired heat plant	1.6
Biogas heat plant	3.0
Gas turbine	0.4

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

High costs of heat network building in the scattered rural areas or small cities. This is due to low-density housing, which increases the length of the heating network. In Poland, the unit construction cost of heat network is approx. 500,000 euro per km [137].

The rise of energy poverty. Scientists from the University of Szczecin, in a study of the impact of the COVID-19 pandemic on the phenomenon of energy poverty in Poland, confirmed that in 2020 (up to and including May) the share of expenditure on energy carriers in relation to disposable income per person increased by an average of 1.3% compared to 2019. Following a higher share of expenses on energy carriers in relation to disposable income, according to the authors, energy poverty in 2020 (until May) increased to 21.4%, i.e., by 13.7% compared to 2019 and it was compounded by job loss and reduction earnings, especially for those with the lowest and middle income. It can be expected that the scale of the phenomenon could be even more significant [138]. Many people have lost their jobs and are unable to pay their energy bills regularly. Not to mention invest money in the energy transformation of the region.

Inability to compare the RESCoop creation and exploitation costs for Polish conditions. There is no active bioenergy community in Poland. As a result, there are no examples that could provide some economic indicators related to the bioenergy community creation, operation and maintenance, heat costs etc.

Lack of a subsidy program for the creation of bioenergy communities in Poland. There are government programs such as Clean Air [139] to subsidize the replacement of obsolete heating devices with low-emission boilers. These are periodic recruitment, and it is unknown what these types of funding will look like in the future. The current system of financing the creation of the RESCoop is unclear. In addition, the processing time for such applications is long, which demotivates activity in this field.

E) SOCIAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Social integration and development of the local area. Local eco-activists could mobilize other inhabitants to some activities focused on BECoop creation and integration in the local area. Thus, it could integrate the people allocated in different parts of the logistic chain (biomass producer, biomass processor, biomass supplier, biomass user) and lead to the local development (i.e., job creation, new SME creation).

There are actions promoting the use of RES in the region. The Commune Office of Oborniki Slaskie performs information campaigns for residents who want to take advantage of the program of co-financing the installation of RES installations (e.g., installation of PV installations, replacement of old heat sources with low-emission ones).

Increase in the ecological awareness of Poles. Based on the "Tracking research report on awareness and ecological behaviour of the inhabitants of Poland in 2020 developed by the Ministry of Climate and

Environment in October 2020, in comparison to 2018, there is an improvement in the environmental awareness of Poles. The sample size in individual editions of the study was 1,010 people. Percentage of Polish residents who are not willing to spend more on clean energy: 2018-48%, 2020-16%; percentage of Poles who believe that the improvement of the state of the environment depends on the activity of each of us: 2018-57%, 2020-63% [140].

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Activity of BECoop sceptics in the local pilot area. However, some sceptics may obstruct operations among the local community by spreading rumours about the harmful effects of building a bioenergy community.

Failures and lack of activities related to RES development by local associations. In 2017, five municipalities near Wroclaw: Prusice, Oborniki Slaskie, Wisznia Mala, Wolow and Zmigrod created the Renewable Energy Cluster of Trzebnickie Hills [141]. As part of their activity, photovoltaic and bio-power plants were to be built. However, it collapsed due to a failure to obtain external funds for its development. The communes were not sufficiently involved in applying for external funds, hence the effect.

The reluctance of local society towards cooperatives. The negative experience of rural residents related to the concept of cooperative, the effects of which can also be observed today, was the experiment of the communist authorities related to attempts at forced collectivization of agriculture. The idea was associated with the nationalization of agriculture and state control to all independent social initiatives, including cooperatives. Farms were forcibly taken from people in order to nationalize them. The exploitation of workers, and corruption of heads of work units often took place in state-collective farms [142].

F) TECHNICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Well-developed technologies for biomass combustion in the small and middle-size scale. There is a choice on the market for each form of fuel and boilers that meets the current ECO DESIGN guidelines [48]. In addition, there are also well-developed devices and equipment for the production of pellets/briquettes / bales, etc.

Increasing installation reliability. Problems with biomass combustion appeared already in the 90s. Since then, the manufacturers of installations (mainly boilers) have introduced solutions to eliminate many operational problems, including corrosion, slagging and uncontrolled ignitions.

The owners of the households are familiar with solid fuel combustion. Thanks to the experience of coal combustion, it is easy to switch to biomass, which is cleaner, and the devices for its combustion are increasingly fully automated.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

The risk of problems with boiler operation.

Boiler is too large for the heat demand it is supplying

Biomass boilers are designed to run for extended periods. When a biomass boiler is too large it only needs to fire for a very short time to satisfy the heat demand placed upon it. This leads to many short periods of

firing during operation known as cycling. If a boiler cycles regularly it goes through multiple start up and shutdown phases which are known to reduce efficiency, increase emissions, increase component wear and increase auxiliary electricity consumption for components such as fans running at a higher speed than during steady operation. In the case of automatically fed boilers, excessive cycling means the boiler fails to reach its most efficient state of operation and temperatures never reach those required for optimal combustion and heat transfer. This results in increased emissions.

Poor quality fuel

Biomass combustion is heavily influenced by the type and quality of fuel burned within the boiler. Your biomass boiler should be designed to burn a particular type and grade of fuel cleanly and efficiently. This is specified by the manufacturer. The use of poor quality fuel causes increased emissions, low efficiency, component failure, increased repair costs, high running costs and poor performance of the system. Fuels with a high moisture content can lead to difficulties maintaining operating temperatures, leading to an increase in particulate emissions, incomplete combustion, loss of efficiency and even damage to the boiler or flue.

Poor adjustment of boiler and system controls

Well-adjusted controls ensure the safe, efficient and optimum operation of the biomass boiler whilst satisfying the heat demand of the site. When controls are unavailable, set incorrectly, or not regularly reviewed the performance of the biomass system can suffer. Poor control can result in the boiler operating when there is little demand for heat. This leads to multiple start up and shutdown phases, known as cycling. This leads to an increase in electricity consumption [143].

Solid biomass requires additional space for storage. The low bulk density of solid biofuels determines the necessity to provide large boiler room and fuel store areas. In biomass boiler houses with a capacity of up to 25 kW, the fuel composition may be located in the room where the boiler is installed. However, it is recommended to separate it with a wall whose distance from the front of the background cannot be less than 1m and 2m from boilers with traditional fuel feeding. It is most advisable to locate the store near the boiler room in a separate room. The area of the fuel storage should enable fuel storage for the entire heating season [144].

The biomass logistics is not well developed. Currently, there are large producers of biomass fuels, mainly pellets, on the market. Small, local producers are often unable to break down barriers to market entry.

E) OTHER ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Very high share of households heated by coal. In Poland, over 50% of households are heated directly or indirectly by fossil fuel in the form of coal [145]. It creates a space for the changes to switch fossil fuels into biomass fuels.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lack of energy communities in Poland. Currently, there are no RESCoops in Poland. As a result, there is a lack of experience and best practices in the Polish conditions. No one wants to be the experiment in this field.

2.3.4 Italian Pilot Area

A) POLITICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

National strategies taking account the use of "clean energy. In 2017 the National Energy Strategy [146] (a 10-year plan approved by the Italian government to manage the change of the national energy system) has established several priority goals to be implemented by 2030. Among others, the main goals are i.e., attaining Europe's environmental and decarbonization targets by 2030 in a sustainable way and in line with the future targets set by the United Nations Climate Change Conference held in 2015 (also known as the Paris Climate Conference), decreasing primary consumption of oil products by 13.5 million tons of oil equivalent by 2030 and doubling investments in clean-energy research and development, from €222 million in 2013 to €444 million in 2021.

National Recovery and Growth and Resilience Plan 2021. In April 2021, the Italian government presented to the European Commission the National Recovery and growth and Resilience Plan (PNRR) [147]. The budget allocated for the Green Revolution and the ecological transition is 57 billion euros (30% of Plan). All the actions foreseen in the PNRR are aimed at stimulating job creation and growth. The renewable energy and hydrogen component provides investments in research and development (R&D), in innovative low carbon technologies production plants, and, finally, in new renewable energy generation innovative plants (green transition), with a significant contribution to reinforcing the competitiveness of companies and labour skills and to maintaining technology leadership.

National reforms beneficial for the development of renewable energy. Law Decree No. 76/2020. Urgent Measures for Simplification and Digital Innovation [148] includes simplification of authorization procedures for renewable onshore and offshore plants and new legal framework to sustain the production from renewable sources and time and eligibility extension of the current support schemes, adoption of national programs on air pollution control (in accordance with Directive (EU) 2016/2284 [149] and with the Climate Decree Legislative Decree no. 111/2019 [150].

The use of bioenergy considered in local development strategies. The task that the Lombardy Region aims [156] to set itself in the construction of an energy-climatic transition strategy towards a low-carbon economy, is divided into a long-term program of decarbonization and circularity of the entire economic system, functional to both a robust mitigating action against climate drift and a new vision of the use of resources, materials and energy in terms of renewability, compatibility with health and the quality of the environment. The defined goals are:

- reduction of CO_2 emissions by 40% by 2030 and net carbon neutrality by 2050,
- between 28-32% reduction in energy consumption in all sectors compared to 2005 levels (in quantitative terms, it is estimated that final consumption by 2030 will have to be between 17.5 and 18.5 Mtoe, compared to 25.6 million toes consumed in 2005, with a reduction compared to the consumption recorded for 2017, including between 6.8 and 5.8 Mtoe, or approximately 25% of current consumption),
- production from renewable energy sources by 2030 must make it possible to cover between 31 and 33% of final energy consumption in the region.

Agreement for sustainable development of Lombardy. On July 22nd, 2019, the Regional Government approved the "Agreement for sustainable development in Lombardy [157]. The Region provides for:

assessment and monitoring of the regional regulations and plans in terms of sustainability, a catalogue of good practices, and enhancement of dissemination and promotion actions.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Funding limitation in incentive program for RES plants. Integrated National Energy and Climate Plan includes a scenario of the RES burden evolution considering i.e., expiration of incentive period for RES plants. It is estimated that by 2030 the incentives burden could decrease by about 5,6 billion euros with respect to 2015 [158].

Low growth of forecasted energy production from biomass. The forecasted increase in the thermal power of bioenergy is more than 25 times lower than the increase in the thermal power of heat pumps (*Table 13*).

Table 13. Forecasted energy production from RES to 2030 [156].

Technologies powered by RES	Forecast	Intervention penetration	Increase
Bioenergy	Solid: limited increase linked to local district heating networks Biogas: maintenance of the installed power after incentives with possible conversion to biomethane and / or through flexible systems	Solid: Approximately 20% increase compared to the installed power to date Biogas: Stabilization of installed power of biogas	30 MWth
Heat pumps	Sharp increase of all heat pump technologies	100% increase over current power	800 MWth

B) LEGAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

The concept of energy community is recognised by the Italian legislation. The renewable energy community must meet the following requirements:

- be an autonomous legal entity which, acting in its own name, can exercise rights and be subject to obligations, having as its main corporate purpose (as evidenced by the Articles of Association and/or the articles of association) that of providing environmental, economic or social benefits at community level to its shareholders or members or to the local areas in which it operates, rather than financial profits,
- have a statute or an instrument of incorporation providing participation in the open and voluntary community, the community is autonomous and effectively controlled by the shareholders or members forming part of the configuration, compliance with all the conditions set out in the Resolution, with reference to those set out in the private law contract pursuant to art. 42bis of Law Decree 162/19, described in par. 2.1.1 of the Technical Rules [159],
- have shareholders or members who are natural persons, small and medium-sized enterprises (SMEs), territorial bodies or local authorities, including municipalities, provided that, for private companies, participation in the renewable energy community does not constitute commercial activity and / or main industrial, be the owner, i.e., have full availability of the production plants belonging to the configuration.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Limited power of the bioenergy community. The entry into force of the decree-law 162/19 (article 42bis) [159], related implementing measures of the resolution 318/2020 / R / eel of ARERA [160], and the Ministerial Decree of 16th September 2020 [161] provide for the establishment of the Renewable Energy Communities only up to 200 kW.

C) ENVIRONMENTAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Restrictions on the installation and use of low effective woody biomass heat generators in the Lombardy Region. From 01.01.2020 it has been in force throughout the region [162] the ban on the new installation of heat generators fuelled by woody biomass with emissions higher than those identified by Ministerial Decree no. 186 dated 7/11/17 [163] for the 4 class (obligation to install generators with at least 4 class), the ban on the use of heat generators powered by woody biomass with emissions higher than those identified by Ministerial Decree no. 186 of 7/11/17 for the 3 class (prohibition of use for 0, 1, and 2 class generators), from 1 October 2018, in pellet heat generators with a rated thermal output of less than 35 kW, the obligation to use quality pellets that comply with the conditions set out in Annex X, Part II, section 4, paragraph 1, letter d), part V of the legislative decree n. 152/2006 [164], and that it is certified in compliance with class A1 of the UNI EN ISO 17225-2 standard [165].

Impact of CHP plants powered by biomass on the reduction of pollutant emissions. A medium power biomass district heating plant (3-5 MWt) contributes to a CO_2 savings of around 2,753 t/year (thermal only), of 4,257 t/year (cogeneration). A plant of average size (about 5 MW) compared to the domestic boilers allows to avoid emissions of about 10 tons of dust on an annual basis [166].

D) ECONOMIC ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Competitive prices of biomass fuels. Considering the fossil fuels and biomass fuels used for heating purposes, the biomass (as a source of energy) belongs to the relatively cheap sources of energy (*Table 14*).

Competitive prices of domestic pellet boilers. Plants based on some domestic pellet boilers are several times cheaper than other energy solutions (*Table 15).*

Table 14. Unit fuel prices in Lombardy [167]

Type of fuel	Fuel price	LHV	Energy price
Light oil	1.25 EUR/kg	23 MJ/kg	9.56 EUR/GJ
Natural gas	0.6 EUR/kg	21 MJ/kg	6.19 EUR/GJ
Wood chips	35 EUR/m^3	23 MJ/kg	8.26 EUR/GJ
Electricity	0.15 EUR/kWh	3.6 MJ/kWh	41.67 EUR/GJ

Table 15. Unit CAPEX of energy plants in Italy [168].

No	1 MW	CAPEX
1	Biomass Thermal boiler	0.3-0.6 M€
2	Biomass DH network	1.0 M€/km
3	Biomass Gasification	2.5-3.0 M€

No	1 MW	CAPEX
4	ORC Biomass Plant included boiler	3.5-4.0 M€
5	Agricultural Biogas Plant	2.8-3 M€
6	Onshore Wind Turbine	1.5-1.8 M€
7	Offshore Wind Turbine	3.0-3.2 M€
8	Solar Park	1.0-1.2 M€
9	Gas Boiler (MW thermal)	0.10-0.15 M€
10	Gas turbine	0.8-1.2 M€
11	Domestic pellet Boiler (20 kWx50)	0.125-0.14 M€
12	Domestic wood Boiler (20 kWx50)	0.6-0.8 M€

Fiscal deduction as "Eco-bonus. The Law Decree n. 34 of 19 May 2020 [169] finalized to revive the economy "Decreto Rilancio introduces the new scheme incentive scheme so-called "eco-bonus that previews a fiscal deduction of 110% of the expenses incurred from 1 July 2020 to 31 December 2023 for the specific intervention in efficiency and renewable sector.

Program for the provision of subsidies to public and private investors. Lombardy Region developed a program [176] for the provision of subsidies to public and private investors, determined by means of an open competition based on rules that were specific to the different topics of the framework. These topics are such as: using district heating and biomass plants or creating agricultural biogas plant.

E) SOCIAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Job creation. Each bioenergy community employs staff for administrative and management activities (general information desk, energy contracts management, RES plants development, etc.). Additionally, the cooperative may set up a team of "trusted technicians (engineers, architects, designers, installers) who are members of the cooperative and benefit from training activities organized by the cooperative's staff and offer their professional services to the cooperative members.

Campaigns and training initiatives for fighting against energy poverty. Ènostra is an energy community located in Lombardy Region. It promotes awareness-raising campaigns and training initiatives for both vulnerable consumers and societal actors, supports and participates in projects aimed at tackling energy poverty, and offers support and assistance to local municipalities that aim to develop local Renewable Energy Communities [170].

Development of local activist groups. Since 2020 Ènostra has been starting to develop an internal initiative to set up local groups of active members, which can promote initiatives in their own territories (e.g., development of new local renewable power plants, organization of raising awareness and training activities, collaboration with other local environmental and ethical initiatives) [170].

The extensive experience of energy communities in local pilot area. Local Pilot Area has extensive experience in the operation of energy communities. At the turn of the 19th and 20th centuries, within the mountain communities of the Alps, they have been established to use local water resources energetically.

F) TECHNICAL ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Forest wealth. According to the data published by the Global Forest Resource Assessment (2010) [171] edited by the Food and Agriculture Organization of the United Nations, the Italian forest heritage covers an area of approximately 10.8 million hectares, equivalent to 36.2% of the entire national surface. Between 1990 and 2010 the Italian wooded area increased by almost 20%, compared to an increase of 5% recorded over the same period in the entire European Union. This expansion of forest stands is due not only to reforestation interventions, but also (and above all) to the natural recolonization of marginal agricultural land, which has experienced increasingly frequent abandonment phenomena. These phenomena have been favored by various factors, including a political and cultural approach that often preferred tout court conservation of the forest heritage, rather than its conservation through active management and technical-physical elements.

Limitations in the use of low effective boilers. From 1 January 2020 [162] it is forbidden to use wood biomass generators with environmental characteristics lower than 3 class and install woody biomass generators with environmental characteristics lower than 4 class.

Innovative particulate matter and nitrogen oxides abatement technique. RSE has developed a nitrogen oxide abatement technique, which is not bulky and easily integrated into existing appliances, to be used on wood biomass combustion plants of medium size (from hundreds of kW up). The technique consists of integrating, in a single plant unit, two of the most effective combustion flue gas purification technologies: dust removal through filtration with fabric sleeves and denitrification (DeNOx) using a Selective Catalytic Reduction reaction (SCR) which reduces NOx to nitrogen and water with high efficiency by using ammonia or urea as a reducing agent in a catalytic reactor [172]. This arrangement saves a space and a reduction in investment and maintenance costs.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Reduction in the extent of forestry interventions. According to a trend also confirmed by the statistics provided by Eurostat (2013) [173] compared to a volume of 9.7 million (M) m^3 of timber harvested in 1995 fell to a volume of 7.7 Mm^3 in 2012. In Italy, there were 0.93 m3/ha of wood harvested from Italian forests in 2000, whereas in 2010 it decreased to the value of 0.71 m3/ha. Comparing these values to the average of the European Union, it was 2.5 times lower (in 2000) and even 3.4 times lower for the year 2010.

Growing trend of Italian imports of assortments potentially destined for energy purposes. According to FAO data [171], over the last few years, the trend of Italian imports of assortments potentially destined for energy purposes has been continuously growing, reaching a value of 3.8 Mt in 2013. By this trend and these values, Italy covers the role of: 1st world importer of firewood, third importer of pellets for civil use, 3rd importer of wood residues and waste, 12th importer of wood chips from coniferous. There are many critical issues associated with such high use of imports, including: the risk of energy inefficiency in the transport of biomass and consequent emissions of greenhouse gases into the atmosphere, the wide use of imports, which does not favor the active management of national forest resources and could stimulate the creation of oversized plants compared to the supply of biomass on a local scale.

Information gaps in determining the amount of material used for energy purposes. There are information gaps regarding, for example, the share-part of imports of wood chips and residues intended for energy use compared to other uses (panels, pulp for paper use) or the actual final use of the recycled material (packaging and other wood products at the end of their life cycle). This experience, moreover, confirms that the wood-

energy sector in Italy is characterized by the presence of an important component of the informal economy, mostly linked to small-scale uses, mainly carried out by private operators and not recorded by official statistics.

Series of limitations both for the use and for the installation of woody biomass heat generators in the households. The Agreement for the improvement of air quality signed between the regions of the Po Valley and the Ministry of the Environment provides for a series of limitations both for the use and for the installation of woody biomass heat generators in the households [174].

G) OTHER ASPECTS

Supporting factors, driving the uptake of bioenergy community projects:

Popularity of harvesting wood from poplar plantations. Considering the mass obtained from poplar plantations, the real value of the obtained raw material in the Lombardy Region is almost double that monitored by the forest harvesting reports, equal to about 1.2 million m^3 per year [175].

Solid biomass as the main source in the thermal sector. The primary renewable source in the thermal sector is solid biomass of about 7 Mtoe, used above all in the domestic sector in the form of firewood or pellets [175].

Favourable climatic features. Lombardy has a large flat land and many mountain areas, a rather cold climate during winter and a hot and humid climate during summer, especially in the flat land. Therefore, considering its climatic characteristics, the features of the built environment, and its institutional dynamism, Lombardy represents an interesting case of study in the field of energy policies.

Many other RESCoops in Italy. There are many bioenergy communities in Italy. They can serve as examples and sources of information and experiences.

2.3.5 Summary of Desk Research at the Local Level

The following supporting factors have been commonly identified across all Pilot areas:

The consideration of RE and bioenergy uptake in local development strategies

- **Spain:** Climate Change Strategy of the Basque Country to 2050 - 40% renewable energy consumption out of the final consumption as the target for 2050), Energy policy 2030 elaborated by Energy Agency of the Basque Government - increase of the use of renewable energy by 126% to achieve a utilization of 966,000 toe by 2030, which would mean achieving a 21% share of final consumption for renewable energy, 3E2020 & Navarre Energy Plan Horizon 2030 (PEN 2030) - by 2050 all the energy supply - electricity and heat - will be covered by renewable sources;
- **Greece:** The main priority of the operational plans of the RoT is energy production through the activities of the primary sector (i.e. biomass exploitation) the Regional Waste Management Plan (elaborated in 2016) identified the energy production by the livestock waste and the pellet production by biomass as recommended measures for the energy recovery of the regional waste;
- **Poland:** Regarding the Low-Emission Economy Plan for Integrated Territorial Investments of the Wroclaw Territorial Area - the Oborniki Slaskie commune, in the field of energy activities, the effective production and distribution of energy to reduce greenhouse gas emissions and other pollutants are being implemented, such as: application of individual low-emission heat sources in areas where the development of a heating network is unjustified;
- **Italy:** The task that the Lombardy Region aims to set itself in the construction of an energy-climatic transition strategy towards a low-carbon economy, is divided into a long-term program of decarbonization and circularity of the entire economic system, where one of the main goals is the production from renewable energy sources by 2030 must make it possible to cover between 31 and 33% of final energy consumption in the region.

The ambitious goals in the field of energy transformation of the country

- **Spain:** The National Integrated Energy and Climate Plan 2021-2030 assumes 42% of renewables over final energy use;
- **Greece:** The NECP aims to achieve a minimum share of 35% RES in gross final energy consumption by 2030;
- **Poland:** the goal of the "Energy Policy of Poland until 2040 is at least 23% share of renewable energy sources (RES) in gross final energy consumption by 2030;
- **Italy:** The main goals of National Energy Strategy are i.e.: doubling investments in clean-energy research and development, from €222 million in 2013 to €444 million in 2021.

Renewable energy communities concept defined at national legislation

- **Spain:** Renewable energy communities have been defined by article 6 of the 24/2013 Electric sector law and nowadays modified by Post Covid recovery Royal decree 23/2020;
- **Greece:** The term Energy Community has been introduced in the Greek legislation, by the means of Law 4513/2018;
- **Poland:** the concept of energy community has been introduced in art. 2 point 33a Act of 19 July 2019 amending the Act on renewable energy sources and certain other acts;
- **Italy:** the concept of energy community has been introduced in Law Decree 162/19.

Local activities and awareness raising events related to RES development at the local level

- **Spain:** in Basque region there are some local activities related to RES development, such as: IHOBE, or The Basque Energy Board (EVE);
- **Greece:** in the pilot area there is ANKA AE (Anaptixiaki Karditsas Anonimi Etaireia), a development company which supports penetration and wider use of RES, development of new collaborative structures and the social and general development of Karditsa regional unit and of other areas in Greece;
- **Poland:** the Commune Office of Oborniki Slaskie performs information campaigns for residents who want to take advantage of the program of co-financing the installation of RES installations (e.g. installation of PV installations, replacement of old heat sources with low-emission ones);
- **Italy:** in the pilot are there is Ènostra energy community, it promotes awareness-raising campaigns and training initiatives for both vulnerable consumers and societal actors, supports and participates in projects aimed at tackling energy poverty, and offers support and assistance to local municipalities that aim to develop local Renewable Energy Communities.

Additional commonly identified supporting factors:

- Requirement to use high-efficient biomass boilers – new biomass boilers have to comply with the requirements of ECODESIGN Directive.
- Competitive prices of biomass fuels - in each Pilot Area, the energy produced from biomass fuels was the lowest.
- Competitive prices of domestic pellet boilers - in each Pilot Area, comparing the prices of 1 MW installations (PV installation, biogas plant, ORC Plant, wind turbine etc.), the use of domestic biomass boilers is the cheapest option (the price of this installation is several times lower than the others).

Supporting factors identified in specific regions:

- **Greece** & **Poland** developed plans of distributed energy development
- In **polish** TV there are programs raising ecological awareness of the residents - there are popular science programs where researchers consider the current state of the natural environment and suggest possible solutions for its improvement (analysing their advantages and disadvantages) i.e. Play Green broadcast on Polish Television.
- In **Greece** & **Italy** there are financial support programs for RESCoop creation
- **Greece**: indirectly promotion of bioenergy and the creation of RESCoop by "Saving at Home programme that aims to replace of old, inefficient installations by new, effective ones ones (i.e. natural gas/LPG burners/boilers, heat pumps, geothermal heat pumps, biomass/wood pellet boilers);
- **Italy**: "eco-bonus previews a fiscal deduction of 110% of the expenses incurred from 1 July 2020 to 31 December 2023 for the specific intervention in efficiency and renewable sector.
- In **Spain** & **Greece** there are significant possibilities to create a forest logistic chain for RESCoop – big potential in harvesting and providing significant amounts of biomass, transportation, biomass storage systems, supplying boilers for different kinds of biomass.

The following hindering factors have been commonly identified across all Pilot areas:

Lack of full transposition of RED II Directive, adopting and defining energy communities into national law

- national regulations implementing the RED II directive containing a number of barriers to the development of energy communities (e.g., in Poland, the RES Act contains restrictions that are not listed in the EU directive, such as a limited number of members, limited power of cooperatives, limited area)

Hindering factors identified in specific regions:

- In **Poland** there is a lack of promotion and low awareness about RESCoop among the politicians at national level – the policy makers do not promote the RESCoop development. There are no clear and targeted initiatives to encourage citizens for RESCoop creation.
- In **Greece**, **Poland**& **Italy** there are limitations in terms of RESCoop operation
- **Greece**: except for the mandatory and optional activities listed in the law 1667/1986 on civil cooperatives, no further activity can be exerted by an EC; this limits its scope;
- **Poland:** according to the Act of 19 July 2019, amending the Act on renewable energy sources and certain other acts, bioenergy communities cannot be located in municipalities, the number of cooperative members may not exceed 1000 participants, the total installation capacity is limited to 10 MW in the case of electricity, 30 MW in the case of heat, it has to be located in the area of no more than 3 rural or urban-rural communes directly adjacent to each other;
- **Italy:** the entry into force of the decree-law 162/19 (article 42bis), related implementing measures of the resolution 318/2020 / R / eel of ARERA, and the Ministerial Decree of 16th September 2020 provide for the establishment of the Renewable Energy Communities only up to 200 kW.
- In **Poland** there are high costs of heat network building in the scattered rural areas or small cities. - this is due to low-density housing, which increases the length of the heating network. In Poland, the unit construction cost of heat network is approx. 500,000 euro per km.
- In **Greece** & **Poland** there is a low trust to cooperatives
- **Greece**: the vast majority of cooperatives schemes (especially farmer cooperatives) went often bankrupt, mainly under their own mismanagement. As a result, local communities have lost confidence in cooperatives schemes;
- **Poland**: the negative experience of rural residents related to the concept of cooperative is the effect of the experiment of the communist authorities related to attempts at forced collectivization of agriculture.
- In **Poland** there are no RESCoops - as a result, there is a lack of experiences and best practices in terms of RESCoop creation in polish conditions.
- national regulations implementing the RED II directive containing a number of barriers to the development of energy communities (e.g., in Poland, the RES Act contains restrictions that are not listed in the EU directive, such as a limited number of members, limited power of cooperatives, limited area)

2.4 Key findings of Desk Research

Within the next years, the knowledge acquired will contribute to forming and developing a set of detailed rules for energy communities to be implemented all over Europe. Energy communities might follow the same path of development in countries that share similar legal and regulatory frameworks, but this will be more visible by the end of the decade. It is also possible that supportive Members States' choices will indeed assist energy communities to thrive while in the case of less-supportive countries, energy communities might remain marginalised.

Member States are called to draw on the experiences of existing energy community initiatives, or create a temporary space for them to emerge in. They need to specify principles of "autonomy, and "effective control in order to avoid elite-capture by traditional energy companies, and profit-over-value mentality. They are called to consider the value that community energy can provide to the public network and pro-actively support the set-up of such projects, also putting in place participation mechanisms for energy poor and vulnerable populations.

Overall, for citizens and communities to benefit from initiatives such as the Clean Energy package, Member states, national governments and, of course, local authorities - as the closest body of government to citizens - have an important role in translating all new opportunities, as well as supporting the projects and initiatives which already exist. The support of civil society is also an important factor to take into account. In several countries, RESCoops are often supported by the local or national environmental NGOs. The relationship with NGOs can go from classic partnership to founding member of the RESCoop and therefore the ties between the civil society and the members of the RESCoop are very close.

Apart from political and regulatory factors**, the future for renewable energy communities is promising as the interest of citizens and local authorities for climate change and involvement in energy transition grows** [177].

The national/local approach to the development of the RESCoops is still very often different across the EU. As a result, some key findings can be defined:

- Biomass is widely available in EU countries, but its harvesting should be carried out in a sustainable manner (insuring no negative impact of biomass harvesting on the carbon content in forests). The use of waste biomass for energy production is in line with circular economy. The GHG emission related to biomass logistics is lower in comparison to fossil coal, the use of local biomass resources is highly recommended.
- RED II contains provisions that aim to facilitate the participation of individual prosumers and energy communities in the energy system (there are no legal barriers),
- The development level of local energy communities is not the same in all Member States (in some countries is considerably more advanced than in others). Moreover, there are different national and regional formal regulations that define the structure, range of operation, limitations and allowances for RESCoops (legal restrictions regarding the operation of energy communities, the possibility of their connection to the grid, the allowed power capacity or the number of the members),
- There is no common EU framework for crowdfunding in renewable energy projects.
- In many EU countries there are still lower heat and electricity final costs from fossil fuels as well as low environmental awareness that significantly hinders the RESCoops development.
- There is lower emission of pollutants from biomass combustion in comparison to use of fossil fuels.
- There is still no proper promotion of energy communities in individual EU Member States that would reach the local community, especially those living in rural areas. Some reluctant civic behaviour related to the development of RESCoop is associated with negative memories of the past communism.

- There is a wide range of machines and devices available on the market, at every stage of the logistics chain, necessary for the operation of energy communities based on solid biofuels.
- Solid biofuels require relatively large space for storage. The need to build a heating network in the existing infrastructure is complex. The Central Heat and Power (CHP) Plant is complex.
- There are favourable installation prices based on domestic boilers (20x50 kW) in comparison to the CHP. As a result, the citizens may prefer the energy community development basing on their own heating system, although the impact of CHP plants powered by biomass on the reduction of pollutant emissions is much greater.
- There is a complexity of the process of developing RES projects by energy communities. Moreover, a high investments costs are required for most of ECs (the engagement of local governments is recommended to guarantee the projects realization and some funds acquisition for reducing the initial expenditures),
- In many countries there is still a problem of energy poverty that inderectlu hinders the creation of the RESCoops by the general public due to the required high investments costs (high costs of heat network building in the scattered rural areas or small cities). Currently, one of the leading causes of energy poverty is the COVID 19 pandemic. Many people have lost their jobs and are unable to pay their energy bills on a regular basis. Not to mention invest money in energy transformation of the region.

3 Interviews

3.1 Interviews' Methodological Approach

The critical factor for performing successful interviews in this field is the appropriate identification of representatives of particular groups of different stages of the community energy logistics chain or as well as actors having an impact on their functioning (*Figure 3*).

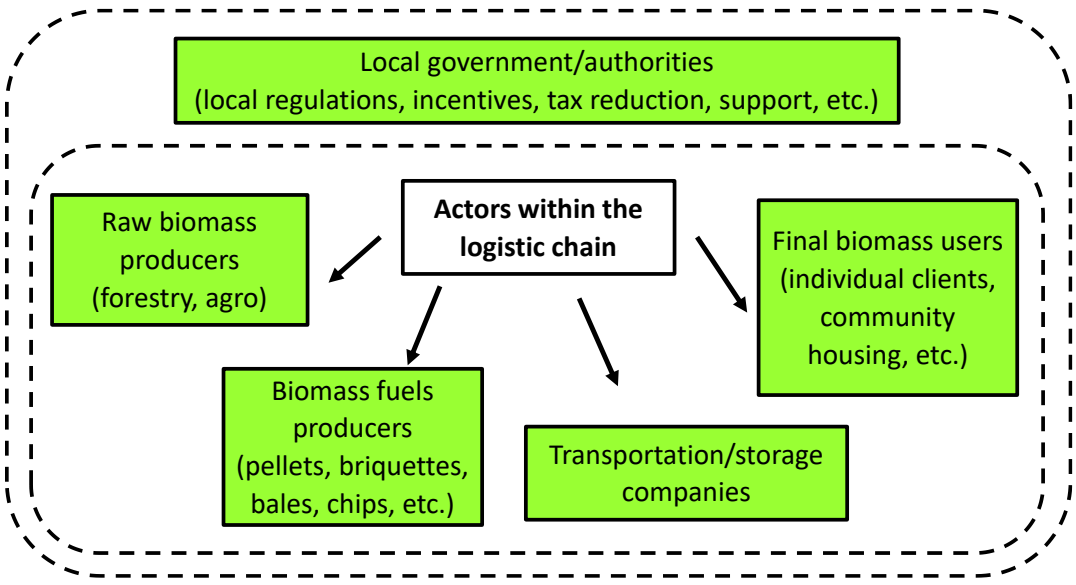


Figure 3. Actors of the logistic chain related to energy communities operation at local level.

The main types of stakeholders interviewed at the local and EU level are presented in *Table 16* and *Table 17,* respectively. Three interviews (per Pilot Area) at the local level and five interviews at the EU level have been performed. At first, BECoop partners had to identify potential stakeholders through desk research or by consulting their organization's contacts' network. After this initial screening, interview invitations have been sent to stakeholders (e.g., e-mail invitations). All interviewees filled out an Informed Consent Form before taking part in the BECoop interviews. The summary of interview transcripts is presented below.

Types of stakeholders interviewed

Table 16. Interviews at the Local level

Representative of inhabitants
Representative of local forest inspectorate
Representative of local authority
Representative of biomass producer
Representative of Farmer's Cooperative
President of forest company
Solid fuel seller
Biomass provider
Farmer
Regional Policy Maker

Table 17. Interviews at the EU level

Representative of European Non-Governmental Advocacy Organization on Energy Poverty and Community Action
Expert from Energy and Environment Association (EEA)
EU Policy Maker
Policy Officer
Representative of European Federation of Citizen Energy communities

3.2 Key Findings of Interviews at the EU level

In the case of the EU-level investigations, interviews with (i) Representative of European Non-Governmental Advocacy Organization on Energy Poverty and Community Action (ii) Expert from Energy Environment Association , (iii) EU Policy Maker, (iv) Policy Officer and (v) Representative of European Federation of Citizen Energy communities were performed. This section summarises the key findings from the, 5 in total, EU interviews. Detailed transcripts are annexed (*Annex I*).

The main conclusions from interviews at EU Level are, as follows:

- RESCoops can help reaching the goals of European Green Deal (EGD) and energy decentralization empowering a more efficient clean-energy transition.
- There are a lot of promotion actions related to RESCoops promotion. However, these actions are not enough oriented to final users (citizens). Local municipalities should act as a key players and be more engaged in the process of setting up RESCoops.
- There are varying timelines of transposition of the RED II by different member States.
- The lack of trust in the cooperative concept due to historical/political background in some Member States hinders the RESCoops development.
- In many MS, there are additional restrictions related to the rules and operation conditions of the RESCoops.
- There is not equal need for community biomass heating projects across all EU countries – different geographical locations and climate conditions influence the duration of heating season and, therefore, affect the biomass demand and costs.
- Energy community projects bear the potential to bring economic and social value back to the community.
- The uptake of energy communities is recognized as a mean to alleviate energy poverty (especially in rural areas) and can contribute to a decrease in the unemployment rate (if developed locally).
- There is lack of clarity regarding what a cooperative is and consequently how to gather data and create an overview of this concept's impact,
- There is not a sufficient information flow among varying actors belonging to the bioenergy logistic chain, especially at the local scale.
- The potential of EU biomass is large; however, its harvesting should take place in a sustainable manner to avoid deforestation and insure biodiversity.
- There is a need to elaborate a balance between large biomass companies (lobbying for their interests) and local decentralized initiatives (suffering lack of the representation and power on the energy market) to insure fair access of the final users to the bioenergy
- In the areas with well-developed gas network there is a poor social perception of bioenergy (gas utilization is simple and does not require a storage space). As a result, the production of biomass fuels (i.e. pellets) is not profitable. Moreover, in these regions there are no heating networks (which is very often an obstacle in RESCoops creation oriented to CHP building)
- The investment in centralized biomass installations is expensive and its operation is complex.
- There is a lack of clear and well-described good examples of the RESCoops, including essential and easy to grasp information about relevant funding schemes, technical data, social impact, costs, rules of operation etc.

3.3 Key Findings of Interviews at the Local Level

This section summarises the key findings from the pilot level interviews. Transcripts are annexed (*Annex II*).

The following supporting factors have been commonly identified across Pilot areas:

There is a large potential for the development and further uptake of RESCoop in the Pilot Areas

- **Spain:** interviewee thinks that in the region there is access to significant amounts of forestry biomass. From this biomass, different quality pellets and wood chips are produced that can be used for energy purposes. Local sustainability law requires sustainable management of the forests in order to consider the pellets generated as renewable (to avoid logging without reforestation);
- **Greece**: interviewee thinks that in the municipality there is a considerable biomass potential (agricultural, forestry and urban biomass);
- **Poland:** interviewee thinks that municipality have sufficient biomass resources for RESCoops establishment;
- **Italy:** in the local area, there are large forest areas which can provide (harvested in a sustainable way) significant amounts of biomass for heating purposes.

Energy communities can significantly contribute to the mission of improving air quality, which would be essential especially in the Polish and Italian Pilot areas

- **Poland:** interviewee stresses out that the acceptable levels of pollutants are exceeded several times, also during heating season;
- **Italy:** interviewee thinks that air quality and pollution are critical in different areas of the Po Valley, the local society is conscious of the changes that must happen to improve the state of the environment.

A great need and often will for local government to get involved in RESCoop establishment

- **Spain:** EVE (Basque energy agency) together with Diputación (Local government of the region) cover 50% of the investment costs;
- **Greece:** interviewee said that there is a political will for RESCoop creation;
- **Poland:** local authorities approve of the development of RESCoops, which is crucial for action in this area;
- **Italy:** commune is already working on energy self-sufficiency project based on local resources.

Possibility of cooperation between neighbouring municipalities, especially in Greek and Italian Pilot Area

- **Greece:** interviewees see the possibility of cooperation between municipalities in terms of RESCoop creation, the main reason is the costs reduction of the required investments to build the single energy unit;
- **Italy:** interviewee thinks that municipal initiatives could allow for a better organizational management in biomass supply logistics, the cooperation should improve the profitability of the RESCoop and, thus, increase the interest in their development.

Positive impact of RESCoop on local entrepreneurship

- **Spain:** interviewee thinks that energy cooperative can generate close collaboration networks between residents;

- **Greece:** interviewee thinks that RESCoop creation can impact on local development and lead to the energy self-sufficiency of the community;
- **Poland:** interviewee thinks that RESCoop may reduce unemployment in the region;
- **Italy:** interviewee thinks that RESCoop creation can be an opportunity for small and medium-sized enterprises to create a network for the production and consumption of bioenergy.

The following hindering factors have been commonly identified across Pilot areas:

Difficulties in fully understanding the environmental benefits if there are no bill savings involved

- more and more people are interested in sustainable and less carbon-intensive heating solutions, but for many of them it is difficult to understand the environmental benefits if there is no economical bill savings involved.

Lack of information and awareness around energy communities

- **Spain:** many people from the region are not aware about the idea of a RESCoop, its role and benefits for local society, there are no wide promotion actions with good examples to convince society start thinking about this activity;
- **Greece:** according to the opinion of interviewee, there is not too much easily available information about energy communities, their principles of the internal operation, form and structure as well as legal obligations;
- **Poland:** in Poland there is no RESCoop, so the residents are not conscious of this concept;
- **Italy:** there are indications among the general public that, in the future, energy production will be automated to such an extent that no new jobs will be created. The local society is focused too much on the job creation, as a result, other benefits are not recognized (lower heat price, people integration etc.).

Low levels of ecologic awareness

- **Greece:** the attitude of local people to environment protection and use of RES in the region is rather at a low level, which results from lack of information about the real and measurable profits of such a concept;
- **Poland:** most of the inhabitants do not care about the environment, therefore, they burn very often low quality biomass (moist wood), as a result, the heat release is low leading to the negative opinion about the biomass utilization.

The energy community is perceived badly among the society

- it may be caused by past events, such as forced collectivization of agriculture (Polish Pilot Area) or corruption in cooperatives (Greek Pilot Area).

Reservations to the RESCoop registration, operation and financing process

- **Greece:** interviewee stated that the formal registration of a RESCoop establishment requires many documents and permissions related to the operation, grid connection etc.;
- **Poland:** there are no programs directly supporting the launch and development of local energy initiatives;
- **Italy:** according to opinion of the local authority, instead of dealing with subsidies in marginal areas, the support system should encourage the model of development of energy self-sufficiency in marginal areas.

4 Conclusions

A summarizing table with main findings per EU and pilot level is presented below (*Table 19*).

Table 18. Summarising table(s) with main findings at the EU and pilot level.

EU level	
Desk Research	**Interviews**
Supporting factors: • Biomass represents more than 60% of current renewable energy production in the EU28 –majority is solid biomass. • There is a clear definition of the Renewable Energy Community provided by new RED II Directive giving the legal entity for this type of organizations/associations. • RED II contains provisions that aim to facilitate the participation of individual prosumers and energy communities in the energy system and to enable consumers to produce and self-consume energy individually or collectively and ensure they are remunerated for the power they feed into the grid. • Calling to transpose the new directives into EU members national law within a period of 2 years, that is by 2021. • The European Commission published a *Communication on Unleashing the potential of Crowdfunding in the European Union* [10] which helps to unleash the potential of crowdfunding in the EU. • There is no negative impact of biomass harvesting on the carbon content in forests. • Sustainable landscape and forest management to harvest biomass for energy purposes has a positive impact on biodiversity. • The use of biomass for energy purposes may involve non-ecological production of biomass for other purposes. • There are multitude forms of non-institutional involvement in renewable energy projects. • Willingness for energy independence, away from large companies, constitutes an important factor that can empower participation in energy communities. ***Hindering factors:*** • The level of development of local bioenergy communities is not the same across all Member States (in some countries it is considerably more advanced than in others). • A series of technical difficulties as well as time and cost constraints should be considered when designing and establishing a heating network.	• RESCoops can help reaching the goals of European Green Deal (EGD) and energy decentralization empowering a more efficient clean-energy transition. • There are a lot of promotion actions related to RESCoops promotion. However, these actions are not enough oriented to final users (citizens). Local municipalities should act as a key players and be more engaged in the process of setting up RESCoops. • There are varying timelines of transposition of the RED II by different member States. • The lack of trust in the cooperative concept due to historical/political background in some Member States hinders the RESCoops development. • In many MS, there are additional restrictions related to the rules and operation conditions of the RESCoops. • There is not equal need for community biomass heating projects across all EU countries – different geographical locations and climate conditions influence the duration of heating season and, therefore, affect the biomass demand and costs.

Spanish Pilot Area	
Desk Research	**Interviews**
Supporting factors: • High biomass potential (especially forestry). • Existence of other RESCoops in the country (Specifically in Spanish Pilot Area there are other 3 RESCoops). • The National Integrated Energy and Climate Plan 2021-2030 assumes 42% of renewables over final energy use by 2030. • Special emphasis on green job creation in rural areas, in line with the Spanish strategy on depopulation, by encouraging renewable energies like biomass or biogas, and by promoting the bio-economy strategy with a view to generating economic value. • There is a support scheme for the creation of RECs • Renewable energy communities concept is defined at national level. • The minimum requirements to be met when developing an energy community at the local level are defined. • The prices of biomass fuels are much lower than conventional fuels. • Heating units based on biomass domestic boilers are several times cheaper than other energy solutions. • The level of ecological awareness of local community is satisfactory. • Big possibilities for RESCoop logistic chain creation. • Strong position of pellets on the Spanish energy market. ***Hindering factors:*** • Insufficient control of pollutants emission from small capacity boilers.	• in the region there is access to significant amounts of forestry biomass. From this biomass, different quality pellets and wood chips are produced that can be used for energy purposes. • renewable energy cooperatives can have a great social and economic impact at the local community. • Many people from the region are not aware about the concept of RESCoop, its role and benefits for local society, there are no widely disseminated awareness-raising or promotion actions with lighthouse examples to attract the general public's attention and further engage them in such a mission.

Greek Pilot Area	
Desk Research	**Interviews**
Supporting factors: • Existence of other RESCoops in the country • The Greek NECP aims to achieve a minimum share of 35% RES in gross final energy consumption. • NECP: bioenergy's contribution at the national level is expected to remain stable, while solar and ambient heat and geothermal increase. • The use of bioenergy considered in local development strategies (RoT, RIS3). • The renewable energy communities concept is defined at national level. • The minimum requirements to be met when developing an energy community at the local level are defined. • Energy communities can form unions and a Hellenic federation of energy communities. • Competitive prices of biomass fuel. • Local activities related to RES development often take place. • Significant possibilities to create a logistic chain for RESCoop at local level (based on agricultural, forestry, urban biomass). ***Hindering factors:*** • Lack of information regarding the exact ways of implementing the goals of the country's energy transformation. • There is a need of greater interaction between forestry/agricultural, energy and environmental policy. • By early 2022, energy communities are called to participate in competitive processes (e.g., compete with private investors in bids) to ensure the operational support of renewable energy projects • Except for the mandatory and optional activities listed in the national law, no further activity can be exerted by an EC. • The limits of emissions are less strict than the Eco-design Regulation requirements (equivalent to Class 5). • Many biomass boilers available on the Greek market have not undertook proper type testing, even with wood biomass fuels. • Solid biofuels and fossil fuels have a VAT of 24%, Natural Gas and electricity have a VAT of 6%, thus affecting the final heating cost of each medium. • Problem of energy poverty in the country • Lack of trust to cooperative schemes due to their bad reputation related to corruption in these institutions.	• There is a considerable biomass potential (agricultural, forestry and urban biomass). • There is a political will for RESCoop creation. • Recognition of possibility of cooperation between municipalities in terms of RESCoop creation - the main reason would be increasing investment chances to build a single energy unit. • RESCoop creation can impact on local development and lead to the energy self-sufficiency of the community

Polish Pilot Area	
Desk Research	**Interviews**
Supporting factors: • The "National Plan for Energy and Climate for 2021-2030 estimated that in 2030, there will be approximately 300 energy sustainable areas at the local level in the country. • The goal of the "Energy Policy of Poland until 2040 [121] is at least 23% share of renewable energy sources (RES) in gross final energy consumption in 2030. • Implementation of Low-Emission Economy Plan for Integrated Territorial Investments of the Wroclaw Territorial Area • The concept of community energy is recognised by the Polish law. • The rules for the operation and control of community energy have determined in Polish Law. • The introduction of the act of anti-smog resolution by Lower Silesia government. • There are popular science programs in polish TV where researchers consider the current state of the natural environment and suggest possible solutions for its improvement (analysing their advantages and disadvantages) i.e. Play Green broadcast on Polish Television. • Considering the fossil fuels and biomass fuels used for heating purposes, the biomass belongs to the relatively cheap sources of energy. • There are favourable prices for the installation based on biomass domestic boilers. • There are actions promoting the use of RES in the region. • Increased ecological awareness of Poles over the last years. ***Hindering factors:*** • Past failures in settlement of energy community. • No RESCoops in Poland (lack of comparison with other plants). • Lack of promotion and low awareness about RESCoop among politicians, local governments and general public at regional and national level. • There are strict legal requirements for community energy (i.e. limited power, limitations in location). • High costs of heat network building in the scattered rural areas or small cities (approx. 500,000 euro per km). • The rise of energy poverty in Polish Pilot Area caused by COVID-19 pandemic. • The reluctance of local society towards cooperatives related to forced collectivization of agriculture in the past political system. • There is a very high share of households heated by coal (over 50% of households are heated directly or indirectly by fossil fuels).	• In Poland, there are no programs directly supporting the launch and development of local energy initiatives. • Sufficient biomass resources are being reported, providing a good starting ground for RESCoop establishment. • The acceptable levels of pollutants are exceeded several times also during heating season. • The establishment of RESCoops may reduce unemployment rate in the region.

Italian Pilot Area	
Desk Research	**Interviews**
Supporting factors: • Italian Pilot Area has an extensive experience of energy communities. • There are several RESCoops in Italian Pilot Area. • Lombardy Region has great resources of forestry biomass. • The Lombardy Region aims to cover between 31 and 33% of final energy consumption in the region from RES. • The concept of energy community is recognised by the Italian legislation. • The biomass (as a source of energy) belongs to the relatively cheap sources of energy. • Domestic biomass boilers are several times cheaper than other energy solutions. • Implementation of fiscal deduction of the expenses in renewable energy sector. • There are initiatives for fighting against energy poverty (i.e. Ènostra promoting awareness-raising campaigns). • In Lombardy, harvesting wood from poplar plantations has become more and more popular. ***Hindering factors:*** • There is a funding limitation in incentive program for RES plants. • Low growth of forecasted energy production from biomass: the forecasted increase in the thermal power of bioenergy is more than 25 times lower than the increase in the thermal power of heat pumps. • Italian Law limits the power of energy community (only up to 200 kW). • Reduction in the extent of forestry interventions over the last years.	• In the local area, there are large forest areas which can provide (harvested in a sustainable way) significant amounts of biomass for heating purposes. • air quality and pollution are critical in different areas of the Po Valley. The local society is conscious of the changes that must happen to improve the state of the environment. • Municipal initiatives could allow for a better organizational management in biomass supply logistics. The cooperation should improve the profitability of the RESCoop and, thus, increase the interest in their development. • RESCoop creation can be an opportunity for small and medium-sized enterprises to create a network for the wider production and consumption of bioenergy.

Overall remarks

From the point of view of the EU and EU directives, there are no obstacles in the context of the development of energy communities. Moreover, Member States are encouraged to support such initiatives at the local level. However, education and promotion (for the local community) of heat and electricity generation by an energy community is still needed. Involving the local community is the absolute key to success. There are various business models for supporting investments in energy communities, but at the same time there are no well-described energy communities which are the basis for showing good practices and examples. To achieve success, it seems to be necessary to involve local authorities in the development of energy communities, as they act as a guarantee of investment success. A serious problem is the high cost of building a heating network in rural areas. It is necessary to pursue a sustainable biomass harvesting strategy for energy purposes (both on a global and local scale). Energy communities can be one of the solutions to reduce energy poverty. An element supporting the development of RESCoops is the trend to reduce pollutant emissions, reduce the use of fossil fuels and increase the use of local energy potential. The technology of using biomass fuels for heating purposes is known among EU countries.

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Annexes

Annex I: Results of Interviews at the EU Level

In the case of the EU-level investigations, interviews with (i) Representative of European Non-Governmental Advocacy Organization on Energy Poverty and Community Action (ii) Expert from Energy Environment Association , (iii) EU Policy Maker, (iv) Policy Officer and (v) Representative of European Federation of Citizen Energy communities were performed.

INTERVIEW 1 – EUROPEAN NON-GOVERNMENTAL ADVOCACY ORGANIZATION ON ENERGY POVERTY AND COMMUNITY ACTION

Supporting factors, driving the uptake of bioenergy community projects:

Bioenergy is moving up the EU agenda. In general, biomass is not neglected. Biomass is still recognized as a renewable energy source and is widely used in many countries across Europe to meet their shares in renewables targets. However, more and more attention is paid to the sustainable use of biomass. In this aspect, there is much discussion across the EU Members and consultations within the European Commission. Members States have to make appropriate decisions at the local level about biomass utilization for energy purposes.

RESCoops can help reaching the goals of European Green Deal (EGD). Energy community projects need to bring economic and social value back to the community and need to be open so that people can join with relative ease. It does not have to be open to absolutely everybody, but it is not a private club where people are practically solely aiming at getting financially wealthier. This concept needs to be participatory so that members bring meaningful engagement and decision-making back to their community; this is tied to geography specificities.

RESCoops can help in energy decentralisation and empower a more efficient clean-energy transition. We need to think about a much more meta and macro idea of decentralized power to address energy poverty. A crucial factor is decentralizing power away from large corporations, away from opaque and undemocratic means of energy access, and away from the fossil fuel-dominated energy system . This is the very practical ambition of energy communities.

The uptake of energy communities can contribute to a decrease in the unemployment rate. This is an initiative created by people for people. The renovations of the energy production systems led by citizens for citizens bears the highest chances for attracting and engaging local communities in this endeavor; the element of trust is already there. It will not solve all the problems related to unemployment, but for sure, it will cause some movement in the job market.

Energy communities as an outreach or education kind of hubs. Energy communities are central stakeholders that are well placed to engage those who are living in energy precarity and also to educate others around energy poverty. RESCoop serves as the ideal concept in terms of local actors who could potentially funnel funding or funnel expertise towards the energy poor and serve as an education hub.

RESCoops recognised as a means to alleviate energy poverty. Energy communities have a crucial role in tackling energy poverty, but they should not be over-relied on, and they should not be kind of passed over all the responsibility (energy poverty is a structural issue that requires a structural response). One of the arguments for creating RESCoops is to provide cheaper energy.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Scepticism of many Non-Governmental Organizations (NGOs) towards bioenergy. The mood towards bioenergy is shifting amongst NGOs to be even more sceptical and to be even more critical or even negative. It is a result of numerous bad examples of using biomass for energy purposes causing deforestation or leading to additional indirect CO_2 emission (i.e. biomass importing from other continents).

INTERVIEW 2 – EXPERT FROM ENERGY AND ENVIRONMENT ASSOCIATION (EEA)

Supporting factors, driving the uptake of bioenergy community projects:

Biomass as a popular solution in combating energy poverty in EU. Biomass is an option that comes to mind to the certain Member States to tackle energy poverty or due to forestry potential or agricultural situation. Therefore there is an acknowledged attractiveness and appeal to use biomass.

Study on prosumers also presenting the cooperative cases will be published this year. The EU has positive thinking about RESCoops. What types of energy communities we need in Europe, what they are supposed to achieve, how we want to transform the current energy system to encourage energy communities that are really leading to change and those who share the benefits and lead the transformation of the whole energy sector. We will find the answers to these questions in the study.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Inability to properly analyse the functioning of RESCoop in the EU. Energy communities constitute an ambiguous term; it lacks clarity regarding what a cooperative is, and consequently, how to gather data and create an overview of their impact is currently rather tricky. There is a high need for precise data from specific plants to assess their assets and impacts, in particular: plant/system capacity, annual energy production, number of members, energy costs for a cooperative member, degree of energy coverage, O&M costs, investment costs for a member, profitability, financial model, etc.

Concerns about the quality of biomass used for energy purposes. In some contexts, biomass can be a solution, but it can aggravate the problem in other places. There are concerns about the quality of the data available regarding biomass. There is no good overview regarding the feedstock or where it is coming from, not only in terms of carbon dioxide abatement but in particular also for the quality of forest and biodiversity and nature-based solutions. On the one hand, there is a risk in competing demands for more energy, biomass solutions to reach the 2030 target and biomass seen as the lowest hanging fruit, on the other hand, maybe increasing for chemical purposes and industrial applications. When used in residential applications, biomass combustion is increasing the emissions mainly due to the use of old boiler constructions. The studies indicate an increase in PM2.5, PM10, and volatile organic compounds, but other chemical compounds and aerosols are emitted (not only at the residential level). This is related to the energy density, the water quality, the calorific value of the fuel in the end, and the technologies that transform it.

More loosely requirements for low and medium power boilers. The small and medium combustion plants are also more loosely regulated in case of emissions than larger combustion plants. Their emissions standards limits are higher, which influences lower installation costs in comparison to large capacity boilers. Moreover, small boilers do not bear any environmental fees and rigorous procedures of waste management and costs. So, the small boiler owners might be reluctant to switch the heating systems.

INTERVIEW 3 – EU POLICY MAKER

Supporting factors, driving the uptake of bioenergy community projects:

A lot of promotion actions organized by EC related to RESCoop. There is a lot of focus on citizen engagement. And these cooperatives are a representation of this. The EC is aware of many social benefits arising from this activity.

Municipalities can be a key player in setting up RESCoops. Collaboration with municipalities might be essential towards better RESCoop infrastructure integration. Their support and commitment are crucial as meeting the legal/formal aspects is very important to convince the local community to create a RESCoop.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

The problem of "big players on the energy market. There is an interest from the EC to support R&D in developing RESCoops, but big players also play a part in lobbying for their interests, while decentralized initiatives lack the representation (and financial muscle) to make themselves heard in equal terms.

Problem with information flow between RESCoop in EU. There is not enough information flow. There is an interest from the EU, but due to the diverse aspects of these decentralized models, there's a lack of access to the data, and consequently difficult to make a better assessment of them.

Legally undefined "energy community concept. It's unclear what a cooperative is – this needs to be better and more clearly defined.

Difficult communication between RESCoop and the EU. There is a lack of representation of these decentralised initiatives in Brussels.

INTERVIEW 4 – POLICY OFFICER

Supporting factors, driving the uptake of bioenergy community projects:

Agricultural residues as a common source of energy. Agricultural residues are theoretically able to provide a substantial contribution to renewable energy targets in the several Member States and accommodate competitive uses and soil organic carbon preservation. Agricultural waste might often be considered as something outside our eco-design principles, while this is a massive pool of untapped biomass resources. They can be converted into bioenergy and bio-based products by cascading conversion processes within the circular economy and should be considered residual resources. There is a need to facilitate a holistic approach and optimize materials and knowledge flow management in this context. The use of agro-biomass for energy

favours a societal shift towards greater sustainability and energy self-sufficiency. This affects several areas such as: reduced GHG emissions, recovery of residues and recycling of waste, farming preserving soil fertility, decarbonizing forests.

Creation RESCoops help to reach the goals of the European Green Deal. Moving towards the Energy Union, we need to understand that it is not the case of one fit-for-all solution. Through the uptake of energy community, we reduce the (societal among else) risk of reaching energy solutions (and employing respective technologies) that will be mutually beneficial both in practical terms (demand-driven, efficacy) as well as in bringing back to people (societal approval, actual profits). In addition, these decentralized systems further empower numerous valuable possibilities being connected on the grid.

Implementation of RED II directive is helpful in RESCoop development. From 2020, Article 23 of the RED II requires Member States (MS) to increase the share of RE in the heating and cooling sector by an average of 1.3% per year. This annual target should be explicitly monitored and become binding for all MS. It is an important indicator for solutions related to biomass.

RESCoops can alleviate energy poverty. Energy poverty is a worrying reality, especially in central-east European countries. In order to get there, we do need innovative business models. We need better to identify the co-benefits of bioenergy at the community level, bringing it back to people, reducing among else their energy (or heating) bills. We also need to fight against colluding or specific interests that still exist, especially at the regional level, that keep favouring fossil-fuelled solutions.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Legal and political obstacles in the EU member states. Specific national regulations have not yet adopted the RED II recommendations and lack political will / limited initiatives.

Unknown "energy community term among the EU community. Fair share of general public is still unaware of the concept.

Bioenergy installations require more than solar or wind technologies. Bioenergy community projects are considered to be more technically complex and might include increased maintenance needs. Bioenergy community projects often require an initial capital to be invested, which is often higher. Feedstock availability is a significant concern (in addition, people might often be unaware of the biomass potential of a region).

Not equally great need (and therefore demand) for community biomass heating projects across all EU countries. First of all, we should consider the different calorific needs of varying Member States. For example, these needs are lower in southern countries (e.g., Malta, Greece, Spain etc.).

Conservative approach of the European Union in terms of RESCoop promotion. EU so far has a quite a conservative approach (reduced funding schemes) with regard to rural development.

INTERVIEW 5 – EUROPEAN FEDERATION OF CITIZEN ENERGY COMMUNITIES.

Supporting factors, driving the uptake of bioenergy community projects:

Biomass is widely available. The potential of biomass is significant in many countries, which is fundamental for developing RESCoops in these areas.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Varying timelines of transposition of the RED by different member States. Slow speed on transposing the EU regulations into national law in some Member State cases (in this case, this is mainly referred to as the RED II Directive case).

Lack of trust in the cooperative concept due to historical/political background in some Member States.

This issue concerns mainly Eastern European countries with a Soviet past. In countries affected by communism, everything was familiar and belonged to you. The state as the owner could manage it in any way (take, sell, liquidate, etc.) without consultation and clear reasons. As a result, no one cared for the common good because it did not guarantee anything. After the fall of communism, citizens regained their freedom and the right to own goods they had decided for themselves. Hence, joint ownership continues to have bad associations in terms of certainty of participation and management influence.

Time and capacity constraints resulting from the volunteering nature of energy communities. Inhabitants do not have time for additional activity in the area of cooperative energy activity. They also do not have the appropriate competencies and knowledge to assess the viability of the solution. As a result, they prefer not to change the current state.

Still great need for optimising communication. Difficulties in communicating what the energy community scheme is all about and how it can be materialised / we need to lower the level of complexity in terms of the language and means used when communicating the potential of EC – we often overburden actors with too much theoretical information and guidebooks instead of fostering direct collaboration and interaction with good existing practices (to bring them up to speed).

Lack of targeted support from local authorities. They are often not fully aware of the co-benefits of the scheme – or that they can themselves be also part of a RESCoop.

Lack of expertise and knowledge in order to start a RESCoop. R&D activities should be expanded in this regard.

Financial credibility of RESCoops. Another issue that needs to be addressed is the banks that require specific guarantees from energy initiatives for getting a loan. Since energy communities cannot provide that, a local municipality could do that on their behalf. In the Netherlands, there are examples where municipalities offer loans for the initial phases of such projects.

Countries based on a more "central planning – less power to regional authorities pattern are left behind in terms of development speed (compared to countries that follow a more co-design policies approach).

For example, in the Netherlands, the local (provinces) authorities that are in charge of issuing a permit for establishing a solar panel or wind farm – whereas in the case of, for example, Greece, such permits are only issued by a single state agency. That usually leads to a much less flexible supporting mechanism.

Often-limited supporting schemes initiated by local authorities. This is what should be strengthened. There is a need for them to provide support (that includes financial help) at least at the initial stages of a project and, therefore, assist the volunteers of community energy to have the necessary power to pursue their project.

Difficulties for RESCoops to compete in the energy market. Even though energy communities are welcomed by a theoretically enabling framework by the Commission, in practice, they are pushed out of the energy market when competing with traditional companies. Therefore, perhaps there should be dedicated competitions only for energy communities. Ideally, the cooperatives should have the strength to compete to the same auctions and tenders as large companies. It is crucial to support the communities during their first steps and overall always have the means to assess the timing and maturity of an energy community project. Such criteria can help judge whether there are fair conditions to participate in a competition, tender, or auction. If they take part in a competition, additional factors need to be considered (apart from the price), such as the number of people being involved and the share of funds in the local community.

Lack of knowledge and awareness of the general public regarding bioenergy. People are often unaware of the bioenergy potential, which is connected to a lack of trust in its respective technologies. Moreover, there is scepticism towards bioenergy as the general public often sees it as a competitor of food production while they do not consider it a sustainable and clean solution. People are often further sceptical of potential atmospheric pollution emissions. Another factor that intensify the problem is the difficulties in handling biomass.

Annex II: Results of Interviews at the Local Level

Spanish Pilot Area

In the case of the Spanish pilot area, interviews with **(i) a biomass provider representative, (ii) a farmer, (iii) a regional policy maker and (iv) a local municipality representative** were performed.

INTERVIEW 1 – BIOMASS PROVIDER

Supporting factors, driving the uptake of bioenergy community projects:

There are biomass resources in the region. In the region there is access to significant amounts of forestry biomass. From this biomass, different quality pellets and wood chips are produced that can be used for energy purposes. Local sustainability law requires sustainable management of the forests in order to consider the pellets generated as renewable (to avoid logging without reforestation).

There are companies dealing with biomass harvesting and processing. The logistic part related to forestry biomass harvesting, storage, and processing is well-organized. These companies cooperate. Different forms of biofuel are produced, which are suitable for boilers somewhat distant from urban environments to supply large installations or for systems that feed micro-grids for heating in rural environments. There is cooperation across the actors belonging to the logistic chain, so the chance to create RESCoop seems to be high.

Potential to increase the local economy. Regarding ESCOs and the forestry resource, the preferred option is the local one due to the current availability. Despite this, the Basque Country sustainability law does not establish a criterion of origin when assessing it as renewable energy. Bioenergy implies a local economic empowering because it uses local resources and generates close collaboration networks. It generates associated or indirect activities.

There are middle-size buildings heated by biomass. In the region there are some public buildings, hospitals or nursing homes equipped with biomass boilers. It creates possibility for energy community/cooperative establishment.

The biomass may compete with fossil fuels in rural areas. Possibility of total replacement of the existing gasoil boilers exists in remote areas due to the resemblance of the logistics. The biomass combustion is more ecologic than diesel oil. Boilers comply with the Eco-design regulations and there are even condensation technologies. Moreover, the pellets are cheaper that diesel oil or natural gas tertiary tariff.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

The heat demand is relatively low in the region. The heating season is not too long, during the year only hot water is required. It causes, that big heat buffers are recommended to reduce start-stop operation of the boiler. It increases the investment costs of the system. Non repayable financing is still necessary (20-30 % investment cost).

Solid biofuel quality and storage system. The consumers are sensitive to unstable fuel quality of selected forms of biomass, ash removal and more frequent burner services. Storage of biomass by final users is a problem. It requires space and bigger silos.

Well-developed gas network. There is a good access to the natural gas network in urban areas, which is a main competitor to the biomass in terms of heat production. As a result, significant amount of biomass must be exported to other regions i.e. Canary Island. It influences also on the low performance of the associated logistics: lower demand implies lesser load of the same transport.

Poor social perception of bioenergy. Ignorance, lack of comprehension about its neutrality, distrust to the importance of environmental issues in electric generation facilities. Many people are not aware that ashes can also be used as fertilizer for soils (high potassium content).

Pellets production is not profitable. A pellet company is not profitable by itself, only companies that have waste as a by-product to generate pellets (as a complementary activity).

Lack of the heat network in the region. High investments are required to build the heat network (maybe oriented to smaller facilities for small villages or neighbourhoods, as microgrids). It is a main problem in terms of BECoop creation for heat distribution.

INTERVIEW 2 – FARMER

Supporting factors, driving the uptake of bioenergy community projects:

Biomass as fuel can be attractive. Biomass is cheaper than diesel oil and can replace fossil fuels. Is it more sustainable (environmentally friendly), lower pollutants emission. It has potential for local development as many companies from a region can be engaged.

Experience in sharing communal pastures. The communal is a widespread concept in the rural areas.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

The middle-size biomass boiler installation is complex. The creation of middle-size biomass boiler installation requires high investment costs. Furthermore, there are logistics problems related to silos for biomass and stable physical parameters. Little information about the subsidies and other financial support.

No promotion in terms of local biomass utilisation. Little information on the benefits of biomass. The ignorance about the development of the biomass logistic chain. There is a cultural fear of changes regarding new technologies for heating supply. No data with success stories in this area. In the region, there is a lack of good examples of the RESCoops. Too little discussion about the RESCoop creation.

INTERVIEW 3 – REGIONAL POLICY MAKER

Supporting factors, driving the uptake of bioenergy community projects:

There is a biomass potential in the region. Local origin is prioritized, but without this hindering economic viability, biomass travel is not ruled out, and the environmental sustainability law encourages sustainable forest management but does not establish proximity criteria when considering biomass as a renewable source. At the same time, the interviewee considers that, economically, it is more profitable to consume biomass from a closer origin avoiding transportation costs. In addition, the use of regional biomass helps the local economy, generates employment, stabilizes the fuel price, decreases energy dependency, and provides environmental sustainability.

The stakeholders of the logistic and value chain are present. The current state of technology is known. The technology is mature. The biomass resources are sufficient. Some companies obtain biomass, especially forestry. There are producers of a selected range of biomass, installers/service technicians of heating devices and consumers on the market. There is a very advanced and resourceful value chain for solid biomass at the local level, for forest-based solid biomass and energy service companies associated with heat delivery solutions. It seems that there is only a need to merge the stakeholders of this market and create BECoop.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Just a few prototypes or pilot cases to be followed. The heat network is not a solution highly developed. Heat demand is limited. There is little conception of pooling resources in the urban environment, which dominates a somewhat more particular context. Gasification urban environments are making individual natural gas-based boiler solutions very competitive. Replacing individual gas boilers with pellet boilers requires investment and a change of mentality. The initial investment is high. Complex logistics in the urban environment try to find more accessible single points of access to the system in heat networks. There are different problems for urban (storage and logistic problems) and rural (scattered users) areas in terms of RESCoop creation.

First economic bill then ecology. More and more people are interested in more sustainable and less carbon-intensive heating solutions. However, it is difficult to understand the environmental benefits if there are no economic bill savings involved. The price per thermal kWh delivered is lower than natural gas as an alternative source, but high investment costs are the main problem in the development of the heating system based on biomass. Another related issue is depopulation in rural areas reducing the interest in heat network development.

There are no widely promoted supporting actions oriented to heat network development. The administration provides some aid programs, but they are not promoted properly. There are also some communal heating networks but no development projects to use for BECoop development. The government should present examples of this activity to encourage the community to consider such solutions. It is necessary to promote district heating networks serving public and private buildings. Acceptance by the municipality, risk, and trust are essential, as well. Most practical might be for centrally heated buildings to connect. In addition, it would be helpful to have a fixed price for biofuels, supply guarantee clauses, or reduced biofuel costs by applying reduced VAT rates. Encourage the conversion of the entire fleet of traditional fossil fuel-fired boilers to new biomass boilers in rural areas through aid schemes, reduced building permit rates, tax breaks, etc.

The demand for pellets or wood chips is relatively low in the region. In the region, companies are having wooden waste sub-products and producing pellets or another form of biomass. Also, the municipalities with rights related to the forest resources can generate locally chips. But, unfortunately, the is not enough demand to make a business on that activity alone sustainable. There are also problems with logistics, storage facilities, and transportation.

Economically not very profitable projects, with high initial investments and risks. High-risk projects in terms of execution (biomass boiler + district heating). It required significant investments with complicated procedures and allowances. The construction is also time-consuming. The profitability might be a problem if the biomass prices and heat demand are not secured.

INTERVIEW 4 – REPRESENTATIVE OF THE MUNICIPALITY

Supporting factors, driving the uptake of bioenergy community projects:

There are buildings equipped with the central heating system. There is an example of small DH feeding three buildings heated by a central boiler (300 kW) fired forestry biomass from local resources in the region. So, there are elements of the logistic chain, but it requires some management activities and local community engagement. Moreover, If the central heating installation is shared, it is possible to have more excellent knowledge of the status of each user and to adapt to possible non-payments, as an element of facing energy poverty.

Local biomass influences regional development and environment. The use of biomass from regional resources engages local companies and manpower. This can be attractive if the locally sourced biomass is processed and delivered to the customer in the shortest possible logistics chain, with the involvement of local companies. Moreover, biomass is more sustainable (environmentally friendly) than fossil fuels (like natural gas).

Municipalities with local biomass ownership improves the feasibility of the system. Forestry (pine), forest exploitation rights held by the municipality of forest maintenance work, etc. Forest management plans and trees are marked for forest clearing, and these lots are purchased with an estimation of two years.

Local aid programmes facilitated by the local government. The explicit engagement of local authorities in creating the RESCoops seems crucial to reach a target. For example, EVE (Basque energy agency), together with Diputación (Local government of the region) cover 50% of the investment costs. Thus, the participation of the local authority is a kind of guarantee that the investment will be realized.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Operation and maintenance problems of biomass boiler. The biomass boilers are sensitive to fuel quality. Burning low-quality and moist fuel lead to mechanical/electronic failures of the boiler. As a result, district heating based on biomass is characterized by more operation problems than gas heating solutions. In the case of wood chips, extra storage space is required, Moreover, the problem is the necessity to pour the wood chip pile to prevent its biological degradation and control its moisture content. Due to the technical problems and the security of supply issues, thermal comfort in buildings cannot be guaranteed. It may partly explain

the low interest in biomass utilization for heating purposes, or even some opposition to these solutions. Finally, high investment costs are required for this installation.

Heating systems basing on gas are less troublesome. Gas boilers do not require fuel storage. The quality of gas is stable. The heat price using gas is not much more expensive than biomass (if O&M costs are included in the analysis). The comfort of gas utilization is greater. In relation to biomass, there is a distrust of the users about the guarantee of supply and a lack of knowledge about the benefits of the technology.

The investment in centralized biomass installations are expensive. It is challenging to obtain profitability below ten years without subsidies and other supporting programs. The stakeholders look at the economy first, then at the other benefits related to biomass utilization. Ideally, a sufficient number of final users must be convinced to make it profitable.

Lack of knowledge of the local community about the RESCoop. Many people from the region are not aware of the idea of RESCoop, its role, and its benefits for local society. Unfortunately, there are no broad promotion actions with good examples to convince society to start thinking about this activity.

Greek Pilot Area

In the case of the Greek pilot area, interviews with **(i) a representative of a municipality, (ii) a biomass producer and (iii) a farmer's cooperative** were performed.

INTERVIEW 1 – REPRESENTATIVE OF THE MUNICIPALITY

Supporting factors, driving the uptake of bioenergy community projects:

Local authorities in the municipality are very open for the bioenergy community development and are ready to support this initiatives. The local government treats the RES cooperatives as a development tool that, alongside energy production, will boost local employment and more revenues for municipalities. Therefore, there is a political will in this subject, as well as the possibility of cooperation between neighboring municipalities in terms of RESCoop.

The municipality would like to join and be a part of the energy community. They strongly believe in developing the local economy and increasing social activity thanks to this initiative. Moreover, as the financial resources are scarce, they have to investigate robust solutions to reduce the energy cost.

According to the opinion of representative of the municipality, the RESCoop based on biomass is needed in the region. There is the abundance of residual forest biomass in this local area, which can play a significant role in energy (heat and electricity) production. Furthermore, biomass usage is also a kind of prevention of residual biomass accumulation in the forest (reduce the risk of fire). Therefore, this activity should lead to an increase in employment in the region.

For the people conscious of climate change, environmental protection is an added value. Some people are able to pay more for cleaner energy offered by RESCoop (even 20% more as long as the money is intended for the protection of the environment).

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

The attitude of local community to environment protection and use of RES is neutral. The reason for such thinking is a lack of disseminated, proper information. The state of the local environment conditions is not as bad as in other regions. The vast majority of citizens consider that RES does not concern them. In their opinion, it is only a state business.

The local potential to create a RESCoop is ranked as neutral. The social resources are in short (aged population), older people do not like changes or new initiatives interrupting their way of life.

The bureaucracy is complicated and time-consuming. The formal site of RESCoop establishment requires many documents and permissions related to the operation, grid connection, etc

The economic situation is bad.

The current economy in Greece is not good. The unemployment is high.

INTERVIEW 2 – REPRESENTATIVE OF BIOMASS PRODUCER

Supporting factors, driving the uptake of bioenergy community projects:

RESCoops may play a positive role for the local community (is needed in the region). Renewable energy communities can produce energy more efficiently. RESCoop incorporates a group of people who deal with the whole energy chain of RES. It will mobilize the local community to create a value chain. It should impact on local development and lead to energy self-sufficiency. Cooperation between neighbouring municipalities in terms of RESCoop is very possible.

Local people have a positive attitude to environment protection and RES. In recent years, the local community started increasing the ecological awareness, moving away from the consumption of fossil fuels and choosing more willingly ecological fuels such as pellets and briquettes. The farmer is able to pay more for cleaner energy offered by RESCoop (up to 20% is acceptable).

Local biomass potential is significant. In the municipality there is a considerable biomass potential. Some solutions are required to exploit it properly.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Farmers are not so open to join the RESCoops. They are not aware of how the energy communities operate internally, the structure, and the legal obligations. The information-sharing about RESCoops is weak.

The local potential to create RESCoop is not big. Many biomass producers, farmers, and biomass cooperatives hesitate. They do not know what an energy community is. There is a lack of necessary information about RESCoop roles, possibilities, and operation principles.

Lack of confidence in the involvement of local authorities in the creation of RESCoops. There are doubts that regional government can adequately encourage the development of energy communities.

Low level of cooperation between biomass producers and local society (final users). There is a kind of ignorance of the local community in biomass producers' minds (main obstacle in RESCoop development). The exchange of information between local biomass producers and inhabitants is weak. They do not see profits that both sites can reach.

INTERVIEW 3 – REPRESENTATIVE OF FARMER'S COOPERATIVE

Supporting factors, driving the uptake of bioenergy community projects:

The Farmer's cooperative claims to be ready to join the concept. They see the RESCoop as a group of people who deal with the whole energy chain of renewable energy. Because the farmers are affiliated with the group, they are aware of the advantages arising from a community. They expect similar profits from being a part of the energy community. Therefore, their enthusiasm is very positive. Thanks to the RESCoop creation, the local development of the region is expected and the proper exploitation of local energy potential.

RESCoops are needed in the region. The interviewed person is deeply convinced that the energy community is needed in the region. Even more, farmers declare ready to pay more for cleaner energy (up to 20% is acceptable), acknowledging the significant environmental benefits of using fossil fuels.

The need of cooperation with neighbouring regions. As the farmers' cooperative, they see the possibility of cooperation between municipalities regarding RESCoop creation. The main reason is the costs reduction of the required investments to build the single energy unit.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Not too much information on the functioning of the RESCoop. According to the opinion of the member of the farmer's cooperative, there is not too much readily available information about energy communities, their principles of the internal operation, form and structure, as well as legal obligations. The information sharing and promotion are not well developed.

Low engagement of the local society to environment protection. The attitude to environmental protection and use of RES in the region is relatively low, resulting from a lack of information about the tangible and measurable profits of such a concept.

Low engagement of local municipality in the field of the RESCoop. The regional government is passive in this area. There are no organized actions that could encourage others to the development of the RESCoops. There are no promotion actions, meetings, or other events that would share information about the RESCoops.

Lack of involvement of the local community in environmental protection. The local environment is in good condition. There is a problem with illegal landfills, but low pollution of the atmosphere does not motivate local society for decisive actions in this field. Even more, there is a kind of ignorance and negligence of the local community in environmental protection.

Polish Pilot Area

In the case of the Polish pilot area, interviews with representatives of **(i) inhabitants at the pilot region, (ii) local forest inspectorate and (iii) local authorities** were performed.

INTERVIEW 1 – REPRESENTATIVE OF INHABITANTS

Supporting factors, driving the uptake of bioenergy community projects:

The initiative of bioenergy communities could find the followers. Among the environmental-friendly citizens, there is a positive attitude to the bioenergy community. Moreover, they are able to pay more for cleaner energy. Unfortunately, eco-friendly citizens constitute a significant minority in the town.

The use of RES by household owners in Poland is significantly growing. Due to large financial incentives on the part of the Polish state and the convenience of their use, RES are more and more widely and willingly used. This can be seen on the example of photovoltaic panels on roofs of houses as well as in the statistical data (Poland ranks first in terms of new photovoltaic installations across Europe).

Establishment of an energy cooperative as an opportunity to improve air quality. Air pollution in the local pilot area during the heating season (as in the other regions of our country) is very high. It results from the use of high-emission fuels and combustion in low-efficiency boilers. Any departure from hard coal, or coke, which is a prevalent fuel in Poland, too is a turn in the right direction.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Coal is still recognized as a good heat source among local people. Coal is seen as a reliable source of heat and is cheaper. Despite the increasing doses of information on environmental protection, for the general public, especially in small cities and rural areas, coal is still the favored source of heating (despite its apparent disadvantages). Unfortunately, pellets as an example of biomass energy source still cannot break through to the awareness of the population.

The ecological awareness of the local citizens is poor (ecology is often ignored). Most of the inhabitants do not care about the environment. Therefore, they burn very often low quality biomass (moist wood). As a result, the heat release is low leading to the negative opinion about the biomass utilisation. The culture of heat production by burning solid fuels is low. In rural areas, there are very often municipal waste (plastics) or low quality coal used for heating. The costs are the most important. The ecological education and how to do it in practise is more than needed.

Lack of knowledge among the local society about the idea of energy communities. In the region there is no energy community. Most of citizens have no idea about such an option – energy (heat or electricity) production by local society. Lack of existing examples of RESCoops is an barrier in this field. It is related to reluctance of people to new solutions. Intensive discussions and promotion actions are required.

The energy community is perceived very badly among the society. Due to the need to possess deeply rooted in the Polish society, the willingness to create RESCoops are quite low. Negative experiences with cooperatives as the legacy of the communism times in Poland have a significant impact on this type of

enterprise. Society has no established respect for the common good. The level of trust in the sharing of goods is insufficient.

INTERVIEW 2 – REPRESENTATIVE OF LOCAL FOREST INSPECTORATE

Supporting factors, driving the uptake of bioenergy community projects:

There is a potential to create RESCoops in the region. There are no energy communities in our commune. Residents produce heating and electric energy on their own. If there was the opportunity to set-up a cooperative, under certain conditions, it would be possible in our local environment. Local authorities approve of the development of RESCoops, which is crucial for action in this area.

RESCoop is a chance to reduce heating costs and pollutants emission. Building a biomass combustion plant within a cooperative can reduce the costs of collecting and utilizing bio-waste produced by residents. The level of natural environment pollution in the town and in the commune of Oborniki Slaskie is considered to be of average levels. The neighbouring forests contribute in the clean-up of polluted air. Nevertheless, residents' awareness of environmental protection should be higher. RESCoop can change that. The discussion about ways of air quality improvement can improve people's awareness of the environment's quality.

Energy community can have significant impact on society. Being eco-friendly starts to be more and more a fashionable attitude. Furthermore, building energy communities may reduce unemployment in the region.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Many aspects of RESCoops seem hard to grasp by the general public. Energy communities include complex legal, technical and financial constraints, which are difficult to understand by ordinary citizens, who could be the future members of this association. The investment costs are high and the financial model is difficult to realize in practise.

Very low awareness of inhabitants around the RESCoop concept. In the region there is no movement among local society to produce energy in a collaborative manner. The citizens are not conscious of such trend or even formal possibility. There is a strong need to enable discussion and promotion related to RESCoop together with improving the awareness of residents in the field of environmental protection, production and use of clean energy sources. In general, RESCoop in Poland and in our region is in its infancy stage. The more people talk about it and the more best case examples are being broadcasted, the faster this initiative will be developed here as well.

INTERVIEW 3 – REPRESENTATIVE OF LOCAL AUTHORITY

Supporting factors, driving the uptake of bioenergy community projects:

The potential for bioenergy communities creation is high. In the region, there are sufficient biomass resources for BECoop establishment.

The RESCoops are needed in Poland. The RESCoop could have an impact on socialization of the production process, combining social and economic goals and an improvement of the condition of the natural environment, ensuring the sustainability and reliability of the supply of the required amounts of energy, economic development of the region, rational use of local energy resources and creation of jobs within the local government community. Ultimately, the acquisition of biomass can be extended to forest, waste biomass, which allows the maximal reduction of coal imports.

There is a need to improve the air quality. There are smog alerts in Poland more and more often. During the heating season the acceptable levels of pollutants are exceeded several and sometimes even several hundred times.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lack of direct support for RESCoop creation. Currently, in Poland there are no programs directly supporting the launch and development of local energy initiatives. It is necessary to eliminate the legal barriers existing due to the still very early stage of development of such projects in Poland. The engagement of local authorities seems to be necessary.

Lack of experience in RESCoop. In the region as well as in Poland the subject of RESCoop is at a very early stage of the development. Local authorities have only started working on communicating information to the public. There are no examples, no experiences, no significant engagement.

Bad image of the RESCoop. There is a need to improve the image of cooperatives, which was severely damaged during the period of the socialist system. The cooperative movement should be presented in a new light with all its advantages in a broad information and promotion campaigns. Low awareness of some or maybe even most of the residents about RESCoop. People do not trust new but convenient solutions. We have to show the good sides of renewable energy sources.

New definition of biomass for energy purposes. The amendment of the Act on renewable energy sources and introduction of a definition of energy wood. According to its assumptions, as well as in practice, energy wood will be the raw material of the low quality, unsuitable for other industrial use. First of all, it would be wood from sanitary cuts, i.e. the removal of trees dying or dead due to drought, diseases, insect pests or fungal pathogens. After the amendment to the RES Act there is a risk of misinterpretation of the use of forest biomass resources for energy purposes. Environmental organizations and residents may recognize acquisition of the raw material as environmentally unfriendly, enabling the intensive exploitation of forests and the cutting of valuable trees and burning them in power plants.

Italian Pilot Area

In the case of the Italian pilot area, interviews with **(i) a local authority representative, (ii) the president of a forest company and (iii) a chips & wood seller** were performed.

INTERVIEW 1 – LOCAL AUTHORITY

Supporting factors, driving the uptake of bioenergy community projects:

Involvement of the local government in RESCoop creation. Commune is already working on energy self-sufficiency from local resources. They have proposed an energy efficiency model for Valtellina (their local area). So, the attitude of the government for this activity is positive.

Local people have a positive attitude towards environmental protection and RES uptake. Inhabitants think that by protecting the environment and using more RES, they can have cleaner air and control flue-gas emission. They are able and willing to pay more for energy from renewable sources. Very important for them is symbiosis with nature. Currently, forests are not so intensively exploited as in the past.

Lands rich with natural resources. In the local area, there are large forest areas which can provide (harvested in a sustainable way) significant amounts of biomass for heating purposes. The technology for biomass harvesting in mountain area is well developed. As it is a local resource, it can have an impact on further development of the region.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Lack of appropriate knowledge in terms of RESCoop activity among citizens. There are indications among the general public that, in the future, energy production will be automated to such an extent that no new jobs will be created. The local society is focused too much on the job creation, as a result, other benefits are not recognized (lower heat price, people integration etc.).

Improper management of the support system for energy investments by government. According to opinion of the local authority, instead of dealing with subsidies in marginal areas, the support system should encourage the model of development of energy self-sufficiency in marginal areas.

INTERVIEW 2 – PRESIDENT OF FOREST COMPANY

Supporting factors, driving the uptake of bioenergy community projects:

Willingness to participate in the RESCoop concept. Forest company declares willingness and readiness to join a RESCoop concept if other, necessary for this activity, stakeholders (e.g., biomass processing actor, supplying company, biomass user - final consumer) would express their engagement as well. This collaboration must be guaranteed for a long-term period.

Big possibility of cooperation between neighbouring municipalities. Municipal initiatives could allow for a better organizational management in biomass supply logistics. The cooperation should improve the profitability of the RESCoop and, thus, increase the interest in their development.

Bad air quality in Italian Pilot Area. Air quality and pollution are critical in different areas of the Po Valley. The local society is conscious of the changes that must happen to improve the state of the environment. Therefore, the uptake of heating networks or a better organization of the whole system related to energy production could help to reach necessary targets.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Objections to the form of financing. The forms of financing in terms of use of biomass at the level of domestic plants (boilers) and not in community form are only partially activated. A revised/improved financing strategy in supporting actions in this field is required. Long term vision should be elaborated.

No willingness to pay more for clean energy. According to respondent's statement, renewable energy should also be price-competitive. It is a crucial factor to convince the stakeholders and final users to follow the RESCoop direction. However, economic factors appear to be more important than protecting the environment. Without financial benefits it is difficult to move forward.

Limited areas to create heat networks within RESCoop. The regional policy towards methanisation has excluded several territories from the construction of small/middle power plants fed by biomass or heat networks development.

Lack of sufficient knowledge about woody biomass processing by local people - especially by administrators, planners. The market of biomass in the region is not puzzled properly. Biomass must undergo valorisation before use for heating purposes. If the biomass quality is good, there are no exploitation problems. It is important in terms of positive image achievement about biomass for energy purposes.

INTERVIEW 3 – CHIPS & WOOD SELLER

Supporting factors, driving the uptake of bioenergy community projects:

Opportunity to increase competitiveness among enterprises. An opportunity arises for small and medium-sized enterprises to create a network for the production and consumption of bioenergy. It can lead to lower costs for local society and increase of the utilization of the biomass (as a product) supplied/delivered by local company.

Positive thinking about the function of the cooperative. The presence of a network of consumer cooperatives is deeply rooted in the territory. This should facilitate the implementation of this activity in practice. As the people are organized, the information share and support actions are easier to perform.

Hindering factors that constitute a barrier to the uptake of bioenergy community projects:

Society's fear of unsustainable forestry biomass management. People are afraid of splitting and parcelling of wooded properties due to poor accessibility. It can limit the willingness to use biomass for energy purposes. Deforestation risk might be a problem for BECoop development.

Inaccurate estimation of energy demand. They do not have enough data to analyse the aggregated potential for heat demand using biomass. The value of the heat demand is crucial in terms of profitability and required investment analysis. Long term perspective of biomass usage is important, as well.

Limited range of RESCoop. In agricultural areas, biogas will become a source for part of the heating. Small towns with few inhabitants in particularly cold areas (located in Italian Pilot Area) can be obstacle of energy community development, too. It this sense, the biogas is a competitor for BECoop developing the solid biomass utilization.

Lack of involvement of local authorities in promoting RES. Local authorities are not involved in the activities promoting RES. This may be due to their political views. Such a policy of the local authorities makes difficult raising the environmental awareness of the the residents, and indirectly creation of a bioenergy community.

Annex III: MS Regulations around energy communities and their connection to the grid

Table 19. Regulations of energy communities connection to the grid [15]

Member state	Relevant definition in the energy legislation	Support mechanism for RE installation	Tax Incentives for RE installation	Priority access to the grid for RE installation	Simplified permission for RE installation
AT	Definition of self-consumption	Yes	-	Fees for connection & using the grid	depending whether the installation is for commercial use
BE	No definition available	Yes	Yes	Only fixed fee for connection	For solar installations
BG	Definition for energy self-consumption	Yes	Yes	Simplified procedure for installations smaller than 30 kW	For installations up to 30 kW
CY	Definition of self-consumption	Yes		Fees for the application & using the grid	No permit needed for installations up to 5 MW
CZ	No definition available	Yes		Fee for connection	No permit needed for installations up to 50 kW
DE	No definition available	Yes	Yes	Yes	No permit needed for PV installation of rooftops or mini CHP and heat pumps
DK	No definition available	Yes		For wind turbines fees only for the connection to the closest technically feasible point	
EE	No definition available	Yes	Yes		No permit needed for installations up to 100 kW
EL	Definition for energy community in the new 2018 law	Yes	Yes	Fee for connection	No permit needed for installations up to 20 kW
ES	Definition of self-consumption	Yes	Yes		No permit needed for installations up to 30 kW
FI	No official definition available	Yes	Yes		
FR	General definition of self-consumption and definition of collective self-consumption	Yes		Yes	No permit needed for PV installations on buildings connected to the grid
MJ	Definition for residential prosumers	Yes	Yes		No permit needed for household power plants
IE	No definition available	Yes		Yes	For micro generators up to 6 kW
IT	Definition of self-producer	Yes		Fees for the application & connection	For installations up to 20 kW
LT	Definition of consumer that produce electricity	Yes	Yes	Lower connection cost	For installations up to 10 kW
LU	Definition of self-producer	Yes		Fee for connection	No permit for installations up to 10 MW
LV	Definition of autonomous producer		Yes		
MT	No definition available	Yes		No fees for small installations	No permit for installation with total peak generation capacity up to 1500 kW
NL	No definition available	Yes	Yes		No permit needed for household solar installations
PL	Definitions of prosumer and energy cooperative	Yes	Yes	No fees for micro installation	No permit needed for micro installations
PT	No official definition available	Yes			No permit needed for installations up to 1 MW
RO	Provisional definition for prosumer in the Energy Strategy 2016 – 2020	Yes		Yes	No permit needed for installations up to 100 kW
SE	Definition of prosumers	Yes	Yes		
SI	No definition available	Yes			
SK	No definition available	Yes			For installations up to 10 kW except wind turbines