Czech-Austrian Winter and Summer School

Energy Communities:

Status Quo, Opportunities and Barriers

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Abstract:

The paper addresses the relatively new concept of energy communities (EC) and with that connected decentralization, decarbonisation, democratisation of the energy sector. The motivation behind this paper is to examine the status quo of EC, its opportunities and barriers for their implementation, while it will also focus in particular on EC in the Czech Republic and Austria, and the comparison of the two. The paper sets to assess the status quo and the added value of EC in opposition to other collective or individual implementation of renewable energy systems (RES). For this purpose, the study of the four aspects of EC, i.e. legislative, social, technical and economic, are undertaken. The results show that while there are many barriers towards implementing EC, the benefits prevail, and the existing barriers can be overcome (as shown in several case studies). This research affirms that the development of EC is improving and regular assessment and sharing of good practices of EC is needed in the coming years.

List of Abbreviations

EC - Energy community
REC - Renewable energy community
CEC - citizen energy community
MS - Member State
EU - European Union
UCEEB - University Centre for Energy-Efficient Buildings

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I. INTRODUCTION

Due to the increasing concerns regarding environmental degradation and worsening of the climate change, the European Union (EU) established a new international organisation The Energy Community in 2005, launching many projects with the aim of creating an integrated European energy market based on common values, principles and common grounding policies. The purpose of The Energy Community is to ensure that EU countries and its neighbours provide an enabling framework at the national level so that the energy sector becomes more decentralized and democratic in terms of citizens' participation, which will in turn help decarbonise the energy market. The Energy Community activities are in compliance with The Directive (EU) 2019/944 of the European Parliament and of the European Council, which maintains that the purpose of the internal electricity market, which has been gradually introduced in the EU since 1999, is to organize competitive cross-border electricity markets, thus providing real choice for all EU final customers, whether citizens or businesses, as well as new business opportunities, competitive prices, efficient investment signals and higher service standards and contribute to security of supply and sustainability (SMĚRNICE EVROPSKÉHO PARLAMENTU A RADY (EU) 2019/944). Energy communities (EC) represent a concept that when put into practice (mainly in a larger geographical and economic area) will achieve these aims. Not only do the current changes in the electricity market lead to the emergence of new entities, such as EC, aggregators, and distributors, but also to the emergence of new services such as storage service, flexibility service, maintenance service and others. Among the first EC in EU belongs the community of Ulfborg, in Denmark, established in 1978 by the members of that community. This gave rise to the existence of many other EC, mainly in Denmark, Germany and the UK. The concept of EC has been becoming ever more popular trend mainly in Northern and Western countries and have had positive results and impacts. Apart from the overall goals, energy communities abound with many other benefits, ranging from social and economic up to other environmental benefits for the EC members and larger local communities as well. Nevertheless, the concept of EC has become somewhat inconsistent over the years due to the complexity of its nature and its innovative format as well as the inconsistent use of terminology. While there are many benefits to EC, it is definitely necessary to pursue further research, develop the many aspects of the concept itself and the enabling national frameworks as well as to regularly report on the status quo, results, barriers and good practices of existing EC.

II. MOTIVATION, OBJECTIVE AND METHODOLOGY

Energy systems have been undergoing a transition from a centralized to a more decentralized ones, in which the consumers may play an active role in generating, distributing and storing the energy. Such a model of self-generation and provision of energy has been lately piloted and established in several European countries forming the so-called energy communities. The motivation behind this seminary work is to explore the concept of EC.

The objective of this seminar paper is to analyse the status quo, opportunities and barriers of EC, and to compare the current situation in the Czech Republic (CZ) and Austria (AT), both in the context of the EU. The objective is also to assess the added value of such a model of community. To do so, the paper aims to answer the following questions.

1. What is the added value of Energy Communities? (e.g. community of prosumers as opposed to an individual prosumer)
2. What are the barriers to establishing energy communities?
3. What are the differences in implementation and feasibility of implementation in AT and CZ and in other EU countries?

The research will be conducted on the state-of-the-art of the EC from four perspectives i.e. social, technical, economic and legislative. The main focus will be put on the legislative and policy framework of EC in CZ, AT and in the context of the EU. Subsequently, examples from AT, the CR in the context of the EU will be explored to assess the degree of development of the concept of EC in those countries. The former two will be consequently compared. The seminar work will explore the problematic issue of self-generation and the surplus optimization which may be achieved thanks to flexibility through various prosumers (importance of having a balance in supply and demand of energy). The analysis will also deal with the projected economic demands and returns (dealing with feed-in-tariffs, joint procurement) as well as societal aspects (community building and other community benefits). The main focus though will be put on the legislative and policy framework (current policies at EU and across EU MS, the barriers and shortcomings) in the studied countries.

The definitions and the background information gathered throughout the research, as well as the analysis of several case studies, will be used to determine indicators that will enable us to compare the two countries, to identify the barriers, and to assess the added value of the concept of EC. A proposition for the modalities of energy communities will be made as the output of this work accompanied with a brief discussion on present barriers and the future opportunities.

III. THEORETICAL PART

3.1. Energy community

Energy community represent a group of various stakeholders including citizens, public authorities and entrepreneurs who join together to produce, consume, sell, distribute and store energy based primarily on socio-environmental values with the view of economic benefits for the community. In another words ''energy community is a way to 'organise' citizens that want to cooperate together in an energy sector related activity based on open and democratic participation and governance, so that the activity can provide services or other benefits to the members or local community (REScoop, 2019).'' Energy communities represent a new smaller stakeholder in the energy market, but its business model is based on the added value the activity brings to the local community rather than on a commercial profit. On a broader level, energy communities support energy decarbonisation by making way for decentralized renewable energy production and consumption. The complex phenomenon of Energy communities has four major aspects that need to be addressed when dealing with the status quo of Energy communities and its benefits and barriers, i.e. legal, social, technical, and economic aspects.

3.2. Activities of energy communities

There are several activities that EC can undertake. These range from traditional activities of producing energy, that are most common, up to service provision which occurrence is increasing more and more. The EU report on EC lists the following activities that many energy communities may and do engage in: generation, supply, consumption and sharing, distribution, energy services, electro-mobility and other activities including e.g. consultation services to help develop new communities and cooperatives, and awareness-raising campaigns to promote energy communities, decarbonisation of energy etc. Some EC undertake only individual activities, and some combine several of them. This depends on the type of EC and on the capacity (in terms of size, finances, etc.) of the EC.

Generation: Generation of renewable energy is usually the main activity and may be the only activity energy communities undertake. In this business model producers are not prosumers as they only generate and sell it to a supplier (by means of feeding it into the network). Though, it is important to mention that in some countries the purchase price is not and/or does not have to be guaranteed.

Supply/Sale: Energy communities may also supply i.e. to sale and/or resale electricity to the participants of the community or to external customers from the vicinity. This includes also "aggregation activities combining customer loads and flexibility or generate electricity for sale, purchase or auction in electricity markets (Caramizaru and Uihlein, 2020)."

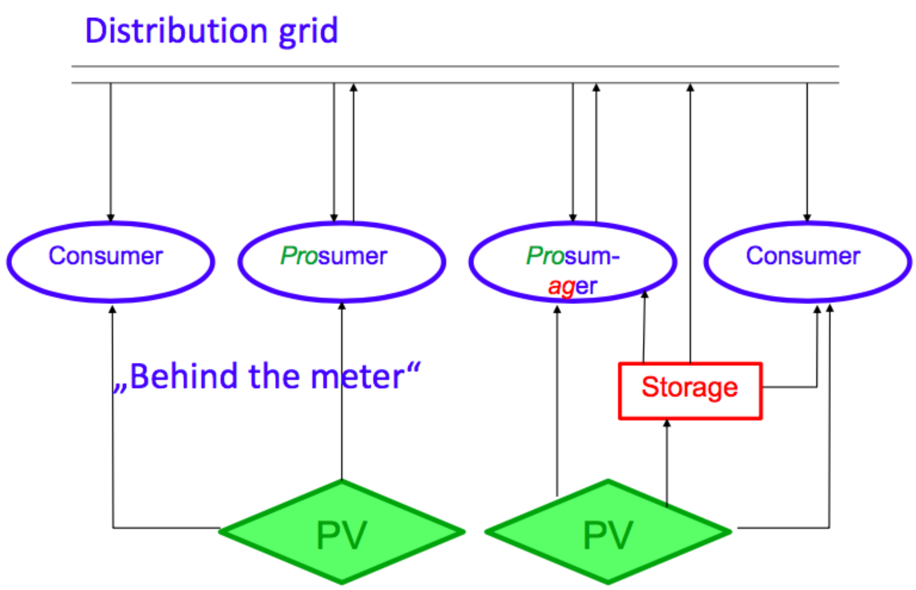
Consumption and sharing: Consumption and sharing is "collective self-consumption (that) can be seen as a combination of energy production, distribution, supply and consumption within a geographically confined area, either at a building scale (e.g. multi-level apartments) or block scale (different buildings)“ (Hannoset, Peeters and Tuerk, 2020: 38).

Distribution: “Distribution of electricity on high-voltage, medium-voltage and low-voltage distribution systems ensures the delivery to participants of the community, outside customers and/or outside consumers, but does not include supply. Whether this activity is allowed will depend on the member state” (Hannoset, Peeters and Tuerk, 2020: 38).

Electro mobility services and energy services: Electro mobility services may include car sharing and car pooling, operation of charging stations etc. Energy services include services related to energy efficiency and savings to members and customers of the energy community, integration of energy storage and smart grids, consumption monitoring but also mobile applications, energy saving tips and tricks (e.g. the use of specific appliances) etc.

As a consequence of the various activities, the typical passive consumer who is dependent on large corporations may become a prosumer i.e. producing customer who may not only draw electricity from the grid but also consume it and feed it into the network. The various modalities of customer/consumer and prosumer are shown in Picture 1.

Picture 1: 1Consumer and prosumer modalities and interactions with the grid



[1]

[1] (Haas, 2019)

3.3. Benefits generated by energy community

There are many social, environmental, financial, technological, and other benefits related to energy communities. Although, it happens to be difficult to classify some of these benefits into these (at least) four categories, as the benefits sometimes fall into more than one category or they interlink and overlap. Generally, among some of the benefits belong the following: **prosumer empowerment and ownership, democratic participation, social cohesion, better lifestyle, education, social innovation, acceptance and awareness tackling**, local investments and re-investments, low-cost energy bills, energy poverty, regenerating local economy, improvement of the environment, improvement of well-being and health, local job creation and skills, energy efficiency, **increasing acceptance of renewable energies**, infrastructure development and others (Caramizaru and Uihlein, 2020). The benefits will be discussed further according to their classification in their respective section and/or in more sections as the benefits overlap.

However, it might be argued, that some of these benefits might be undertaken and achieved without joint or collective aim of energy communities. This is definitely true to some degree as individual production and consumption (e.g. in form of collective self-consumers) may definitely bring some financial benefits, energy savings, improvement of the environment etc., but it can hardly improve e.g. energy efficiency in such a degree as in energy communities (due to e.g. the reserved capacity, peak shavings, feeding in the network and selling etc.). Likewise, it can barely support or create social cohesion, significantly increase local investments, or e.g. increase acceptance and awareness of renewables and other related problems which will be discussed in the sections below. Not only are not some of the benefits produced at all but also those that are produced cannot reach the effect as when undertaken collectively. Collective action affects people psychologically as it spurs and influences the actions of other people. Moreover, collective undertakings have also economic benefits in form of joint procurement.

3.4. Legislative Aspects

3.4.1. Types of Energy Communities and terminology

There are several concepts that are often used when dealing with energy communities. These concepts are not of the same nature though their definition is similar as the concepts partly overlap, or some concepts are an old variant that is not used in current legislature and therefore is not up to date. This is causing some difficulties regarding the understanding of the EU legislative framework of energy communities and so the different concepts will be shortly described.

Collective self-consumption vs. energy communities: The difference between jointly acting renewables self-consumers and energy communities is that the former focuses on the activity itself rather than on the organizational format of the participants. Therefore, jointly acting renewables self-consumers are contractual parties i.e. there is a legally bounded contract between the participants themselves and/or with a third party. And the intended use of the former is self-consumption while the latter may also undertake other activities (such as sale of the electricity). On the contrary, EC is a legal entity that is recognised by its specific ownership/membership, governance, and its primary purpose which can never be only profit-driven, and at the same time, it must comply with the national and EU measures to be considered EC. However, self-consumption, as it represents an activity, may be a type of activity undertaken by EC.

Renewable energy communities and citizen energy communities: There are two types of energy communities acknowledged by the EU, and these are renewable energy communities (REC) and citizen energy communities (CEC)

Table 1: Comparison of the "Renewable Energy" and "Citizen Energy" Community concepts according to the REDII and the EMDII (Frieden et al., 2019: 6).

Article 2(16) Recast Renewable Energy Directive 'Renewable Energy Community'	**Article 2(11) Recast Electricity Directive 'Citizen Energy Community'**
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.** The REDII further states that RECs shall be entitled to **produce, consume, store and sell** renewable energy, including through renewables power purchase agreements.	A legal entity that: (a) is based on **voluntary and open participation** and is **effectively controlled by** members or shareholders that are **natural persons, local authorities, including municipalities, or small enterprises**; (b) has for its **primary purpose to provide environmental, economic or social community benefits** to its members or shareholders or to the local areas where it operates **rather than to generate financial profits**; and (c) **may engage** in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders.

[2]

Both types have some common aspects as their basis i.e. open, voluntary and collective legal entity driven by socio-environmental value orientation rather than profit, with specific governance. However, there are some differences in the activities they may undertake (where REC focus only on renewables), eligibility criteria (when it comes to the size in REC) and effective control and autonomy (since REC must be autonomous, each member having one vote, and is controlled by the members of the community that are in proximity to the REC project).

Local energy communities: Local energy community is the out-of-date variant of nowadays valid type of energy community. This denomination and its definition were used in the early

[2] (Frieden et al., 2019: 6)

stages of the development process of what is now known as citizen energy communities. This term is no longer used in current legislature and may be found in older versions of policy papers etc.

Energy cooperative: Cooperatives is one of the legal structures of energy communities that is most common among the existing energy communities and might therefore be mistakenly thought of as the only type i.e. equal to energy community. An example of energy cooperative is Renewable energy cooperative (REScoop), which is a type of both citizen energy cooperative and renewable energy cooperative.

Types of approaches for energy communities

Table 2: Types of approaches for energy communities

No	Name
class 1	Collective generation and trading of electricity
class 2	Generation-Consumption Communities
class 3	Collective residential and industrial self-consumption
class 4	Energy positive districts
class 5	Energy islands
class 6	Municipal utilities
class 7	Financial aggregation and investment
class 8	Cooperative Financing of Energy Efficiency
class 9	Collective service providers
Class 10	Digital energy supply and demand response systems

[3]

3.4.2. EU legal framework

Last year, in 2019, the Clean Energy Package reunited in order to present a legislative framework which allows EU consumers the right not only to citizens but also to communities to become active participants in the energy sector. Establishing the name of Energy Communities as well as some basic laws helps in the process of creation of the new projects.

There are two different definitions according to framework (Summed up in section 2.1.2 Table 1) The revised Renewable Energy Directive includes the term renewable into the laws applied to an EC, however the revised Internal Electricity Market Directive (IEMD) makes citizens responsible of the system, allocating them with new roles within the EC.

[3] (Tuerk, 2019)

Both describe an EC as a possible type of organising collective citizen actions (under different forms such as associations, cooperatives among others, though many other forms are existing and other forms may be established on national level if necessary) in the energy system (Frieden et al., 2019). They should have non-commercial economic aims combined with environmental and social community objectives. A distinction of the IEMD is: firstly, the fact of allowing the possibility of other citizen initiatives, such as those arising from private law agreements, secondly the new type of entity due to their membership structure, governance requirements and purpose. In contrast the RED can vary the characteristics of type of actor depending on the size and ownership structure. Moreover, RED asks the Member States to set guidelines to promote, facilitate the development of renewable energy communities, as well as taking them into consideration for their design of renewable energy support schemes. For the IEMD, this integration into a framework is more oriented to open a fair role as market actors.

The purpose of the frame is to ensure equality in terms of operation and to avoid discrimination not including the foregoing rights and obligations that other markets have.

3.4.3. National enabling frameworks

Energy communities are defined on EU level in in the recasts of the Renewable Energy Directive and in the Electricity Market Directive as described above. However, some Member States (MS) implemented and adopted their own definitions, measures and policies in the past and/or they have been in the process of implementing some regulatory measures that would enable the establishment of energy communities. These measures differ from MS to MS, where some MS have developed the policies profoundly and others have not yet taken stand on this issue. Among the Member states that have already addressed this issue belong Belgium, Germany, Denmark, Spain, France, Netherlands, Poland, Slovenia and the United Kingdom among others.

Nevertheless, MS are obliged to comply with the EU policies and measures regarding energy communities. If MS have existing laws relating to EC, they have to revise them and amend if necessary. MS have to develop definition of CEC and REC on a national level, so that parties interested in establishing energy community have the rights to do so and to participate within the energy system without being discriminated on the market as described in the EU legal framework. MS have to do this by the transposition deadline of 30 June 2021. If MS fail to meet this deadline MS breaches the EU law, and enforcement proceedings may be undertaken by the EU and taken to the Court of Justice of the EU.

3.4.4. Legislative Framework in Austria

Electricity industry and organization law (ElWOG) is the federal law that regulates the organization in the field of electrical industry. In general, the main objectives of this federal law is to provide cheap and high-quality electricity to the Austrian population and economy; establishing the internal electricity market directive; renew is to develop electricity production from renewable energy sources and to provide access to the electricity grid from renewable

sources. ElWOG includes basic electrical law provisions such as licensing for distribution system operators, as well as a number of direct federal legal standards such as the determination of system usage fees. Another important point is that the basic legal provisions are not legally binding and become officially binding only with the adoption of 9 federal state executive laws.
ElWOG 1 in 2017 contains many changes. For example, the amendment supports private and commercial bulk self-consumption. Some municipalities and federal governments have moved from general PV support to company-based, i.e., private support for larger-scale installations or collective self-consumption. An example of this the city of Graz at the federal state level can be given.
Beyond that, in late 2018 a new renewable energy legislation was presented that will come into force in 2020 ('Erneuerbaren Ausbau Gesetz 2020') and EAG 2020 was adopted by today's Austrian Federal Government Council of Ministers. This new law will enable to extent the collective self-consumption to implementing EC which will make it possible to generate, store, and distribute renewable electricity as well as establishing local grid structures. The aim is to reduce greenhouse gas emissions, increase renewable energy, increase energy and resource efficiency, promote clean technologies and increase Austria's competitiveness. In addition, EGA took a holistic approach and based on the 2012 Green Electricity Act (ÖSG 2012), which is responsible for about 17.3 percent of renewable electricity in Austria.

3.4.5. Legislative Framework in the Czech Republic

At present, Czech legislative system is unprepared for implementation and establishment of EC as the legislation does not know these concepts, neither energy communities nor prosumers (and other concepts related to the legislation of EC). However, as the EU new directives demand MS to create enabling framework for energy communities, the Government of the Czech Republic has started preparing a new legislature in the energy sector. This will focus on policies and measures that should enable energy decarbonisation and democratization. Earlier this year, in 2020, the government of the Czech Republic presented a proposal for a more comprehensive amendment to the Energy Act, which should take effect on January 1, 2021. The proposed changes include the expansion of business areas in the energy sector by intermediary[4] activities in the energy sectors, for which a license will not be required under the Energy Act. The proposal also aims to further promote consumer protection. In addition, the electricity trader should, among other things, have the right to perform the activity of an aggregator. "An electricity trader shall have the right to act as an aggregator, which combines network load or electricity produced from several customers or electricity generators for the purpose of participating in the electricity market, the ancillary services market or for managing deviations, at the offtake or transmission points of electricity market participants with whom it has a contract relating to the supply or consumption of electricity" (Novela zákona - Energetický zákon - EU, 2020: 56).

[4] An intermediary activity should be, for example, when someone provides another person with an opportunity to conclude a contract for the supply of electricity or gas, both by the licensee and the customer.

However, the proposed law neither includes nor mentions EC. The concept of EC and its enabling mechanisms should be included in a subsequent major amendment to the Energy Act. However, due to the inefficiency of its proposition, implementation and so on, it is likely that deadline for implementation set by the EU law will not be met.

3.5. Social Aspects of Energy Communities

Technology and market economy cannot achieve the transition of society and economy based on fossil fuels towards a more decarbonised society and green economy on its own. The transition of energy sector is dependant also on societal transformation. In that sense we talk about deep ecology as opposed to shallow ecology which would focus only on technical and economical means of reducing CO2 emissions rather than going to the roots of the problem and changing personal attitudes which then become the co-drivers of change. Civil society and citizens play a crucial role in decentralization and energy sector decarbonisation.

3.5.1. Governance: Values and principles

The most common legal structure of energy communities is cooperatives. Cooperatives are typical of communities with deeply rooted traditions as in Netherlands, Germany, Sweden, Belgium but also in the UK. The principles of renewable energy cooperative (REScoop), which are based on their values, will be therefore used to broadly define the values of energy communities, even though cooperatives are only one of the several sub-types of legal structure of energy communities. The principles, though, are common to both the EU legislation of EC as well as to cooperatives. ''Cooperatives are based on the values of self-help, self-responsibility, democracy, equality, equity, and solidarity. In the tradition of their founders, cooperative members believe in the ethical values of honesty, openness, social responsibility and caring for others'' (REScoop, 2019). This is put into practice by the principles of Voluntary and Open Membership, Democratic Member Control, Member Economic Participation, Autonomy and Independence, Education, Training, and Information, Cooperation among Cooperatives and Concern for Community (REScoop, 2019). These principles do not apply to the same extent to other types of energy communities but may in general show the value structure of energy communities.

As the values themselves imply, citizens or other entities who usually decide to set up or join an energy community are usually determined by their socio-cultural context. The motivation behind joining such an initiative is determined by moral motivations related to the community (creating social capital), active civil citizenship and environmental concerns. Thus, the motivation is not merely economic, but it is in accordance with the values that EC are based on, and they in turn generate several social, communal and environmental benefits (as well as economic benefits).

3.5.2. Social aspects: benefits

From a socio-technical point of view, communities can bring the following benefits: local value, energy citizenship and democracy, generating financial returns for the community, education and mobilisation of citizens, and social cohesion (Caramizaru and Uihlein, 2020). While many other benefits have been already mentioned, these contribute to the community and local region the most.

Generating financial returns for the community or reinvesting the profits means that the community generates profits through the assets they own and the services they provide. These profits may be reinvested in the local community, create jobs which in return again enriches the community as the financial assets circulate locally. Financial capital within the community also creates **local values** by enabling the community to invest into projects related to sustainability, greening the economy and reducing CO2 emissions. This can also create local jobs and keep the financial capital locally, also enriching the community. Citizens or members of the community may participate (directly or indirectly) in **democratic decision-making** and governance as they are co-owners of given assets. This not only strengthens **social cohesion**, community feeling of belonging and concern for the community and consequently trust among citizens and other stakeholders, but it also gives rise to **education** and **mobilisation of citizens towards more global issues** i.e. collective action to combat more global issues such as degradation of the environment and climate change (Caramizaru and Uihlein, 2020). Other social aspects, related more to individuals than the community, are better and different lifestyle and health benefits among others.

3.6. Technical Aspects of Energy Communities

Nowadays academic studies about energy communities have a strong concern about the scale of the projects, precisely the scale and degree of complications, both for the technical maintenance and for the management of the expected results (ownership of the facilities). This last one is a basic aspect for maintaining the community relations. We can speak about the examples in wind parks in the UK, where the conflicts about the repartition ended up by splitting up the community project.

In terms of the **socio-technical criteria**, a broader vision should be considered. For example, the different systems needed for the different seasons. It is the case in Austria, they have a cooperative distributed system consisting on a combination of biomass heat circuits for winter and PV systems for summer.

The case which has the biggest viability in technical terms as an example, is the one of isolated zones, which are far from any energization program. For them, the energy communities would present a big advantage because it makes the energizing solution more flexible, allowing various technologies to be implemented. What would be an installation of a unique source of energy limited to capacity or budget, can now be expanded to a multi-source and more efficient (in terms of use) installation.

One of the biggest challenges of energy communities is to conceive distributed energy, a system encompassing heating, cooling and electricity.

According to a new energy policy, security and quality of supply include, among other aspects, the availability of energy at a reasonable, predictable and competitive price; reliable access to energy; the quality of supply and the flexibility of the system. The aim is to achieve a bidirectional (produce and manage energy to and from the periphery of the system) energy system, with active demand management.

In order to integrate an energy community to the current energy system, adequate and mature technology are a basic requirement. But not only, it would also be necessary to decouple the economic growth from the increase in energy demand (equivalent to a more efficient usage). Also, accessible knowledge is required, this means that the techniques should be mastered by a critical mass of qualified professionals and technicians. The simplicity and accessibility of a technological device, as well as its social acceptance, are catalysts for the adoption of technological innovations.

The study case of small communities, which are the main beneficiaries of energy prosumers solutions, has a simpler approach because the management of short circuits comes naturally and therefore small-scale technologies are applied.

Big scale technologies impose significant technological challenges, one of them is the need for networks to have greater flexibility to respond to typical variations from some sources, such as solar and wind energy. Flexibility expresses the ability of an electrical system to adapt profiles generation and consumption, so that you can balance supply and demand. If mismatches between supply and demand occur, the voltage and frequency of the system are affected, and consequently the reliable supply of electrical energy (IEA, 2014a). A flexible system can be reached through 4 main sources: dispatchable energy sources[5], storage, interconnexion with other electricity systems, and response to demand by changing the load.

There are two specific contexts the EC may be engaged in network operation i.e. public grid and micro grid. **The microgrid concept** is ideal for EC in terms of connection. The U.S. Department of Energy Microgrid Exchange Group describes a microgrid as the group of interconnected loads and distributed energy resources, within a determined border, acting as a unique entity regarding the electric network. It can be connected or isolated form the network. (Ton & Smith, 2012). Various definitions exist but these are the basic elements.

The advantages: a rise in efficiency, reduction of the total consumption, less environmental impact and operational benefits for the primary network. A specific advantage of microgrids is the robustness in case of extreme failures and the velocity to restore the system. This is due to the capacity of working in isolated mode when the network encounters a blackout or other type of failures. The operational benefits come from the ability to operate independently when failures occur in the main network, due, among others, to the fact that it can use the energy of its storage devices until the restoration of the general network services.

As for the **disadvantages**, the main challenges concern the integration to the existing infrastructure and the planning at the three levels (generation, transmission and distribution) which is strongly dependant on the degree of predictability (the meteorological and geophysical effect are not correlated with the load demand, therefore the power balancing requirements encounter difficulties when there are no reserves). Due to its complexity, the

[5] This refers to a power system that can be controlled, turned on or off on demand. For example, coal or nuclear power plants, hydroelectric, biomass, geothermal and ocean thermal.

interconnexion process implies a great challenge, since the reluctance troubles from the transmission level are shifted to the distribution level.

Renewable Energy Systems often have a proportional bond with the increase of effective surface (energy density and capacity of extraction). But work is being done to improve the efficiency of the technologies such as CSP (Concentrating Solar Power), PV cells and Wind Turbines. Likewise, improvement is made in terms of forecasting, if the predictions become more accurate, the grid integration and management of the different resources can be more easily handled.

When there is excess of production, the demand side management need to communicate with storage systems, such as heat pumps, water reservoirs or even neighbouring locations in order to avoid wasting the output. Demand side participation is crucial to solve issues of unbalanced systems. It is defined as the flexible – shiftable[6] or curtailable – end-user loads responding to control signals (EU Parliament, 2010). Specifically, in energy communities the diversity of energy consumption profiles is already a first step of the demand adaptability.

The current electricity network was designed for a unilateral operating mode, where the load and customers are passive. And Renewable Energy Systems demand a bidirectional operation mode, besides they introduce changes or the active and reactive power flows. However, the demand-response function introduces a more flexible and interactive connection.

3.7. Economic aspects of energy communities

There is a close connection between EC and socio-cultural factors. In general, the relationship between interested parties and their surroundings play an important role. Various initiatives show that economic benefits and broader social and moral goals linked to community participation are interdependent. Based on this, EC are strong in the socio-cultural context. Confidence of people and participating communities is one of the most important factors that motivates joining in EC. Thus, the participants can feel more confident in their work or in the projects they provide finance and as a result, they continue to produce more effectively than before. These socio-cultural contexts provide knowledge and skills to the participants or financial providers involved in the projects. Another generalization that can be made is that the level of welfare of citizens is an important variable of community-based energy projects as it can play a major role in supplying the purchasing power and enough capital to cover the investments. The EU MS or regions with higher household income are more likely to invest in EC (such as in Northern countries) as opposed to countries or regions with lower household income (such as in Southern EU and Eastern EU)

[6] This doesn't imply that the overall consumption will change, only that can be postponed in time.

3.7.1. Economic benefits and opportunities

A significant asset of EC is that it can enable a large group of customers/prosumers to participate in electricity markets, including those who might not otherwise have the possibility to do so. And so EC benefit economically due to local labor, local materials and business, local shareholders and local banks from rural areas. In addition, renewable energy projects have facilitated communities by creating a trust fund aimed at investing the money they earn by selling electricity in the local economy. This makes it easy for several communities to invest money in any small business of their choice. An example of this is EWS Schönau, which is an energy cooperation that rejects nuclear energy after the Chernobyl disaster. It has more than 7872 members. This cooperative has a local distribution grid, and grid maintenance work is outsourced to local companies. The taxpayer's money for network maintenance is kept in the community. It also creates employment and job opportunities because it prevents migration of potential talents to large cities.
Another economic benefit of Energy Communities is by promoting energy savings. For example, Ecopower exempts the price of energy or customers from fixed costs and reduces electricity bills. Ecopower is Belgium's most successful energy cooperative and acts as a green electricity producer and supplier. Capital collected by this kind of EC and cooperatives is used to finance projects whether or not they cooperate with other EC.
Apart from the positive impacts to the community, one of the benefits of jointly acting prosumers in the form of an Energy community as opposed to individual prosumer is also Joint procurement which represents an important (not only) economic benefit for the energy community (as well as for public authorities dealing with the EC).

"**Joint procurement** (JP) means combining the procurement actions of two or more contracting authorities. The key defining characteristic is that there should be only one tender published on behalf of all participating authorities" (ICLEI, 2008: 2). The benefits achieved through JP are mainly lower prices, administrative cost savings, sharing of skills and expertise, and timesaving among others. Lower prices are achieved due to economies of scale (as in bulk sale or wholesale), i.e. the higher the demand in one contract, the lower the price per demanded unit. The contract management is less demanding with lower administrative costs in terms of one tender as opposed to many individual tenders. As there might be various, small and larger stakeholders, in a given energy community, sharing of expertise and skills creates better capacity for procurement which might be also largely timesaving. JP is commonly used in the UK and Sweden and less common or almost non-existent in many EU countries, especially in Southern countries.

3.7.2. Investment in Energy Communities

People are tackling climate change these days and investing in community energy projects is one of the simplest ways to do so. Many property owners want to make the buildings environmentally friendly but cannot afford upfront costs. However, there are means to overcome this. Brighton & Hove Energy Services Co-operative (BHESCo) stands for Brighton and Hove Energy Services Co-operative. It is a not-for-profit social enterprise that works with homes and businesses in Sussex to make energy more financially and environmentally sustainable. BHESCo finances all energy projects on behalf of their customers by using the

'Pay as Savings' initiative. The project works as follows: Investments are used to finance preliminary project costs. These costs are then repaid through savings in monthly energy bills. BHESCo is a non-profit social enterprise whose mission is to empower everyone in England to meet the financial and environmental cost of their energy needs with efficient buildings and clean, affordable, community-owned energy. For example, individuals and groups in the UK have invested in projects that collectively reduce a total of 71,000 tons of CO2 emissions annually. This is equivalent to taking 15,074 cars off the road.

Another example is investment in community energy groups such as the Brighton Energy Cooperative. Investors become members of an energy cooperative and get the return of this investment (5% is quite common).

3.7.3. Financial risks and barriers of investing in energy community

Communities that undertake renewable energy initiatives face some risks including uncertainty in the planning process, uncertainty about a community's investment appetite and capacity, steep learning curves for community volunteers, difficulty in accessing affordable patient debt finance, and lastly overcoming funding gaps is also poses another difficulty. It further increases perceived risk for community investors.

Some problems can be identified when the energy community is analyzed economically and financially. First of all, it can be said that the history of energie community is not very old. Therefore, lack of experience can sometimes be a problem. So, it becomes difficult to get projects financed by banks and institutional investors

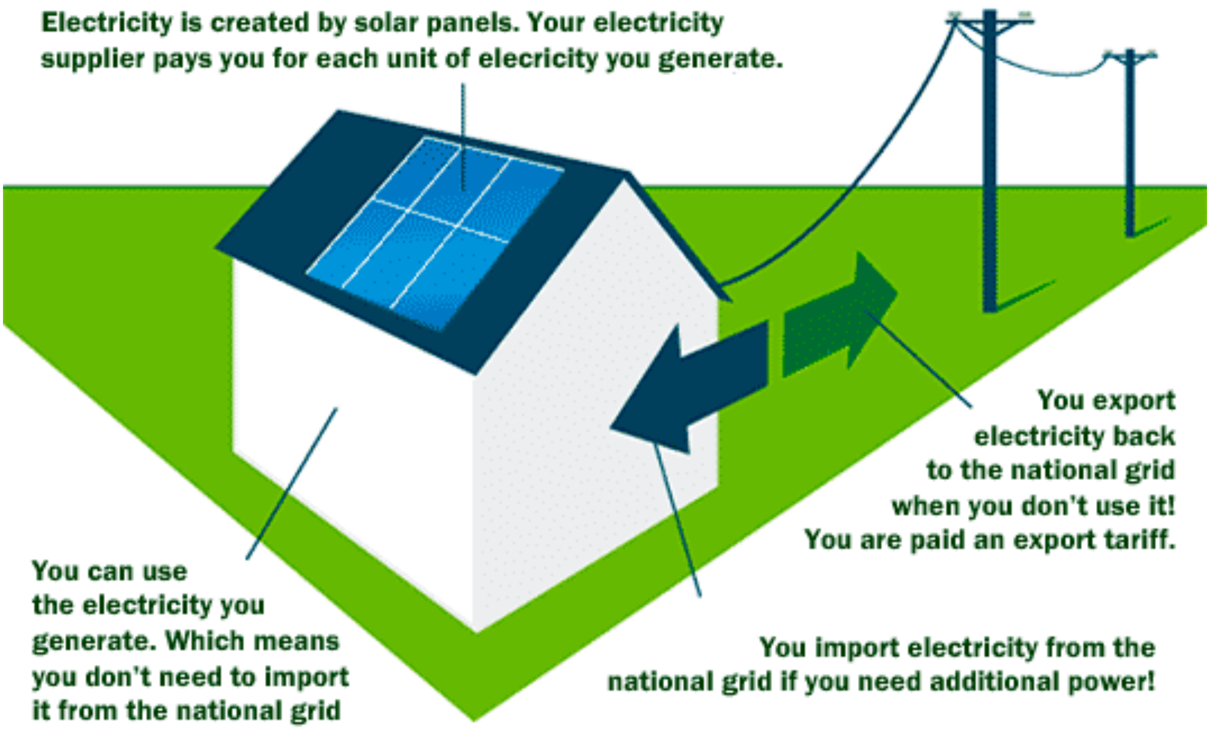
Another point is that energy community consists of various heterogeneous individuals, companies, government agencies and non-profit organizations and there is a complex contractual arrangement between these organizations. In addition to the uneven division of costs and benefits and free-wheeling behavior leads to negative results. Also, competitions in the field of energy and changing government regulations make energy communities difficult and complex for their business venture and investment.

3.7.4. Renewable Energy Support Mechanisms: Feed-In Tariffs and Auctions

Feed-In Tariff (FIT) is a policy tool. The overall aim is to promote investment in renewable energy sources. This usually means the price above the market offered by small-scale power generators, such as solar or wind power, to the grid. FITs usually involve long-term contracts, from 15 to 20 years. Used most notably in Germany and Japan, it is common in the U.S. and around the world. If production is not economically viable, FIT is required to encourage renewable energy sources in the early stages of their development. It usually includes long-term contracts and prices based on the cost of production of the energy in question. Long-term contracts and guaranteed prices protect producers from some of the risks inherent in renewable energy generation and encourage investment and development that might not otherwise occur. It is believed that about three quarters of global solar energy is linked to tariff guarantees. Japan, Germany, and China have successfully used FIT in the past decade, and a total of dozens of countries have used them to some extent to ensure the development of renewable energy.

Features of FIT: Customers must have an electricity generation system. This system must be connected to the distribution network through import / export meters that record electricity transfer from and to the grid. The energy used by the customer on site is deducted from their power usage. When a customer does not use all the electricity produced by his own system, two things may happen, first the excess is exported to the network, and second, the FiT rate is exported per kilowatt-hour (kWh) of electricity exported. In case of lack of production of electricity, i.e. the system does not generate enough energy to meet the customer's demand, electricity is imported from the grid. For example, at night, during day-time peak periods, or in winter when there is fewer daylight hours the system does not generate enough energy. It is also summarized in Picture 2.

Picture 2: Feed In Tariff scheme



7

Advantages of feed-in tariffs: They contribute to lowering investment risks and financing costs. For RES investors and financing institutions, the existence of FIT combined with long-term contracts guaranteed by the government provides transparency, predictability and security. The presence of FIT contributes to RES market development.

Disadvantages of feed-in tariffs: In FIT there are many factors affect pricing and it is hard to keep up with changes in cost of renewable energy systems. In addition FIT has been the definition of remuneration levels which are neither too low to be attractive for investments,

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[7] Feed-in Tariff <http://www.homelogicenergy.co.uk/feed-in-tariff-questions-answered/>

neither too high in order to avoid overcompensation ("windfall profits") and a market development that leads to the escalation of costs of the RE support scheme or to technical problems with the electricity system.

Auctions:
Renewable energy auctions is a kind of support mechanism for renewable energy technologies. They are also known as "demand auctions" or "procurement auctions". In general, renewable energy auctions are opened by the government of a given country. Project developers can bid in the auction and specify the price per unit of electricity from which they can carry out their projects. The government can then list different proposals. For this, it takes into account prices and other criteria. The best candidates are then selected, and the government signs a power purchasing agreement with the successful bidders. (Lucas, et al., 2013) REA[8] have become a popular policy tool. Auctions can be organized in many different ways, but an important point is their adaptation to country-specific conditions.

Auction types:
There are 3 different Auction Models: Sealed Bid Auction, Iterative Process/Descending Clock Auction, Hybrid Type Auction. In general, the sealed-bid auction is simple and easy to implement, it also promotes competition and prevents dispute. However, Descending Clock Auctions are more difficult to implement, but they provide fast price discovery and greater transparency. A more detailed explanation is given below by adding Hybrid Type Auction.

Sealed bid auction:
They offer closed offers to all auction bids at the same time. No bidder knows how much other auction participants bid. Closed bid means a written bid placed in a closed envelope. Bids are ranked from lowest to highest according to their prices and possibly other additional criteria. The highest bidder is usually declared the winner of the bidding process.

Iterative Process/Descending Clock Auction:
A price is declared by the government or auction officer for the new renewable energy generation project. Bidders explain how much they can bid for this price. Then, the price is gradually lowered by auction and causes lower production volumes offered by the bidders, and the amount of proposed production continues until it matches the new renewable energy volume that the government wants to invest. Unlike the Sealed Bid Auction, bidders know each other's bids at this auction. Thus, they can change and adapt their offers according to the competition.

Hybrid Type Auction:
These auctions are made up of a combination of different models. Can combine both of the auction types above and take advantage of them. For example, it may include a first phase with an increasing or decreasing hour auction, followed by a second phase using a closed bid auction. Here, the first step is to provide price discovery for the bidders. The second stage consists of sealed bid auctions, which ensure that tenderers cannot be hidden at their prices.

[8] Renewable Energy Auctions

Picture 3: Summary comparison of bidding procedures

Criteria / Options	Sealed-bid process	Iterative process	Hybrid process
Simplicity	Straightforward	Requires gathering all the bidders	More difficult to implement and communicate
Transparency and fairness	Possibly opaque mechanism once offers are opened	Open real-time information	Ensured by the iterative phase
Bidders' ability to react	Information must be dis-closed before-hand	Gradual disclosure of information, allowing agents to respond	Only during the iterative phase
Prevention of collusion and price manipulation	Undisclosed in-formation makes bid coordination more difficult	Bidders may force the auc-tion to terminate early	Second phase makes collusion more difficult
Matching supply and demand	Supply and demand curves fully known	Requires some assumptions for optimal results	Supply and demand curves fully known in the second phase

Characteristics of the relevant attribute: Poor — Medium — Very good

[9]

Comparison of FIT and Auctions

There are some differences between FIT and auctions. One of them is the price discovery mechanism. Policy makers are the determiners of the price of the FIT, but in auctions the industry determines the project price by bidding competitively among the bidders. Auctions are a useful way to discover the true cost of technology, if the country does not have sufficient cost data and has little experience in setting a particular price. However, the important point

[9] (Ferroukhi, et al., 2015)

is that auctions must be competitive. If there is a special interest from the government's point of view for the renewable energy generation to be focused on a certain sector (example farmers, private household, industry etc.) then FIT is often the better policy to target a certain type of production. (Jacobs, 2015) In addition auctions are better for large-scale projects than FIT. On the other hand, since FIT is less risky for project developers, they help support small-scale projects and emerging technologies.

IV. Existing Case Studies

4.1. Energy communities in Europe

Middlegrunden Wind Farm in offshore Copenhagen, Hvide Sande Wind Farm in Denmark, Bioenergy Village Jühnde in Germany, Brixton Energy in England, CWM Arian Renewable Energy in Wales and Ecopower in Belgium are some examples of EC in Europe that have been studied in the *Cultures of Community Energy. International case studies*. Denmark, Germany and the UK have now a long history of policies that are favourable to support community-scale energy generation and infrastructure. Particularly for the two first, it came as a response to the oil crisis and the nuclear energy protest in the 1980s.

Among the EU, a remarkable project is the Norton Energy wind community in England. Located in South Yorkshire. Historically the village is strongly linked with the carbon extraction from the mines in Askers, which closed in 1993. When the mine closed, it brought within many economic and social problems. Since then the inhabitants who were marked, have been reinventing their lives. In 2007, the Community Interest Company[10] Origin Energy, the eligibility of this project relied on the high wind speeds and the availability of an adapted place. For the first phase, members of the OE have provided the necessary knowledge to carry out the pre-installation[11]. They have mobilized a variety of skills and relevant experience (from a civil engineer and a designer). When the plan of the project was finished, and based on the district's total electricity consumption, it was determined that two 2 MW turbines were to be installed. The energy produced would be sold to the grid in order to generate incomes.

A cooperative Norton Energy Community was created so the residents of the Norton district can become members and have benefits from it, nowadays there are 200 members and the possibility of becoming one is still open. The NEC has four main objectives: the improvement of the local and global environment, the local choices and results, the collective choices and results, and the socio-economic regeneration. Therefore, it was fundamental to consider the local's opinion face to the installation of the wind turbines. Besides the reduction of CO_2 emissions or the savings to the community, the processes of pre-installation and the structuring of the EC were carefully chosen with the intention of being an alternative mode of social organization, economic regeneration and collective ownership.

France being one of the 8 countries in EU that have established a legislation for collective self-consumption, made possible the creation of Urban Solar Energy, who aims to solve the problem of high transport costs and energy losses during transport, bringing the production areas closer to the consumption areas. (Other countries with established legislation for

[10] United Kingdom CICs Regulator in 2011 defines that all the incomes must be reinvested in a specific local space.
[11] Initial modelling of the wind speed to find the most adapted spot, sourcing fonds, negotiating with landowners, detailed mapping of the possible locations, contact with planners and councils, design of the cooperative proprietary structure, choice and purchase of the turbine, coordination and design of the community survey.

collective self-consumption is e.g. Slovenia and Austria.). The potential of rooftop PV panels in the city of Lyon[12] is big enough to cover the totality of the consumption of its inhabitant.

Physical storage is still in its infancy, the surpluses produced by the PV installations can be used to supply other local consumers, focusing on a short circuit. This project is considered halfway between self-consumption with storage and collective self-consumption, moreover it relives the restrictive regulations associated with individual self-consumption. Nowadays, urban solar gets the energy from hydraulic sources and photovoltaics, since it is a model for urban spaces it is difficult to have a wind turbine in the cities. But energy from nuclear, petroleum or carbon source is banned, in order to assure the clients a local and carbon neutral energy.

Some role model countries that seek to close the gap between communities, energy and their public institutions are Denmark, Germany, the Netherlands, Belgium, England and Scotland. We can draw a conclusion from their experience, when the authorities involved in financing particular projects take the existence of a specific EC for granted and thereby assume a series of rules, trusts and agreements prior to their intervention, the setting up of a new EC becomes more accessible and facilitate their preservation (Walther R., 2016)

4.2. Energy communities in the Czech Republic

There is not a single case study of energy community in the Czech Republic which might be not only due to missing legislation in the country but also due to other socio-cultural and economic reasons. In general, there is a really low participation or implementation of energy communities in Eastern Europe which might be due to the economic situation in the countries in this region (as higher participation occurs in higher income countries regions). The next reason may be that there is a negative connotation with the term cooperatives (due to the history under the Soviet rule and to that related centralized economy and (forced) collective ownership). Lastly, one of the reasons might be the traditional culture - whereas some countries are typical of communities based on tight cooperation, others might be less community-oriented.

However, there are several ongoing researches focusing on energy communities in the CR, although there has not been any other project yet implemented in the CR. Among the pioneers in the CR belong the cities of Kladno and Písek and the University Centre for Energy-Efficient Buildings (UCEEB) of the Czech Technical University (CTU), all of whom are working on energy community related projects. UCEEB has started developing a model of positive energy districts in the CR in 2019. Positive energy district is one of the approaches of energy communities, which aim is to build cities as active producers of energy. (UCEEB, 2020)

There are some inspiring pioneers who, while not establishing energy communities, are working with energy efficiency and green energy. The city Litoměřice strives to achieve low carbon emissions and energy self-sufficiency by 2030. The city of Litoměřice has saved 830,000 euros since 1212 thanks to energy efficiency projects and is investing these savings in energy saving solutions through the Energy Savings Fund (OECD Report). Very similar is

[12] 6.5 million m2 can be used for rooftop Photovoltaics

the village Kněžice, which is an energy self-sufficient village. In 2006, Kněžice became the first domestic energy self-sufficient municipality in Central Bohemia.

4.3. Energy communities in Austria

Austria has made progress on renewable energy. It has set targets such as 100% electricity supply from renewable energies by 2030 and climate neutrality until 2040. It also works to expand renewable energies. Another aim is to encourage the participation of broad stakeholder groups with increasingly decentralized components. The increased involvement of these consumers creates additional business opportunities for new and existing players in the energy industry. Community production facilities are seen as the basis for further development of renewable energy communities in Austria. The Renewable Energy Resources Law (EAG) currently under preparation and the revision of ElWOG will provide a framework for this. In addition, renewable energy communities have, until now, been at the center of implementation in Austria in the field of electricity.

If the energy communities and studies in Austria are to be mentioned, the importance of Wien Energy should not be forgotten.Wien Energie is Austria's largest regional energy provider. The company supplies more than two million people with electricity, natural gas and heat, about 230,000 commercial facilities, industrial facilities and public buildings, and about 4,500 agricultural enterprises in Vienna, Lower Austria and Burgenland. As part of an innovation project by Wien Energie, it invests more than two million euros in total for a period of about five years. Another project is the Vienna Energy Project of Energy Communities, a step where every consumer can contribute something. For example, with the 'Krieau power plant', home technology centers for residential and office buildings may change, thus saving up to 60% on site-specific renewable energy in CO2 emissions.

V. RESULTS AND DISCUSSION

In recent years, citizen involvement and community co-ownership has been playing an increasingly important role in energy decarbonisation in Europe. Many countries such as Denmark, Netherlands, Germany and the UK have been continuing with this trend, but other countries of the EU such as Austria and Slovenia, that have not previously used this concept, have enabled collective self-consumption as a pre-stage for EC or are now enabling the implementation of EC (Poland). Other EU MS whose legislative system does not enable the establishment of EC, such as in the Czech Republic, are now amending legislation related to energy sector. However, there are still many obstacles in establishing EC when it comes to legislative, technical, as well as economical, but also social aspects of EC.

When it comes to the legislative, one of the key problems is, as mentioned above, the non-existence of current legislation in EU MS that does not enable the implementation of energy communities as well as the overall inconsistency in individual MS of the EU. There are also other energy market policies and mechanisms that will need to be amended and/or implemented in order to support the establishment of EC. This is related to the economic aspects of EC.

While there are many economic benefits and energy savings related to energy communities and from that arising other social benefits, the energy market is not open and/or not open enough for prosumers to participate in the energy market. New legislation related to the energy market sector will allow this. Also, appropriate policies, auction systems, feed-in tariffs, subsidies or other administrative tools (such as tax reliefs etc.) should be also introduced to boost the new concept in the energy market and to support those regions and communities that would not otherwise had the opportunity to participate. Therefore, these economic and administrative tools should aim mainly at less economically developed regions of the EU in order to make EC truly open for all interested participants.

Technological innovation will be truly needed. As we could imagine at the beginning of this research, EC face a big road in terms of technology and technical learning. Besides the need of improvement in forecast accuracy, renewable energies generation technology, interconnexion between the users and operation control, it is very important to implement at the same time a full hand of accessible information and to have qualified professionals and technicians. Overall, one of the key factors that could solve the main problem of balancing the generation and load, is the demand-response mechanism.

These two aspects bring us to the social one. As long as there is socio-political acceptance with market acceptance, the community acceptance will come more naturally. Citizens, community and civil society participation will not only bring many personal and local benefits to the communities, but it will in turn boost the local economy and improve the environment. The financial profits and collective consent will enable more of technological innovation, all of which will create a positive feedback among the four aspects of EC. The achievement of these benefits is though conditioned by the socio-political and market acceptance

The added value of Energy Communities i.e. a community of prosumers as opposed to an individual prosumer, lies both in the nature of collective undertakings as well as in the legal status of EC which enables the communities to undertake more activities. Both of these factors are socially and economically more beneficial than collective self-consumption.

The comparison of EC in Austria and the Czech Republic shows that Austria is further ahead of the Czech Republic when it comes to the legislation and implementation related to EC. The government of the Czech Republic has amended the Energy Act legislation which, however, neither implements nor introduces the concept of EC. New Energy Act should follow in the coming years, providing an enabling framework for EC and for prosumers to actively participate in the energy market. There are no case studies of EC yet though. Only private initiatives as being undertaken by individual research and development centers on the development of various types of EC (such as energy positivity districts by UCEEB). On the other hand, Austria enabled collective self-consumption in 2017 and in 2020 will be releasing new laws extending collective self-consumption into enabling the establishment of EC (enabling storing, delivering and distributing renewable electricity) as well as the creation of local grid structures.

VI. CONCLUSION

The paper shows that EC are on the good track towards their implementation in the EU MS and that the development of EC and EC enabling framework has improved in recent years. The paper may also conclude that EC might definitely change the future of energy markets as well as to increase in the acceptance of renewable energy, by which the EU might achieve its goals related to the reduction of CO2 emissions. However, the described opportunities and barriers need to be appropriately addressed as discussed in this paper. The results shown in this paper regarding the opportunities and barriers as well as the added value of EC as opposed to other formations may be generalized to all the regions of the EU and to all EC. However, most of the barriers should be generalized to those countries with low EC occurrence (mainly due to economic and legislative reasons). Regular assessments of EC, their main aspects and case studies to draw inspiration from should be undertaken regularly to see the EC development.

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VIII. APPENDIX

	Rural / urban	Size / technology	Partnership with others?	Other factors
Denmark and Germany				
Middlegrunden, Denmark	Urban	Large-scale wind	Joint with commercial developers	Offshore, near Copenhagen. One of the first projects
Hvide Sande, Denmark	Small town in rural area	Large-scale wind	Linked to local business organisation	Linked to town district heating plant
Bioenergy Village Jühnde, Germany	Rural	Biomass and other technologies – small scale but whole village	Partnership with local university	
UK				
Wiltshire Wildlife, England	Rural	Solar PV, medium-large scale	Partnership with commercial developer	
Brixton Energy, England	Urban	Solar PV, small scale in several locations	Worked closely with local authority	Strong social element including apprenticeships etc
Cwm Arian Renewable Energy (CARE), Wales	Small town	Medium, wind	Community-led	Not yet built due to a series of difficulties
Horshader Community Wind Turbine, Scotland	Rural	Small, wind	Community-led with support from Community Energy Scotland	
Wild cards				
Ecopower, Belgium	Operates across the Flanders region	Range of technologies	Co-operative but very large in scale	Generates and supplies electricity to households
Buan County, South Korea	Rural	Solar PV	Community-led	
Energy Coop Aysén, Chile	Predominantly urban	Not yet operational	Community-led	Early stage; mainly focussed on networking & feasibility
Creluz, Brazil	Rural	Hydro - small-scale but large network	Community-led	

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