This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

active communities & energy prosumers for the energy transition

GRANT AGREEMENT NUMBER 957781

WP3 – Consumer engagement methodology definition & activity coordination

D3.6 – Report on existing European energy communities and success factors

Responsible organisation	UCC
Contributing organisation(s)	Hypertech, GECO, RINA-C, Mytilineos, ESB, EDBR, MIWenergia, LaSolar, AEM, EEE
Due date of Deliverable	31/08/2021
Actual date of submission	17/09/2021
Type of deliverable	Report
Dissemination level	Public

Authors

Name	Organisation	e-mail	Role
Breffní Lennon	UCC	blennon@ucc.ie	Editor/Contributor
Niall Dunphy	UCC	n.dunphy@ucc.ie	Editor/Contributor
Lauren Quinlivan	UCC	lauren.quinlivan@ucc.ie	Contributor
Paola Velasco	UCC	PVelasco@ucc.ie	Contributor
Christine Gaffney	UCC	christine.gaffney@ucc.ie	Contributor
Basak Tanulku	UCC	BTanulku@ucc.ie	Contributor

Reviewers

Name	Organisation	e-mail
Sebastian Koch	EEE	s.koch@eee-info.net
Taco Kuiper	ESB	taco.kuiper@energiesamen.nu
Siward Zomer	ESB	siward.zomer@energiesamen.nu

Deliverable is

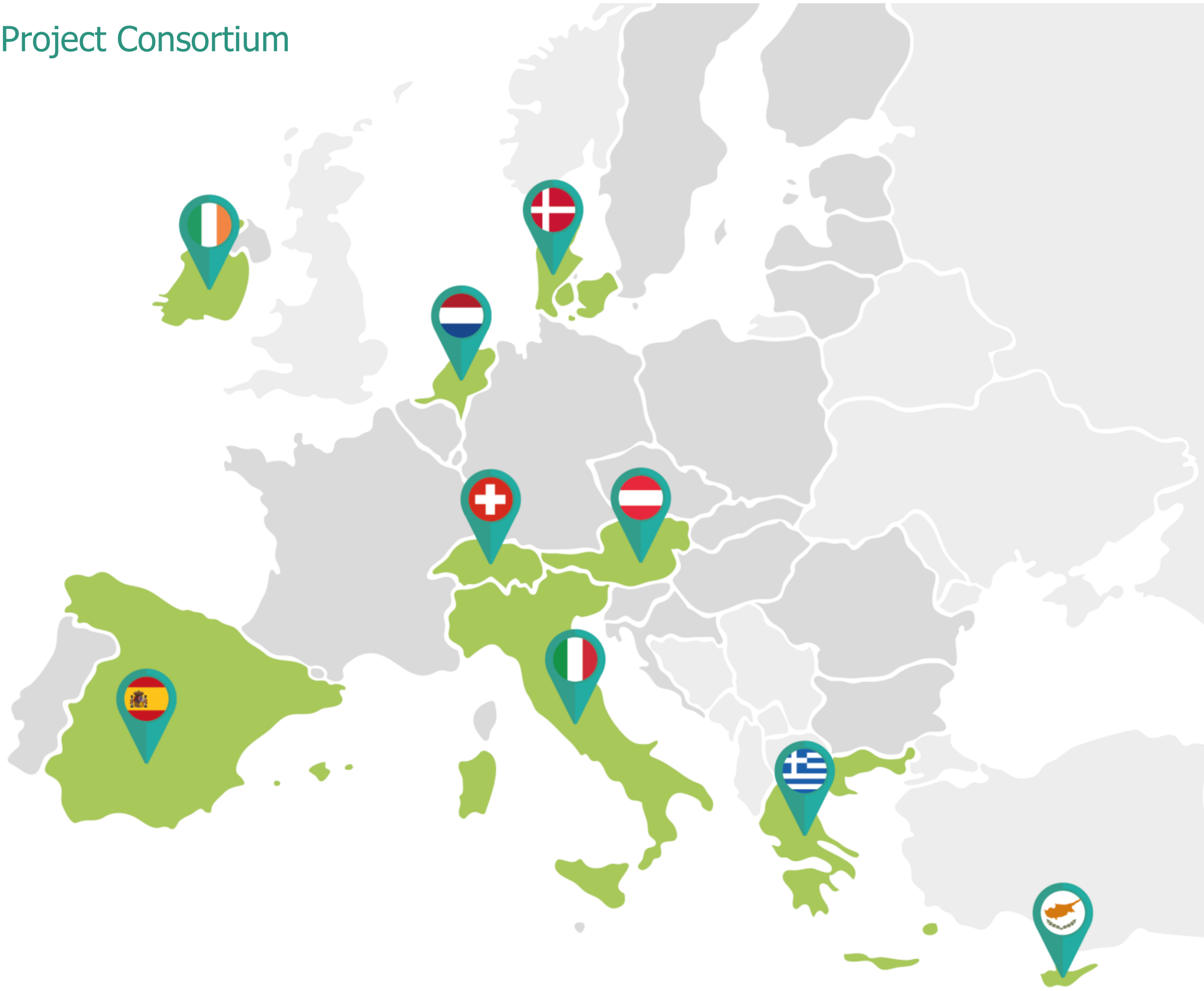
Fully Accepted	✓
Accepted with minor revisions	
Rejected unless modified as suggested	
Fully Rejected	

Version history

Version	Date	Comments
1.0	31.08.21	1st Draft (for reviewers)
1.1	09.09.21	Final draft (submitted to Hypertech)
1.2	17.09.21	Final draft v2 (updated for Hypertech amendments)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Project Consortium



Austria
- European Center for Renewable Energy Güssing GmbH

Cyprus
- Witside International Markets LTD

Denmark
- Geco Global APS

Greece
- **Hypertech** (Project Coordinator)
- Ethniko Kentro Erevnas Kai Technologikis Anaptyxis
- Mytilinaios Anonimi Etaireia
- QUE Technologies Kefalaiiouchiki Etaireia

Ireland
- University College Cork National University of Ireland, Cork

Italy
- Rina Consulting SPA

Netherlands
- Bedrijfsbureau Energie Samen BV
- Cooperatief Energie Dienstenbedrijfs Rivierenland BA

Spain
- My Energia Oner SL
- La Solar Energia Sociedad Cooperativa
- Fundacion Undacion Circe Centre De Investigacion de Recursos Y Consumos Energeticos
- Viesgo Distribucion Electrica SL

Switzerland
- Azienda Elettrica Di Massagno SA

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Executive Summary

A key objective of work package 3 is to understand the drivers and motivations of citizens as they engage with the energy system, most often in their role as consumers. This deliverable reports on work undertaken for Task 3.2 of the work package and is the result of a detailed desk-based research mapping the types of participation citizens are undertaking as part of the energy transition, whether it be as producers, consumers, or prosumers of energy. The deliverable outlines existing and emerging patterns of consumer engagement around energy, including current demand response initiatives in the EU. An overview of the socio-political status of community energy in fourteen European countries is presented, encompassing broad range of experience across member states and includes an illustrative case study from each country. These case studies represent a diverse range of energy projects and characterise the drivers, limitations, and challenges encountered by those currently engaged in community energy development. In addition, the socio-economic, socio-cultural, and geographic factors involved in CEC formation are examined to develop an in-depth understanding of the factors driving community engagement.

This report should be considered in conjunction with its companion deliverable, D3.9 Energy Governance Analysis and Typology for Communities. Taken together, they provide an overview of the key factors currently impacting CEC formation in Europe and the governance frameworks that are driving it.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Glossary

CE	Community Energy
CEC	Citizen Energy Community
CEP	Clean Energy Package
CER	Comunità Energetica Rinnovabile – Translation: renewable energy community
DR	Demand Response
CES	Community Energy Scotland
DSO	Distribution System Operator
eG	eingetragene Genossenschaften – a registered cooperative
EMS	Energy Management System
EPA	Établissement public à caractère administrative (France)
EU	European Union
EV	Electric vehicle
FIT	Feed-in Tariff
GHG	Greenhouse Gases
KEV	Kostendeckende Einspeisevergütung
kWh	kilowatt hours
kWp	kilowatt peak, i.e. the maximum electrical power under standard conditions (1kWp = 1000kWh)
LEI	Local energy initiative
MKF	MehrKostenFinanzierung
REC	Renewable Energy Community
REP	Renewable Energy Project
RES	Renewable Energy Source
RES-E	Renewable energy source – electricity
RES-H	Renewable energy source – heat
RES-T	Renewable energy source – transport
SAC	Special Area of Conservation
SCC	Self-Consumption Community
SFOE	Swiss Federal Office of Energy
SPA	Special Protection Area
VRE	Variable Renewable Energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Table of Content

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

1 Introduction

1.1 Background

Over the course of the 20th century, the evolution of electricity – and the energy system more generally – has produced networks geared towards large-scale generation with centralised transmission and distribution typically owned and operated by state-owned operators and/or large investors. These systems satisfied the objective of providing access to electricity to populations and businesses, aided industrial and social growth, and characterised industrial development for the past one hundred years. However, the highly centralised energy system, had little or no citizen involvement (Bauwens et al., 2016) beyond the market parameters of demand and supply as consumers. With the introduction of the European Green Deal and the Clean Energy for All Europeans package, this is set to change dramatically within the European Union, a change that is being replicated elsewhere as the countries around the globe commit to reducing their emissions of greenhouse gases in response to the ongoing climate crisis. The development of renewable technologies and distributed energy "is now rapidly altering the electricity industry landscape worldwide" (Gui & MacGill, 2018, p. 94). Beyond the infrastructural changes that will be required as the energy system shifts away from a largely centralised energy production model, the evolution of the renewable energy system offers the opportunity to implement local governance over energy production, including energy self-sufficiency, at both the community and regional levels (van der Schoor & Scholtens, 2015).

Also, when considering energy for what it is – a socio-technical system – significant social and technical inertias remain, hindering the transition. For instance, the legislative and regulatory contexts (at both national and sub-national levels) remain largely organised towards maintaining existing centralised models where incumbent utility companies dominate energy production and distribution. However, there are growing calls for a more decentralised approach involving geographically dispersed, small-scale generation units located close to consumers (Goldthau, 2014). Decentralised systems offer a number of advantages including reduced costs for transmission and distribution and a larger share of renewable technologies (Sims et al., 2007). These systems will require 'smart' infrastructure solutions and provide actors with concurrent roles while becoming both producers and consumers of energy. This new configuration requires a more active role from energy users, who become "prosumers" or energy services providers (Stern, 2014). For instance, decarbonisation initiatives such as Germany's "Energiewende" suggest a greater decentralising of the means of production and strengthening regional level transmission infrastructure is likely needed to deal with issues such as peak load demand.

Despite their benefits grid integration of variable renewable energy (VRE) sources presents major challenges to the energy system, especially in terms of matching their variable output to electricity demand. Resolving this issue requires the deployment of several simultaneous and integrated solutions, a key one being demand response, which in turn offers a role for prosumers to become involved in, and contribute to, the effective operation of the energy system. Energy communities are a promising organisational vehicle for involving citizens – particularly with regards to residential demand – in the energy transition. These can be both formal and/or informal citizen-led initiatives that collectively facilitate the local deployment of energy technologies. There is also evidence that the implementation of these local RES installations can enhance the social acceptance of such technologies at the local level (Toke *et al.*, 2008), and promote public participation in decision-making on vital infrastructure (MacArthur, 2013). Though, arguably energy communities do not necessarily have to involve energy technologies per se (which usually means energy generation projects). Indeed, in the context of demand response, it may even be inappropriate. Whether it is in the context of energy production or relating to demand, energy communities still often lack the tools needed to adequately exploit the full array of opportunities available and to create financially viable projects based on the provision of services citizens actually want.

ACCEPT H2020 is a project which aims to deliver a digital toolbox for energy communities to 1.) offer innovative and desired digital services, complementing their existing non-digital services to their members and costumers, and 2.) gain access to revenue streams that can financially support a well-functioning operation and ensure longevity of the energy community itself. To achieve this, the ACCEPT consortium is framing the citizen engagement and business modelling activities with the same priority as the technical development ones. The ACCEPT outcomes will be demonstrated and validated in four pilot sites in the Netherlands, Spain, Switzerland, and Greece, directly involving more than 750 residences and 3,000 citizens.

This deliverable outlines existing and emerging patterns of consumer engagement around energy, including current demand response (DR) initiatives in the EU. A knowledge bank of citizen energy communities (CECs) is presented with notable successes, limitations, and innovations from each initiative highlighted. An overview of the socio-political status of community energy in fourteen European countries encompassing broad range of experience across member states and includes an illustrative case study from each country. These case studies represent a

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

diverse array of projects and characterise the drivers, limitations, and challenges encountered by those currently engaged in community energy development. In addition, the socio-economic, socio-cultural, and geographic factors involved in each CEC are examined to develop an in-depth understanding of the factors driving community engagement.

1.2 Context

In 2015 the European Commission set out its vision of the Energy Union, with citizens at its "core" – taking "ownership" of the transition, benefitting from new technologies to reduce their energy bills, and participating actively in the market (European Commission, 2015). The term 'community energy' is used to describe a diverse range of energy actions based on citizens' participation in the energy system. Such projects may involve varying degrees of citizen participation in decision-making – more often during the middle to late phases of a project – and a benefit sharing mechanism (Walker & Devine-Wright, 2008). The community energy movement in many respects can be characterised as a combination of the energy transition and social innovation, with a cohort of citizens (often with help) more actively pursuing alternative ways of organising and governing energy systems that are both more participative and democratic (van der Schoor et al., 2016). Through its various activities, these movements can promote sustainable energy production and consumption practices, as well as offering energy communities the opportunity to actively participate in social innovation through shifting consumer behavioural patterns (Caramizaru & Uihlein, 2020), offering citizens the potential to access and alter the social arenas of decision making (Pohlmann & Colell, 2020). Through the movement, these once passive consumers of energy can potentially become active energy prosumers (van der Schoor et al., 2016).

The European Commission's Clean Energy for All Package (CEP)[1] outlines a prominent role for citizens and communities in the sustainable energy system. The legislative framework, as it is set out in two key directives, defines two types of community energy: "renewable energy communities" (RECs) and "citizen energy communities" (CECs) (Nouicer et al., 2020). The CEP formally acknowledges and sets out the legal frameworks for certain categories of community-orientated energy initiatives under the common term "energy community". Two formal definitions of energy communities currently exist, defined in two separate legally binding directives of the CEP: the revised Internal Electricity Market Directive (EU) 2019/944 (European Parliament and Council of the European Union, 2019) which introduces the term "citizen energy communities" and the revised Renewable Energy Directive (EU) 2018/2001 (European Parliament and Council of the European Union, 2018) which sets out the framework for "renewable energy communities".

As new market actors, CECs must be provided with 'a level playing field vis-à-vis other market participants', while in contrast, RECs can compete for support 'on an equal footing with other market participants' which is a significant difference (Lowitzsch et al., 2020, p. 20). The Renewable Energy Directive 'calls on Member States to "take into account specificities of renewable energy communities when designing support schemes"' (Lowitzsch et al., 2020, p. 20). While there is a close relationship between the two concepts in terms of governance, ownership and control, and purpose, there are also some significant differences which impact on how they must be treated and legislated for by Member States. Both types of energy community are legal entities; based on open and voluntary participation; value rather than profit driven; have specific governance criteria linked to membership; and are collective in nature (Roberts et al., 2019). Under Article 22 of the Renewable Energy Directive, RECs are permitted to produce, consume, store, and sell renewable energy; to share renewable energy within the community; and to access energy markets. Moreover, Member States are also obliged to 'carry out an assessment of the existing barriers and potential of development of renewable energy communities in their territories' (European Parliament, 2018, p. 40).

[1] Within the Clean Energy Package, CEC and REC are new legal entities, defined as non-commercial energy market actors, whose primary purpose is to provide 'environmental, economic or social community benefits', and as such Member States must ensure that both must be able to operate in the energy market without discrimination (European Parliament, 2018) (European Parliament, 2019, p. 16). CECs are defined in terms of an energy system covering all types of electricity, while the latter term REC remains solely focused on renewable energy. Rather than focusing solely on profit-making, these EU legislative documents establish energy communities as new types of non-commercial entities that primarily focus on providing environmental, economic and/or social benefits to communities (REScoop.EU, 2019). As part of these directives, energy communities are framed using specific criteria and activities which ensure they may operate within the energy market without discrimination (Roberts et al., 2019).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

The significant differences between the two types of energy community relate to 1.) their geographical scope – REC are effectively 'communities of place' tied to the proximity of the renewable energy project (REP), whereas the CEC is a 'community of interest' not necessarily located in the area of the REP; 2.) their activities – CEC are confined to the electricity sector, and can be renewable energy RE or fossil-fuel based unlike REC which has a broader range of activities; and 3.) their participants – membership of a CEC is very flexible, any actor can participate, and it allows joint-partnerships with commercial entities, as long as decision-making power remains with the community, whereas REC are limited to natural persons, and micro-, small-, and medium-sized businesses for whom the REC is not their main business, and local authorities. EU member states are also required to ensure that socioeconomically vulnerable consumers are able to participate in REC (Caramizaru & Uihlein, 2020).

1.3 Structure

In this report, notable examples of established citizen energy communities (CECs) will be examined and outlined, focusing on their successes, limitations, and potential innovations and as they are framed by combinations of underlying socio-economic, socio-cultural and geographic factors. The report is divided into five sections as outlined below:

- This first introductory section presents an overview of the report, details the background to the work, provides context for the task undertaken, and presents the structure of the document.
- The second section outlines the research methodology undertaken during the task, detailing the research philosophy adopted and describes the research methods adopted for data collection and analysis.
- The third section provides a brief overview of the citizen energy communities (CECs) concept and related theories and introduces the fourteen illustrative case studies highlighted from the in-depth desk study carried out during the task.
- The fourth section considers the key factors driving consumer engagement and is informed by ongoing debates in the literature and from the case studies.
- The final section comprises a conclusion, providing a summary of the key findings and recommendations to be incorporated in ACCEPT within the wider WP3 work plan.

1.4 Interdependencies with other tasks and deliverables

This deliverable should be viewed as a companion deliverable to *D3.9 Energy Governance Analysis and Typology for Communities* of the ACCEPT H2020 project. Taken together, both deliverables inform the approach being taken in the co-creation processes undertaken in tasks 3.1 and 3.4. In addition, they will provide a theoretical and conceptual foundation to work planned for Task 8.4 which will deliberate on the participatory methods trialled in the project. The two deliverables also contribute to the partners ongoing participation in Task 10.2 Synergies building & collaboration with other H2020 projects and also UCC contributions to the Energy Communities Working Group of the BRIDGE initiative.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

2 Methodology

2.1 Introduction

The work presented in this report is primarily comprised of desk-based research. Such research involves the selection and analysis of data from the existing literature – principally from academic research databases, and 'grey literature' – such as politico-legal documents and reports. Literature reviews are foundational to the research process (Kitchenham & Charters, 2007). Assessing the extent of the existing research, as well as the knowledge, theories, and practice-based analysis that is documented provides the bedrock upon which to develop new knowledges, theories, insights, and approaches to further research (Webster & Watson, 2002). Moreover, insights gained from existing knowledge, theories, and practices can properly inform the framework within which research is conducted.

The aim of this literature review is to provide an overview of the socio-political status of community energy. This will be achieved by reviewing the selected literature and exploring an illustrative case study from each of fourteen European countries. These case studies represent a diverse range of projects, and characterise the drivers, limitations, and challenges encountered by those engaged in community energy development, as well as identifying those aspects of each project which have applicability in relation to the CEC domain more broadly. In order to assemble a broadly representative collection of case studies that captured a diversity of geographical locations, population composition, economic development, and national RE system landscapes an initial scoping exercise was carried out in order to identify the key case studies to be used in the study. The selection criteria for the case studies were defined to capture a diversity of CEC formations so as to develop as comprehensive an assessment of the energy community landscape as possible, within the overall parameters of the research project. The criteria considered for case study selection were:

- (i) the scale of the energy community project;
- (ii) the specific form of CEC;
- (iii) capturing the broad range of experiences across the fourteen diverse European countries; and
- (iv) the extent of available literature on individual projects.

The selection criteria and subsequent analysis of the case studies involved a rigorous thematic analysis that identified the common themes emerging from the wider literature review and from the case studies themselves. Thematic analysis is widely used in qualitative research and according to Braun and Clarke (2006) should be considered a core method for qualitative analysis, as it provides the practitioner with the key skills of identifying, analysing, organising, describing, and reporting on the key themes from the data they engage with. As such, it offers the requisite skillset for conducting many other forms of qualitative analysis (Nowell et al., 2017). Also, as a process for encoding qualitative information, it can be thought of as a bridging tool between the language of qualitative research and the language of quantitative research (Boyatzis, 1998).

As a companion document, the literature review conducted for this report was undertaken in tandem with the literature review that informs Deliverable 3.9[2], which applies a multi-level energy governance perspective to our analysis and typology of those key drivers influencing citizen and consumer engagement.

2.2 Literature review

The value of the literature review for the research process is often underestimated. While often dismissed by some as merely a preliminary exercise, or a precursor to 'real' research (Onwuegbuzie & Freis, 2016), reviews of the literature are in fact a crucial part of the research process (Dunphy et al., 2021). Significantly, assessing the existing store of knowledge, the gaps as well as the insights, is essential for framing current and future research. A literature review also has the capacity to serve as a research method in its own right where the synthesising and integrating findings and analysis of existing literature contributes to the development of new knowledge and insights (Torraco, 2005). For this deliverable, the objectives of the literature review are twofold: firstly, to map existing and emerging patterns of consumer engagement with current demand response (DR) initiatives in the EU and, secondly, to identify key factors driving consumer engagement and CEC formation, and positioning them within their socio-economic, socio-cultural, and geographical contexts. These objectives are achieved by utilising specific research methods to identify the existing research on community energy and energy communities including both conceptual

[2] Deliverable 3.9 Energy Governance Analysis and Typology for Communities should be considered a companion report to this deliverable.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

analyses, as well as literature reporting on RE projects; as well as identifying research specific to the case studies and their socio-political contexts.

> 'The review of literature itself comprised the familiar iterative process of searching, reading, annotating, organising, summarising, analysing, and finally synthesising'
>
> Dunphy *et al.* (2021, p. 10)

The principal sources of literature searched for were the bibliographic databases available through university library subscriptions, or available for free online, including open access journals, and online national and European data portals. The material selected includes academic literature, European and national government legislation and reports, as well as research project reports. Although all major search engines will identify the majority of the material that is extant, nevertheless, all search engines have their strengths and weaknesses (Falagas et al., 2008). In order to overcome weaknesses within individual databases, three search engines were selected: Science Direct[3], JSTOR[4], and Google Scholar[5].

To ensure the appropriate relevant literature was captured – and in accordance with best practice – a dual approach was taken to the methodology which, in addition to the systematic literature review, comprised of 'snowballing' procedure from the reference lists from key academic articles and reports (Kitchenham & Charters, 2007).

For the Database searches, we utilised a Boolean keyword search. A Boolean keyword search is a data mining operation which allows a researcher to combine, or exclude, terms using the 'Boolean operators' AND, OR, NOT in order to identify relevant material in an academic database. In common with every method, it has both advantages and disadvantages. It is flexible and allows multiple terms to be used in combination, however, it can yield either too many or too few results. With regard to the 'social' or 'human' aspects of the energy system, a particular difficulty for using keyword searches arises from the indeterminate meaning of some terms, and the variability in terminology usage across energy research more generally. This arises in part from the diversity of disciplines now involved in energy research, the emergent nature of much of that research, as well as the emergent nature of energy communities themselves (Markard et al., 2012). Selected articles were reviewed to identify the range of terms commonly used as keywords indicating that the paper concerned energy communities, which were then included in the systematic Boolean keyword search.

Using a snowballing procedure to supplement the Boolean keyword search process provides an extra research layer that helps to ameliorate the gaps that may arise from the variation in definitions of key terms and ensures that relevant research will not be omitted inadvertently. The 'snowballing' process involved both 'backward' and 'forward' snowballing (Jalali & Wohlin, 2012). Backward snowballing involves identifying additional relevant articles in reference lists; while forward snowballing entails identifying additional research that has cited articles that have been determined to be of relevance for the research objective. A further layer of snowballing utilises the search engine functions to identify linked research articles, as well as examining the 'recommended' articles suggested by the academic databases for relevance.

2.3 Data analysis and interpretation

Since the early 2000s, the still-emerging field of "sustainability transitions" has resulted in an ever-expanding body of research, and research material, including an expansion of conceptual frameworks, terminology, and language, across a number of academic disciplines (Markard et al., 2012). The emergent nature of energy communities, the expansion of terminology and related linguistic variabilities has been further impacted by the introduction of the European Clean Energy Package (CEP) and the new definitions of renewable energy communities and citizen energy communities, and the consequent issues that will arise from the transposition of the two directives into the legal frameworks of individual Member States, which has already begun to introduce added diversity at the national level (CEER, 2019).

In an effort to overcome the variability of terminology used for energy communities, selected articles whose subject matter concerned energy communities were reviewed to identify the range of relevant terms and descriptions commonly used as keywords; these terms were then used in the systematic Boolean keyword search. The terms identified from that review to be used in the search included: 'community energy', 'renewable energy communities', 'clean energy communities', 'citizen energy communities', 'energy cooperatives', 'sustainable communities', 'local

[3] www.sciencedirect.com
[4] www.jstor.org
[5] scholar.google.com

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

energy communities' and 'community energy'. Secondary terms such as 'demand response', 'energy storage' were also used to aid identification of relevant studies.

Data analysis in such a mobile field of research brings specific challenges. Case studies were selected to capture examples that represent or illuminate significant themes of relevance for achieving the project goals. Forward snowballing and utilising the search engine functions provide obvious advantages for identifying potential case studies of interest. Selecting the case studies was in and of itself an iterative process. Practical considerations of co-location with project partners and participating communities were obvious metrics for inclusion. Capturing a diverse range of national contexts was defined as a priority in order to enhance the applicability of the findings, as well as to learn from the specific issues that may arise in diverse contexts in order to develop the knowledge parameters

This report provides an overview of the community energy experience in fourteen European countries, the majority of which are member states of the European Union. It outlines the country-specific contexts for each country, including their reaction to the EU legislation on climate change and energy, how the term community energy is understood and applied, and a brief history of energy communities and/or citizen-led initiatives on energy and the associated challenges experienced in each country. Developing a deeper understanding of the factors that drive engagement will help us to understand the motivations and expectations of participants in the living labs set out in task 3.1.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

3 Citizen Energy Communities (CECs)

3.1 Citizen Energy Communities in Context

The expansion in community energy initiatives reflects the drive to find alternative ways of organising and governing energy systems (van der Schoor et al., 2016). Energy communities have emerged as a new form of social movement that can facilitate and develop participative and democratic energy processes (Caramizaru & Uihlein, 2020), while also increasing social acceptance of energy technologies at the local level (Bauwens & Devine-Wright, 2018; Toke et al., 2008). There are also many social advantages to CECs. Community-based energy projects provide the opportunity for more deliberative and inclusive citizen participation, and they offer the opportunity to implement local governance over energy production (van der Schoor & Scholtens, 2015). Local community ownership and involvement in the planning process of the project results in positive attitude to the RE development, and even a sense of pride and attachment to it (Bauwens & Devine-Wright, 2018).

Data on community energy initiatives is incomplete[6] (Caramizaru & Uihlein, 2020). However, in Europe, there are approximately 3,500 renewable energy cooperatives which are the most common form of energy community in North-Western Europe, although the term itself can represent different legal forms, governance, and ownership structures. There are also other types of energy communities with varying governance models in place. Germany with 1750 has the strongest tradition of community-owned energy, and with Denmark (700) has the highest number of citizen-led energy organisations in the EU (Caramizaru & Uihlein, 2020). In 2019, both the Netherlands and the UK had sizeable 'energy community initiatives' at 500 and 431, respectively; followed by Sweden (200), France (70), Belgium (34), Poland (34), and Spain (33) (Caramizaru & Uihlein, 2020).

These numbers are set to increase dramatically. According to the estimates, by 2030, 17% of installed wind capacity and 21% of solar capacity in Europe could come from energy communities (European Commission, 2016). By 2050, almost half of EU households are expected to produce some form of renewable energy (Kampman et al., 2016)[7]. At the EU level, by 2050, half of the population (over 264 million people) are projected to be producing at least some of their own energy (electricity) while approximately 37% of the energy produced by energy citizens are projected to come from cooperatives (Caramizaru & Uihlein, 2020).

The research literature reflects the ongoing effort across disciplines to develop an understanding of the rationale driving the expanding movement towards dispersed, community-orientated energy presumption. Walker and Devine-Wright (2008), argue that energy projects can be characterised as community projects by defining the target group (who the project is for) and the active participants (who the project is by). Rogers *et al.* (2008) describe such projects as community initiatives when the local community participates actively in the planning, decision-making and/or exploitation of the project, and benefits from its revenues or other results. CEC projects are initiatives often undertaken by volunteers who wish to respond to issues they feel strongly about, such as climate change or energy security.

CECs are now defined by the revised Renewable Energy Directive (EU) 2018/2001 as a possible type of organising collective for citizen actions in the energy system (Frieden et al., 2019). Energy communities are considered as non-commercial market actors that combine non-commercial economic aims with environmental and social community objectives. The directive frames energy communities around specific criteria and activities to ensure they have an equal stance when operating in the market without discrimination (Roberts *et al.*, 2019). CECs are characterised by the following three key conceptual criteria:

1. Governance: participation must be open to all potential local members based on a non-discriminatory criterion and be voluntary (Caramizaru & Uihlein, 2020).
2. Ownership and control: emphasis on the participation and effective control by citizens, local authorities and smaller businesses whose primarily economic activity is not in the energy sector (Roberts *et al.*, 2019).

[6] Also, while Member States are obliged to transpose the two key directives into national legislation, each MS is responsible for implementing national legislation and policies for energy communities and the national policy landscape in individual member states still tend to favour a centralised energy system which maintains barriers to decentralising and democratising energy (Heldeweg & Séverine Saintier, 2020).

[7] It should be noted that while Kampman is referring to household prosumption and not necessarily CECs, some home prosumption could form part of a CEC project under the right circumstances.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

3. Purpose: their primary goal is to generate social and environmental benefits rather than solely financial profits (Roberts *et al.*, 2019).

Energy communities perform traditional activities, while also engaging new business models. Usually, small-scale initiatives have mostly involved renewable energy. However, an increasing number of energy communities are taking new roles such as generation, supply, consumption and sharing, distribution, energy services, and electro-mobility.

3.2 Overview of CECs in action

The transition to a sustainable energy system is transforming neighbourhoods and communities, and is likely to have a significant impact across all of society (van der Schoor & Scholtens, 2015). Realising the vision of a decentralised sustainable energy system, as well as energy neutrality, zero carbon emissions, and viable sustainable energy communities will require a shared vision, cohesive organisation, and active engagement and relationship building within the local network of actors (van der Schoor & Scholtens, 2015). However, the international experience of creating 'energy communities' has generated mixed results (von Wirth et al., 2018). Taking a global perspective, Sen and Ganguly (2017) identified the main challenges to expanding renewable energy as market failures of underinvestment, low GHG emission quota prices, energy monopolies, RES unaffordability, and RES market risks; informational barriers including the impact of uncertainties on energy production, lack of generation and demand data, lack of modelling solutions, and a lack of RES expertise; socio-cultural barriers including inefficient use of land for RES, and weak communication; and policy barriers, including institutional relationships with existing energy system stakeholders, existing policy regime, and lack of RES supports[8].

Among Member States, Germany is the strongest performing in terms of shifting to renewable energy production, although its primary energy consumption is still dominated by fossil fuels (approx. 76% in 2020), and a steadily decreasing consumption of nuclear energy, at 6% in 2020, with a total phase out by 2022 planned. The German transition, 'Energiewende', has the ambition to achieve 60% of its final energy consumption, and 80% of its electricity generation by renewable means, by 2050 (Radtke & Ohlhorst, 2021). In common with other member states, achieving these goals will require the active engagement of citizens. However, despite the strong presence of citizen participation in the energy system in Germany, there is a lack of diversity amongst participating citizens, with especially low participation rates amongst the young and women in particular, with participation largely concentrated amongst academics with higher income levels (Radtke & Ohlhorst, 2021). On further examination, the retrenchment of Energiewende has seen it shift from being an exemplar of 'energy democracy' to its current state of tending towards exclusion of some demographics especially younger adults, women, and people of low socio-economic means and is related to two key causal factors: finance and regulation. The German experience shows that progress on expanding RE can stall, and has implications for the energy transition within the varying socio-political contexts of the other Member States (Radtke & Ohlhorst, 2021).

Community energy projects can be characterised by different degrees of community involvement in decision-making and benefits sharing (Walker & Devine-Wright, 2008) and differ according to their: activities, energy technologies, organisational structure and ownership, variations in geography, variations in organisational scale, different membership motivations, and socio-economic innovation (Caramizaru & Uihlein, 2020). Regarding activities and organisational forms, both CECS and RECs can comprise a wide range of activities such as generation, supply, consumption and distribution (of electricity), energy services, electro-mobility and other related activities such as consultation service information and awareness-raising campaigns, or fuel-poverty measures. In most of the 24 cases in the JRC Science for Policy report, most energy communities deal with the generation and supply of energy (page 13). Also, a growing number of energy communities have begun to operate in sectors that have been traditional held by energy utilities or car manufacturers (*e.g.* mobility services) (Caramizaru & Uihlein, 2020, p. 13/14).

Many authors have noted the variable use of a range of terms connected to citizen energy communities, as well as energy communities more broadly, and the issues that this can cause when trying to analyse, contrast and compare different forms of citizen energy communities. For example, 'energy cooperatives' are not always 'citizen energy cooperatives', and changes in naming, and recording methodologies over the decades adds further complication

[8] In the European context, a PESTLE (political, economic, social, technological, legislative and environmental) analysis of energy community development in remote locations identified a number of barriers to establishing energy communities in four countries: Finland, Ireland, Norway, and Sweden. These included issues of trust, low political support, lack of experience in civic activism and in setting up cooperatives, as well as organisational challenges (Aoidh et al., 2018).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

(Radtke & Ohlhorst, 2021). Consequently, energy communities are rather heterogeneous with regards to their organisational models and legal frameworks. While most of them are energy cooperatives, there are also limited partnerships, community trusts and foundations, housing associations, non-profit customer-owned enterprises, public-private partnerships, and public utility companies (Caramizaru & Uihlein, 2020).

Renewable energy (RE) cooperatives are a widely-known example of a community-oriented energy project, enabling citizens to collectively own and manage RE projects at the local level (Huybrechts & Mertens, 2014). These represent an alternative model of ownership to the incumbent corporate capitalist model, with members and users operating as owners rather than merely investors and local residents from the neighbouring area able to buy shares to finance a project (Walker & Devine-Wright, 2008). These initiatives also represent a new governance structure that involves equal voting and rights for all its members (Bauwens et al., 2016), and tend to be financed through a variety of mechanisms including self-financing, investment-based crowdfunding, traditional bank loans, joint ventures, leasing, etc. (Bauwens, 2019; Punt *et al.*, 2021; REScoop, 2014).

The RE cooperative sector varies enormously across Europe and indeed worldwide – while the cooperative model has been well-established in some EU countries, it remains marginal in others. Cooperatives are common in countries with strong community-oriented socio-cultural traditions such as in Germany or Sweden. For Germany, Caramizaru and Uihlein (2020) highlight the tradition of eingetragene Genossenschaften (eG) – *i.e.* register cooperatives – as a contributing factor. In the UK, renewable cooperatives have mainly been formed as industrial and provident societies. Formal institutional rules, such as support mechanisms for renewables, along with societal norms that favour cooperative models and finance mechanisms have been identified as major influences on the formation of community energy (Bauwens et al., 2016; Breukers & Wolsink, 2007; McLaren Loring, 2007). However, the phase out of subsidies across the EU has led community actors to be increasingly interested in new models such as micro-grids, local energy companies, and peer-to-peer trading.

In sum, energy communities can bring a host of benefits to the energy system. They can facilitate flexibility to systems operations and alleviate the need for traditional network upgrades. Citizens may also benefit from lower energy prices and access to private capital from renewable investments through their active participation.

The role of community energy projects remains largely in generation, but this role is gradually expanding into areas such as energy supply, energy efficiency and electro-mobility. And, although energy communities can bring much-needed innovation potential, their contribution to the energy transition is not fully understood EU-wide, as well as the barriers preventing communities from participating in energy projects.

3.3 Citizen Energy Communities: Case Studies

A wide range of community energy projects exist across Europe, most involving some form of energy generation – solar panels on school buildings, windmills installed by village residents, small biomass installations and district heating networks (Caramizaru & Uihlein, 2020). This section provides examples of citizen energy communities in fourteen European countries, including the participating countries of the ACCEPT H2020 project. It maps out the country-specific contexts that inform CEC formation in each country and highlights an illustrative example of the types of CECs in each country. In addition to the illustrative case study, a number of other notable examples are also provided for each country.

Greece

Greece has tended to follow EU energy policy quite closely in recent years, transposing EU regulations into national law relatively quickly. For instance, "Energy Communities" was defined under national Law 4513/2018 the same year as the Renewable Energy Directive (EU) 2018/2001 was published, making Greece the first member state to pass a law in national parliament on Energy Communities (ECs). Under this definition, an energy community was interpreted as a cooperative that aims to enhance the social economy, encourage solidarity and innovation in the energy sector, address energy poverty and promote sustainable energy production and efficiency at the regional and local level.

Recently, the Electra Energy Cooperative produced a report (2020) based on a four-month survey investigating the progress of energy communities in Greece since the introduction of Law 4513/2018. The research team collected both qualitative and quantitative data, and gathered information from official bodies and registries, and the participating energy communities. According to this research, there are more than 409 citizen energy communities in Greece, located mainly on the mainland and northern parts of the country. Most of these initiatives comprise of

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

solar energy projects, followed by wind energy, and then biomass. This survey provided some valuable insights into the emerging ecosystem of energy communities in Greece. According to the researchers, energy communities have become more popular among citizens. However, in many instances, the realisation and operationalisation of such projects has remained difficult to achieve (Electra Energy Cooperative, 2020).

Motives for potential members to join an energy community range from recognising the opportunity to contribute to collective action in the management of a common resource, to empowerment in terms of ownership, an existing strong environmental awareness, to potential return on a financial investment. For some, this last most was considered the most important. Mainstreaming energy communities has led to new financial mechanisms such as a greater diversification of financial tools and products catering to the needs of individual projects and communities. According to the report, 90% of the surveyed cooperatives support the idea of creating a federation of energy communities in Greece.

Main socio-political contexts

Although Greece has significant potential in terms of RES resources (*i.e.*, abundant solar and wind), its efforts to develop and grow a strong energy community sector faces several challenges. Recently the Ministry of Energy and Environment withdrew incentives that were granted previously to energy communities. This shift in policy may threaten the burgeoning energy community sector in Greece, along with individual participation of citizens in the energy transition since they must now compete with private investors on bids to ensure operational reinforcement of renewable energy projects. These adjustments are not consistent with the Greek National Energy and Climate Plan and the EU legislation, which focuses on a framework that promotes and facilitates the development of Renewable Energy Communities and Citizen Energy Communities (REScoop, 2021).

At present, CECs remain underrepresented on the Greek islands with the exception of Crete where five CECs are active (Electra Energy Cooperative, 2020). Although, in most EU countries, islands are probably the more important locations for establishing CECs (indeed, the transition to sustainable energy may in fact help turn around the ongoing decline for some island communities across Europe where access to the current highly-centralised fossil fuel infrastructure has traditionally proved difficult). A notable development in recent years has been the unprecedented influx of migrants and refugees, which has put additional pressure on already stretched resources. The potential contributions CECs can make to the islands could see such projects provide opportunities for cross-community collaboration in terms of upskilling and job creation, while also alleviating the very significant environmental pressures on fragile island ecosystems.

Illustrative Case Study: Greece

(1) Hyperion Energy Community, Greece

Overview

The Hyperion Energy Community consists of over thirty members who collected approximately €20,000 to commission a 60 kW solar park in a neighbourhood of Athens, Greece's capital city. In 2018, they set up the Energy Community legal entity, with the intention of using any financial surplus generated from the project to provide free electricity to energy-poor households in the area and to develop educational campaigns for recruiting new members. Hyperion's aim is to make an immediate, practical change to members' financial situation by significantly reducing their energy bills through net-metering (close to zero by paying off all loans). This is very important to the CEC as many households in the area are vulnerable to energy poverty. Also, through continuous education campaigns and participatory decision-making, members aim to familiarise themselves with cooperative principles and learn from a broad range of socio-technical issues. While their first and primary activity will be energy production (and self-consumption), they aim to expand their activities into other areas including energy efficiency, e-mobility, distribution, storage, *etc*. Hyperion will also open their tools, knowledge, and resources to the surrounding communities. A stated mission of the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

project is to contribute to wider political change in Greece, with solar energy seen as a common good for all (Genervest, 2021).

Project summary	Drivers
HYPERION SOLAR COMMUNITY *Type:* cooperative enterprise *Model:* Virtual-net metering / collective self-consumption *Location:* Athens, Greece *Capacity:* 180 kWp Photovoltaic plant *Membership:* 36 members *Funding:* Initial €20k self-funded *Status:* under development *Support:* Electra Energy Cooperative	Ongoing crises in Greece including the COVID-19 pandemic, extreme weather events brought about by climate change, and the widening gap in socio-economic equality are all motivating factors for its members. Promoting a social and solidarity economy **Limitations** Community-specific factors Financial and perceptual barriers **Challenges** Advisory assistance to the management or participation of members

Other notable examples

- *Minoan Energy Community*: Minoan Energy Community was founded in October 2019 and located in Crete. Within less than a year, the energy community organised several workshops in rural and urban locations, engaging farmers, local enterprises, citizens, municipalities, cooperatives, and Crete's Regional Authority. Minoan Energy Community is currently planning and developing a wide range of projects, including wind parks, photovoltaic installations, hybrid RES projects and energy storage. Four working groups have been formed to support the development of the cooperative in its early stages. The four groups oversee technical, administrative, promotion & communication, and education.

- *Union of Agrinio* founded in 1930 by the cooperatives of tobacco and olive producers, Union of Agrinio operates in the region of Aetoloakarnania. Apart from its successful commercial activities in the agri-food sector, the Union took a strategic decision to get involved in renewable energy projects. The Union has already developed 17 energy communities. Ten of them will build wind projects with a capacity of 168MW, involving 1750 families. Seven of them will develop solar projects with a capacity of 126MW, involving 500 families.

- *Collective Energy Community (CoEn)*: is a cooperative founded in 2020 in the Attica Region to contribute to the development of sustainable and just energy solutions both for its members and the local community. The members have different backgrounds and aspirations. Among its founding members, there are highly qualified researchers with experience in preparing and implementing research programs, both at the European and national level. The non-profit social enterprise "School of Earth" is a member of the CoEn, which has focussed on developing educational courses and awareness-raising activities around contemporary social and ecological issues. It aims to become an active hub to provide its members of opportunities to collaborate, experiment and act for a common purpose. CoEn is working on its first energy sharing project for its members.

Ireland

According to the Sustainable Energy Authority of Ireland (SEAI), up to March 2021, there are more than 500 community energy projects[9] in Ireland comprising more than 25,000 members (SEAI, 2021). The main motivations

[9] It should be noted that many of these projects still at an early stage of development.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

for people to join an energy community are to lower both their energy use and their climate impact. The SEAI provides mentoring and funding to help communities achieve their sustainable energy goals, with many energy communities having completed upgrades to their homes, businesses, and public and community businesses. Others have invested in larger scale renewable sources (RES) of energy to benefit their area.

Ireland aims to increase its renewable energy targets to 16% of its final energy consumption by 2020, which is separated into three categories: 40% electricity (RES-E)[10], 12% of heating (RES-H), and 10% of transport (RES-T). Despite a drop in overall emissions due to the ongoing COVID-19 crisis, Ireland did not meet its 2013-2020 EU targets for greenhouse gas emissions reductions (Environmental Protection Agency, 2021). Renewables only made up 12.0% of gross final consumption relative to the 2020 target of 16.0% (SEAI, 2020). Ireland is also on track to miss its 2030 target too if current trends remain the same.

Watson *et al.* (2020), who have charted the progress of "grassroots" community energy in Ireland from 1986 onwards, suggest that while infrastructural support is emerging it still requires much greater coherence and needs to be able to respond more effectively to community needs. They also note that while 'energy citizenship' is becoming more widely accepted as an ambition for policy makers, energy communities (while growing) remain on the backfoot, processing varying levels of experience and, capacity, cohesion, local leadership and access to funding and resources.

Main socio-political contexts

The main challenges to developing community energy projects in Ireland include ensuring access to the National Grid, facilitating fair and secure payments for community energy schemes, institutional barriers to micro-generation and auto generation, barriers to funding and finance supports to help groups at the initial stages of development (also for feasibility planning and construction stages), and to facilitate the development of community microgrids through a smart grid programme so that electricity generated locally can be consumed by more than one user (Friends of the Earth Ireland, 2017).

Illustrative Case Study: Ireland

(2) Comharchumann Fuinnimh Oileáin Árann / Aran Islands Energy project, Ireland

Overview

In 2012, a group living on the Aran Islands, which is situated at the mouth of Galway Bay on the west coast of Ireland, established a co-operative to become energy independent and carbon neutral by 2022. The 1,200 inhabitants primarily speak Irish, and the islands are part of the Gaeltacht (those areas in Ireland where Irish language is predominant). Islanders would generally also be proficient in English. Initial steps were made into looking at ways to increase the energy efficiency of their homes and businesses, how best to generate energy locally using renewable energy sources and using electric vehicles (EVs) for transport.

The co-operative is run by volunteers and have an energy masterplan (2018) in place outlining the roadmap they envisage for transforming the energy infrastructure on the islands. They have also made a commitment to encourage local stakeholder involvement. Funded through the Irish government's Better Energy Homes programme, the project initially focussed on energy efficiency improvements for local businesses, public buildings, and homes, before broadening out to local energy generation including

[10] Under the EU Renewable Energy Directive, the level of renewable penetration required in each of the end-use sectors is broken down as follows: renewable energy source electricity (RES-E), renewable energy source transport, and renewable energy source heating and cooling (RES-H&C), which may appear as RES-H or RES-C in an individual member state's National Renewable Energy Action Plan (NREAP) depending on the priority being taken.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

solar photovoltaic (PV). In 2013, 50 homes were upgraded with increased insulation, window and door replacements, new boilers, fireplace replacement, heat pumps and solar panels (Fuinnimh Oileáin Árann, 2016). Applications for similar schemes in 2014 soared to 180 following significant earlier community engagements. Householder feedback included reporting having increased disposable incomes through reductions in heating bills. Following an upgrade of the local nursing home, residents reported improved levels of comfort at reduced energy costs. There have also been tourism benefits, with several groups travelling to the island to view ongoing projects. Also, thirty residents participated in a trial of eight electric vehicles over three years. The trial found there was a 78% reduction in transport energy costs and a 68% reduction in energy imports when compared to a new diesel car. Around 20% of the electricity used to run the EVs came from wind energy sources. Separately, a bicycle renting business purchased 14 electric bikes and had 2 kW of PV panels installed (Department of Communications Climate Action and Environment, 2015). Data collected from monitoring devices installed at several projects are being used to develop a web-based interface to monitor energy supply and use on the islands.

In 2018, they were awarded the Best Community at the Sustainable Energy Authority of Ireland's (SEAI) Sustainable Energy Awards.

Project summary

Fuinneamh Oileáin Árann
Aran Islands Energy

Type: cooperative enterprise

Model: Collective self-consumption / energy transition infrastructure

Location: Aran Islands, Ireland

Capacity: proposal for three 900kW wind turbines.

Membership: total unknown, membership only for residents on the island

Funding: Various government grants and funding schemes, also membership fees

Status: ongoing

Support: local universities, Community Power (Ireland)

Drivers

Finding a solution to the prohibitive cost of sourcing electricity from national grid, and rising fuel costs for marine and on-island transport.

Promoting a social and solidarity economy

Limitations

Geographic and seasonal limitations result in higher development costs.

Financial and perceptual barriers

Challenges

Dependence on expensive and polluting fossil fuels for electricity production, heating, and transport.

Advisory assistance to manage the coop, though now has one full-time manager and two part-time assistants.

Other notable examples

- Community Power (https://communitypower.ie/): is Ireland's first community-owned electricity supplier. The initiative grew out from an existing community-based wind farm, Templederry Wind Farm in Co. Tipperary, which are now two separate operations. Community Power focuses on developing other community owned renewable energy projects in Ireland. The wind farm has been operating since 2012 with two turbines generating 15 GWh of electricity every year. The initiative also buys renewable electricity from several small

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

and micro-hydro and wind generators across Ireland and sells it to their customers. The initiative is supported by the Tipperary Energy Agency, Friends of the Earth Ireland and Smart M Power. They also work with the Energy Community Tipperary Co-operative, the Aran Islands Energy Co-operative, Tait House Community Enterprise, and Claremorris and Western District Energy Co-operative.

- Energy Cooperatives Ireland (ECI) (https://www.energyco-ops.ie/): is a cooperative network focusing on renewable energy consulting to promote community access to renewable energy. It comprises renewable energy experts, experienced cooperative regulations advisers, expert project managers, financial advisers and a highly skilled communications and media team. ECI has a democratic structure and supports cooperatives with wider community membership to develop their businesses, aiming to distribute benefits to all communities.

Czech Republic

In the Czech Republic, renewable energy comprises approximately 12% of the country's overall energy profile (35% nuclear, 53% fossil fuels). The main renewable sources are biogas, biomass and solar (around 25% each), are followed by hydroelectricity (about 18%), with the remaining largely taken up by wind projects (CMS, 2020).

Czech civil society and local municipalities regard community energy as a critical opportunity to improve wellbeing in cities and rural communities. However, cooperative ownership of renewable energy is still at an early stage in Czech Republic. Approximately 45 municipalities own decentralised renewable energy power plants (mostly biomass heating plants), three municipalities own wind power plants, four operate small hydroelectric power plants and seven own photovoltaic arrays (Community Power, n.d.-c).

Community ownership is strongly represented in the apartment building sector. Many flats are owned by a consortium of owner-occupiers. Energy efficiency projects for such flats might be seen as community power projects. There are opportunities to develop projects focused on energy efficiency improvements of apartment buildings and municipal buildings employing subsidies and other funding streams from the EU. As a result, the number of these kind of community projects may rise.

Main socio-political contexts

Between the years 2004 and 2013, the Czech Republic more than doubled its renewable energy capacity. However, feed-in-tariffs and other supports for renewable energy were discontinued in 2013, which has had a negative impact on the development of renewables, including community energy. Today, there are no supports for renewable energy projects or for enabling citizens take ownership of their energy supply, except for a limited investment support for small rooftop PV arrays. In addition, some measures actually discourage establishing community energy project using RES. Projects such as wind turbines have been found to be inappropriate when sited near military areas or villages in particular regions. However, once the Renewable Energy Directive is transposed, community energy may find a more favourable platform over the coming years (Friends of the Earth, 2020).

Illustrative Case Study: Czech Republic

(3) VERONICA CENTRUM HOSTĚTÍN, CZECH REPUBLIC

Overview

The village of Hostětín in the Czech Republic is located on the edge of the White Carpathians Landscape Park, with no connection to the natural gas network and poorly supported connection to the national electricity grid, resulting historically in intermittent electricity supply. It is now considered largely self-sufficient in terms of energy, the majority of which comes from renewable energy through the operation of a municipal biomass central heating plant and solar power plant. The biomass plant has an installed capacity of 732 kW, fuelled by wood chips supplied by nearby sawmills, and is connected to 69 of the 81 homes in Hostětín by a 2.4km long distribution line. The overall investment in the biomass plant of CZK 36.4 million (€1.4 million) was financed by

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

contributions from the State Environmental Fund of the Czech Republic, a Dutch grant, the Czech Energy Agency, and from citizens living within the vicinity of the heating plant. The investment in the heating plant was complemented by a thermal insulation scheme, which local citizens also availed of further reducing the energy demand. The PV power plant required an investment of CZK 4.4 million (€0.17 million) from four separate entities, the village of Hostětín (as owners of the installation site) as well as three Czech foundations – Nadace Partnerství, Nadace Veronica and Nadace české architektury in equal parts of 31 per cent each. When PV production reaches its peak in the summer months, the heating plant remains out of operation. Approximately 85 per cent of energy production is fed into the national grid (Malý et al., 2019).

In 2012, Hostětín received the Climate Star award, which is given to the most successful European Climate Alliance municipalities and regions for projects of environment and climate protection. The municipality has also won l awards for its approach to the use of renewable energy sources, such as the Energy Globe 2007 and the Czech Solar Award 2009. It was the national winner of Energy Globe 2020. The Centrum Veronica Hostětín was built in 2006 to further the villages agenda of establishing a resource and training centre that could provide education services on environmental and energy related topics and serve as a practical example for municipalities.

Project summary

HOSTĚTÍN
Oficiální internetové stránky

Type: Municipality

Model: Collective self-consumption / energy transition infrastructure

Location: Hostětín, Czech Republic

Capacity: 732 kW central heating plant, also solar arrays on a number of public and private buildings

Membership: 70 households use the central heating plant paying a fixed price linked to operating costs that is supplemented by a variable tariff linked to consumption per household.

Funding: State Environmental Fund of the Czech Republic, a Dutch government grant, the Czech Energy Agency, and local citizens

Status: ongoing

Support: Centrum Veronica Hostětín

Drivers

Stated objectives include improving energy security, promoting sustainable development, job creation and the use of local resources.

Counter depopulation trends and improve standard of living

Limitations

Geographically isolated from main population centres.

Financial and perceptual barriers at early stages.

Challenges

Developing competencies (knowledge, skills, and attitudes) and retaining experienced staff and stakeholders.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Other notable examples

- *Drahany Wind Farm*: is an illustrative example of consumer (co-)ownership in partnership with a joint-stock company, Eldaco a.s., which holds the majority ownership. In 2008, Wind Park Drahany a.s. was established to drive forward the construction of the wind farm. As part of the arrangement, individual citizens and/or municipalities can become shareholders of the wind farm, hold full voting rights, and are entitled to a share in the profits. By 2017, shareholders in the project numbered in the hundreds. A total of 13 wind turbines, with an installed capacity of 39 MW, is planned for the wind farm, which will be located in the municipalities of Drahany, Otinoves and Rozstání Olomouc Region of the Czech Republic. The total investment for the project is in the region of CZK 1.56 million (€60 million). Of this, CZK 312 million (€12 million) is equity, with Eldaco providing CZK 234 million (€9.1 million) and its citizen shareholders contributing CZK 78 million (€3 million). An additional CZK 1.248 billion (€48 million) was secured through a bank loan to be paid back over a period of 13 years. (Malý et al., 2019, p. 2016).

- *Kněžice Bioenergy Centre*: A bioenergy centre project was established in the Czech village of Kněžice in 2007 consisting of a biogas plant with combined heat and power (CHP). It has an electrical output of 330 kW and a thermal output of 405 kW, in addition to a municipal heating plant consisting of two boilers of 800 and 400 kW. The project is the first Czech energy-self-sufficient municipality – the bioenergy project supplies heat to around ninety percent of the village's population through an autonomous heating grid and feeds the electricity it produces to the national grid. The centre is fully operated by the municipality. Bi-products and waste material from cereal crops and flaxen straw, and sorrel stalks are collected and provided to the plant by local farmers, with the ash and digestate from the biogas station used then for land fertilisation. The village secured CZK 83.7 million (€3.2 million) from the European Regional Development Fund and CZK 11.1 million (€0.43 million) from the State Environmental Fund. The remaining CZK 43.2 million (€1.7 million) in funding was financed through a bank loan to be paid back over a period of 15 years (Malý et al., 2019, p. 216).

Italy

The country has experienced an increase in community energy project over the period 2008 to 2013, with the majority being local energy community projects. These comprised mainly of PV plants of 100 kW or less. A small number of initiatives comprised the larger megawatt-sized plants or were network style-projects of different plants coming together to several hundred kilowatts. Most community energy projects have been established from top-down initiatives (local authorities or private company), while a small percentage of them (24%) have been developed through bottom-up initiatives (citizens or grassroots organisations).

The key factor for the increase in the number of community energy projects in Italy has the rolling out of the feed in tariff (FIT) support scheme (Candelise & Ruggieri, 2020). In 2019, a new decree was introduced based on the European Union's "Renewable Energy Directive" (RED II), precisely those in Article 42bis of the Milleproroghe Decree "Innovation in the field of self-consumption from renewable sources", which provides subsidies for RECs and legally defines energy communities as communities that exchange energy for the purpose of collective self-consumption, both instantaneous and deferred. The primary goal of the decree is to benefit communities "at an economic, social and environmental level". All energy consumers can participate in these communities. There are mainly two forms of community: energy communities (many-to-many) and groups of self-consumers who live in the same building or condominium (one-to-many). Before the decree, some pioneering energy communities, such as the case of the Piedmont region, became early adapters of law n.12 / 2018 "Promotion of the institution of energy communities" there. The same for those living in the Puglia Region, which issued laws no. 42/2019 "Establishment of regional energy income" and n. 45/2019 "Promotion of the institution of energy communities". Also, in the Sardinia region, energy communities have been actively promoted. Currently, the number of energy communities in Italy is quite low and can be regarded still as very much at the piloting stage, but it is envisioned that between 25,000 to 100,000 CEC will be developed over the next 10 years (REGALGRID, 2021).

Main socio-political contexts

The gradual national rollout of an Italian regulatory framework for energy communities, in conjunction with a renewed national support for RES initiatives, is progressively shaping the CE sector there. Which other CE implementation models that will be supported by the legislator will depend on the policy decisions that will be taken in the future as the implementation process for the EU Directive progresses. For example, a provision was included in the recent Italian Law 8/2020 for small-scale, collective self-consumption of renewable energy plants below

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

200kW for customers on the same low voltage distribution sub-grid (Candelise & Ruggieri, 2020). The future will certainly be less centralised.

Illustrative Case Study: Italy

(4) Comunità Energetica Rinnovabile (CER) Magliano Alpi, Italy

Overview

Italy's first renewable energy community energy was established in the Northern Piedmont town of Magliano Alpi in December 2020. The REC aims to provide for the energy needs of up to half its residents, deploying a 20 kWp photovoltaic system on the roof of the Town Hall. The system is connected to the Town Hall and can share the energy produced and not self-consumed with the CER (at present users include the local library, gym and school, in addition to the four residents were first to join). There are also two EV charging columns that can be used free of charge by residents. Informed by work from the Energy Center (2021) of the Polytechnic of Turin, which launched first version of its Manifesto of Energy Communities in July of that same year, the Comunità Energetica Rinnovabile (CER) Magliano Alpi drew up its own document charting its plans for developing its own energy community. A key aim of the town is to form part of a consortium of five municipalities to create a series of RECs, once the EU's REDII directive is transposed into Italian law in 2022 (Balkan Green Energy News, 2021). In the meantime, seven people comprise the REC with the mayor acting as president. In 2021, the municipality aims to provide another 20 kWp from another photovoltaic system to be installed on the roof of the municipal gym in accordance with Legislative Decree 34/2019, the so-called Growth Decree. A membership fee of €25 per annum will required of individual citizens who wish to become involved in the project, with the options of producer, consumer and prosumer being available.

A recent Energy4Com report on the initiative's real-time detection of energy flows and the IoT management and monitoring platform indicated that they produced 24 MWh of which 20MWh was self-consumed energy: 20 MWh. Plans are now underway to develop CER2 at the municipality's sporting facility and CER3 at a yet unidentified industrial facility in the area.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Project summary

Type: Municipality-initiated

Model: prosumer electricity

Location: Magliano Alpi, Italy

Capacity: 20 Kwp photovoltaic system

Membership: 7 users (3 municipal users, 3 domestic users, and 1 small craft business user)

Funding: public funding

Status: in operation since 2020

Support: Energy4Com – managing energy services). Polytechnic of Turin – advice and research.

Drivers

The energy transition

Ministerial Decree of 16 September 2020 of the MiSE

Onus to promote "local short supply chains" for energy

Limitations

Limited to photovoltaic infrastructure, at the moment

Challenges

Developing competencies (knowledge, skills, and attitudes) and retaining experienced staff and stakeholders

Reduce energy poverty

Increase energy self-consumption in Magliano Alpi

Design innovative energy prosumer business models using IoT platforms

Other notable examples

- *RETENERGIE*: The RETENERGIE cooperative was founded in 2008 and is considered one of the most significant cooperatives in Italy in terms of innovation and size (Borroni et al., 2019). Its purpose is to produce renewable energy from plants financed through its members, sell this energy to its members (through a daughter company, Ènostra) and provide energy-related services. The aim of the cooperative is to allow citizens throughout the country who lack the ability to install RE systems the opportunity to become (co-)owners of cooperative facilities. The cooperative envisions a new type of energy development based on citizen energy prosumership, as well as an investment model with strong ethical and social connotations. In 2018 the cooperative counted over 1,000 members contributing to 13 running projects, most of those solar PV, throughout the country (Borroni et al., 2019).

- *E-Werk Prad*: E-Werk Prad is a self-reliant community, operating as a cooperative in Prato Stelvio since 1926. The cooperative is composed of 4 biomass stations, 210 solar thermic plants, 5 micro hydro plants and 141 PV installations. The cooperative was initially established by 40 families, though in 2018 counted 1,300 participating families, all of which are shareholders and (co-)owners of the power plants. Households now pay roughly 12 cents per kWh for electricity and 7 cents per kWh for heating, and the cooperative makes around EUR 1 million in profit annually (Borroni et al., 2019).

Switzerland

Although the share in renewable energy (ambient heat, biomass, wind power and solar power) has increased in Switzerland since 2005, the bulk of the country's energy mix still comprise the usual oil, natural gas, nuclear power and hydropower (Hive Power, 2021a). Approximately 60% of the country's total domestic electricity production comes from its 638 hydroelectric power plants. Many Swiss citizens are strongly opposed to nuclear power and Switzerland, through its Energy Strategy 2050, aims to pivot away from nuclear power focusing instead on a strategy of energy-saving through improved efficiency, hydropower growth, and renewable energies. The fully revised Energy Act adopted in 2017 was set out to boost the use of renewable, locally sourced energy with the involvement and financial support of communities seen as essential to achieving this.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

The renewable energy market is supported by the Kostendeckende Einspeisevergütung (KEV) feed-in-tariff and its predecessor, the Mehrkostenfinanzierung (MKF), as well as specified policy goals and targets. Furthermore, renewable energy is also supported through national support mechanisms like the SwissEnergy Programme, which is managed by the Swiss Federal Office of Energy (SFOE). Also, the Swiss government has put in place other measures under its Energy Efficiency and Renewable Action Plans of 2008, such as financial support for replacing existing heating systems with renewable energy alternatives (*e.g.* heat pumps and biomass), revising and strengthening building codes and standards for new buildings (Hive Power, 2021a).

A 2018 survey conducted by the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) noted that of the approximately 150 energy cooperatives they engaged with that formed during the 1990s – and all those formed after 2011 – almost exclusively used renewable energy sources. The key aims of many energy cooperatives is to promote a combination of the following incentives: a more decentralised energy generation system, to strengthen local identity and the local community, and to offer an alternative to nuclear energy. Most energy cooperative members were found to be either private individuals, farmers, and communes or their representatives and while Switzerland has roughly the same number of energy cooperatives per thousand inhabitants as say Germany, Swiss cooperatives are usually smaller and much less visible in the public discourse. However, this contrasts with their often close cooperation with communes, energy supply companies and local communities (Seidl, 2018).

Main socio-political contexts

Although most energy cooperatives are economically viable in Switzerland, they have limited potential to grow and develop with insufficient government subsidies and market outlets being two of the main barriers that inhibit growth in this sector (Seidl, 2018).

Illustrative Case Study: Switzerland

(5) Lugaggia Innovation Community (LIC), Switzerland

Overview

The municipality of Capriasca installed a 30 kWp PV plant in the village of Lugaggia on the roof of the local kindergarten. The building is located on the edge of a residential area, mainly consisting of single-family houses. The self-consumption potential of the kindergarten is limited because most of the production takes place during school summer holidays when the localised consumption demand is low.

AEM, the DSO serving the area, intends to promote the creation of a self-consumption community (SCC) named Lugaggia Innovation Community (LIC), which aims to connect the kindergarten and ten nearby houses. The energy exchange inside the community will be compliant with existing laws regulating the SCCs.

By creating the SCC, AEM aims to test and verify its capability to provide new energy services to its customers, by leveraging two novel technical solutions provided by the Swiss companies Optimatik and Hive Power. The first solution consists of a centralised energy management platform, which uses the existing smart meter infrastructure for sensing and actuation. The second solution implements a decentralised control approach secured by blockchain technology and requires the installation of a computing and controlling unit, with is then connected to the smart meters. To further increase the flexibility in the SCC, AEM will install a district-level storage system.

A key goal of the Lugaggi Innovation Community is to evaluate the needs and requirements of the project to its realisation in a real environment context. The project

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

aims to provide recommendations to allow replicability and scalability of peer-to-peer self-consumption communities. In particular, an important goal of the project is to ensure fair treatment of all stakeholders (especially local stakeholders) and implement measures that promote a more efficient use of energy resources (*e.g.* limit excessive consumption, *etc.*). In order to evaluate the degree of knowledge and/or the level of acceptance among community stakeholders to participate in one of these new self-consumption communities, the LIC is setting up a living lab to examine these issues.

Project summary	Drivers
LIC LUGAGGIA INNOVATION COMMUNITY *Type:* Municipality *Model:* prosumer production and distribution SCC *Location:* Lugaggia, Switzerland *Capacity:* 30 kWp PV plant *Membership:* a living lab has been established to test users' acceptance *Funding:* through the Hive Power platform, the project received funding from the European Union's Horizon 2020 research and innovation fund *Status:* ongoing *Support:* Consortium of project partners, including AEM, SUPSI, OPTIMATIK, Hive Power and Landis+Gyr	Commitment to the energy transition Finding solutions to resolve the following: 1.) operational challenges, 2.) overloading of grid components and 3.) the current high cost of self-generation **Limitations** Limited to photovoltaic infrastructure, for now. No mention of community-oriented benefit scheme for the energy vulnerable. **Challenges** Developing competencies (knowledge, skills, and attitudes) and retaining experienced staff and stakeholders. Acceptably from community stakeholders Using blockchain to decentralise the management of energy bills

Other notable examples

- *Sunraising Bern/Energiewerke Bern Partnership*: A partnership between Sunraising Bern, a non-profit start-up founded in 2015, and Energiewerke Bern (EWB), the electric utility company, aims to promote citizen (co-)ownership of renewable energy technologies. Sunraising offers the residents of Bern a chance to buy shares in a locally installed solar plant from which they receive a share of electricity generated for free for 20 years. Sunraising installs and maintains the solar panels, and sells the shares of the solar plant. The power generated is then fed into the electric grid managed by EWB, which delivers the electricity to Sunraising customers (Broughel *et al.*, 2019)..

- *Appenzeller Energie*: The association Appenzeller Energie was founded in 1991 in response to the nuclear accidents at Three Mile Island in the United States and Chernobyl in the former Soviet Union. In 2017 the association had about 200 members involved in the construction of a number of RE-generating facilities, including solar photovoltaic installations, hydroelectric power stations, wind turbines and solar thermal systems. The electricity generated is sold to the national grid operator as 'grey' electricity, while customers from the local area can avail of a facility to purchase certificates of origin for €0.136/kWh. The association has a strong regional focus, offering workshops and opportunities for cooperation with local groups (Broughel *et al.*, 2019).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

United Kingdom

The experience in the UK over the past 20 years has generally been one of rapid growth and investment in renewable energy projects. In 2017, the UK community energy sector comprised a total electrical generation capacity of 249 MW (Community Energy England, 2021). The introduction of a Feed-in Tariff scheme (FIT) in April 2010 is widely regarded as having kickstarted the rapid expansion of community-oriented renewable energy projects there. Subsequent changes to the FIT programme and its related policy instruments, in 2012 and again 2015 in particular, are also widely acknowledged to have actually arrested growth in this sector in the proceeding years after their implementation (Nolden et al., 2020). Despite these setbacks, business model innovation around FITs have provided the foundations for developing community-oriented RES energy projects where a dedicated and skilled team can provide the necessary inputs needed to keep the project going despite the policy, regulatory and planning uncertainties that may arise at each stage of the development process (Hargreaves et al., 2013; Nolden, 2013). Since 2015, community RES projects in the UK are widely believed to be in a state of flux since 'community energy is not quite subsidy free and remains reliant upon government support' (Robinson & Stephen, 2020). Currently, community energy projects are concentrated in South-West England, the London area, and in the Scottish Highlands where the presence of strong regional intermediaries act as positive drivers for development (Berka, 2018).

In 2008, a cornerstone of the UK legislation was enacted with Climate Change Act, which outlined an emissions reduction pathway to 2050 of 80%, and 34% by 2020. Also, it launched the Renewables Obligation (RO) scheme which is one of the country's main support mechanisms for large-scale renewable electricity projects and places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources. Citizens and communities were also engaged in this programme through the "Low Carbon Building Programme", which ran from 2006 to 2010 funding domestic microgeneration technologies and larger-scale distributed generation. This programme was replaced by the microgeneration feed-in tariff scheme in 2010, targeting small-scale energy consumers such as households and community-oriented energy projects (Tanulku, 2012) with homeowners potentially receiving up to £1000 (approximately €1180) for its 'clean energy cashback' mechanism. In addition, the "Renewable Heat Incentive" and other support measures under the "Green Deal" were announced in 2012 further encouraging citizen investment in new RES technologies. While efforts have also been made to reduce carbon emissions with the "Carbon Reduction Commitment" (a cap-and-trade scheme introduced in 2007 and modified in 2015), targeting large energy users in the public and private sectors such as hotel chains, supermarkets, banks, water companies, central government departments and large local authorities.

Regarding community energy, the devolved government in Scotland, wanted to increase the uptake of community renewable projects to 500 MW by 2020 (Haggett et al., 2013). By 2013, there were 360 community energy projects in Scotland, which together constitute 30.4 MW of installed, operational RES generating capacity.

Established in 2007, the Scottish Government established Community Energy Scotland (CES) to provide practical and technical support of community project development, mainly focusing on community wind farms and micro-renewable installations. However, the Scottish Government had limited control on several key barriers for community renewable energy projects, such as grid connection policy, energy market regulation, and levels of prices support regulated by the UK Government. By learning from projects led by communities, the Scottish Government developed some policy innovations that were later adopted at the UK level (Berka, 2018). By the beginning of 2020, Scotland had an installed capacity of 11.8 gigawatts (GW) of RES electricity capacity, accounting for nearly 25% of the UK's total RES generation, and meeting nearly all of Scotland's electricity demand for that year.

Main socio-political contexts

The discontinuing of the FIT scheme is potentially a significant barrier for the community energy sector. According to a 2019 report from Community Energy England 69% of respondents they engaged with had negative views on the future prospects of the community energy sector there given the growing uncertainty from the loss of the feed-in-tariffs and policy and subsidy changes in 2018 (2019). At present, there are 300 community energy projects operating in England (252), Wales (47) and Northern Ireland (1). Of these established since 2015, the two most popular company types are Community Benefit Societies (BenComs) (47%) and Community Interest Companies (CIC) (11%) with most focusing on energy generation (268), low carbon transport (47), energy storage (39) and energy efficiency (102) in 2019.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Sandy Robinson and Dominic Stephen (2020), in their assessment of the community energy sector in the UK post-FIT, present a number of key challenges facing the sector over the coming years, see Figure 1 in the discussion and conclusion section of this report. The greatest barriers included organisational capacity and amount of time involved in progressing a RES project. The very nature of the community energy sector, with its reliance on volunteers and limited opportunities for capacity building continue to hamper the sector. Also, the repeated poor funding has not been resolved there, despite some early-stage funding for technical feasibility studies *etc.* (*e.g.*, the Rural Community Energy Fund) funding supports remain scarce for core staff who can drive a project forward to the operational phase.

Illustrative Case Study: United Kingdom

(6) Isle of Eigg electrification project, UK

Overview

The Isle of Eigg, a small Hebridean Island about five miles long and three miles wide, lies approximately 16 kms off the west coast of Scotland, just south of the Isle of Skye. The population of less than 100 people were previously supplied with electricity using diesel generators. In February 2008, Eigg Electric (a subsidiary of the Isle of Eigg Heritage Trust) established a stand-alone or off-grid system providing reliable, 24-hour electricity for the first time using renewable sources. Most of the approximately £1.6 million (approximately €1.8 million) investment came from the European Union, though residents of the island did contribute between £500 and £1000 for 5kW domestic and 10kW business connections (Krug-Firstbrook et al., 2019). The island is owned and managed by the Isle of Eigg Heritage Trust; a community company limited by guarantee. As a CLG the trust is a separate legal entity with limited liability of its three members – residents of the Isle of Eigg Residents' Association, The Highland Council and the Scottish Wildlife Trust. Eigg Electric Ltd. is a subsidiary of the Isle of Eigg Heritage Trust, a community-owned, -managed and -maintained company tasked with operating and maintaining the electricity system (Isle of Eigg, n.d.-a). The running cost of Eigg Electric is covered by a local energy tariff for residents and businesses, as well as an off-grid FIT and Renewable Obligation Certificates (ROCs) (Krug-Firstbrook et al., 2019).

To provide the island with a continuous, reliable electricity supply three renewable resources were exploited – water, sun and wind – as no single resource remains capable of meeting all the island's electricity needs on its own. The island currently operates three hydroelectric generators (one 100kW and two 5-6kW); four small 6kW wind turbines; and a 50kW photovoltaic array. The renewable energy scheme has provided approximately 95% of the island's electricity since launching in 2008. However, two 64kW diesel generators remain as back-up for when renewable resources are unavailable. Eleven kilometres of underground cable, laid to form a high-voltage electricity grid for the island, distributes the power generated by the renewables throughout Eigg before being converted to domestic voltage by transformers for use in homes and businesses. To ensure that enough electricity exists for everyone on the island, each house has a maximum use limit of 5kW, enough to power a washing machine, at any one time. The limit for businesses is 10kW. OWL[11] meters are used throughout the island to inform residents of how much electricity they are using at a

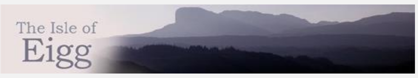
[11] OWL meters are a brand of commercially available digital energy monitors

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

given moment. Should Eigg Electric produce more electricity than necessary, the excess is used to heat community buildings on the island (Isle of Eigg, n.d.-b).

The Isle of Eigg electrification scheme was a community-inspired project, the biggest project outlined in the island's ten-year plan for sustainable development. It holds the title of the world's first community to launch an off-grid electric system powered entirely by wind, water and solar (Caramizaru & Uihlein, 2020) and the project was awarded Best Community Initiative at the 2008 Scottish Green Energy Awards (Krug-Firstbrook et al., 2019).

Project summary



Type: Community-owned off-grid system

Model: prosumer production / collective self-consumption

Location: Isle of Eigg, UK

Capacity: 119kW hydroelectric, 24kW wind farm and 54kW PV array (backup: 160kW diesel generation). Total: 357kW

Membership: all electricity consumed by the 105 islanders (+ 25,000 tourists per annum), with any excess redirected to heating community-owned buildings

Funding: Isle of Eigg Heritage Trust, residents' connection fees, The Big Lottery fund, Highland and Islands Enterprise, European Regional Development Fund, Highland Council, and Energy Saving Trust. Triodos bank assisted in the financial arrangements, providing bridging loans.

Status: ongoing

Support: Clean Energy for EU Islands Secretariat

Drivers

Commitment to the energy transition

Prohibitive cost of interconnector to national grid

Need to find solution to unreliable, diesel-powered electricity generators

Limitations

High cost, limited application, and poor performance and/or intermittence of some of the technologies are three limitations

No mention of community-oriented benefit scheme for energy vulnerable.

Challenges

Reliable supply comes from excess capacity but costs remain high (Chmiel & Bhattacharyya, 2015).

Modular back-up capacity and more wind power needed to improve system functioning.

Other notable examples

- *Energy4All*: Energy4All is a network of 28 renewable energy cooperatives founded in 2002. Between all the cooperatives combined, Energy4All represents thousands of members across the UK and has created 30MW of electricity capacity. First founded in Barrow-in-Furness by the Baywind Energy Co-operative, the UK's first renewable energy cooperative, Energy4All now works with communities to develop and raise the funds for innovative renewable energy projects (Energy4All, 2021b). The cooperative aims to support the UK and Ireland's transition to low-carbon economies in a way that allows the average citizen to make a tangible contribution to progressing this goal. Energy4All works with communities to develop successful business cases and support them through the planning applications for projects as well as raising the funds necessary to develop them. Energy4All brings technical expertise to the projects and manages their continued operation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Any returns on capital distributed among members is capped to enable surpluses to be returned to support the cooperative's mission. To date Energy4All has been involved in the development of a range of technologies including wind and solar to community heat and hydro schemes (Energy4All, 2021c). Energy4All focuses on helping communities to realise the local benefits – environmental, social and economic – of community ownership of renewable energy. The cooperatives operate under the principle of "one member, one vote". Membership of an Energy4All cooperative usually starts at £250, and the maximum legal investment is capped at £100,000. People living close to the projects are given preference for joining the scheme in the hopes that economic benefits to the local community are maximised (Energy4All, 2021a).

- *Edinburgh Community Solar Limited*: The Edinburgh Community Solar Co-operative (ECSC) was formed in December 2013 as a means of promoting and developing renewable and low carbon energy production in the city of Edinburgh. The cooperative was initially supported by Energy4All in raising the funds required to install solar photovoltaic arrays on 24 host council buildings across Edinburgh (Edinburgh Community Solar Co-operative, 2021b). To date, the cooperative has installed 1.38MW of capacity, generating approximately 1.1GWh per year (weather dependent). The ECSC is a registered charity under the Co-operative and Community Benefit Societies Act 2014, and counts over 540 members (Edinburgh Community Solar Co-operative, 2021a). It continues to be supported by Energy4All who supply management services, share interest management and general administration services (Edinburgh Community Solar Co-operative, 2021b). The electricity generated by the PV arrays is typically sold to the Council to cover the internal demand of the building on which the PV arrays are installed. ECSC also receives an income through the Feed in Tariff. Surplus electricity is exported to the grid. Each year, when all deductions have been made to the income generated, share interest is paid to ECSC members with a cap on the return of 5%. Surplus fund are allocated to the community benefit fund (Edinburgh Community Solar Co-operative, 2021b). The ECSC has begun work on installing more solar panels and energy saving technologies to new sites around Edinburgh and are collaborating with partners on a range of energy saving and low carbon measures (IEA & Edinburgh Community Solar Co-operative, 2021).

- *Aberdeen Community Energy*: Aberdeen Community Energy (ACE) is a community benefit society based in Scotland. Though a more conventional grid-connected energy project than some of the other examples mentioned in this document, the project remains unusual in that it is one of few urban community energy groups, located just outside a large city. ACE allows investors to obtain shares in the energy project – expecting a return of up to 7 percent - while reinvesting excess money generated by the project back into the local community to be spent on community development projects. ACE was set up in 2015 by the Donside Community Association to build, own and operate the Donside Hydro scheme on behalf of the local community. ACE's Donside Hydro project began generating energy in late 2016 through a 100-kW run-of-river scheme, the most economically feasible option under the UK's FIT regime. The project received the title of Best Scottish Community Energy project at the Scottish Green Energy Awards in 2016 (Krug-Firstbrook et al., 2019).

- *Brixton Energy*: Brixton Energy is a cooperative operating three rooftop community solar energy projects in the Brixton area of south London since 2012. Each individual project is registered as a Community Benefit Society owned by its shareholders, who are often a mix of residents or organisations and investors. Each project has between 80 and 100 investors, the percentage of which are local varies between projects e.g. over 70 per cent of investors are locals in Lambeth, though this is only 50 per cent in Brixton. The installation of each project is financed by both the shares sold and funding from local and national grants. The first two solar energy projects required a minimum shareholding of GBP 250, though this was lowered to GBP 50 for the third project to encourage those with less financial resources to invest. Electricity produced by the projects is first sold to users within the buildings, and excess is then sold to the National Grid. Brixton Energy supports the locality by offering 20 per cent of project profits to be spent on energy saving and efficiency initiatives in the local community and placing a strong emphasis on community engagement and education (Krug-Firstbrook et al., 2019).

- *Wiltshire Wildlife Community Energy (WWCE):* is a Community Benefit Society and the owner of two solar farms in a rural area in the Southwest of England. The first wind farm, initiated in 2013, is 100 per cent owned by WWCE and was financed through a community share offer that allowed the public to make investments in WWCE. As a Community Benefit Society, all shareholders have the same voting rights, irrespective of the size of their investment. A 'split ownership' arrangement between WWCE and a commercial company was adopted for the second solar farm, which allowed the overhead costs of grid connection to be shared between the two partners, thus increasing the total amount of RE generated. The split ownership model resulted in tensions between WWCE and the other commercial partner in the arrangement, who operated on a different set of expectations and timescales (Krug-Firstbrook et al., 2019).

Sweden

The energy profile for Sweden is an interesting one. Despite being a high energy user, its emissions levels remain relatively low when compared to countries of a similar size. The rollout of RES technologies there has been extensive and deep, with the overall share of renewable energy used still growing. In fact, by 2012 Sweden had already met its 2020 targets. In 2019, renewables made up 230.7 TWh of the country's total energy supply of 548 TWh. Electricity generation that same year reached 166 TWh, comprising 39 per cent nuclear power, 39 per cent hydropower, 12 per cent wind power and 0.4 per cent solar power with combustion-based power providing the majority of the remaining ten per cent (Swedish Energy Agency, 2019). Compared to other countries, Sweden has historically had relatively low and stable energy prices for customers for heating and electricity. This special characterisation of high shares of renewable energy, centralised energy production, a strong involvement from local governments in energy production, and relatively low energy prices has resulted in Sweden having numerous CE initiatives yet still having fewer when compared other European countries of a similar size (Magnusson & Palm, 2019).

The electricity market is highly centralised with few large utility companies having any contact with users beyond the traditional transactional arrangements. Also, despite a liberalised energy market and favourable policies towards renewable energy it has mainly fallen to local authorities to initiate and operate community-oriented energy projects, engaging citizens in the process (Magnusson & Palm, 2019). By 2019 there were approximately 140 active community energy projects, the majority comprising wind and PV cooperatives (78 active, 20 discontinued) and eco-villages (32) usually located in rural areas. Also, eight rural communities operate a variety of production models with a local focus (mainly hydropower, district heating or energy-saving plans) (Magnusson & Palm, 2019). Most community energy projects are found in the Västra Götaland region and Norrland in Northern Sweden.

Motivations for developing RES projects are mainly financial, but also energy security through self-supply. Most solar and wind cooperatives are organised as incorporated associations, which sell shares to members and invest in renewable electricity production. Technologies differ from one project to another: some have installed energy-efficiency measures while others are running renovated hydroelectric power plants. The profits made by four of the communities using hydropower goes back to the community as investments in community centres or school buildings.

Main socio-political contexts

There is a lack of a coordination by the umbrella organisations tasked with supporting community energy initiatives in Sweden is pronounced. Speaking to participants involved on community energy initiatives or grassroots innovations, Magnusson and Palm (2019) discovered that while they were aware of these organisations they did not see a benefit from joining them. This attitude may explain, in part at least, the slow development of community energy sector in Sweden. In addition, the future of the sector can be described as uncertain considering the growing insecurity from changes to the regulations such as a tax on wind cooperatives (the development of wind cooperatives was strong during the 1990s and 2000s, but a new tax interpretation of the regulation in 2009 has slowed down development considerably with only a small number of new cooperatives having started since then). Furthermore, little economic support from government and low electricity prices are two additional factors informing the financial and perceptual barriers experienced by citizens looking at the potential viability of new community energy projects in Sweden (Magnusson & Palm, 2019).

Illustrative Case Study: Sweden

(7) Solbyn Association, Sweden

Overview

Solbyn is an eco-village in Southern Sweden established in 1988 and made up of fifty households. Solbyn Association, the tenant-owner association involved in running the project, also consists of fifty apartments housing tenants who wish to implement a long-term strategy on environmental, energy and economic sustainability. The village places

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

an emphasis on promoting self-sufficiency and communal living, as well as encouraging social contact (Caramizaru & Uihlein, 2020).

The association was founded in 1978 by a group of well-educated, environmentally motivated citizens who decided to develop and live in an ecological village. Inspired by Rachel Carson's book Silent Spring, members met every six weeks over ten years to plan and build the village. The association is largely self-managed and volunteer-led, fulfilling administrative functions through a number of boards, interest groups and housing committees (Solbyn Association, 2018).

The site of the village has a southwest exposure, which allows residents to maximise the solar gain of their buildings through passive solar heating techniques, with each structure having large windows and a built-in glasshouse extension on the south-facing side with much smaller windows to the north. All windows are triple glazed and the dedicated heat exchange systems contributes to the overall energy efficiency of the buildings and improves ventilation. This device is placed above the stove to allow for the air exiting the building to heat the air entering. The air of the house is exchanged every two hours incurring minimal heating costs. Furthermore, thick insulation and cement walls contributes to the house slow cooling down and heating up. These measures halved energy costs (when compared to similar houses in the Swedish region (Thomas, 2015).

In addition to improved energy efficiency, each home is equipped with electric radiators and water heaters (with some heat stored in concrete walls from solar gain). Also, a portion of members have bought shares in wind farms and establishing their own PV arrays to offset the impact of electricity consumed from non-renewable sources (Norbeck, 2004).

Project summary

Type: Community-owned passive solar village, tenant-owner association

Model: energy efficiency project

Location: Dalby, Sweden

Capacity: 50 apartments, each saving 30% on energy compared to a standard house (est. 13,300 kWh pa in Solbyn vs. 19,200 kWh pa standard) = 295,000 kWh saving each year

Membership: 50 households

Funding: self-funded with support from the HSB housing cooperative

Status: ongoing

Drivers

Commitment to the energy transition

EU targets to 2020 and 2030

Swedish energy targets: *e.g.* The Electricity Certificate System

Limitations

Members must be part of the tenant-owner association

Lack of engagement with the local municipality

Challenges

How to meaningfully engage with the municipality.

Difficult in translating socio-technical challenges between niche and regime (Kim, 2016)

Motivating municipality to accommodate new initiatives

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Support: HSB housing cooperative	

Other notable examples

- *Farmarenergi I Eslöv AB*: is a cooperative composed of nine farmers who came together to provide small-scale local district heating through solar and bioenergy. Through a 15-year long-term agreement with the Eslov municipality, the cooperative supplies local heating through a closed network, generally producing in the region of 2,000-2,500 MWh/year (Caramizaru & Uihlein, 2020; LRF, 2016). Excess electricity from the cooperative's solar farms and wood chip boiler is sold to Kraft Energie. The cooperative retains a strong interest in renewable energy and places importance in achieving energy independence (Caramizaru & Uihlein, 2020).

- *Bostadsrättsföreningen Lyckansberg*: is a housing consisting of 85 tenant-owned apartments. The housing association operates a solar cell plant which began producing electricity in 2018 for residential use within the association hall, commonly for purposes such as lighting, laundry cabins and the sauna. When excess electricity is produced this is sold to the grid, whereas should demand exceed supply electricity is bought from the grid instead (Caramizaru & Uihlein, 2020).

Spain

The experience of the energy transition in Spain has seen a general absence of a stable and enabling financial and regulatory framework for community energy and only recently has it seen a shift in this regard with the issuing of a royal decree in June 2020 offering, for the first time, a legal definition for community energy. Despite an encouraging start which saw Spain ranked second worldwide in 2008 in terms of PV solar energy (Ibarloza *et al.*, 2018), subsequent readjustments to the regulatory framework up until 2018 saw community energy projects actually discouraged through a series of changes to various legal instruments, increased bureaucratic and administrative red tape, culminating in the so-called 'sun tax' in 2015. This did much to stymy growth in community-and/or citizen-led solar power projects in Spain over the intervening years (Nally, 2016). However, in 2019 the sun tax was abandoned, and community-oriented RES initiatives have started to slowly emerge once again. Wind energy, usually produced by large energy utilities, is now the most popular type of renewable energy in the country and there is considerable interest in energy ownership. Existing community energy initiatives are generally concerned with photovoltaic arrays for collective self-consumption, while a transposition of the European directives on energy communities is still forthcoming. Local institutions, primarily local and city councils, have been crucial to promoting the initiatives of local energy communities in Spain and there are many local municipalities eager to get involved in energy projects. Community energy projects in Spain have a strong educational and community support culture, with groups active in schools, adult education centres, workshops, and energy cafes. This has helped build greater awareness and support for the transition to RES technologies among the general population (Friends of the Earth Europe, 2020).

Main socio-political contexts

Changing regulations, particularly linked to taxes, has made citizens reluctant to invest in community energy projects, particularly after 2011. There also remains a lack of legal and financial supports, hindered by a still emerging governance framework and definition of community energy that is further compounded by significant large bureaucratic and administrative burdens. Furthermore, a certain oligopoly has emerged in the energy market with companies like Iberdrola, Endesa, Naturgy, EDP España and Repsol presenting significant barriers to the advancement of energy production by communities and individual citizens. Large renewable energy developers, especially those producing wind power, are buying lands from farmers to establish energy plants, which in turn provide limited benefits to local people (Friends of the Earth Europe, 2020).

Illustrative Case Study: Spain

(8) Som Energía, Spain

Overview

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Som Energia is a non-profit green energy consumer cooperative, the first renewable energy cooperative in Spain. It was founded in December 2010 by 178 founding members – its membership base has experienced exponential growth since then and currently boasts over 70,000 members throughout the country. Som Energia was established based on agreements between several citizen projects relating to the energy transition in Girona, Catalonia, with the aim of promoting citizen engagement with sustainable development projects and selling renewable energy generated by small-scale projects to its members and clients. Currently, the cooperative generates 18.5 GWh/year through renewable sources of electricity, enough to supply the homes of approximately 7,400 partners and clients. The cooperative currently hosts 15 projects, 12 of which are in operation, with a combined installed capacity of 9.7 MW and budget of over €10.5 million, and 3 of which are under construction or in the study phase. Of these projects, the majority are in Catalonia (8), with the rest spread across Andalusia (4), Castile and Leon (2) and Valencia (1) (Borroni et al., 2019).

Members and partners support the cooperative financially in order to support energy production from a number of energy sources (solar, wind, biogas, biomass) (Caramizaru & Uihlein, 2020; Som Energia, n.d.). Initial membership is €100, which is returned upon leaving the cooperative (REScoop, 2015). The cooperative symbolises a social movement carried by its members, which has given rise to significant collective investment opportunities. In September 2015, for example, roughly €800,000 was raised by members in the space of two hours to fund a hydroelectric power plant in Castile and Leon, while approximately €5 million was collected over the course of seven days in October 2017 to develop three PV plants in Valencia, Catalonia and Andalusia. The cooperative also facilitates financial participation of its members in projects which are externally managed by other entities, like Ecooo and Eolpop, but who are linked to the organisation in terms of organisational philosophy (Borroni et al., 2019).

.

Project summary

Type: Cooperative enterprise

Model: Virtual-net metering / collective self-consumption, self-production

Location: Various regions across Spain

Capacity: 9.7 MW installed

Membership: >70,000 members

Funding: Various fundraising initiatives organised by members, also initial membership fee of €100

Status: Ongoing

Drivers

Desire to move further away from the current unsustainable energy model based on fossil fuels.

Promoting citizen engagement with sustainable development projects and fostering the growth of a more social and supportive economy and eliminate energy poverty.

Limitations

Financial and perceptual barriers

Challenges

Changing government policies have made it more difficult to fund projects in the past, such as when the government made

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

	reductions to the FIT scheme with retroactive effect.

Other notable examples

- *Eolpop*: Eolpop is a limited company founded in 2009 with the aim of promoting the construction and management of a (co-)owned, grid-connected wind turbine through the acquisition of small shares by members of the public. The wind turbine in question is located on private land leased in the municipality of Pujalt, west of Barcelona, and has a capacity of 2350 kW. Som Energía and several other RES cooperatives are current shareholders, thus offering the project a wealth of experience in the wind sector. Over the years, citizens participated in the project development through financial support, mostly in terms of pre-registration contributions (€100 for individuals; €250 for families; and €500 for entities). In March 2018, nine years after the project launch, the wind turbine began supplying the grid with renewable energy (Borroni et al., 2019; Eolpop, 2018).

- *Fundacion Terra*: Fundacion Terra was created in 1994 with the purpose of promoting various environmental initiatives, such as the "Ola Solar" project in 2007, which saw the collective financing of a 41.4 kW PV installation on the roof of the Mercat del Carmel in Barcelona. Participation in the foundation is mainly through investment in capital - the investors in the foundation are all private consumers who participation in the economic running of the foundation through "accounts in participation" – though it is possible to participate as a member (Borroni et al., 2019).

- *Barcelona Energía*: Barcelona Energía is the public electric power distributor of Barcelona, founded in 2017 and managed through the public utility company TERSA. The goals of the distributor include feeding locally-produced green energy into the grid; providing electricity to the City Council and other municipal companies; eventually supplying the people of Barcelona with energy (Barcelona Energía, n.d.). The renewable energy supplied by Barcelona Energía originates from a waste-to-energy plant in Sant Adrià de Besòs, a biogas plant, and 41 PV plants installed on various buildings owned by Barcelona City Council. Total installed capacity comes in at 45 MW. Citizen participation in this instance is generally restricted to participation in local governments (Borroni et al., 2019).

Poland

In Poland, there are almost no energy communities in place at present. Currently there are roughly fifty examples of RES infrastructure installed in multi-family housing estates across the country, though this figure is very small when one considers approximately 50% of the Polish population live in this type of accommodation. The Polish Government has established a plan for encouraging the growth of energy communities by channelling €97m of funding from the EU's Recovery and Resilience Facility12 into a national programme. The Krajowego Planu Odbudowy (KPO)13 also aims to provide further support for potential community energy projects by strengthening the economic prospects and social resilience of citizens post-COVID (Government of Poland, 2021). The plan is to allocate resources to support a number of key themes including digital transformation, resilience and competitiveness of the economy, energy and a reduction of energy intensity, green and intelligent mobility and the availability and quality of health care.

Main socio-political contexts

According to the non-governmental organisation CEE Bankwatch Network, a key reason for the low number of community energy projects in Poland to date is the rather miniscule allocation of funding supports RES projects can avail of and, most notably, the Polish government's failure to meaningfully develop an onshore wind and solar energy sector in the country. While CEE Bankwatch Network acknowledge that the €6,347 million allocated to RES and energy efficiency related projects in Poland's recent recovery and resilience plan does suggest a certain change in policy, the projects outlined in the KPO "lack the reformative elements necessary to make an effective and sustainable reduction of greenhouse gas emissions in line with the EU's Renovation Wave Strategy objectives"

[12] The facility is key instrument of NextGenerationEU, a temporary recovery instrument set up to meet the economic and social challenges brought on by the ongoing coronavirus pandemic.
[13] National Reconstruction Plan

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

(2021, p. 2). For example, the current plan to renovate single-family buildings under the Clean Air programme still financially supports the installation of new coal boilers, in conflict with the 'do no significant harm' principle. Also, Poland has still not fully implemented the RED II and internal market directives, which give specific rights and opportunities to active citizens, energy prosumers and energy communities.

Illustrative Case Study: Poland

(9) Spółdzielnia Nasza Energia, POLAND

Overview

Poland's first energy cooperative was established in 2014 in south-eastern Poland with the aim of tackling energy security. The cooperative was a joint project established by Bio Power Sp., Elektromontaz Lublin and the four municipalities of Sitno, Skierbieszow, Komarow-Osada and Labunie. The private-local government initiative was created in response to high electricity prices and aims to ensure energy independence for its consumers by tapping into the potential for a grid of agricultural biogas plants to supply electricity and heat (Caramizaru & Uihlein, 2020). The project began as an effort to tackle regional issues of energy provision and prices. The project consists of 15 interconnected biogas plants which are expected to deliver electricity to public buildings, street lighting and households throughout the region. Membership in the cooperative is open to all private and legal persons: the entrance fee is about €250, while a single share costs roughly €125. The focus in Poland remains on energy clusters, rather than energy cooperatives, meaning cooperatives generally suffer from lack of dedicated support (Borroni et al., 2019). Spółdzielnia Nasza Energia (Eng. Cooperative Our Energy) plans to rely on biogas installations in all the member gminas[14], based on an innovative project proposing a local system of "energy knots", connected with each other by an autonomous grid. It aims at generating locally produced, cheap, green energy to the local communities. The coop will support local development, create jobs and a stable market for biomass, by using the abundant locally grown energy materials. It also aims at benefitting local communities and potential investors by providing lower energy prices and higher energy security (Community Power, n.d.-b).

[14] A gmina is the principal form of the administrative division of Poland and is similar to a municipality.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Project summary	Drivers
SNE Spółdzielnia Nasza Energia *Type:* Cooperative enterprise *Model:* Virtual-net metering / collective self-consumption *Location:* Zamość region, Poland *Capacity: 15 biogas plants will be built, each with a capacity of 0.5-1 MW* *Membership: c. 300* members *Funding:* Initial €150 million investment, with €30 million coming from the cooperative's own resources and the rest covered by subsidies and commercial loans; membership fee of €250 and single share fee of €125 *Status:* Ongoing Support: Bio Power Sp. Z o. o.	Created in response to the high electricity prices offered by system companies. Promoting energy independence and security throughout the region, as well as local development and the creation of jobs. **Limitations** Financial and perceptual barriers **Challenges** Lack of dedicated support for the cooperative due to Poland's focus on energy clusters

Other notable examples

- *Żywiecka Energia Przyszłości*: The Żywiec energy cluster was formed in 2017 following the signing of a civil-legal contract between 20 public and private bodies including local governments, the University of Business in Dąbrowa Górnicza and the Inter-Communal Association for Ecology in Żywiec, which acts as the energy cluster's coordinator. The energy cluster is recognised as a public-private network of cooperation of which electricity generation, demand balancing and some distribution activities are inherent elements. The main goals of the energy cluster are to encourage energy independence for the Żywiec region, as well as reducing air pollution in housing and public enterprises. The cluster also participates in other activities involving the deployment of renewables in the Żywiec region, electro-mobility and promotion of energy efficiency in public resources (Caramizaru & Uihlein, 2020; Żywiec Klaster Energii, 2021).

Netherlands

While the community energy movement in the Netherlands emerged some thirty years ago, it has only really gained momentum in the past ten years or so. Today, there are 623 energy cooperatives in the Netherlands. Almost 70,000 citizens are now members of a cooperative, amounting to about 1% of all Dutch households. The potential reach of these cooperatives is much larger still, considering that all cooperatives want to involve as many people as possible in their projects and use local media to inform their fellow citizens. Effectively, it can be said that a movement consisting of many local propagators has been organising a nationwide campaign for over ten years and helping to mobilise the Dutch population for the energy transition and engaging in:

> A campaign by citizens for citizens with a clear aim: local control over energy savings, energy generation and trade with revenues returning to the local communities. Nearly 70% of all cooperatives is working on energy saving, 75% on solar and 20% on wind projects. Increasing numbers are working on district heating plans
>
> (Hier opgewekt, 2020)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

However, as Siward Zomer (cooperative director of the Dutch federation of energy communities – Energie Samen) explained to Heleen Schockaert for REScoop.EU, while 2020 saw a stagnation in the overall number of citizen initiatives being taken up, the quality replaced quantity in terms of the types of projects taking place. Also, despite the slowdown in numbers, the generating capacity of this sector continues to grow substantially. This positive trend is relevant for all alternative energy resources and services, from solar to wind, renovation, mobility and heating. Solar energy cooperatives have an important place in the energy sector, with 814 collective solar projects providing the electricity to run almost 50.000 households (Schockaert, 2021). These trends in community energy projects in the Netherlands demonstrate how these projects have also become social actors focusing on local benefits and citizen empowerment.

Main socio-political contexts

It remains to be seen if upcoming legislation developed in response to the new EU directive will incorporate new concepts of energy community into national legislation (Reijnders et al., 2020). There remains a clear need for policies that encourage Local Energy Initiative (LEI)15 formation, along with better institutional knowledge of the specific challenges facing local communities when engaging in such initiatives (Ghorbani et al., 2020).

At present, two important legal changes are underway in the Netherlands with the Energy Act and the Heat Act both being revised. It remains unclear how changes to these laws will impact and potentially accommodate energy communities. It is expected, however that the Heat Act's last revisions should go some way to encouraging the supply and use of renewable energy by easing the administrative burden on sustainable heat suppliers. The two laws appear to be quite action-oriented, so there it appears there will be very exceptions made community-oriented energy actors. The idea being anybody can engage in energy related activities so long as they comply with the regulations attached to those activities, with the law primarily focussed on developing a level playing field. However, easier access to the market for other parties should also be supported outside the regulatory framework.

An important issue at present is that energy sharing is not prioritised in the Netherlands and will not therefore be part of the legal framework, as it seems now will be the case. The Dutch government is willing to make an exemption for small-scale energy actors to supply energy without a permit, but these small-scale energy actors still need to adhere to standard market practices, making the exemptions basically unnecessary.

Illustrative Case Study: Netherlands

(10) GridFlex Heeten, NETHERLANDS

Overview

The GridFlex Heeten project was established in 2017 by a number of consortium partners, including the regional grid operator Enexis, the energy cooperative Endona, the University of Twente, Enpulse, Dr Ten BV, the ICT group, Escozon and Buurkracht. The aim of the research project was to develop a unique local energy market model in which the local energy system is optimised through pricing mechanisms, incentives and energy flexibility. The energy cooperative Endona received an exemption from the Dutch Elektriciteitswet (electricity law) in order to participate in the project and experiment with local renewable energy sources and a new type of energy storage, namely sea-salt batteries. The Veldegge section of the village of Heeten in the Dutch province of Overijssel was chosen as the testing ground for the pilot project, with a total of 48 homes currently connected to a single transformer house (Reijnders et al., 2020; Van Der Laan, 2018).

The project centred around the issue of inefficient energy systems – as solar panels and wind turbines provide a lot of energy at times when it is not necessarily needed the project partners sought to find a way of using the energy optimally, for example,

[15] communities of households who self-organise to meet their energy demand with locally produced RES energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

investigating whether generated energy can be shared with the neighbourhood in order to relieve the network or potentially stored for later use. The Gridflex project focused on using energy in the same location it was generated: in the home, at the neighbour's and in the neighbourhood itself. As the energy generated by the project is stored, traded and used locally it does not have to be purchased and thus the costs for this energy are settled in the district. The energy was to be stored in sea salt batteries and used when required. The trial ran until the end of 2019, at which point the goal was to have arrived at a business case which was scalable and applicable for the future.

By using batteries and shifting the energy consumption habits of the village inhabitants, the community was able to reduce their overall energy costs. The sea-salt batteries operated automatically and accounted for changing weather patterns, past energy consumption patterns, and other information about the neighbourhood. The inhabitants were supported by an app which allowed them to predict the expected level of demand on the transformer and plan their consumption practices accordingly. By using a novel pricing mechanism, they were able to demonstrate that it was possible to lower the peaks by up to 36% and at the same time achieve realistic savings for the community[16] (Reijnders et al., 2020). Given the success of the pilot project, further research has been launched as of 2021 investigating other aspects of the project.

Project summary

GRIDFLEX heeten

Type: Municipality-led

Model: Virtual-net metering / collective self-consumption

Location: Heeten, Overijssel, Germany

Capacity: PV installed on a number of houses and a total of 120kWh installed battery capacity (one 5kWh battery in 24 households) resulting in a 36% reduction in peak demand on the transformer servicing the 48 households.

Membership: 48 participating households

Funding: a combination of EU and national subsidies, and DSO-funding (Milchram et al., 2020).

Status: Complete

Support: Consortium of public- and private-sector organisations

Drivers

Aim to investigate what it really takes to make an entire neighbourhood self-sufficient in terms of energy and to take it off the grid

Limitations

Novelty of the technology

Financial and perceptual barriers

Challenges

Use of a novel technology

Business case for the proposed research was not straightforward

[16] ICT Group have produced an interesting report on the energy management system (EMS) used for GridFlex Heeten and shows how it contributes to running of this decentralised energy network (see Lamars, 2020).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Other notable examples

- *Duurzaam Ameland*: is a partnership of the Ameland municipality and a number of companies and research institutes (Eneco, GasTerra, NAM, Signify, Liander, TNO and EnTranCe, Amelander Energie Coöperatie (AEC)). The partnership's goal is to encourage and support the island in its transition to 100% sustainable energy within the next few years. The partnership was founded in 2007, initially consisting of several separate, small-scale pilot projects with sustainable energy technology though this has expanded in recent years. The partnership tests new innovations on a laboratory scale and then put them into practice on Ameland, connecting the various technologies via a smart network, EnergieNet, the first smart electricity grid network of its size (Caramizaru & Uihlein, 2020; Duurzaam Ameland, 2021).

- *Amelander Energie Coöperatie UA (AEC)*: was founded in 2009 with the aim of supplying Amerlander energy users with sustainably sourced electricity and CO_2-compensated gas at competitive prices. It operates a solar park on Amerland, as a unique project. The solar park was the first of its size in the Netherlands and counts 23,000 solar panels. The Park remains connected to the electricity grid and produces enough electricity for over 1,500 households on Ameland, or the entire island during the low season. The cooperative is striving towards 100% green energy supply on the island for the future (AEC, n.d.; Caramizaru & Uihlein, 2020).

Germany

Serious interest in renewable energy in Germany dates back to the 1990s, when photovoltaic (PV) panels and wind turbines were first put forward as potential contenders in the German energy market. Community energy in Germany is understood as renewable energy owned by single owners (including individuals, agricultural enterprises, and smaller corporations) and renewable energy cooperatives. In 2012, 25,049 MW of the total 72,907 MW of installed renewable energy in the country came from community energy projects, translating to roughly 34% of Germany's total installed RES capacity (Wettengel, 2018). Photovoltaic (PV) and wind energy are the most important types of renewable energy in Germany. In addition to private individuals, farmers have also started to look at PV systems as part of their farm infrastructure. Around one third of the solar PV is owned by private individuals (33 percent), with farmers comprising approximately 16 per cent of the installed capacity. Bioenergy also represents a large share of the community energy sector (especially biogas plants and biomass CHP plants) (Wettengel, 2018).

The community owned, renewable energy sector has been supported by federal policies since the early 1990s through infrastructural adaptations, support schemes, and an onus on grid operators to adapt grid extensions to accommodate the needs of renewable energy generators (Fruhmann, Claudia; Knittel, 2016). In 2000, the Renewable Energy Act (EEG) was passed, guaranteeing feed-in- tariffs for twenty years for those producing renewable power. This act led households to install PV panels on their roofs, producing electricity to be used in their homes or fed into the national grid (Wettengel, 2018).

Energy cooperatives remain the most popular form of citizen energy initiative. More than half of Germany's 1,700 RES projects are cooperatives where each member has one vote. These numbers include cooperatives of wind and solar installations, cooperative energy companies, local heating networks and bioenergy villages. The number of new energy cooperatives peaked in 2011 and fell sharply after 2013 due to the decline in new solar installations and an increase in new wind parks (also referred to as wind farms), where limited partnerships between the local community and a limited liability company as general partner (e.g. GmbH & Co. KG17), became the favoured business structure.

Main socio-political contexts

Institutional barriers remain and the operating environment for CE initiatives in Germany can still be quite difficult. Some issues are directly related to the predominant organisational model, the energy cooperative, including recent changes of the financial and legal frameworks for such organisations. These include a requirement for them to hold a banking license if they want to hold minority shares in RES projects, increasing difficulty in accessing mezzanine financing options and the introduction of prospectus requirement rules for securities. Some researchers see CE in its current form in Germany as having a low level of resilience, due to its strong dependence on external factors

[17] GmbH & Co. KG is abbreviation for a limited liability company & limited partnership

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

(Brummer, 2018). For instance, low financing of CE in Germany has meant that most of the work is done by volunteers.

Illustrative Case Study: Germany

(11) Sprakebüll Village eG, Germany

Overview

Sprakebüll is a small municipality in Germany with a population of 247 inhabitants. The village has over 20 years' experience in community engagement and citizen participation. A long-standing tradition of using windmills to generate electricity has led to a high level of acceptance for wind energy among the local population, which has also expanded their efforts to solar and biogas production. For the wind farm project, the Sprakebüll community adopted the GmbH & Co. KG model suitable for larger projects with higher investment potentials, with voting rights dependent on the proportion of capital invested as opposed to the traditional "one member, one vote" principle. Shares were sold based on geographical criteria, with a preference for local citizens investing in wind power. The primary investment motivation in the wind farm for most individuals was profit, which is distributed among shareholders depending on the level of investment (Caramizaru & Uihlein, 2020; CO2mmunity, 2019).

In 1998, a group of twenty-two villagers decided to establish the first wind park in the area, which consisted of 5 wind turbines and was owned by the local people living in the area, A second wind park quickly followed which involved 183 citizens. The Stadum-Sprakebüll wind park then followed in 2011 and 2014, which saw the start of the first repowering project. In 2009, a local family became interested in solar energy and intended to install 100 MW photovoltaic panels on 7 hectares of land but were not able to obtain the appropriate permits to complete the project. Instead, they began selling the solar panels to local investors. In addition to the wind and solar energy projects situated in the village, the population of Sprakebüll also developed a privately-owned biogas plant and set up a district heating cooperative, obtaining funding for a satellite CHP, boiler, and heating network. All three forms of renewable electricity production complement and compensate for each other when supply from one form is low (Caramizaru & Uihlein, 2020; CO2mmunity, 2019).

The wind farm project has resulted in several positive benefits for the community with a greater proportion of wealth generated from it staying in the local economy. Greater local support has also been achieved through communal projects such as bicycle paths, playgrounds, a swimming pool, and the laying of ductwork for a fibre-optic network (Caramizaru & Uihlein, 2020; CO2mmunity, 2019).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Project summary

Type: Limited partnership

Model: Virtual-net metering / collective self-consumption

Location: Sprakebüll, Germany

Capacity: 130 MW (wind, biogas)

Membership: c. 247

Funding: 15 million Deutsche Mark (DM) was raised by villagers and farmers through investments and loans from the banks.

Support: German banks which offered loans for the initial project setup.

Drivers

Potential profit gained from investment in a wind farm project.

Desire to alter the fossil-dominated energy landscape.

Promoting a strong, self-sufficient economy and focusing on local development.

Limitations

Strict environmental laws make building permissions for wind turbines difficult to obtain

Challenges

Changes to the German Renewable Energy Sources Act which requires changes to the marketing of renewable electricity

Other notable examples

Elektrizitätswerke (EWS) Schönau eG: is a multi-utility cooperative founded in Germany's Black Forest in the late 1990s, the first cooperative of its kind to supply the local community with electricity. With the deregulation of the energy markets in 1998. EWS began to sell almost exclusively renewable electricity to local customers and soon after at the nationwide scale. The cooperative now also participates in the supply of natural gas and biogas and actively campaigns against nuclear energy (Caramizaru & Uihlein, 2020). The cooperative was created because of the conversion of another cooperative, Netzkauf GbR, which had originally emerged from a citizen's initiative in response to the Chernobyl nuclear disaster. The cooperative is committed to supporting the energy transition and ensuring a complete and efficient energy supply based on renewable energy technologies. The cornerstones of the cooperative's business activities continue to be civic engagement, co-determination and decentralisation. Today the cooperative has approximately 9,000 members (EWS Schönau, 2021).

- *Bioenergiedorf Jühnde eG:* the first bioenergy village in Germany, located in the centre of the country. The cooperative society was formed out of the village's desire to become economically, ecologically and socially self-sufficient. Talks for the cooperative began in 2001 and energy production began in 2005. The cooperative is Germany's first village to produce heat and electricity by means of renewable biomass (from silage and wood chips), and aims to meet the village's full energy needs through renewables (Caramizaru & Uihlein, 2020).

France

Electricity in France is generated via a number of different sources, including nuclear power, coal, natural gas, petroleum and other liquid fuels and renewable sources. By far the main source of energy comes from its numerous nuclear power plants which represent approximately 70% of the country's overall energy mix. Concerns about nuclear waste and the security risk associated with an overreliance on nuclear power has led the government to support a greater diversification in the energy mix and the rolling out of RES technologies. The growth in the renewable energy share in electricity (RES-E) in France is now approximately 2.9% per year. Hydropower predominates, accounting for approximately 55 terawatts-hours of generated electricity in 2019, or 13% of France's total electricity production in 2018. Under the Energy Transition Law (ETL), the Multiannual Energy Plan (MEP/PPE) sets a general orientation for the energy policy in France from 2019 to 2023 and 2024 to 2028. This general policy includes projections and plans for renewable electricity, hydropower, onshore wind, offshore wind, photovoltaic

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

solar, methanation (waste and biogas), firewood, marine, geothermal and solar thermal generation (Hive Power, 2021b).

Community energy has a role in this context, with the government aiming to bring citizens closer to the centre of the energy system there. Adopting the Energy Transition Law for Green Growth (LTECV) in 2015, France was the first EU Member State to introduce dedicated incentives (called "participatory bonuses") to promote the financial participation of local actors in renewable projects (L. 314–28, article 111). As recently as 2019, the Établissement Public à Caractère Administratif (EPA) identified some 240 community renewable projects in France. Among them, 47% were operational, while 37% were in development (i.e. under financing and technical authorisation), and 16% were emerging (i.e. under pre-feasibility study). Since 2014, the number of these initiatives has multiplied fivefold, with 76% involved in generating solar energy, while 16% are dedicated to wind power and 10% comprising small-scale hydro, biogas, and biomass projects. In terms of total installed capacity for these projects, wind power plants represent the majority (64% of the total installed capacity of French CRE), followed by solar, which accounts for 22% (Sebi & Vernay, 2020).

Main socio-political contexts

Sebi and Vernay (2020) categorise the barriers to community renewable energy projects in France as follows: 1) institutional, 2) market, 3) organisational and 4) behavioural barriers. Also, the French energy system is highly centralised, leaving little room for citizen involvement, whether at the local or national level. Community energy projects depend on public support, which is open to policy changes, while market barriers include the prohibitive cost of securing a grid connection, which heavily impacts the economic feasibility of such projects. Furthermore, CECs still experience difficulties obtaining bank loans and finding affordable insurance, especially when developing roof-top projects. These projects can also experience difficulties when seeking cooperation from local government authorities.

In addition to the above-described external barriers, CEC projects can experience internal barriers too such as the relative homogeneity of members' profiles, which has led to difficulties reaching wider audiences and the sharing of important tasks within the organisation. Given much of the work falls to volunteers, the strength of a given project can often depend on the experiences and skillsets of its volunteers, which can be mixed at best. Most members of French CECs are retired or elderly males with technical backgrounds or who belong to the highest socio-professional categories. Moreover, CECs often face challenges raising money from local stakeholders because they are unable or unwilling to propose attractive returns on investment and/or because these bottom-up initiatives require a higher degree of individual participation. Behavioural or psychological barriers that have an impact on engagement in CEC initiatives include a general reluctance on the part of most citizens to participate or volunteer, given the highly centralised nature of the electricity sector, and France's already low-carbon electricity source (nuclear power) can act as a disincentive for greater mobilisation.

Illustrative Case Study: France

(12) Fermes de Figeac, France

Overview

Fermes de Figeac is an agricultural cooperative situated at the foothills of the Massif-Central, in central France. The cooperative focuses its work on addressing several challenges the area faces, including the preservation of local ecosystems, the development of quality food in the area and the maintenance of a vibrant agricultural economy. The cooperative initiates and participates in regional projects, such as the production of renewable energy and professes an aim to promote responsible development and sustainability. For the past 10 years, Fermes de Figeac has sought to enhance the energy resources present in the region as a means of diversifying farmer incomes. Beginning in 2008, the cooperative installed photovoltaic panels on the roof of a subsidiary company as part of what was then a pilot project. SAES - Ségala Agriculture et Énergie Solaire, the largest collective photovoltaic roofing project in France, was quickly established by the cooperative following the successful pilot project. To date the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

cooperative has equipped 528 farm buildings with PV panels and continues to build on this expertise with the ongoing development of new photovoltaic projects (Fermes de Figeac, n.d.-a, n.d.-b).

The cooperative has also been involved in the construction of 7 wind turbines in the area which today produce the equivalent electricity to meet the consumption needs of over 40,000 inhabitants of the region. Fermes de Figeac began their journey in the wood energy sector with the distribution of wood pellets to farmers, which eventually led to the creation of the Société Coopérative d'Intérêt Collectif Bois Énergie LOT (SCIC BEL) through which the cooperative was able to invest in the installation of wood-fired boilers and the sale of renewable heat to local businesses in a long-term partnership. To date, ten 100kW wood boilers and 1 700kW wood boiler have been installed by the cooperative. Furthermore, Fermes de Figeac has supported the establishment of 4 small collective agricultural methanization unit projects in the regions of Gorses, Labathude, Espeyroux and Viazac, involving the active participation of thirty three farmers (Fermes de Figeac, n.d.-a, n.d.-b)

Project summary

Fermes de Figeac COOPÉRATIVE

Type: Cooperative enterprise

Model: Virtual-net metering / collective self-consumption

Location: Central France

Capacity: 14 MW (7 wind turbines), 9.6MW PV, 1.7MW (11 wood boilers), 4 anaerobic digester projects

Membership: 180 members

Funding: Investments from local farmers.

Status: Ongoing

Support: ALTITUDE cooperative, CAPEL cooperative, Méthaseli Environnement

Drivers

Maintaining the local ecosystem.

Producing high-quality, local food.

Promoting a vibrant agricultural landscape.

Diversifying farmer incomes using a mutual resource.

Limitations

Community-specific factors

Financial and perceptual barriers

Challenges

Advisory assistance to the management or participation of members

Regional agricultural fabric threatened, with aging population and outward migration (Cointe, 2019)

Other notable examples

- *Mobicoop*: France's Mobicoop is a cooperative in the field of shared mobility (carpooling, car sharing) and has approximately 20,000 members. It is the amalgamation of the Carpooling-Libre association (founded in 2011) and Covivo (founded in 2009). Covivo has spent years developing carpooling sites and mobile applications for businesses and communities and was the first carpooling company to develop real-time carpooling. Carpooling-Libre joined forces with Covivo in 2018 to become a cooperative (Mobicoop) with a focus on providing all members of the population (including the elderly, people with disabilities, limited resources) with shared mobility solutions. The cooperative promotes the use of electric car-sharing services and aims to reduce transport emissions and tackle transport poverty (Caramizaru & Uihlein, 2020; Mobicoop, n.d.).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

- *Enercoop*: is a network of renewable energy cooperatives which covers the whole of France, supplying energy in the form of a cooperative society. It was founded in 2005 as a means of offering a citizen alternative once the electricity markets were opened up to competition. Enercoop acts as a supplier of green energy, purchasing energy directly from 300 renewable energy producers – the electricity is 100% renewable and 0% of nuclear origin – and placing profits back into RE projects (Borroni et al., 2019). The Enercoop cooperatives work together to tackle the energy-related challenges of the territories they are based in, ensuring that solutions to the energy transition remain local. Citizens can become consumers or members of the organisation, allowing them to participate in the decision-making process. A fee of EUR 100 is required to become an active member and hold a share in the organisation. As of 2020 the network consisted of 11 separate renewable energy cooperatives covering 100 hydro schemes, 25 windfarms, 104 solar projects and 3 biomass generators (Caramizaru & Uihlein, 2020; Enercoop, 2021).

- *Le Mené's energy self-sufficiency project*: Le Mené is a rural Communaut de Communes (CdC) in Central Brittany. The region is a pioneer in local energy autonomy, led by a group of locals, mostly farmers, who have established a number of energy initiatives – a participatory wind project, a methane plant, an oil mill, low-energy buildings and eco-construction, among others (Borroni et al., 2019). The CdC's three flagship projects include:

    - *Collective methane production*: The Géotexia project brings together around 30 farmers who founded a cooperative in partnership with municipalities and the agroindustry. The project uses manure from pig farms and other organic matter to produce electricity and heat. The methane plant went into operation in 2011 after facing strong opposition from local residents, and now supplies electricity and heat to the locality (Borroni et al., 2019).

    - *Participatory wind energy*: When it was sought to build a second wind farm in the region in 2007 the region's inhabitants were able to invest in the project and negotiate a 30 percent shareholding with the operator, Idex. Since its establishment approximately 140 people have invested in the wind farm in the form of investment clubs called CIGALES. The six wind turbines that make up the park began operating in 2013, encountering no opposition to the project (Borroni et al., 2019).

    - *Production of fuel oil*: A cooperative oil mill, Ménergol, began operating in 2007, bringing together around 40 farmers who aim to replace diesel used in farming machines with locally-produced rapeseed oil (Borroni et al., 2019).

Denmark

Denmark has a strong tradition of community energy dating back to the 1950s when district heating was established into cooperatives and municipal companies. Today, 64% of all heating in Denmark is realised via district heating, which in turn is owned by 350 consumer cooperatives and 50 larger municipally-owned non-profit companies. During the 1980s, the energy sector saw a shift towards a more decentralised model with cooperatives developing grid-connected wind farms and gas co-generated heat and power (CHP) district heating. However, these early successes were stymied by changes to the regulations in the late 1990s which saw the collapse of the Danish home market for wind power (Meyer, 2004) and the closure of local CHPs.

Community wind farms in Denmark date back to the 1970s and, as a result, 70-80% of existing turbines have some sort of community-ownership structure in place. Although the support for energy communities has recently declined, the Danish government has encouraged the development of community-owned energy projects and wind power plants in particular. Since 2009, the Danish Renewable Energy Act requires all new wind power projects to have an ownership model whereby at least 20% is owned by local people. Consequently, community energy generation will occur predominantly in partnership with energy utilities (co-owned community energy projects) rather than in fully private-owned projects (Fruhmann, Claudia; Knittel, 2016). Having said that, the rate of renewable energy power owned by communities has become one of the highest globally.

Denmark is not only a strong producer of wind energy and is preforming strongly in other areas of its energy transition, most notably in terms of energy planning, organising community participation, and networking with neighbour countries regarding the cross-border electricity market and associated infrastructure. Denmark also has significant holdings of oil and gas, located in its sector of the North Sea.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Main socio-political contexts

There remain a number of key challenges for the Danish energy sector and community energy does face an uncertain future (Gorroño-Albizu et al., 2019). First, the Danish transportation system is not based on renewable energy sources. Between the years 1990 and 2016, its total fuel consumption has increased by 49%, CO2 emissions by 20%, and overall GHG emissions by 15%. Second, over 50% of renewables in the energy sector is based on a mix of fuels (more than one third is fossil-based). Biomass is used in most District Heating companies, presenting its own socio-environmental challenges, yet insufficient support and policies in electricity may force citizens to have to turn to biomass for their energy requirements. Third, retail electricity prices in Denmark are among the highest in Europe, in particular for electric transportation and heating. Fourth, further expansion of the wind energy industry is needed at a time when certain conflicting policy instruments remain in place. While wind energy has been a success in Denmark, it still needs to be better integrated into the country's overall energy policymaking (Boscán et al., 2021).

Illustrative Case Study: Denmark

(13) Svalin Co-Housing Complex, Denmark

Overview

The Svalin co-housing complex is a sustainable co-housing community of twenty households located in the city of Roskilde, west of Copenhagen, in Denmark. The houses and shared infrastructure in the community were designed with the aim of accommodating solar panels, a geothermal heat pump and electric vehicles. The community is energy positive, meaning that on a yearly basis it produces more renewable energy than it consumes. Households consume the electricity generated by the housing complex and any surplus is transferred to the national grid. The community ultimately aims to become Denmark's first example of a community collectively consuming 100% renewable and local electricity by sharing excess electrical energy produced between households in a flexible and consumer-oriented market models (*e.g.*, community-based, peer-to-peer, *etc.*).

The Technical University of Denmark (DTU) works with the community in a living laboratory setting for their Energy Collective research project, which examined pathways for enhancing the user's role in relation to the purchasing, sale, and consumption of electricity (Caramizaru & Uihlein, 2020; Center for Electric Power and Energy, 2018). Along with researchers at the university the housing complex is keen to investigate the effects of emerging technologies and techniques for dealing with citizens and energy. For example, the lights along the path within the housing complex serve as one experiment looking at the effect of nudging on promoting green behaviour *i.e.*, appealing to people's feelings - the researchers have developed an algorithm that changes the colour of the lights (red, amber, green) depending on whether the electricity being used in the co-housing complex at a given time has a high or low climate cost associated with it.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Project summary

Type: Energy collective / co-housing community

Model: RES electricity generation and self-consumption; energy services (*e.g.* peer-to-peer trading); electro-mobility; energy sharing

Location: Roskilde, Denmark

Capacity: estimated reduction of 61.79 percent CO_2 per kWh by their green electricity generation (Minh, 2020).

Membership: 20 households

Funding: Supported by residents, the housing contractor and the university

Status: Ongoing

Support: Technical University of Denmark (DTU)

Drivers

Desire to consume 100% renewable and local energy.

Promoting environmental consciousness about the use of electricity.

Act as the first demonstration in Denmark of a community collectively consuming and sharing electricity.

Limitations

Financial and perceptual barriers

A lack of social cohesion among the residents (Leonhartsberger *et al.*, 2021)

Challenges

Expanding the results of investigations to the wider Danish community

Lack of institutional capacity from local authorities will hamper efforts to build and develop further (Athavale et al., 2021)

New Danish regulations on sharing economy in power sector and a lack of social cohesion among the residents (Leonhartsberger *et al.*, 2021)

Other notable examples

- *Marstal Fjernvarme*: The Marstal Fjernvarme cooperative was established in 1962 on the island of Ærø in Denmark. It exists as a solar district heating plant which connects 1,600 customers to a collectively owned district heating network. The network provides hot water to almost all the inhabitants of the island town of Marstal. The heat is generated using 100% renewable resources: 50-55% from solar energy, 40% from biomass and 2-3% from a heat pump. Burning bio-oil accounts for a small percentage of the overall renewable energy profile, though this can fluctuate from year to year depending on how harsh the winter gets (Marstal Fjernvarme, 2021).

- *Slaglunde District Heating*: A spike in heating prices resulting from the commercial takeover of a local heating plant in 2013 drove the inhabitants of the town of Slagslunde to form a cooperative through which they were able to buy back the district heating plant from E.ON. The heating system consists of 1 MW electricity and 4 MW of heat installed capacity and required a total investment of €1.7 million. As of 2016, the annual heating bills of the 231 Slagslunde consumers had reduced by approximately €3,000 and the daily water spill decreased from 2,000 litres to nine litres. The Slagslunde District Heating system continues to be managed by committed local residents and has received awards in recognition of its success (Borroni et al., 2019).

- *Middelgrunden Wind Turbine Cooperative*: is a world-renowned best practice example of citizen (co-)ownership of a wind farm. The wind farm itself is located offshore, outside the Harbour of Copenhagen at Middelgrunden. The cooperative was established in 1996 by a group of wind turbine enthusiasts whose goal was to promote the production of electricity through the construction, establishment and management of wind turbines. The wind farm was established following the installation of 20 turbines with an installed capacity of 40 MW. The cooperative attracted almost 9,000 citizen investors, many of whom expressed concerns for the environment and/or hoped to receive financial benefits from the project (Borroni et al., 2019).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

- *NGF Nature Energy Holsted*: NGF Nature Energy Holsted is a new generation of biogas plant which delivers biogas to the national natural gas grid, having been inaugurated in August 2015. It is a subsidiary of NGF Nature Energy A/S and is jointly owned by Brørup-Holsted Biogas A.m.b.a., the farmer-owned supplier association, and NGF Nature Energy. The main contractor, Xergi, owns about 10 percent of the plant. The plant receives biomass in the form of slurry from cattle, pigs and mink, as well as organic industrial waste and energy crops, and can process about 400,000 tons of biogas per year. All biogas from the plant is cleaned for CO2, water and sulphur, resulting in the same quality as natural gas (Borroni et al., 2019).

Belgium

In Belgium, the majority of community energy projects comprise renewable energy sources cooperatives (REScoops). They are members of the European federation of renewable energy cooperatives, which is represented in Belgium by REScoop Vlaanderen and REScoop Wallonie. There are sixteen wind turbines, 320 PV installations, three water mills, one plant oil cogeneration plant and wood pellets factory. In Belgium, many of the REScoops were established after most of the suitable sites for (wind) development were already taken up by commercial interests. However, legislative changes there are trying to reverse this by changing the business model to require 25% (co)ownership for citizens and a further 25% for municipalities (Community Power, n.d.-a).

Main socio-political contexts

Based on an in-depth analysis of Belgian federal and regional law, as well as the relevant EU Directives, the Institute for European Studies (IES) - along with the law firms Metha, Blixt and Fieldfisher, and ENGIE – published a summary report titled Legislative options and obstacles for energy communities in Belgium (Oberthur et al., 2020), which presented the key challenges Belgian policy makers and energy community organisers face given the current policy landscape there. The report also suggests how to address these issues through legislative and organisational adaptations. A key issue to emerge from the report is the current practice of not differentiating between energy communities and commercial actors when it comes to supply licencing and supplier obligations. The authors propose that modifying the license requirements for CEC initiatives that would enable them to more easily sell their surplus energy to the regular market would greatly improve their commercial sustainability. Energy Communities also face challenges when accessing the national grid, operating and maintaining their RES plant, data management, and identifying the most suitable electricity balancing model for their project. In addition, energy communities often have to wait a long time before the public distribution system operator (DSO) adapts the grid to their needs. A potential solution here might be to allow energy communities as DSOs, but this is not without its own risk both to the CEC and the wider electricity network. There is also a need for setting regulations for EC membership conditions including any minimum membership period, notice period or early termination fee. In terms of practical issues related to the operation of energy communities, the report recommends the appointment of a manager to facilitate and ensure the smooth management of the energy community project and to ensure that members provide a mandate for the energy community to be able to negotiate a joint contract with an external supplier for the residual consumption etc. (Oberthur et al., 2020).

Illustrative Case Study: Belgium

(14) Ecopower, Belgium

Overview

The Ecopower cooperative was established in 1992 by a number of Flemish citizens sitting around a kitchen table. Today it is one of the largest energy cooperatives, with a membership of over 56,000. The cooperative was initially established with the purchasing of a watermill as part of a co-housing project and continued to grow over the years. Ecopower acts as both a producer and supplier of renewable electricity to its members who mostly reside in the region of Flanders (Caramizaru & Uihlein, 2020). The cooperative aims to raise awareness and inform members about ‘rational energy consumption’ and promote energy efficiency. The cooperative invests in a diverse range of renewable energy projects including wind turbines, solar panels, small hydropower

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

plants and a wood pellet factory for small-scale heating of buildings and domestic hot water (Ecopower, 2021a). Ecopower returns interest to its members (capped at 6%) which acts as an opportunity to further reinvest in renewable energy projects. The cooperative's Ecotrajet project also supports citizens in commissioning energy renovations for their homes, and through initiatives focusing on energy efficiency Ecopower's members have witnessed a 50% reduction in the average electricity consumption over the past 10 years (Caramizaru & Uihlein, 2020). Ecopower operates according to the international principles of cooperative entrepreneurship. All shareholders are regarded as co-owners of the production installations. The cooperative places greater importance on ecological and social impacts than on financial profits (Ecopower, 2021a). Ecopower embraces collaborations between it and other organisations, including cooperative and non-cooperative companies, research institutions and local authorities – these partnerships allow Ecopower to progress its goal of providing citizens with sustainable, renewable energy (Ecopower, 2021b).

Project summary

Type: Cooperative limited liability company

Model: Virtual-net metering / collective self-consumption

Location: Flanders, Belgium

Capacity: c. 100 GWh per year

Membership: *>56,000* members

Funding: From members and partnerships with other organisations

Status: under development

Support: Numerous cooperative and non-cooperative companies, research institutions and local authorities

Drivers

Raise awareness about energy consumption and its ecological and social impacts

Promote energy efficiency

Limitations

Community-specific factors

Financial and perceptual barriers

Challenges

Advisory assistance to the management or participation of members

Other notable examples

- *Courant d'Air*: The Courant d'Air cooperative was founded in 2009 and currently comprises over 2,500 members. The cooperative's main purpose is pursuing the development of renewable energies which can be placed in the hands of its own citizens. Courant d'Air currently operates 6 wind turbines and in recent years the cooperative made its first investments in photovoltaics and hydropower. As well as these renewable energy investments, the cooperative has established an alternative mobility project, offering up a shared electric car for use by its members. The cooperative promotes energy efficiency measures and has developed information and awareness-raising programmes for citizens of all ages, for example, the Generation Zero Watt programme, that focus on renewable energies and energy efficiency (Courant d'Air, 2020b). Membership in the cooperative is open to everyone with a share subscription of €250, and the cooperative acts

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

democratically according to the principle "one person, one vote". The money brought in through subscriptions is used to finance renewable energy projects (Caramizaru & Uihlein, 2020; Courant d'Air, 2020a).

- *Beauvent*: is a cooperative that operates as a renewable energy producer. Originally, families from the Westhoek region of Belgium came together with the shared idea of using less energy without sacrificing life's luxuries – the cooperative was established in the year 2000 and membership currently stands at over 5,000. The cooperative operates under the 7 International Cooperative Alliance principles of: voluntary and open membership; democratic control by members; economic participation by members; autonomy and independence; education, training and provision of information; cooperation between cooperatives; and attention to the community (Beauvent Cooperative, n.d.-a). The Beauvent cooperative is currently focused on producing renewable energy through several different means. Beauvent continues to collect funds to invest in installing photovoltaic solar panels on the roofs of cooperatives, companies, schools, and public buildings. The cooperative has to date invested in 5 wind turbines and 4 combined heat and power (CHP) plants. Beauvent is also currently working on developing a heat network in the city of Ostend which will heat homes, companies, apartments, schools, hospitals and a number of different facilities across the city (Beauvent Cooperative, n.d.-b). The power produced by the cooperative is sold to Ecopower and other large final customers. The cooperative aims to make funds available for educational and awareness raising-projects on many energy issues (Caramizaru & Uihlein, 2020).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

4 Factors Driving Consumer Engagement in CECs

In this section, the socio-economic, socio-cultural, and geographical factors as they relate to the CECs outlined the case studies above are examined. For a detailed exploration of the governance and socio-political contexts informing citizen and consumer participation in Europe's energy transition please see the companion document to this report, *D3.9: Energy Governance Analysis and Typology for Communities*. The insights gained from that work has been applied to the case studies outlined in this report.

Contextual factors, in particular socio-economic, socio-cultural and geographic factors play a key role in the successful implementation of renewable and clean technologies (Elmustapha et al., 2018). These comprise a combination of intersecting drivers ranging from the socio-economic and socio-cultural, to geographical factors, as well as national and regional energy policies, and the specific contexts of individual projects including the experiences and characteristics those actors involved, all of which contribute to the successful (or otherwise) creation and continuation of CECs (Ruggiero *et al.*, 2021). As Bauwens *et al.* (2016) suggest, these factors at a minimum interact and create differences in terms of motivations and engagement levels of individual community energy members and in turn influences how they respond collectively to the numerous challenges suggest projects present.

A. Socio-Economic Factors

Energy communities can be characterised by a strong focus on (usually RES) energy production, while also saving money and generating income at the local level. However, energy communities also need to navigate the various levels of bureaucracy in place in each country, stay up to date on the types of grants and funding applications available, and (at least from some members) maintain a detailed knowledge of the technical configurations and standards associated with their specific project. Most notably, the diversity of economic structures, institutions and economic performances between member states all impact the likelihood for success for individual CECs. High income member states (usually those northern and western European countries) tend to have more community energy initiatives, and member states with lower wealth distributions tend to have fewer examples. This can indicate that citizen welfare is an essential factor affecting the likelihood of covering investment spending and engagement with community energy projects (Caramizaru & Uihlein, 2020).

The case studies also highlight the importance of creating funding and financial supports that help groups in the initial stages of development. Energy policies and economic supports such as feed-in-tariffs, tax incentives, and appropriate and timely access to the national grid are among the strongest factors that influence the success rates for CECs. In countries like Germany and Denmark, support schemes for RES projects have acted as a catalyst for mobilising citizens and communities (Curtin et al., 2017). During the 1990s, with the introduction of FITs in countries with strong renewable energy policies, also saw an upswing in citizen and community investors eager to see a financial return on what was then still quite a new industry in many respects (Hewitt et al., 2019) with community ownership investments in wind energy growing particularly popular in Germany with local businesses and individual citizens forming cooperatives to finance local wind energy projects.

However, a long-term analysis of these policies and the changes made to them over the years presents a more complex picture of their impact in mobilising interest in community energy initiatives. Most notably, financial cuts and restrictions to these schemes has led to a certain cooling of interest and in some instances actively discouraged community investment that was up to then growing in scale (Wierling et al., 2018). For example, when changes were made in Denmark's FIT scheme in 2003, many existing community energy cooperatives were dismantled, and a decline in the emergence of new CECs took place (Bauwens et al., 2016). In Germany, there was a significant drop in the number of newly founded energy cooperatives in 2015, a noticeable change from the previous year, due to the financial restrictions and new tendering rules that were introduced there. Famously, changes in Spanish regulations, which introduced a backup charge (popularly referred to as the 'sun tax') billed to all photovoltaic (PV) producers effectively acted as a block to the diffusion of PV self-consumption systems post-2015 (López Prol & Steininger, 2017). Similarly, in Greece, the state's recent move away from incentives is threatening the emergent energy community sector there. The discontinuation of feed-in-tariffs and other supports in the Czech Republic also had a negative impact on the development of renewable energy initiatives, including CECs. Furthermore, insecurity in regulations such as punitive taxes for wind cooperatives contributes to the uncertain future for these types of CECs in countries like Sweden and Spain. Fluctuating energy prices also has a significant effect on how citizens engage with energy: for example, rising energy prices may increase CEC formation in an effort to reduce the costs incurred by consumers, in turn promoting further diffusion of renewable energy, such as what happened in Spain following an increase in electricity prices there in 2012 (Capellán-Pérez et al., 2018).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

B. Socio-Cultural Factors

The socio-cultural factors informing citizens' decisions to establish an energy cooperative vary across Europe. A common motivation for citizens across the different types of initiatives studied, is a strong interest in finding energy solutions for themselves that find solutions to local needs that municipalities or national governments have not been able to resolve. Investments in community-oriented energy infrastructure including RES installations, energy efficiency projects, district heating, and EV charging point infrastructure is frequently characterised as specific cooperatives choosing a (co)ownership model that invests in solar, wind or district heating projects. However, it remains uncommon to see the energy produced by such projects supplying customers outside the membership base, suggesting that community objectives take centre-stage over more traditional profit-driven enterprises seen in the past (Caramizaru & Uihlein, 2020).

Also, research by Yildiz et al. (2015) notes that the educational backgrounds and the level of wealth of individuals usually involved in community-oriented projects tend to be higher than the population average. For example, they concluded that the majority of energy cooperative members in their study were university graduates (51%), which consequently indicated that higher income groups were overrepresented. This represents a significant challenge, especially in terms of bringing underrepresented groups onboard when trying to establish citizen energy communities.

Another driver has been the growing interest in environmental issues and a greater awareness of full extent of the impact human activities are having on the natural environment, with the shift towards RES energy often seen as a potential solution to our current dependence on fossil fuels. However, differences especially in terms of prioritisation remain. For instance, a strong interest in RES energy is more prevalent in wind and PV cooperatives, while wider environmental concerns are often more significant for those living in eco-villages and rural communities having been inspired by different social movements such as the anti-nuclear movement, sustainable development and self-sufficiency debates, ecological footprints, and link between greenhouse gas emissions and climate change (Magnusson & Palm, 2019). Coupled with this growing global perspective, a common theme among many community energy initiatives has been to solve local issues as a contributing part to the wider social and political issues mentioned.

There are also historical factors that impact the organisational choices of those establishing CECs. For instance, in Eastern Europe community energy projects are often viewed through the lens of past experience and linked to state-run cooperative models of past communist regimes resulting in a certain apathy on the parts of many citizens (Beckmann et al., 2015; Hewitt et al., 2019). In contrast, there is a strong tradition of cooperatives in northern and western Europe. In Germany, Denmark, and Belgium for example, where cooperatives have had a long and positive history, CECs are more like to emerge given the history of collective action in those countries (Caramizaru & Uihlein, 2020). The lack of interest in CECs found in Eastern Europe does not necessarily indicate an inherent distrust in community-oriented initiatives per se, but rather is indicative of a deep lack of trust towards national and local political institutions learned over years of communist misrule. This lack of confidence towards the state apparatus, which is also emerging in some western European countries will invariably impact on how CEC formation develops over the coming as member states are responsible for implementing the energy policies and support schemes tasked with driving it (Hewitt et al., 2019).

C. Geographical factors

The geographical location of community-based energy projects implies that access to the national grid can play a significant role in their development. RES energy projects, and energy communities, are often established in remote areas where existing energy infrastructure has been underdeveloped. Establishing a community energy project in remote areas may on the surface appear easy, given the demographic profile of the population living in such areas may be spatially dispersed but socially and culturally homogeneous. Conversely, when considering community energy projects in an urban context, such as large cities, efforts to develop CECs there may be further complicated by culturally and socially diversified populations living there. In addition, ownership and property rights may be more complex. Having said that, when considered in the broader sense, "energy communities are contiguous processes of both the energy transition and social innovation" (Caramizaru & Uihlein, 2020, p. 4). Also, the spatial dimension is further extenuated when we consider how decentralised, RES energy projects can promote sustainable energy production and modify consumption practices especially when the need for a secure energy supply is prioritised in those case studies involving off-grid systems or energy islands, such as the Island of Eigg in Scotland.

Furthermore, building viable CECs in remote and rural areas can present other challenges, particularly in areas which that have official protection status, such as designated national parks, nature reserves, or have European status as a Special Area of Conservation (SAC)18 or Special Protection Area (SPA)19. Establishing CECs in these areas can require complex interactions between energy communities, local authorities, and other relevant stakeholders tasked with maintaining protected landscapes.

Another geographical consideration are the pathways needed to shift from the highly centralised energy infrastructure currently in place in most European countries (particularly in France, the UK and Ireland), and the more flexible, decentralised frameworks required by the Energy Transition. Also, shifting powerful vested interests in the energy markets of most European countries, especially those with energy markets controlled by a limited number of energy companies (Garrués-Irurzun & Rubio-Mondéjar, 2017) will require significant effort on the part of governments, the energy incumbents and local actors (Linares et al., 2008). For instance, FIT schemes on their own had little impact on the UK's highly centralised energy system, and further interventions such as tax incentives and specialised grants were also needed to bring about change (Curtin et al., 2017).

[18] Falling under the terms of EU's Habitats Directive (92/43/EEC), SACs are prime wildlife conservation areas considered to be important both at a national and European level.
[19] Falling under the terms of the EU's Birds Directive (2009/147/EC), SPAs are designed to protect rare, vulnerable and migratory species of birds, in addition to wetland habitats.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

5 Discussion and Conclusion

Despite energy being inextricably intertwined with society and with the social and personal life of every individual (Jasanoff & Kim, 2013), the energy system has traditionally been narrowly conceptualised as primarily a technological system composed of the infrastructure and hardware for energy production, distribution, and consumption, with its social dimensions largely ignored (Miller *et al.*, 2013). However, the energy system is not simply one of technology, infrastructure and hardware, it is in actuality a socio-technical system that consists of a 'cluster of elements', a complex network of intersecting and interacting elements incorporating both social and material dimensions that include infrastructure, supply networks, regulations, technology, energy user practices, and social and cultural meanings (Geels, 2005).

The essentially reductive concept of the energy system as primarily an infrastructural and technological system, and the refusal to recognise the importance of the 'social' aspect of the socio-technical energy system for the energy transition, has only recently been challenged in the field of energy research. This ongoing re-evaluation of the energy system, which fully encompasses its 'human dimension', is not without its own complexities, however. Inherent systemic biases, normative structures that favour the current status quo, and institutional and individual hesitancies continue to challenge both the research and wider efforts to meet the challenges of the climate crisis. This has been starkly illustrated by the failure of techno-economic interventions to significantly impact on rising energy demand (Sovacool, 2014), for example. Though this is now changing, translating research on the social aspects of the energy system into actionable solutions to the energy transition remains somewhat illusive given insights from the social sciences that could meaningfully effect change are still largely absent from much of the technical research on energy (Wong, 2016).

As part of this ongoing effort, this deliverable outlines existing and emerging patterns of consumer engagement around energy in fourteen European countries and includes current demand response (DR) initiatives. It also presents a knowledge bank of citizen energy communities (CECs) and discusses how differing interpretations of the EU directives focused on CECs have resulted in nuanced differences between countries when transposing them into national law, where applicable. A wider overview of the situation in each of the fourteen European countries was also presented with illustrative case studies highlighting some of the notable successes and challenges experienced by those currently engaged in community energy development. In addition, the socio-economic, socio-cultural, and geographic factors involved in CEC formation was examined to develop a deeper understanding of the factors driving community engagement in Europe.

While there is considerable variation in the experiences across the fourteen countries, the research uncovered a number of interesting insights from the literature. For example, Sandy Robinson and Dominic Stephen (2020), in their recent assessment of community energy sector in England and Wales (UK), point to the ongoing need for a more proactive policy and support landscape by government if the sector is to develop and grow, and ultimately meet its potential in contributing to the low carbon energy transition. The removal of a targeted feed-in tariff in March 2020 and the ongoing Covid-19 crisis are seen as two key challenges to the sector. While the Covid-19 crisis can be understood as part of a wider societal response, the removal of the feed-in tariff in the UK has resulted in greater uncertainty for potential and existing energy community projects. It has also thrown up doubt on whether current business models in the sector can cope with what has been a systemic shock to the sector there. This move towards disincentivising community energy projects has resulted in similar negative experiences for citizens elsewhere, in Spain and Greece for example. In Germany and Denmark, the governments have been more active in supporting community energy projects and, as a result, have seen much higher proportions of community-owned RES energy projects, though variation does occur on the type of RES technology being targeted. The preference of one RES technology over another (*e.g.*, wind energy in Denmark) can partly be explained by geographical factors such as the prevalence of wind and solar energy *etc*., but also on existing political and market frameworks already in place in each country.

Therefore, the transitioning of large technical systems are accompanied by – and indeed necessitate – broader transitions across regulations and policy, maintenance and distribution networks, production systems, market and user practices, infrastructure, and the cultural and symbolic meanings assigned to those physical structures (Geels, 2005; Geels *et al.*, 2015). The current transition to a 'sustainable energy system' involves more than simply substituting one source of energy for another. It will involve new, highly visible, infrastructure on the rural, and urban, landscape – wind turbines, solar farms, power grids and pipelines – as well as new and innovative business models to bring about the change that is required. The transition will also see people readjusting to how they live with energy in their everyday lives and is likely "to transform social infrastructures, changing established patterns of life and work and allocating benefits and burdens differently from before" (Jasanoff & Kim, 2013, p. 189). Among the many issues involved with the energy transition, how the benefits and burdens are allocated is a crucial

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

determining factor – especially in terms of the broader social impacts of the transition, as well as on the timely and successful implementation of that transition. As Robinson and Stephen (2020) point out, numerous barriers remain for the community energy sector (in their case England and Wales) – and these same barriers can be seen across Europe particularly for smaller organisations (Hewitt *et al.*, 2019) – despite the policy and support landscapes having improved in most European countries due to the EU. These barriers include uncertainty brought about by changing policy supports, to organisational and financial constraints for community energy groups looking to develop their energy project. Also, up to recently, there has been a tendency to focus almost solely on power generation, without considering the other options open to citizens who may wish to participate differently, whether that is as a producer, consumer, or prosumer. Figure 1 below illustrates the types of barriers currently experienced by community organisations in the UK and while they give greatest weight to the ending of the feed-in tariff there, the list of barriers can be which can still be transposed to those operating in other European jurisdictions as evidenced from the experiences in the other thirteen countries outlined above. While the weighting given to each barrier will differ across the European Union, the issues of a lack in organisational capacity, expertise, and the limited access to funding and/or subsidy changes are common experiences for community energy organisations across the bloc. For the Interreg-funded LECo project, Nic Aoidh *et al.* (2018) outline similar common barriers in their PESTLE analysis[20] of the challenges faced by local energy communities in Finland, Ireland, Norway, Sweden and Germany.

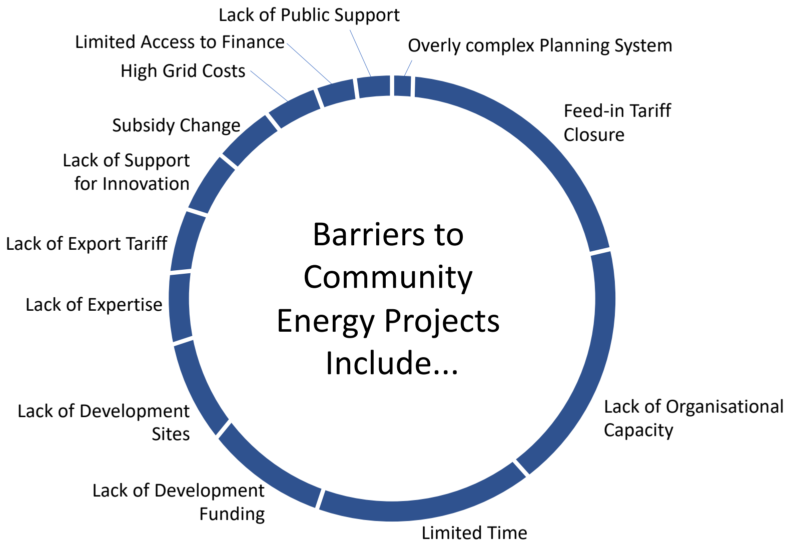


Figure 1 Barriers to community energy projects, including CECs and RECs (source: Robinson & Stephen, 2020)

Given these ongoing challenges, Robinson and Stephen suggest several pathways for supporting community energy projects (which include CECs and RECs) and those community groups involved, see Figure 2 below.

[20] PESTLE analysis is a useful tool for identifying the macro-level factors that can impact an organisation or sector. These can include Political, Economic, Social, Technological, Legislative, and Environmental factors. In *D3.9 Energy Governance Analysis and Typology for Communities*, we draw on the works of both Robinson and Stephen (2020) and Nic Aoidh *et al*. (2018) to inform our own analysis of the governance and socio-political contexts that condition and structure current (and future) pathways to participation in Europe's energy transition.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Figure 2 Key supports for community energy projects, including CECs and RECs (source: Robinson & Stephen, 2020)

Recognising that greater support is needed that fully considers the actual time and capacity requirements involved in community energy projects should be a priority for funders than has heretofore been the case. With this mind, funding should also be delivered in such a way as to ensure that communities can best utilise early-stage funding and instigate impactful local energy projects (Robinson & Stephen, 2020, p. 28). The authors also call for funding bodies to offer additional supports that can deliver capacity building services such as community energy workshops, advice and peer mentoring services, access to appropriate business models and facilities that can provide information on the specialised technical knowledge required, while also fostering initiatives that support new partnerships and maximise project impact (*ibid.*).

While these tend to focus on the practicalities of project implementation, such supports would free up community energy organisations to have a much greater impact on the rollout of CECs rather than become bogged down by bureaucratic inertias as has been the case for many up to now. Citizen participation in the energy transition through membership of energy communities is seen as central to the successful transition to a sustainable energy system (Berka & Creamer, 2018). However, how citizens are allowed to participate and engage in the energy system – and what roles they are assigned – will determine the relative success or failure of the energy transition. In the companion deliverable, *D3.9 Energy Governance Analysis and Typology for Communities* of the ACCEPT H2020 project, the governance and socio-political contexts that condition and structure current (and future) pathways to participation in Europe's energy transition are examined. Applying a multi-level perspective, this companion report analyses how the intersecting governance and socio-political barriers and drivers of consumer engagement inform current citizen energy (CEC) formation and complements the work presented here. Taken together, both deliverables offer an in-depth understanding of CEC formation, and community energy more widely, are being developed across the European Union and its neighbouring countries.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Bibliography

AEC. (n.d.). *Amelander Energie Coöperatie*. Www.Amelandenergie.Nl.

Aoidh, A. N., Hülsken, C., Good, C., Neachtain, E. Ó., Elfgren, E., HOgáin, F. Ó., Ruuska, H., Risberg, M., Suibhne, O. N., Leonard, P., Etelamaki, P., Fischer, R., Kajimura, R., Herrmann, S., Müller, U., & Mehl, W. (2018). *Pestle Analysis of Barriers to Community Energy Development. Deliverable of the LECo Project, funded under the EU's Northern Periphery and Arctic Programme*.

Athavale, S., Barreto-Gomez, L., Brandl, G., Kassai, A., & Köstler, R. (2021). *Guidelines for local authorities on stakeholder engagement. Deliverable 4.1 of the EXCITE H2020 project* (Issue February).

Balkan Green Energy News. (2021). *Italy's first renewable energy community set up in Magliano Alpi*.

Barcelona Energía. (n.d.). *Barcelona Energía*.

Bauwens, T. (2019). Analyzing the determinants of the size of investments by community renewable energy members: Findings and policy implications from Flanders. *Energy Policy*, *129*, 841–852. https://doi.org/10.1016/j.enpol.2019.02.067

Bauwens, T., & Devine-Wright, P. (2018). Positive energies? An empirical study of community energy participation and attitudes to renewable energy. *Energy Policy*, *118*(August 2017), 612–625. https://doi.org/10.1016/j.enpol.2018.03.062

Bauwens, T., Gotchev, B., & Holstenkamp, L. (2016). What drives the development of community energy in Europe? The case of wind power cooperatives. *Energy Research & Social Science*, *13*, 136–147. https://doi.org/10.1016/j.erss.2015.12.016

Beauvent Cooperative. (n.d.-a). *Over ons*. Www.Beauvent.Be.

Beauvent Cooperative. (n.d.-b). *Projecten*. Www.Beauvent.Be.

Beckmann, V., Otto, I. M., & Tan, T. (2015). Overcoming the legacy of the past? Analyzing the modes of governance used by the Polish agricultural producer groups. *Agricultural Economics (Zemědělská Ekonomika)*, *61*(5), 222–233. https://doi.org/10.17221/190/2014-AGRICECON

Berka, A. L. (2018). Community Renewable Energy in the UK: A Short History. In *Handbuch Energiewende und Partizipation* (pp. 1011–1035). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-09416-4_59

Berka, A. L., & Creamer, E. (2018). Taking stock of the local impacts of community owned renewable energy: A review and research agenda. *Renewable and Sustainable Energy Reviews*, *82*(October 2017), 3400–3419. https://doi.org/10.1016/j.rser.2017.10.050

Borroni, A., van Tulder, F., Goebel, K., Wokuri, P., Yalçın-Riollet, M., Gauthier, C., Diaz-Foncea, M., Bretos, I., Borroni, A., van Tulder, F., Yildiz, Ö., Gotchev, B., Holstenkamp, L., Müller, J. R., Radtke, J., Welle, L., Rønne, A., & Gerhardt Nielsen, F. (2019). Consumer (Co-)Ownership in Renewables in Italy. In J. Lowitzsch (Ed.), *Energy Transition* (pp. 295–318). Springer International Publishing. https://doi.org/10.1007/978-3-319-93518-8_14

Boscán, L., Kaiser, B. A., & Ravn-Jonsen, L. (2021). Beyond Wind: New Challenges to the Expansion of Renewables in Denmark. In *International Political Economy Series* (pp. 319–348). https://doi.org/10.1007/978-3-030-54514-7_13

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Sage.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Breukers, S., & Wolsink, M. (2007). Wind power implementation in changing institutional landscapes: An international comparison. *Energy Policy*, *35*(5), 2737–2750. https://doi.org/10.1016/j.enpol.2006.12.004

Broughel, A. E., Stauch, A., Schmid, B., & Vuichard, P. (2019). Consumer (Co-)Ownership in Renewables in Switzerland. In J. Lowitzsch (Ed.), *Energy Transition: Financing Consumer Co-Ownership in Renewables* (pp. 451–476). Springer International Publishing. https://doi.org/10.1007/978-3-319-93518-8

Brummer, V. (2018). Community energy – benefits and barriers: A comparative literature review of Community Energy in the UK, Germany and the USA, the benefits it provides for society and the barriers it faces. *Renewable and Sustainable Energy Reviews*, *94*, 187–196. https://doi.org/10.1016/j.rser.2018.06.013

Candelise, C., & Ruggieri, G. (2020). Status and Evolution of the Community Energy Sector in Italy. *Energies*, *13*(8), 1888. https://doi.org/10.3390/en13081888

Capellán-Pérez, I., Campos-Celador, Á., & Terés-Zubiaga, J. (2018). Renewable Energy Cooperatives as an instrument towards the energy transition in Spain. *Energy Policy*, *123*, 215–229. https://doi.org/10.1016/j.enpol.2018.08.064

Caramizaru, A., & Uihlein, A. (2020). *Energy communities: an overview of energy and social innovation*. Publications Office of the European Union. https://doi.org/10.2760/180576

CEE Bankwatch Network. (2021). *Assessment of Poland's recovery and resilience plan*. https://bankwatch.org/wp-content/uploads/2021/04/2020-04-22_Polish-RRF-assessment_final.pdf

CEER. (2019). *Regulatory Aspects of Self-Consumption and Energy Communities* (Issue June).

Center for Electric Power and Energy. (2018). *A small community is pushing the agenda for a greener future*. CEE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

Website: Cee.Elektro.Dtu.Dk. https://www.cee.elektro.dtu.dk/news/2018/06/a-small-community-is-pushing-the-agenda-for-a-greener-future?id=f28a7d84-d1ec-4e24-9e1e-263e5639e49a

Chmiel, Z., & Bhattacharyya, S. C. (2015). Analysis of off-grid electricity system at Isle of Eigg (Scotland): Lessons for developing countries. *Renewable Energy*, *81*, 578–588. https://doi.org/10.1016/j.renene.2015.03.061

CMS. (2020). *Renewable energy law and regulation in Portugal*.

CO2mmunity. (2019). *Sprakebüll-A Pioneering Energy Community in Norh Frisia, Germany*.

Cointe, B. (2019). Mutualising sunshine: economic and territorial entanglements in a local photovoltaic project. *Local Environment*, *24*(11), 980–996. https://doi.org/10.1080/13549839.2018.1436044

Community Energy England. (2021). *Definition, benefits and potential of community energy | Community Energy England*.

Community Energy England, & Community Energy Wales. (2019). *Community Energy - State of the Sector Report 2019*. https://communityenergyengland.org/pages/state-of-the-sector-report%0Afiles/386/CommunityEnergy-StateoftheSectorReport.pdf

Community Power. (n.d.-a). *Belgium*. Retrieved July 30, 2021, from https://www.communitypower.eu/en/belgium.html

Community Power. (n.d.-b). *Poland*. Communitypower.Eu. Retrieved July 29, 2021, from https://www.communitypower.eu/en/poland.html

Community Power. (n.d.-c). *The Czech Republic*. Communitypower.Eu. Retrieved August 2, 2021, from https://www.communitypower.eu/en/czech-republic.html

Courant d'Air. (2020a). *Courant d'Air*. Www.Courantdair.Be.

Courant d'Air. (2020b). *Notre coopérative*. Www.Courantdair.Be.

Curtin, J., McInerney, C., & Ó Gallachóir, B. (2017). Financial incentives to mobilise local citizens as investors in low-carbon technologies: A systematic literature review. *Renewable and Sustainable Energy Reviews*, *75*, 534–547. https://doi.org/10.1016/j.rser.2016.11.020

Department of Communications Climate Action and Environment. (2015). Ireland's Transition to a Low Carbon Energy Future 2015-2030. In *Government White Paper on Energy* (p. 122). https://www.dccae.gov.ie/documents/Energy White Paper - Dec 2015.pdf

Dunphy, N. P., Lennon, B., Quinlivan, L., Velasco Herrejón, V., & Curran, R. (2021). *REALISE Deliverable 4 . 1 Critical review of EPE initiatives* (p. 53).

Duurzaam Ameland. (2021). *About Us*. Www.Duurzaamameland.Nl.

Ecopower. (2021a). *A citizen cooperative for renewable energy (REScoop)*. Www.Ecopower.Be. https://www.ecopower.be/over-ecopower/onze-werking

Ecopower. (2021b). *Onderzoek & ontwikkeling*. Www.Ecopower.Be. https://www.ecopower.be/over-ecopower/onderzoek-ontwikkeling

Edinburgh Community Solar Co-operative. (2021a). *About Us*. Www.Edinburghsolar.Coop.

Edinburgh Community Solar Co-operative. (2021b). *How it Works*. Www.Edinburghsolar.Coop.

Electra Energy Cooperative. (2020). *Mapping of Energy Communities in Greece*. http://electraenergy.coop/wp-content/uploads/2021/05/DRAFT-Mapping-of-energy-communities-in-Greece.pdf

Elmustapha, H., Hoppe, T., & Bressers, H. (2018). Understanding Stakeholders' Views and the Influence of the Socio-Cultural Dimension on the Adoption of Solar Energy Technology in Lebanon. *Sustainability*, *10*(2), 364. https://doi.org/10.3390/su10020364

Enercoop. (2021). *Our story*. Www.Enercoop.Fr.

Energy Center. (2021). *"MANIFESTO" Le Comunità Energetiche per una centralità attiva del Cittadino nel nuovo mercato dell'energia* (p. 6). Politecnico di Torino. https://www.energycenter.polito.it/content/download/1276/8059/file/MANIFESTO Comunità Energetiche _Giugno 2021.pdf

Energy4All. (2021a). *Benefits of Community Ownership*. Www.Energy4all.Co.Uk. https://energy4all.co.uk/benefits-of-community-ownership/

Energy4All. (2021b). *Welcome to Energy4All*. Www.Energy4all.Co.Uk. https://energy4all.co.uk/

Energy4All. (2021c). *What do we do?* Www.Energy4all.Co.Uk. https://energy4all.co.uk/about-us/what-do-we-do/

Environmental Protection Agency. (2021). *Ireland will not meet its 2020 greenhouse gas emissions reduction targets. Action is needed now to meet 2030 EU targets*. https://www.epa.ie/news-releases/news-releases-2021/ireland-will-not-meet-its-2020-greenhouse-gas-emissions-reduction-targets-action-is-needed-now-to-meet-2030-eu-targets.php

Eolpop. (2018). *Evolución del proyecto - Cronología del proyecto "Vivir del aire del cielo."* Eolpop.

European Commission. (2015). Energy Union Package - A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy. In *COM(2015) 80 final*.

European Commission. (2016). *Staff Working Document Impact Assessment Accompanying the Document Proposal for a Directive of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources (Recast)*.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

European Parliament. (2018). Directive (EU) 2018/2001 of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. In *Official Journal of the European Union* (Vol. 2018, Issue L 328, pp. 82–209). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN
European Parliament and Council. (2019). Directive 2019/944 on Common Rules for the Internal Market for Electricity. In *Official Journal of the European Union* (Issue L 158, p. 18).
European Parliament and Council of the European Union. (2018). *Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources* (p. 128).
European Parliament and Council of the European Union. (2019). *Directive (EU) 2019/ 944 of the European Parliament and of the Council - of 5 June 2019 - on common rules for the internal market for electricity and amending Directive 2012/ 27/ EU* (p. 75).
EWS Schönau. (2021). *About Us* . Www.Ews-Schoenau.De.
Falagas, M. E., Pitsouni, E. I., Malietzis, G., & Pappas, G. (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. *The FASEB Journal : Official Publication of the Federation of American Societies for Experimental Biology*, *22*(2), 338–342. https://doi.org/http://doi.org/10.1096/fj.07W9492LSF
Fermes de Figeac. (n.d.-a). *Nous, coopérateurs !* . Www.Fermesdefigeac.Coop.
Fermes de Figeac. (n.d.-b). *Renewable Energies* . Www.Fermesdefigeac.Coop.
Frieden, D., Tuerk, A., Roberts, J., D'Herbemont, S., & Gubina, A. F. (2019). *Overview of emerging regulatory frameworks on collective self-consumption and energy communities in Europe* (Issue June 2019). IEEE. https://doi.org/10.1109/EEM.2019.8916222
Friends of the Earth. (2020). *Community Energy in Hungary and the Czech Republic Briefing*.
Friends of the Earth Europe. (2020). *Community Energy in Spain Briefing. October*.
Friends of the Earth Ireland. (2017). Community Energy for Ireland. In *Friends of the Earth Ireland*.
Fruhmann, Claudia; Knittel, N. (2016). *Community Energy Projects: Europe's Pioneering Task, Climate Policy Info Hub, 03 March 2016*.
Fuinnimh Oileáin Árann. (2016). *Comharchumann Fuinnimh Oileáin Árann - The Aran Islands Energy Co-op*. http://www.aranislandsenergycoop.ie/
Garrués-Irurzun, J., & Rubio-Mondéjar, J. A. (2017). The Nuclear Business and the Spanish Electric-Banking Oligopoly: The First Steps. In *The Economic History of Nuclear Energy in Spain* (pp. 67–96). Springer International Publishing. https://doi.org/10.1007/978-3-319-59867-3_3
Geels, F. W. (2005). The dynamics of transitions in socio-technical systems: A multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). *Technology Analysis & Strategic Management*, *17*(4), 445–476. https://doi.org/10.1080/09537320500357319
Geels, F. W., McMeekin, A., Mylan, J., & Southerton, D. (2015). A critical appraisal of Sustainable Consumption and Production research: The reformist, revolutionary and reconfiguration positions. *Global Environmental Change*, *34*, 1–12. https://doi.org/10.1016/j.gloenvcha.2015.04.013
Genervest. (2021). *Hyperion E.C.* Genervest.Org. https://genervest.org/project/hyperion-energy-community/
Ghorbani, A., Nascimento, L., & Filatova, T. (2020). Growing community energy initiatives from the bottom up: Simulating the role of behavioural attitudes and leadership in the Netherlands. *Energy Research & Social Science*, *70*, 101782. https://doi.org/10.1016/j.erss.2020.101782
Goldthau, A. (2014). Rethinking the governance of energy infrastructure: Scale, decentralization and polycentrism. *Energy Research and Social Science*, *1*, 134–140. https://doi.org/10.1016/j.erss.2014.02.009
Gorroño-Albizu, L., Sperling, K., & Djørup, S. (2019). The past, present and uncertain future of community energy in Denmark: Critically reviewing and conceptualising citizen ownership. *Energy Research & Social Science*, *57*(July), 101231. https://doi.org/10.1016/j.erss.2019.101231
Government of Poland. (2021). *Krajowy Plan Odbudowy - National Reconstruction Plan*. https://www.gov.pl/web/rozwoj-praca-technologia/krajowy-plan-odbudowy
Gui, E. M., & MacGill, I. (2018). Typology of future clean energy communities: An exploratory structure, opportunities, and challenges. *Energy Research & Social Science*, *35*(October 2017), 94–107. https://doi.org/10.1016/j.erss.2017.10.019
Haggett, C., Creamer, E., Harnmeijer, J., Parsons, M., & Bomberg, E. (2013). *Community Energy in Scotland: the Social Factors for Success*.
Hargreaves, T., Hielscher, S., Seyfang, G., & Smith, A. (2013). Grassroots innovations in community energy: The role of intermediaries in niche development. *Global Environmental Change*, *23*(5), 868–880. https://doi.org/10.1016/j.gloenvcha.2013.02.008
Heldeweg, M. A., & Séverine Saintier. (2020). Renewable energy communities as 'socio-legal institutions': A normative frame for energy decentralization? *Renewable and Sustainable Energy Reviews*, *119*, 109518. https://doi.org/10.1016/j.rser.2019.109518
Hewitt, R. J., Bradley, N., Baggio Compagnucci, A., Barlagne, C., Ceglarz, A., Cremades, R., McKeen, M., Otto, I.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

M., & Slee, B. (2019). Social Innovation in Community Energy in Europe: A Review of the Evidence. *Frontiers in Energy Research*, *7*, 1–27. https://doi.org/10.3389/fenrg.2019.00031
Hier opgewekt. (2020). *Local Energy Monitor | HIER opgewekt*. https://www.hieropgewekt.nl/local-energy-monitor
Hive Power. (2021a). *Hive Power - Renewable Energy In Switzerland, What You Should Know*.
Hive Power. (2021b). *Renewable Energy In France; What You Should Know - Hive Power*.
Huybrechts, B., & Mertens, S. (2014). The relevance of the cooperative model in the field of renewable energy. *Annals of Public and Cooperative Economics*, *85*(2), 193–212. https://doi.org/10.1111/apce.12038
Ibarloza, A., Heras-Saizarbitoria, I., Allur, E., & Larrea, A. (2018). Regulatory cuts and economic and financial performance of Spanish solar power companies: An empirical review. *Renewable and Sustainable Energy Reviews*, *92*, 784–793. https://doi.org/10.1016/j.rser.2018.04.087
IEA, & Edinburgh Community Solar Co-operative. (2021). *History*.
Isle of Eigg. (n.d.-a). *About Eigg*. Www.Isleofeigg.Org.
Isle of Eigg. (n.d.-b). *Eigg Electric*. Www.Isleofeigg.Org.
Jalali, S., & Wohlin, C. (2012). Systematic literature studies. *Proceedings of the ACM-IEEE International Symposium on Empirical Software Engineering and Measurement - ESEM '12*, 29. https://doi.org/10.1145/2372251.2372257
Jasanoff, S., & Kim, S.-H. (2013). Sociotechnical Imaginaries and National Energy Policies. *Science as Culture*, *22*(2), 189–196. https://doi.org/10.1080/09505431.2013.786990
Kampman, B., Blommerde, J., & Afman, M. (2016). *The potential of energy citizens in the European Union*. https://cedelft.eu/publications/the-potential-of-energy-citizens-in-the-european-union/
Kim, M. Y. (2016). *The Influences of an Eco-village towards Urban Sustainability: A case study of two Swedish eco-villages* [Uppsala University]. http://www.diva-portal.org/smash/get/diva2:962977/FULLTEXT01.pdf
Kitchenham, B., & Charters, S. (2007). Guidelines for performing Systematic Literature Reviews in Software Engineering. *Engineering*, *2*, 1051. https://doi.org/http://doi.org/10.1145/1134285.1134500
Krug-Firstbrook, M., Haggett, C., & van Veelen, B. (2019). Consumer (Co-)Ownership in Renewables in Scotland (UK). In *Energy Transition* (pp. 395–419). Springer International Publishing. https://doi.org/10.1007/978-3-319-93518-8_18
Lamars, P. (2020). *Chain Analysis GridFlex Heeten: Report 2020*. https://ict.eu/wp-content/uploads/2021/07/CO2-Chain-Analysis-GridFlex-Heeten-2020.pdf
Leonhartsberger, K., Bhat, K., Ettwein, F., Rao, B.-V., Stefan, M., Berne, P., Hallbeck, J., Stryi-Hipp, G., McKeever, P., & Nwobu, J. (2021). *High-Level Description of Use Cases and Business Models. Deliverable 3.1 of the CLUE H2020 project* (Issue March).
Linares, P., Javier Santos, F., Ventosa, M., & Lapiedra, L. (2008). Incorporating oligopoly, CO2 emissions trading and green certificates into a power generation expansion model. *Automatica*, *44*(6), 1608–1620. https://doi.org/10.1016/j.automatica.2008.03.006
López Prol, J., & Steininger, K. W. (2017). Photovoltaic self-consumption regulation in Spain: Profitability analysis and alternative regulation schemes. *Energy Policy*, *108*, 742–754. https://doi.org/10.1016/j.enpol.2017.06.019
Lowitzsch, J., Hoicka, C. E., & van Tulder, F. J. (2020). Renewable energy communities under the 2019 European Clean Energy Package – Governance model for the energy clusters of the future? *Renewable and Sustainable Energy Reviews*, *122*(April 2020), 109489. https://doi.org/10.1016/j.rser.2019.109489
LRF. (2016). *Farmarenergi i Eslöv AB, Skåne*. Www.Lrf.Se.
MacArthur, J. (2013). Renewable Energy and the Social Economy in Alberta. *The International Journal of Environmental Sustainability*, *8*(4), 121–130. https://doi.org/10.18848/2325-1077/CGP/v08i04/55068
Magnusson, D., & Palm, J. (2019). Come Together—The Development of Swedish Energy Communities. *Sustainability 2019, Vol. 11, Page 1056*, *11*(4), 1056. https://doi.org/10.3390/SU11041056
Malý, V., Šafařík, M., & Matoušek, R. (2019). Consumer (Co-)Ownership in Renewables in the Czech Republic. In *Energy Transition* (pp. 201–222). Springer International Publishing. https://doi.org/10.1007/978-3-319-93518-8_10
Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, *41*(6), 955–967. https://doi.org/10.1016/j.respol.2012.02.013
Marstal Fjernvarme. (2021). *About us*. Www.Solarmarstal.Dk.
McLaren Loring, J. (2007). Wind energy planning in England, Wales and Denmark: Factors influencing project success. *Energy Policy*, *35*(4), 2648–2660. https://doi.org/10.1016/j.enpol.2006.10.008
Meyer, N. I. (2004). Development of Danish Wind Power Market. *Energy & Environment*, *15*(4), 657–673. https://www.jstor.org/stable/43734674
Milchram, C., Künneke, R., Doorn, N., van de Kaa, G., & Hillerbrand, R. (2020). Designing for justice in electricity systems: A comparison of smart grid experiments in the Netherlands. *Energy Policy*, *147*, 111720. https://doi.org/10.1016/j.enpol.2020.111720
Miller, C. A., Iles, A., & Jones, C. F. (2013). The Social Dimensions of Energy Transitions. *Science as Culture*,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

22(2), 135–148. https://doi.org/10.1080/09505431.2013.786989
Minh, C. T. T. (2020). *Social business model for sustainable energy: Danish community energy* [Utrecht University]. http://dspace.library.uu.nl/handle/1874/398710
Mobicoop. (n.d.). *History of the Cooperative* . Www.pro.Mobicoop.Fr.
Nally, B. (2016). Six of the best and worst countries for solar power policy and progress. *Renewable Energy Focus*, *17*(5), 173–174. https://doi.org/10.1016/j.ref.2016.08.003
Nolden, C. (2013). Governing community energy—Feed-in tariffs and the development of community wind energy schemes in the United Kingdom and Germany. *Energy Policy*, *63*, 543–552. https://doi.org/10.1016/j.enpol.2013.08.050
Nolden, C., Barnes, J., & Nicholls, J. (2020). Community energy business model evolution: A review of solar photovoltaic developments in England. *Renewable and Sustainable Energy Reviews*, *122*, 109722. https://doi.org/10.1016/j.rser.2020.109722
Norbeck, M. (2004). Solbyn. In *Individual, Community, Environment: Lessons from Nine Swedish Ecovillages* (pp. 39–47). ekoby.org. http://www.ekoby.org/index.html
Nouicer, A., Kehoe, A.-M., Nysten, J., Fouquet, D., Hancher, L., & Meeus, L. (2020). *The EU Clean Energy Package*. European University Institute. https://doi.org/10.2870/58299
Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis. *International Journal of Qualitative Methods*, *16*(1), 160940691773384. https://doi.org/10.1177/1609406917733847
Oberthur, S., Söebech, Ó., Derde, H., Jackers, K., Vanhoenacker, J., Vermeir, T., Vandorpe, W., & Haverbeke, D. (2020). *Legislative options and obstacles for energy communities in Belgium: Summary of key issues identified & recommendations, ROLECS project, Task 2.3.1*.
Onwuegbuzie, A. J., & Freis, R. (2016). *7 Steps to a comprehensive literature review. A multimodal and cultural approach*. Sage.
Pohlmann, A., & Colell, A. (2020). Distributing power: Community energy movements claiming the grid in Berlin and Hamburg. *Utilities Policy*, *65*, 101066. https://doi.org/10.1016/j.jup.2020.101066
Punt, M. B., Bauwens, T., Frenken, K., & Holstenkamp, L. (2021). Institutional relatedness and the emergence of renewable energy cooperatives in German districts. *Regional Studies*, 1–15. https://doi.org/10.1080/00343404.2021.1890708
Radtke, J., & Ohlhorst, D. (2021). Community Energy in Germany – Bowling Alone in Elite Clubs? *Utilities Policy*, *72*, 101269. https://doi.org/10.1016/j.jup.2021.101269
REGALGRID. (2021). *Energy communities in Italy: legislation and future scenarios | Regalgrid*.
Reijnders, V. M. J. J., van der Laan, M. D., & Dijkstra, R. (2020). Energy communities: a Dutch case study. *Behind and Beyond the Meter: Digitalization, Aggregation, Optimization, Monetization*, 137–155. https://doi.org/10.1016/B978-0-12-819951-0.00006-2
REScoop.EU. (2019). *Q&A: What are "citizen" and "renewable" energy communities?* 17.
REScoop. (2014). *Handbook on Investment schemes for REScoop projects* (pp. 1–84). REScoop.eu. file:///Users/breffni/Downloads/Financial-Handbook-for-REScoops-English.pdf
REScoop. (2015). *The Energy Transition to Energy Democracy*.
REScoop. (2021). *Greek energy communities at risk: urgent action needed - REScoop*.
Rivas, M. J., Stanley, J., & Forkan, G. (2018). *Energy Master Plan 2018 Árainn and Inis Meáin* (Issue August, p. 59). https://documentcloud.adobe.com/link/track?uri=urn%3Aaaid%3Ascds%3AUS%3A3ac6ce69-9692-494d-9001-d8c57b620868
Roberts, J., Frieden, D., & D'Herbemont, S. (2019). Energy Community Definitions. In *COMPILE H2020 Project* (Issue May). https://www.compile-project.eu/
Robinson, S., & Stephen, D. (2020). *Community Energy: State of the Sector 2020*. https://communityenergyengland.org/files/document/484/1615989181_CommunityEnergy-StateoftheSector2020Report.pdf
Rogers, J. C., Simmons, E. A., Convery, I., & Weatherall, A. (2008). Public perceptions of opportunities for community-based renewable energy projects. *Energy Policy*, *36*(11), 4217–4226. https://doi.org/10.1016/j.enpol.2008.07.028
Ruggiero, S., Busch, H., Hansen, T., & Isakovic, A. (2021). Context and agency in urban community energy initiatives: An analysis of six case studies from the Baltic Sea Region. *Energy Policy*, *148*, 111956. https://doi.org/10.1016/J.ENPOL.2020.111956
Schockaert, H. (2021). *February Success Story: the Rising Tide of Dutch Cooperatives*. REScoop.EU. https://www.rescoop.eu/news-and-events/news/february-success-story-the-rising-tide-of-dutch-cooperatives
SEAI. (2020). *Energy in Ireland: 2020 Report* (Issue December). https://www.seai.ie/publications/Energy-in-Ireland-2020.pdf
SEAI. (2021). *More than 500 Communities are now part of SEAI's Sustainable Energy Community Network | News & Media | SEAI*.
Sebi, C., & Vernay, A. L. (2020). Community renewable energy in France: The state of development and the way

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

forward. *Energy Policy*, *147*, 111874. https://doi.org/10.1016/J.ENPOL.2020.111874
Seidl, I. (2018). *Energy cooperatives: renewable energy thanks to strong local roots*. Swiss Federal Institute for Forest, Snow and Landscape Research. https://www.wsl.ch/en/news/2018/11/fostering-renewable-energy-with-energy-cooperatives.html
Sen, S., & Ganguly, S. (2017). Opportunities, barriers and issues with renewable energy development – A discussion. *Renewable and Sustainable Energy Reviews*, *69*, 1170–1181. https://doi.org/10.1016/j.rser.2016.09.137
Sims, R., Schock, R., Adegbululgbe, A., Fenhann, J., Konstantinaviciute, I., Moomaw, W., Nimir, H., Schlamadinger, B., Torres-Martínez, J., & Turner, C. (2007). *X. Zhang in: B. Metz, OR Davidson, PR Bosch, R. Dave, LA Meyer (Eds.), Energy supply in climate change 2007: mitigation contribution of working group III fourth assessment report of the IPCC*. Cambridge University Press, Cambridge, United Kingdom and New York, USA.
Solbyn Association. (2018). *Solbyn*. Solbyn.Org. http://www.solbyn.org/
Som Energia. (n.d.). *Who are we?* Www.Somenergia.Coop.
Sovacool, B. K. (2014). What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. *Energy Research and Social Science*, *1*, 1–29. https://doi.org/10.1016/j.erss.2014.02.003
Stern, P. C. (2014). Individual and household interactions with energy systems: Toward integrated understanding. *Energy Research & Social Science*, *1*, 41–48. https://doi.org/10.1016/j.erss.2014.03.003
Swedish Energy Agency. (2019). *Energy in Sweden 2021: An overview*. https://energimyndigheten.a-w2m.se/Home.mvc?resourceId=133464
Tanulku, B. (2012). Low Carbon Landscape Project: Arnside & Silverdale Area of Outstanding Natural Beauty. In *Landscape for life.org.uk* (Issue September).
Thomas, G. (2015). *Green living in Sweden's Ecological Village of Solbyn*.
Toke, D., Breukers, S., & Wolsink, M. (2008). Wind power deployment outcomes: how can we account for the differences? *Renewable and Sustainable Energy Reviews*, *12*(4), 1129–1147.
Torraco, R. J. (2005). Writing Integrative Literature Reviews: Guidelines and Examples. *Human Resource Development Review*, *4*(3), 356–367. https://doi.org/10.1177/1534484305278283
Van Der Laan, M. (2018). *Marten's Challenge: Taking an entire neighbourhood off the grid? Let's investigate if this is really possible!* https://ict.eu/blog/martens-uitdaging-een-hele-wijk-van-de-meter-af-wij-onderzoeken-of-het-kan/
van der Schoor, T., & Scholtens, B. (2015). Power to the people: Local community initiatives and the transition to sustainable energy. *Renewable and Sustainable Energy Reviews*, *43*, 666–675. https://doi.org/10.1016/j.rser.2014.10.089
van der Schoor, T., van Lente, H., Scholtens, B., & Peine, A. (2016). Challenging obduracy: How local communities transform the energy system. *Energy Research and Social Science*, *13*, 94–105. https://doi.org/10.1016/j.erss.2015.12.009
von Wirth, T., Gislason, L., & Seidl, R. (2018). Distributed energy systems on a neighborhood scale: Reviewing drivers of and barriers to social acceptance. *Renewable and Sustainable Energy Reviews*, *82*, 2618–2628. https://doi.org/10.1016/j.rser.2017.09.086
Walker, G., & Devine-Wright, P. (2008). Community renewable energy: What should it mean? *Energy Policy*, *36*(2), 497–500. https://doi.org/10.1016/j.enpol.2007.10.019
Watson, A. C., Boyle, E., Mullally, G., & Gallachóir, B. Ó. (2020). *Responding to the Energy Transition in Ireland: The Experience and Capacity of Communities* (Issue 337). Environmental Protection Agency. http://www.epa.ie/pubs/reports/research/climate/research337.html
Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly*, *26*(2), xiii–xxiii.
Wettengel, J. (2018). *Citizens' participation in the Energiewende Clean Energy Wire*. Journalism for the Energy Transition. https://www.cleanenergywire.org/factsheets/citizens-participation-energiewende
Wierling, A., Schwanitz, V. J., Zeiß, J. P., Bout, C., Candelise, C., Gilcrease, W., & Gregg, J. S. (2018). Statistical Evidence on the Role of Energy Cooperatives for the Energy Transition in European Countries. *Sustainability 2018, Vol. 10, Page 3339*, *10*(9), 3339. https://doi.org/10.3390/SU10093339
Wong, C. M. L. (2016). Assembling Interdisciplinary Energy Research through an Actor Network Theory (ANT) frame. *Energy Research & Social Science*, *12*, 106–110. https://doi.org/10.1016/j.erss.2015.12.024
Yildiz, Ö., Rommel, J., Debor, S., Holstenkamp, L., Mey, F., Müller, J. R., Radtke, J., & Rognli, J. (2015). Renewable energy cooperatives as gatekeepers or facilitators? Recent developments in Germany and a multidisciplinary research agenda. *Energy Research and Social Science*, *6*, 59–73. https://doi.org/10.1016/j.erss.2014.12.001
Żywiec Klaster Energii. (2021). *Cluster activity in the Żywiec region*. Www.Klasterzywiec.Pl.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.