ENPOWER

POWER IN OUR HANDS

D2.1 | ENPOWER Gap analysis and use case capitalisation towards a consumer-centric energy system

BLUEPRINT

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Energy Activated Citizens and Data-Driven Energy-Secure Communities for a Consumer-Centric Energy System

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Preface

ENPOWER designs, develops, and demonstrates SSH-driven methodologies, interactive and closed-loop tools, and data-driven services for energy-activated citizens and energy-secure cross-sector communities towards a citizen-centric energy system. By combining leading-edge ICTs with social/behavioural dimensions and with sharing economy and value stacking business models the project aims to deploy: 1) a Social Science Framework for energy citizens activation and innovative multidimensional incentives for citizens' participation in energy markets; 2) AI-based consumers clustering and segmentation algorithms; 3) interactive tools and facilitation services for energy community planning; 4) Energy Data Space adaptation to support community-level data-driven activation and interoperable automated privacy and sovereignty-preserving Demand Response (DR); 5) P2P DLT/Blockchain digital marketplace for tokenized energy and non-energy assets reciprocal compensation; 6) data-driven services and apps for energy efficiency and activation performance management; 7) ICT services and Digital Twins for community-level energy optimization and aggregated flexibility management to trade off local self-consumption against grid service provisioning, while boosting a beyond-energy community social welfare; 8) Edge monitoring hubs for automated DR; 9) Business Sandbox for novel sharing economy and social innovation-based business models; 10) methodologies for evaluating different energy community setups, upscaling and replication. ENPOWER framework will be validated along 4 Front Runners energy communities' pilots and further replicated in 2 Early Adopters, covering different levels of maturity of communities, to demonstrate increased RES local self-consumption and consumers participation to the energy markets, while nurturing increased local security of supply. ENPOWER Leadership Programme and blueprints will support EU-wide replication and advice regulatory bodies on communities-friendly enabling frameworks.

Who we are

No	Participant Name	Short Name	Country	Role
1	National Technical University of Athens	NTUA	GR	Coordinator
2	Design Strategy Technology S.r.l	DST	IT	Technology providers
3	INESC TEC - Institute for Systems and Computer Engineering, Technology and Science	INESC TEC	PT	
4	Fundación CARTIF (CARTIF Technology Center)	CARTIF	ES	
5	COMSENSUS D.O.O.	COMS	SL	
6	European Dynamics Luxembourg SA	ED	LU	
7	Audencia Business School	AUDENCIA	FR	Business modelling
8	Regulatory Assistance Project	RAP	BE	Regulatory assistance
9	ICLEI Europasekretariat GmbH	ICLEI	DE	Policy & capacity
10	University of Basel*(associated partner)*	UNIBAS	CH	Social framework
11	Blueprint Energy Solutions GMBH	BLUEPRINT	AT	Pilot 1 - Austria (Front runners)
12	OurPower Energiegenossenschaft SCE	OurPower	AT	
13	Cooperativa de Desenvolvimento Sustentável, CRL	COOPERNICO	PT	Pilot 2 - Portugal (Front runners)
14	WATT-IS SA	WATT-IS	PT	
15	Cooperativa Eléctrica do Vale D'Este CRL	CEVE	PT	
16	EnC of Chalki'Chalkion'	ChalkiON	GR	Pilot 3 - Greece (Front runners)
17	Hellenic Association for Energy Economics	HAEE	GR	
18	Green Energy Aggregator Services SA	GEARS	GR	
19	Parity Platform P.C.	PARITY	GR	

20	Electric Power Research Institute Europe DAC	EEU	IE	Pilot 4 - Ireland (Front runners)
21	University College Cork (MaREI Centre for Energy, Climate and Marine, Environmental Research Institute)	UCC	IE	
22	DC Six Technologies Limited	DCSix	IE	
23	MOL TEIC - Dingle Hub	DINGLE HUB	IE	
24	ESB Innovation ROI Limited	ESB	IE	
25	Békéscsaba Energia ESCO Kft.	BCS	HU	Pilot 5 - Hungary (Early adopters)
26	Enasco Cleantech Alliance LLC.	ENASCO	HU	
27	Montajes Eléctricos Cuerva SL	CUERVA	ES	Pilot 6 - Spain (Early adopters)
28	VERGY COMMUNITY S.L. *(affiliated partner)*	VER	ES	

Executive Summary

This document encompasses all the work developed in deliverable "D2.1 – ENPOWER Gap analysis and use case capitalisation" of the ENPOWER project. This work was performed under task T2.1 within WP2 - Connect, Benefit & Incentivise: Citizen engagement, interactive mechanisms, and multilevel knowledge creation in data-driven energy-secure communities. This report has the main objective of defining and describing the potential High-Level Use Cases (UCs) and performing gap analysis for UC capitalisation. This report will serve as a basis for the work being developed in the remaining work packages (WPs), WP3, 4, 5 and 6.

This document presents comprehensive analysis of regulatory framework and current state of Energy Communities (EnCs) in Europe, including market analysis.

It further breaks down into a detailed methodology for identification of High-Level Use Cases (HLUC), including an explanation of the processes and foundation for HLUCs based on the IEC standard. Mapping of potential UCs followed planned technological enablers (TEs) mapping and verification through online workshops with pilot site leaders and TE main developers. Further on, UC identification and structured description was based on the IEC standard on UC Methodology [5, pp. IEC 62559-2].

The definition and description of the ENPOWER UCs was performed using a combined well-defined methodology. With the list of software tools and available assets and infrastructure, we were able to identify 8 HLUCs that set the relations or actions performed by the ENPOWER solution or between the different ENPOWER actors.

Each of these 8 HLUCs was detailed through: the scope and objective; stakeholders involved; pre- and post-conditions for UC implementation; and a complete HLUC description.

Finally, this document maps the most important HLUCs that will be deployed in each demonstration site. This exercise will be essential for planning the activities of each ENPOWER pilot site, mainly the selection and implementation of the most important ENPOWER services and HLUCs.

Finally, results of fit gap analysis are presented, examining identified gaps in detail. Pilot-level gap analysis is offering a focused assessment of specific use cases. The high-level use case analysis and mapping provide a strategic overview of the project's implications and potential advancements.

The conclusion summarizes the task and deliverable key findings. This is the first out of the three reports of the ENPOWER WP2, which is due on M6 in the deliverable D2.1 and serves as foundation for technical developments in WP3, WP4 as well as WP5.

Table of Contents

Figures

Tables

List of acronyms

EC	European Commission
EnC	Energy Community
WP	Work Package
ADR	Automated Demand Response
AI	Artificial Intelligence
API	Application Programming Interface
BEMS	Building Energy Management Systems
BIM	Building Information Modelling
CECs	Citizen EnCs
DER	Distributed Energy Resources
DR	Demand Response
DSO	Distribution System Operator
EV	Electric vehicles
GDPR	General Data Protection Regulation
HVAC	Heating, Ventilation, and Air Conditioning
HLUC	High-Level UC
IAQ	Indoor Air Quality
IC	Indoor Comfort
ICT	Information Communication Technology
IEC	International Electrotechnical Commission
IoT	Internet of Things
KPIs	Key Performance Indicators
OEMs	Original Equipment Manufacturers
REC	Regional Energy Community
UI	User Interface

1. Introduction

1.1 Objectives of Work Package 2

This document, developed under the Task 2.1, along with all the other tasks under Work Package (WP) 2, provides the foundation for citizen engagement and multilevel knowledge creation within energy-secure communities to facilitate a consumer-centric energy system in Europe.

Its goal is to establish the basis for the development of the ENPOWER social, technological and organisational/business framework, providing groundwork for energy market, community building and co-creation process, consumers analysis and segmentation, co-development of the concept of data-driven energy-secure communities through deliberative citizen engagement, as well as a Business Sandbox for a consumer-centric energy system. Its ultimate achievement is a co-creation and co-implementation process for the design of financial / non-financial incentives mechanisms for individual and collective-level consumer engagement.

Since the goal is for the solutions proposed to be tested and studied in real applications, a systematic analysis is required about both the conditions under which the technological solutions are expected to operate, as well as of the new socio-economic environment formed and the new opportunities created by the widespread application of the proposed solutions.

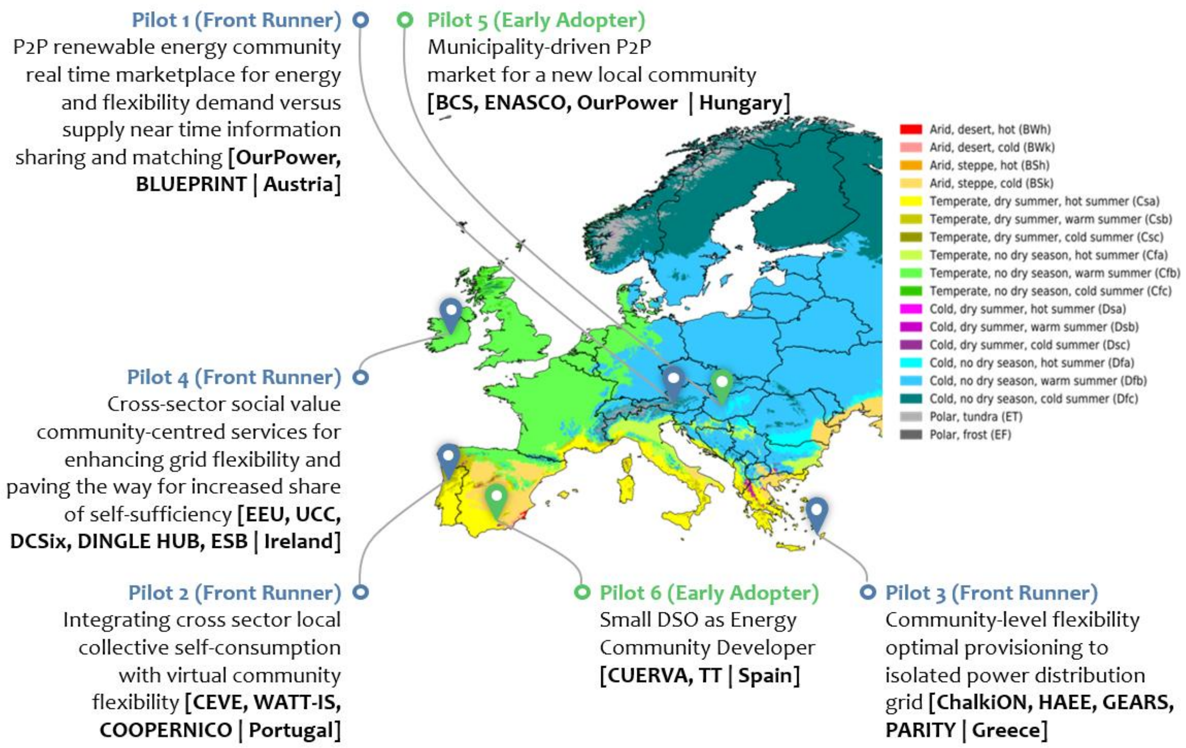

Figure 1: ENPOWER pilots with geographic distribution and main use cases

1.2 Objectives of Task 2.1

This initial task addresses regulatory frameworks, examining recent and upcoming developments to identify gaps impeding consumer participation in the energy market. Additionally, it focuses on a comprehensive gap analysis of market design, encompassing existing market structures, energy system flexibility, EU-level market platforms, and control schemes. It aims to identify gaps hindering fair consumer participation in energy markets through communities and aggregators, covering various market segments. It involves capitalizing on existing use cases from EnC projects within the consortium, updating them based on the gap analysis. ENPOWER pilots were analysed and documented according to a standard methodology, to ensure a streamlined workflow of software development across the pilots throughout the project.

<u>This deliverable has four main objectives:</u>

- Analyse legislation and market barriers in Europe as well as in pilot site countries.
- Define a methodology to be used in the description of the HLUCs.
- Create a list of HLUCs for ENPOWER.
- Provide a gap analysis for HLUC implementation.

To this context, formal analysis of the pilot sites, use case validation, available infrastructure, asset ownership, including governance model for dwellers and EnC management will serve as foundation for further tasks in WP2.

<u>Furthermore, the content of this document will serve as input for:</u>

- Subsequent tasks of WP2 and the development of pilots (WP6) that are framed within the existing EU regulatory framework, as well as the energy and digital transition policy objectives (T7.1-T7.2).
- Technical WPs – WP3 and WP4, which will specify and implement the defined products of ENPOWER and specify the definition of the demonstration activities and the implementation of technological solutions developed in Technical WPs based on the Use Cases (UCs) and requirements.

1.3 Scope

This document is the result of the cooperation of the partners within the Task 2.1. This task aims to examine potential gaps in pilot site’s capacity for implementing the defined use cases along with their network infrastructure's current capabilities to implement UCs successfully. All implementation requirements require certain preconditions that pilot site sites must meet. The selected use cases are related to integrating technologies and solutions of the ENPOWER project, which will be demonstrated at pilot sites. Moreover, these UCs are considering end-users' needs and the necessary electricity infrastructure. Based on that, the mapping of ENPOWER UCs requirements with the pilot site's conditions was realized to provide a picture of the possibilities and extent of realisation of UCs. Testing UCs in real conditions requires the integration and serious consideration of end-users needs and constraints in the process to ensure the seamless and smooth integration of the new technologies in the process of activating demand response in EnCs.

1.4 Structure of the document

This deliverable is structured as follows:

- Section 1 includes the introduction, including scope and the structure of the document.
- Section 2 describes the legal framework under which ENPOWER will operate, as well as the internal policies that are adopted. It follows with an EU-wide market reform that affects development of ENPOWER solutions.

- Section 3 describes methodology for US implementation, including HLUC identification process and lists and describes the main HLUC identified in ENPOWER.
- Section 4 pilot sites gap analysis, followed by a list of references used in the document.
- Annex 1 provides Questionnaires used for data collection from pilot sites during workshops.

2. Legal framework and market barriers

2.1 Gap analysis of EU legal framework

This analysis focusses on providing more insight into regulatory barriers and challenges for consumer participation in the energy sector to support the activities undertaken in the ENPOWER project. It takes stock of the current state of play regarding EU regulation on consumer participation, supporting the following project and pilot activities and developing a base for policy recommendations based on the project results towards the 2nd half of the project. To this end a 'state-of-play' matrix will be developed. For ease of understanding it has been split into three separate segments organized around the topics:

1. Participation of consumers in the energy market
2. Consumer participation in grid management
3. Consumer rights and obligations in energy sector participation

The matrices in the following chapters outline the current EU regulatory situation, ongoing and upcoming changes, and, where relevant, highlight potential barriers and challenges to consumer participation.

In addition, where relevant, regulatory gaps, challenges, and opportunities will be identified. In doing so, specific attention will be given to the following topics:

1. Efficient and effective coordination and unhindered communication between involved stakeholders (system operators, market players and network users)
2. Active participation of (smaller) consumers (residential & SME) in the electricity and heat market
3. Mitigation of issues such as congestion management and balancing in a context of growing distributed energy sources
4. Qualification and responsibilities of all the energy stakeholders, including their interaction in the market procedures

The gap analysis is based on analysis of the primary legal documents and secondary literature.

2.1.1 Citizen participation in the energy sector

Citizen participation in the energy sector has a long history in Europe, with cooperative energy companies in rural areas dating back to the early 20th century.[i] With the growing imperative of the climate crisis and the rise of renewable energy technologies citizens, small- and medium enterprises (SMEs), and municipalities have become increasingly active in producing their own energy. Over the past decade this has led to a boom of renewable energy cooperatives and other energy related collective citizens initiatives. In addition, as home solar systems have become available and affordable for a larger group of households, people have moved from being simple consumers of electricity, to 'prosumers'; being both producers and consumers of electricity.

The adoption of the Clean Energy 4 All (CE4All) Package in 2019 [3] by the European legislative institutions has opened another road for citizen participation in the energy sector by providing a legal framework for EnCs. As these provisions are transposed into national member state legislation, citizens all over the EU will have additional opportunities to participate in the energy sector. Ranging from improved opportunities for 'prosumerism' and optimisation of self-consumption of renewable energy production to becoming involved in providing flexibility services for grid balancing. Although the primary goal for EnC participants is to facilitate social cohesion and innovation the range of energy services, they can engage in, can be a means to that goal, and they can provide system benefits.[ii]

EnCs, and citizen participation in the energy sector in general, however, are still an emerging phenomenon, and regulatory frameworks are still under development in many member states. In addition, there are social, financial, technical, and organizational challenges that remain to be solved.[iii] This applies both to the concept of EnCs and applying the concepts to specific services such as flexibility and energy sharing.[iv]

Consumer participation in the energy sector, however, can occur through multiple routes, expanding beyond EnCs. For example, as consumers and prosumers of energy they respond to energy and grid management price signals, and they can provide input to network codes that regulate the functioning of the grid.

2.1.2 Ongoing developments in EU regulatory framework

As part of the Green Deal the EU increased its main climate target in 2020 from 40% to 55% greenhouse gas (GHG) emission reduction by 2030 (compared to 1990) and climate neutrality by 2050 (European climate law) [4]. Following this heightened ambition, the European Commission (the Commission) brought forward a set of proposals (the 'Fitfor55' package) [2] to revise and update EU legislation to meet the heightened climate target. Expanding the production of renewable energy, driving electrification in different sectors, and improving energy efficiency, including through building renovation are key elements in this package.

To drive these changes the Fitfor55 package proposed to increase the share of renewable energy from 32% in 2030 to 40% in 2030 (from 21.8% in 2021), in response to the 2022 gas crisis this target was increased to a binding 42.5% by 2030 with an optional 2.5 percentage points.[v] Additionally, the EU aims to save an additional 763 Mtoe in energy by 2030, amounting to 11.7% extra savings, compared to the 2020 reference scenario for 2030. To achieve this member states energy efficiency obligation will gradually increase in the period 2024-2030. Specific targets have also been set for renewable energy in buildings (non-binding, 49% by 2030) and renewable energy in heating and cooling (binding, 0.8 percentage points on an annual average basis from 2021-2025 and 1.1 percentage points from 2026-2030).[vi]

Achieving the Fitfor55 target will require increased citizen participation in the energy sector. At the same time, the updated EU legislation will provide increased opportunities for citizens to become involved in the production and management of electricity and heat. For example, to achieve renewable energy in buildings targets, many households and SMEs will need to become prosumers, mainly using solar PV, while increased heat pump deployment to meet renewable energy in heating targets provides additional opportunity for demand response to support grid balancing and optimisation of renewable energy (self) consumption. At the same time, the legal scope for citizen participation has expanded as part of the adoption of the Fitfor55 package. The state-of-play matrices in the sections below provide an overview of both existing legislation with relevance to citizen participation and ongoing revisions being discussed.

2.2 Electricity market reform impact on ENPOWER

The energy price spikes of 2022 stirred up a debate centred on reforming the EU's energy markets to tackle price volatility and spikes and ensure security of supply. In March 2023 the Commission came out with a reform proposal in an attempt to address these issues, objectives included improving protection of vulnerable consumers, providing support to non-fossil flexible sources, and improve long- term price stabilization. In fall 2023, the European Parliament and Council presented their positions on the Commission proposal and trialogues started.

Although the majority of the reform focuses on the general electricity market architecture, several of the positions taken by the three institutions are of relevance to consumers and potentially to consumer participation in the energy markets. For example, to better protect consumers from volatile prices the Commissions proposes to legally enshrine different contract types, set-up crisis pricing regimes for consumers & SMEs, and increase opportunities for renewable energy sharing without having to create an EnC. In addition, it is being discussed to increase and strengthen the use of long-term contracts to provide stability and predictability of energy prices. One way to do this is through power purchase agreement (PPA) contracts, which are long-term contracts between an energy generator and a consumer. Currently they are mainly available to large buyers in only a handful of EU member states. Yet, their use could also benefit small consumers (households & SMEs) and municipalities, as they provide long-term security on prices and potentially better prices compared to buying from a retailer as it leaves room for negotiation or volume-based discounts.

The 'state-of-play' matrices below provide an extensive overview of the current EU legislation with regards to consumer participation in the energy sector, including the proposed revisions by the European Commission, European Parliament, and European Council as part of the electricity market reform. At the moment of writing however, no final decision has been reached on the provisions.

Table 1: Electricity Market Directive revisions

Relevant legal provisions	Current situation	Changes following Fitfor55 / ongoing discussions
Electricity Market Directive (EMD II) - Directive (EU) 2019/944[vii]		
Art. 15 Active customers	• Gives consumers the right to sell electricity they generated, including through power purchase agreements. • Can operate individually, as a group ('jointly-acting'), or through aggregators • Can participate in flexibility and energy efficiency schemes and engage in storage. • Can use fossil fuels to produce heat or power • Subject to network charges and financial responsibility for imbalances caused	See Renewable EnCs
Art. 16 Citizen EnC (CEC)	• A legal entity based on voluntary and open participation that is effectively controlled by members or shareholders that are natural persons, SME's, and local authorities, including municipalities • Primary goal is to provide environmental, economic, and/or social community benefits for its shareholders and/or members in the local area where it operates.	Commission proposal for revision of Directive (EU) 2019/944[viii] with relevance to CEC: • Drive member states to increase accessibility of hedging products for REC/CEC when acting as a supplier of electricity (Art. 18)

Renewable Energy Directive III (RED III) – Directive (EU) 2018/2001[ix]		
Art. 21 Renewables self-consumers	• Gives consumers the right to generate renewable energy for own consumption and store and sell excess renewable electricity including through power purchase agreements, electricity suppliers, and peer-to- peer trading arrangements • Can act individually, and through aggregators • Can act jointly with other self-consumers located in the same building, including in apartment blocks, and share their generated energy. • Self-consumers need to pay applicable network charges	See Renewable EnCs
Art. 22 Renewable EnC (REC)	• A legal entity based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity. • Shareholders can be natural persons, SMEs, and local authorities including municipalities. • Primary goal is to provide environmental, economic, and/or social community benefits for its shareholders and/or members in the local area where it operates. • Member states must provide an 'enabling framework'	Following the 2023 revision of the Renewable Energy Directive (RED III) several additions have been made with respect to the rights, responsibilities, and/or opportunities for renewable EnCs: • Article 9 'Joint Projects between Member States' now specifically mentions that member states can include REC in joint cooperation projects on offshore renewable energy. Although optional this gives additional visibility for REC and could lead to increased future opportunities for their participation in offshore renewable energy projects • Article 15a 'Mainstreaming Renewable Energy in Buildings' requires member states to put in place measures to increase renewable energy in buildings. The provision now specifically includes that these measures should i.a. target energy produced on-site or nearby and member states are encouraged to put in place measures to 'substantially' increase i.a.: ○ renewables-self consumption ○ renewable EnCs ○ local energy storage ○ flexibility services such as demand response • Art. 15a encourages member states to promote cooperation between local authorities and renewable EnCs in the building sector, specifically through public procurement. • Article 15d 'public participation' requires member states to promote public acceptance of renewable energy projects through both direct and indirect participation of local communities. • Article 16 'Organisation and main principles of the permit-granting process' requires member states to set up and/or designate contact points to provide

		guidance and facilitation on the permitting process for renewable energy projects. The contact points need to, i.a. , specifically address small-scale projects, renewables self-consumer projects, and renewable EnCs. • Article 16c ‘Permit-granting process for the installation of solar energy equipment’ requires member states to ensure that smaller solar energy installations (<100kW), including from renewables self-consumers and renewable EnCs are granted a permit within one-month. • Article 19 ‘Guarantees of origin for energy from renewable sources’ small installations (<50 kW) and renewable EnCs shall have simplified registration processes and reduced registration fees for guarantees of origin. • Article 23 ‘Mainstreaming Renewable Energy in Heating and Cooling’, Member states are encouraged to put in place regulatory, financial, and support measures to promote renewable EnCs in heating and cooling. In all heating and cooling promotion measures member states need to ensure accessibility for all consumers and especially low-income and vulnerable households. • Article 24 ‘District heating and cooling’ Member states are encouraged to put in place a coordination framework between district heating operators and potential sources of waste heat and cold to facilitate dialogue on using that waste heat/cold, including through renewable EnCs involved in heating and cooling

Table 2: Consumer participation in grid management

Relevant legal provision	Current situation	Upcoming changes/ongoing discussions
Electricity Market Directive (EMD II) - Directive (EU) 2019/944		
Art. 16 Citizen EnC (CEC)	Member states can opt to grant CEC the right to manage distribution networks	No suggested changes
Electricity Market Regulation – Regulation (EU) 2019/943[x]		
Art. 18 Charges for access to networks, use of networks and reinforcement	Consumers and prosumers also participate in the energy sector as individuals responding, for example, to tariffs or offers made by DSO's & TSO's. Currently, Art. 18 sets out conditions for the setting of network tariffs.	As part of the revision of the electricity market design the following proposals have been tabled: Commission: • Tariff methodologies for TSO/DSO shall reflect fixed costs and consider both capital (CAPEX) and operational (OPEX) expenditure to provide incentives for, among other things, the use of flexibility services, demand response, grid balancing, and innovation in the interest of consumers. • Regulatory authorities shall introduce performance targets to incentivize efficiency, including through flexibility services, smart grids, and smart metering. Parliament: The parliament expands on the Commission's proposal, possibly relevant to consumer participation is their additions on promoting the use of locational pricing and time of use tariffs, as these can benefit prosumerism, self-consumption, and flexibility schemes. Council: Supports tariff methodologies to reflect CAPEX/OPEX, and support the integration of renewable energy and non-fossil flexibility sources. Wants performance targets for TSO/DSO to be used only 'where needed'.
Renewable Energy Directive III – Directive (EU) 2023/2413		
Facilitating system integration of renewable electricity RED III Art. 20a	No prior provisions	The adopted RED III has expanded the information requirements for distribution system operators (DSO's) by adding a new article 20a, including: • Making available data on renewable electricity share and GHG emissions content of supplied electricity in each bidding zone in intervals equal to the market settlement frequency (max 1 hour). • Member states need to ensure DSO's have access to this data. • Member states need to incentivize upgrades of smart grids to improve grid

		balance monitoring and availability of real time information. • If technically available DSO's need to make available aggregated and anonymized data on demand response potential and renewable electricity generated and injected into the grid by self-consumers and renewable EnCs • All data needs to be made available in accessible formats to all electricity market participants, including aggregators, end-users, and consumers. Vehicle manufacturers need to make available real-time in vehicle data with relevance to self-consumption optimization and flexibility uses. • Member states need to make sure their national regulatory framework allows domestic batteries, electric vehicles, and other small, decentralised energy resources to participate in electricity markets, including for congestion management, flexibility and balancing services, and through aggregators. Technical requirements for market participation shall be developed in cooperation with all market participants.
EUDSO Entity and ENTSO-E DRAFT Proposal for a Network Code on Demand Response [xi]		
	No prior regulation	The Commission has proposed to put in place a regulation to establish a network code on demand response. To this end EUDSO and ENTSO-E have prepared a draft proposal for consultation with stakeholders. The stated goal of the new regulation is to support fair competition in the electricity market while safeguarding energy system security and integration of renewable energy. It specifically states the regulation will respect the principles of non-discrimination and technology neutrality. It proposes a framework of guiding principles for the development of rules for demand response, including aggregation, energy storage, and demand curtailment. The regulation applies to a range of energy system actors, including customers. Although the proposal does not specifically mention EnCs, it could apply to CEC when involved in grid management operations and/or acting as a designated party.

Table 3 - Consumer rights and obligations

Relevant legal provisions	Current situation	Possible changes/ongoing discussions
Energy Sharing	Energy sharing is included as an activity permitted for renewables self-consumers located in the same building (Art. 21 RED II). They can come up with their own arrangement on sharing their energy as long as relevant charges, fees, taxes, and levies are paid and it falls within the framework described for (joint) self-consumption.	As part of the revision of the electricity market design the following revisions have been tabled: Commission: The commission proposal now includes a definition for energy sharing to make it more accessible and widely used: Art.2 (10a): "'energy sharing' means the self-consumption by active customers of renewable energy either. (a) generated or stored offsite or on sites between them by a facility they own, lease, rent in whole or in part; or (b) the right to which has been transferred to them by another active customer whether free of charge or for a price." While in Art. 15a a 'right to energy sharing' is introduced, explicitly giving all households, SME's and public bodies to have the right to participate in energy sharing as an active customer. The article also describes conditions, rights and obligations for energy sharing. Parliament Right to energy sharing: for households, small enterprises or public bodies, within same bidding zone, or a more limited area (tbc by member state) ▪ Active consumers can appoint an "energy sharing organiser" (=aggregator?) and use a third-party that owns/manages storage or RES generation of up to 6MW each ▪ Deduction from metered consumption within time interval no longer than imbalance settlement period (=15min) ▪ Without prejudice to non-discriminatory taxes, levies and cost-reflective network charges ▪ Not required to comply with supplier obligations if <10,8kW for households or 100kW in apartment blocks ▪ One-stop-shops to facilitate and register energy sharing. ▪ Energy sharing projects owned by public authorities have to make 20% of shared electricity "accessible" to vulnerable customers.

		Promote introduction of plug-in mini-solar systems up to 800W (balcony solar), MS can exempt shared electricity from taxes, levies, network charges.
Electricity Market Directive (EMD II) - Directive (EU) 2019/944		
Art. 4 Free choice of supplier	Consumers have the right to choose their electricity supplier and can have multiple supply contracts at the same time if they have the required connection and metering in place	As part of the revision of the electricity market design the following revisions have been tabled: **Commission:** Customers can have multiple supply contracts using multiple metering/billing points using only one-connection. **Parliament:** Free choice of supplier: several suppliers per connection point to be made possible and treated in the same way. **Council:** No proposed changes
Art. 11 Entitlement to a dynamic electricity price contract	Member states need to put in place regulatory frameworks that enable dynamic electricity price contracts, final customers with a smart meter need to be able to receive a dynamic contract from at least one supplier active in their area and with every supplier that has more than 200.000 final customers.	As part of the revision of the electricity market design the following revisions have been tabled: **Commission** To expand consumers contract rights to include fixed-term, fixed-price, and dynamic electricity price contracts and to improve information provision on contract conditions to consumers. **Parliament:** Fixed term/price contract: consumers with fixed contracts not to be excluded from participation in demand response and energy sharing. **Council:** MS may exempt a supplier >200k final customers from obligation to offer fixed term fixed price contracts if that supplier “only offers dynamic price contracts and the exemption does not have a negative impact on competition or sufficient choice of fixed term fixed price contract”.
Art. 12 Right to switch and rules on switching-related fees	• Consumers have the right to switch supplier and aggregator, and switching needs to be executed within three weeks, and from 2026 onwards within 24 hours. • Consumers cannot be charged switching fees unless a contract is terminated before end of the contracted period. • Household consumers have the right to participate in collective switching schemes and member states need to enable this.	No proposed changes
Art. 17. Demand response through aggregation	Final customers, including through aggregation, have the right to participate in	No proposed changes

	electricity markets alongside electricity producers in a non-discriminatory manner.	
Art. 18 Bills and billing information	Sets conditions for accessible and 'user-friendly' billing for consumers.	As part of the revision of the electricity market design the following revisions have been tabled: **Commission:** Article 18a 'supplier risk management' is added, requiring member states to ensure that energy suppliers put in place hedging strategies to limit price spike risks, including through power purchase agreements. Member States are specifically requested to ensure hedging products are also accessible to CEC/REC. **Parliament:** No proposed changes **Council:** No proposed changes with relevance to consumer participation.
Art. 19 & 20, Smart metering systems and their functionality.	• Member states shall ensure the deployment of smart metering systems to assist the active participation of customers in the electricity market (can be subject to a cost-benefit assessment). • Smart metering systems shall be set up in such a way that they can enable final customers to be metered and settled at the same time resolution as the imbalance settlement period in the national market.	No proposed revisions
Art. 25 'Single points of contact'	Member states shall put in place a single point of contact for information provision to customers on their rights	No proposed revisions
Art. 26 'Right to out-of-court dispute settlement'	Member states shall ensure that final customers have access to effective and accessible out-of-court dispute settlement	No proposed revisions
Art. 27 'Universal service'	Household customers, and optionally SME's, have a universal right to be supplied with electricity and distribution system operators are obligated to connect them	As part of the revision of the electricity market design the following revisions have been tabled: **Commission:** Adds art. 27a 'supplier of last resort': requires member states to appoint suppliers of last resort for at least household customers, households transferred to a supplier of last resorts retain all rights as customers for at least 6 months. **Parliament:** Expands the period in which households maintain their rights until the household has found a new supplier (instead of the proposed 6 months). **Council:** Proposes to no set a requirement of continued service, only existing provision that MS "may" require a supplier of last resort to supply when customer does not receive market-based offer
Art. 28 'Vulnerable customers'	Member states shall take appropriate measures to protect vulnerable customers	As part of the revision of the electricity market design the following revisions have been tabled:

	(definitions can vary by member state), and ensure they enjoy high levels of consumer protection	**Commission:** Member states are required to protect vulnerable customers from electricity disconnections. **Parliament** Disconnection protection: disconnection prohibited of households at risk of energy poverty, and during ongoing legal procedures. Suppliers can't require prepayment systems. **Council** No proposed changes
Art. 33 Integration of electromobility into the electricity network	Sets out conditions for the connection of recharging points for electromobility to distribution grids	As part of the revision of the electricity market design the following revisions have been tabled: **Commission:** No proposed changes **Parliament:** Member states should facilitate connection of public electromobility charging with smart and bidirectional charging functionalities and ensure that DSO connect system users within six months when no grid reinforcement is needed, and one year, if reinforcement is needed. **Council:** No proposed changes
Art. 59 Duties and powers of the regulatory authorities.	Sets out the duties and powers of national regulatory authorities, including the monitoring of the consumer rights outlined in this directive and the removal of barriers to the development of self-consumption and citizen energy communities.	As part of the revision of the electricity market design the following revisions have been tabled: **Commission:** No proposed changes. **Parliament:** Proposes to expand the duties of national regulatory authorities to incl. "monitoring the removal of unjustified obstacles to and restrictions on the development, production, storage, of consumption and selling of self-generated or shared electricity, renewable energy communities and citizen energy communities, including obstacles and restrictions preventing the connection of flexible distributed energy generation within a reasonable time". **Council:** Suggest including the removal of "obstacles and restrictions preventing the connection of flexible distributed energy generation within a reasonable time"
Art. 66a Access to affordable energy during an electricity price crisis		As part of the revision of the electricity market design the following revisions have been tabled: **Commission:** Adds article 66a outlining powers and conditions for the commission to declare a regional or EU-wide electricity price crisis, protecting consumers from extreme price spikes and/or overly high prices. **Parliament:**

		Suggests changes to the proposed conditions on determining when a price crisis can be declared. Including for the regulated price for households applies to max 80% of median household consumption, and 100% for vulnerable household customers. **Council:** Suggest changes to the proposed conditions on determining when a price crisis can be declared.
Electricity market regulation (EMR) 2019/943		
Art. 60 'Amendments of network codes'	Consumers may propose draft amendments to networks codes to the regulatory authority (ACER).	No changes

2.3.1 Member state level implementation

For consumer participation in the energy sector the EU legal frameworks for active customer, EnCs, and energy sharing are the most important, as they provide viable and accessible methods for individual and collective prosumerism. The EnC definitions have been introduced already in 2019 as part of the Clean Energy Package and should have been transposed by end of 2021.

Although of out scope of this gap analysis, the transposition and implementation process have (had) significant potential to raise barriers and or restrictions in the accessibility and viability of these methods. For example, according to the transposition tracker by REScoop.eu – the European federation of citizen energy cooperatives – only five EU countries have a transposition process rated 'good' or 'best practice, and thirteen countries are rated 'bad' or 'substantial deficiencies'.[xii] Although their analysis includes a broader set of indicators than just strict transposition of the REC/CEC definitions it does give a good indication of the environment for EnCs in the specific countries. The main indicator the tracker looks at include:

- the extent to which criteria from the EU definition are reflected in the national definition
- the level of detail in the national level definition
- if there is coherence between the definitions
- whether it clearly describes a purpose for REC/CEC
- what legal entities are allowed
- if citizen participation is ensured
- and if a dedicated regulatory authority has been assigned

The Commission has set-up the EnCs Repository to track and collect member state policy and regulation on the implementation of EnCs.[xiii] By March 2023 it had identified legal definitions and provisions on EnCs in 23 member states. In addition, it has published in depth analyses of the policy frameworks in six countries, with additional country analyses becoming available on a rolling basis.

Results per each Member State where pilot site is located will be presented as part of use cases gap analysis.

3. Methodology for UC identification

3.1 Introduction

This section describes the methodology used to identify and describe each HLUC of the ENPOWER project. This methodology will also guide the identification of the domains, and the actors involved in each HLUC. A given UC is usually a well-structured document whose main objective is to identify, fully describe, and organize its technical requirements. Hence, a UC is described in a technology-neutral way and should identify a set of potential interactions or actions performed by the ENPOWER system or between the identified actors.

The methodology developed in this chapter serves as a roadmap for guiding the various activities to define the final exploitation plan. The process covers interconnected steps tied to different phases:

- Step 1: HLUC identification phase, up to M6 for the first identification of UCs and especially sub-HLUCs and up to M16 to consider inputs from activities in the following step that will help to fine-tune the HLUC and to adjust their strategy as needed.
- Step 2: Consolidation of HLUC up to M6, and alignment with regulatory analysis per pilot site, based on the outcomes of Step 1.

As the project evolves and changes can occur, cycle loops between these steps are anticipated. The HLUC aspects defined in Step 1 will be monitored until the end of WP2. In consolidating HLUCs, new sub-UCs and scenarios could be identified. Lastly, new UCs could emerge during the execution of the project following its evolution.

3.1.1 Key concepts

The relevant terminology related with the UCs used throughout this document will be defined in the following section. To understand the UC template, it is essential to have a set of clear definitions of the main key concepts. Among all the definitions available in the IEC standard, we selected the most important ones: Actor, Domain, Scenario, High-level UC (HLUC), and detailed (Primary) UC (PUC), to be developed at the end of WP2.

An Actor is defined as any entity that communicates and interacts with the various ENPOWER modules and services. These actors can include humans, software applications, systems, databases, and even the power system itself (e.g., aggregator, distributor system operators, DSOs, or transmission system operators, TSOs).

A Domain is an area of knowledge or activity which uses a set of concepts and terminology commonly understood by the practitioners in that area. In the case of ENPOWER, the domains will be defined according to the different stages needed to deploy the different smart solutions.

A Scenario is a possible sequence of interactions, which are described using a step-by-step method with the relevant data exchange properly defined.

A High-Level UC (HLUC) is a UC that describes a general requirement, idea, or concept independently from a specific technical realization like an architectural solution. HLUCs are usually generic and serve as the basis for the development in ENPOWER.

3.2 Detailed Methodology

To ensure the smooth progress of task activities, questionnaires were prepared for each pilot site, consisting of technical, economic, social and regulatory aspects. Information gathering was followed by workshops with pilot site leaders. This coordinated approach resulted in:

1. Gaining a comprehensive understanding of the available infrastructure in pilot sites.
2. Identifying TE mapping per pilot site
3. Identifying relevant HLUCs and associated requirements in line with the ENPOWER project objectives.
4. Identification of potential gaps and limitations for HLUC implementation in each of the pilots.

Using these main objectives of the methodology, the UCs have been kept generic enough in terms of technological implementation to ensure faster replicability. The UCs will also be described with different levels of detail according to their specification. The UCs identified for the project are technical UCs that will capture the different functionality levels present in the project.

3.2.1 HLUC definition process

To develop D2.1, six main activities have been defined to conduct a successful analysis of UCs requirements with pilot site characteristics and capabilities (see Figure 2).

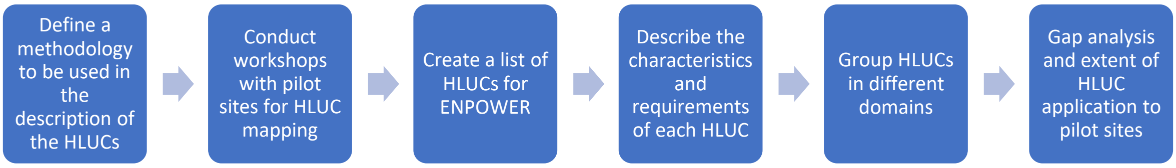

Figure 2: Six main steps of the HLUCs identification and mapping process.

The process used to produce the most relevant content in this report has included most of the ENPOWER partners, through a set of sequential phases that may be described as follows:

1. Identification of the Domains – Considering the ENPOWER modular architecture, objectives, and pilots involved, a list of domains was proposed (see Section 3.2.1).
2. Identification of Actors – The list of Actors considered the main pilot leader roles but was further developed (consider Section 3.2.5).
3. Identification of the HLUCs – A list of HLUCs was proposed for each Domain, considering the objectives and pilots of the ENPOWER project (cf. Section 3.2.3).
4. Workshops on the definition of ENPOWER Domains, Actors, and HLUCs –workshops were held in coordination with WP5 with the partners to further discuss and define the final list of Domains, Actors, and HLUCs.
5. Preparation of the UC template – As mentioned previously, HLUC template was prepared using the IEC recommendations, with the objective of having a common base to describe each HLUC and shared with the ENPOWER partners.
6. HLUC complete description –describe each HLUC having in mind the expertise and responsibilities of each partner in the ENPOWER project.

7. HLUC uniformisation – To ensure consistence between all HLUCs, a review was performed by the task leader to harmonize them into a single document.

3.2.2 Standard methodology and template development

This section gives an overview of the methodological approach followed within ENPOWER in order to identify specific UCs and present in standard format for achieving the project objectives.

The International Electrotechnical Commission (IEC) proposed an international standard methodology to define and describe UCs in its IEC 62559-2 norm, named UC Methodology – Definition of the templates for UCs, actor list and requirements list [5]. IEC is an international organisation that promotes cooperation concerning standardisation in the electrical and electronic fields. The IEC 62559-2 standard also defines the key concepts and the terminology associated with the UC development (which creates the basis for a common repository of UCs), the essential structure for a UC, providing a comprehensive template, and a serialisation method for the definition of UCs.

Given that the IEC standard on UC Methodology (IEC 62559-2) has been reformed concerning the ENPOWER ambitions in electrical fields, software engineering and also considering the project technology developments will require the interaction of different areas of knowledge. Since the project will upgrade the smartness of the existing buildings using IoT-enabled devices, smart meters, and plugs, the use of this standard for the ENPOWER project comes as a natural fit. It will serve as a basis to define the ENPOWER UCs, helping to define high-level requirements and specifications for the early stage of ENPOWER development and contributing to the basis of the work being developed in the remaining work packages (WPs).

However, given the fact that the ENPOWER project is not dealing only with smart grid or electricity field, and also this is a preliminary analysis, it serves as foundation for development of the detailed UCs and scenarios. We have adapted the structure of the UC template, suggested in IEC 62559-2, to better suit the project requirements and the partners involved in contributing to the definition and description of the UCs.

Development of initial HLUC began at the very beginning of the project on the basis of the Grant Agreement and pilot partners workshops, before kick-off of technical work packages in the document. The document maps the main HLUC to pilot sites and builds common ground for HLUC applications across several pilots without developing detailed UCs and scenarios that will further differentiate individual options tailored to pilot specifics. It serves for gap analysis and preliminary mapping. Detailed functional requirements and UC analysis that would consider further project developments and coordination with technical WPs will be conducted in the next tasks of WP2.

The selected HLUCs are classified into appropriate domains, each one describing a different technology and innovative solution proposed within the project, presenting the necessary information regarding functionalities and processes of the ENPOWER tools, which will be implemented within the project.

The template for HLUC therefore consists of the following descriptions:

- Brief Description and Domain
- Actor(s) – stakeholders involved
- Technology Enabler
- Trigger event

- Pre-conditions
- Post-conditions
- Basic Flow

3.2.3 HLUCs identification and processes

The identification of the different Domains and Actors were performed using the IEC standard definitions through an interactive process involving the contribution and the agreement of all partners (as presented in Section 3.2.1).

Data related to installed assets, asset measurements, electrical data, historical data, communication protocol, and real-time network monitoring were collected from the partners. The data collection activity lasted for four months, after which follow-up meetings were organised with some of the pilot sites to confirm the accuracy of the data they had previously provided. After completing the data collection activity, several iterations of ENPOWER partner revisions were conducted. Finally, HLUCs was evaluated for each pilot site individually based on the previously prepared information. Each HLUCs was evaluated by matching the main preconditions with the information to collected from the pilot site leaders and technology developers.

3.2.4 HLUC Base Description and Domain identification

The residential sector in Europe offers huge energy demand flexibility, mainly due to the huge thermal energy storage and power management capabilities of the buildings. Smart meters connected appliances or in-home displays open new possibilities for innovation on the demand side. For instance, DR can be about shifting electric heating and air conditioning away from electricity price peaks, charging or discharging an electric car at times of interesting prices or delaying the use of a washing machine while being rewarded for reducing consumption at peak times. Complementary to the huge potential for residential flexibility, leading-edge ICTs, such as IoT, AI, and Distributed Ledger Technology (DLT)/blockchain/smart contracts, edge computing and big data analytics, enable a great opportunity to develop the residential DR market and this is in focus of ENPOWER project developments.

The ENPOWER project has identified five broad domains from which the different HLUCs will be defined:

- Digitalisation of EnCs
- Forecasting and modelling of EnCs;
- Smart Controls for EnC optimisation;
- EnC market operation;
- User-centred Interaction in support of EnCs.

Matching electricity supply and demand at all times is becoming more challenging and the electricity system needs more flexibility. A flexible consumption (i.e. demand following supply) could - next to energy efficiency as ‘first fuel’ - play an important role in the residential sector. Residential DR can reduce the need for fossil fuel power plants and help integrate renewable energy onto the electric grid by providing increased stability and management.

The first domain identified, Digitalisation, is related with both the collection of data from the sensors to the ENPOWER Platform and the sending of control actions from the ENPOWER Platform to the actuators placed within a given space and/or building.

The Forecasting and modelling is the domain where the UCs related with the performance of the EnC as an energy system, and the prediction of energy loads or maintenance services will be incorporated. This domain will receive data from the ENPOWER Platform, perform all the forecasting and modelling envisioned for the ENPOWER project, and send its results back to the ENPOWER Platform.

Smart controls will be called from the ENPOWER Platform and will use the data from the Forecasting to optimize the general energy efficiency and flexibility of the EnC. Ultimately, the results from the smart controls will be sent from the ENPOWER Platform to the actuators in order to deploy the best possible solution at a given instant of time.

Market domain within the ENPOWER project focuses on the intelligent management and optimisation of EnC energy resources within a broader ecosystem. This domain aims to facilitate the aggregation of energy data, including generation, consumption, and storage information, from various sources and the grid. By leveraging this aggregated data, ENPOWER can enable dynamic energy trading and distribution, allowing energy producers and consumers to optimise their energy utilisation, reduce costs, and contribute to the overall stability and sustainability of the energy system.

The last domain identified, User-centred Interaction, will comprise the UCs that will be responsible to deliver valuable information to the different ENPOWER users through visual interfaces (e.g., website or mobile app) with nudging activities.

3.2.5 Actors involved

As described above, the information of actors involved directly or indirectly in a HLUC is important, is included in the UC templates and exploited also for the modelling of the UCs. Thus, a common understanding and language is required to be established along ENPOWER, which is achieved with the compilation of a common list of engaged actors. Each one of these actors is described and characterised as a person, organisation, device or system.

ENPOWER will align with Regulatory Working Group on the Analysis of the HEMRM (Harmonized Electricity Market Role Model) developed by ENTSO-E and the associated organisations EFET and ebIX analysis and if necessary, adapt its role definition to facilitate a certain level of homogeneity among BRIDGE projects.

Table 4: ENPOWER actors list

Actor name	Description	Actor type
DER unit	Distributed Energy Resource, as a system including any type of generation units, storage units and load flexibility resources connected to the distribution network along with the Gateway responsible for communication management of DER device with a software system.	System
Active customer	A final customer, or a group of jointly acting final customers, who consumes or stores electricity generated within his/her premises located within confined boundaries or, where permitted by a Member State, within other premises, or who sells self-generated electricity or participates in flexibility or energy efficiency schemes, provided that those activities do not constitute its primary commercial	Person

	or professional activity. (Directive (EU) 2019/944 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast))	
Aggregator	A natural or legal person who combines multiple customer loads or generated electricity for sale, purchase or auction in any electricity market, acting as a balancing responsible party, or for selling the accumulated flexibility to the system or network operator.	Organisation
AMI	Advanced Metering Infrastructure. A set of systems that monitor, collect and analyse electricity consumption, and have two-way communication capabilities.	System
EnC manager	A natural or legal person responsible to manage the energy behaviour of the members of an EnC either for the optimisation of the energy usage inside the community or for minimisation of the energy cost or in order to sell the accumulated flexibility to the market or provide services to the operators.	Person
DER owner	The owner of a distributed energy resource	Organisation/Person
End user	Any user/customer connected to the grid (absorbing from or injecting energy to it).	Person
Flexibility manager	The entity responsible for the management of the aggregate sources providing flexibility to the network. Part of the role of the Aggregator.	Organisation
Grid operator	A microgrid operator or a distribution network operator, as the entity responsible for the distribution network planning and development, the safe and secure operation and management of the distribution system, the data management associated with the use of the distribution system and the procurement of flexibility services. This also includes the workforce of the operator to achieve the above (e.g. maintenance personnel / contractor).	Organisation
Market Operator	An entity that provides a service whereby the offers to sell electricity are matched with bids to buy electricity. (Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast))	Organisation

During the work developed in this task, we identified a list of 8 HLUCs, as shown in Table 5. These HLUCs will originate UCs that represent specific functionalities of the ENPOWER system and may not be applied to all demo sites. Regarding the division of HLUCs by domain, in the Digitalisation domain, HLUC is primarily dedicated to collecting EnC and third-party data in energy data spaces compliant way and sending it to the ENPOWER Platform. Forecasting and modelling domain comprises two HLUCs directly related to Digital Twins for consumer-aware optimal flexibility planning and flexibility assessment supporting decision making. The Smart Control domain includes two HLUCs that will be responsible for optimising the energy efficiency and flexibility to grid operators with the definition of the optimal control strategy at a given time. The Market domain includes one HLUC that will be responsible for the aggregation and flexibility of the EnC and participation in the P2P marketplace. The User-centred Interaction domain currently has two HLUCs, that will use a user-centred approach to increase engagement of EnC from the ENPOWER system based on nudging apps, and second one focusing on incentives for EV EnC owners.

Table 5: List of the 8 ENPOWER HLUCs grouped by domain

Domain	#	Name of UC
Digitalisation of EnCs	HLUC1	EnC clustering and segmentation
Forecasting and modelling of EnC	HLUC2	Flexibility assessment of EnC
	HLUC3	Digital Twins for consumer-aware optimal flexibility planning
Smart Controls for EnC optimisation	HLUC4	Grid connected smart control and interoperability
	HLUC5	Community centred services for increased share of self-consumption
EnC market operation	HLUC6	P2P renewable marketplace for energy and flexibility demand
User-centred Interaction in support of EnCs	HLUC7	Nudging for near real-time EnC members activation
	HLUC8	Flexibility management providing incentives to communities of EV drivers

3.2.6 Overview of technological enablers (TE) supporting HLUCs

This section provides a short description of the tools and applications that will be implemented as part of the project.

Table 6: ENPOWER Technological Enablers

TE #	TE Description	Partner
TE-1	Interactive decision support tool for EnC planning	CARTIF, INESC TEC
TE-2	SITEC-Sizing tool for EnCs	INESC TEC
TE-3	CRP social engagement management platform	DCsix, EPRI
TE-4	Energy Data Space compliant tools for sovereign data management, sematic interoperability and exploitation	ED, DST

TE-5	DLT/Blockchain/smart contracts multi-purpose marketplace for increased Trust & Sovereignty and for P2P tokenised assets sharing and compensation	DST
TE-6	Digital Twins for consumer activation	INESC TEC, DST
TE-7	Consumers clustering and segmentation tools	NTUA, UNIBAS
TE-8	FATEC - Flexibility Assessment tool for EnCs	INESC TEC
TE-9	Self-consumption optimisation tool	NTUA, GEARS
TE-10	Closed-loop optimal load control and intelligent monitoring of electric appliances for residential users	NTUA, COMS
TE-11	V2G-based flexibility management platform for providing incentives to communities of EV drivers	PARITY
TE-12	OSTEC-Optimised Scheduling Tool for EnCs	INESC TEC
TE-13	AI-Powered Virtual Energy Manager (WIS4Households)	WATT-IS
TE-14	Nudging Apps for near real time closed loop consumers activation	OurPower, BLUEPRINT
TE-15	Blockchain-based hybrid coalition-based flexibility aggregation tool	DST, COMS
TE-16	P2P digital tools and platforms for consumer activation and social engagement	OurPower, BLUEPRINT
TE-17	P2P energy markets designs and algorithms	INESC TEC
TE-18	Privacy preserving tools for automated interoperable DR	EPRI, DCSix, MaREI, COMS

These technology enablers are described below:

TE-1 - Interactive decision support tool for EnC planning

The interactive decision support tool is expected to be a key enabler for the EnC construction process. It will adapt existing computation modules for sizing the electrical assets (being developed in the national Digital CER Portuguese P2020 project) and the optimisation of heating/cooling assets and networks (H2020 REWARDHeat project, HySGRID+ national Spanish project). The frontend will integrate GIS-based capabilities from previous projects and tools (e.g. REWARDHeat pre-design tool), guided questionnaires (e.g. ATELIER Positive Energy District tool and LocalRES planning tool) and existing database (from H2020 LocalRES). In ENPOWER, the developed tool will allow users to assess the benefits (economic, social, etc.) of becoming a prosumer or joining an EnC and assess different scenarios (size of technologies, etc.). It will give citizens access to knowledge and information as well as help them to define their local EnC, enabling consumers to take the leap to actively participate in the energy activities.

TE-2 - SITEC-Sizing tool for EnCs

SITEC (developed in the national project Digital CER) comprises a set of algorithms (based on the load profile, technical and economic features, existing constraints, investments and operating costs of community assets, and the regulatory framework and business models for EnCs) that allow to assess the investment in individual and collective assets, compare the investments and operating costs with the BAU, and provide the optimal operation of the flexible resources. In ENPOWER, it is expected to extend the tool with the inclusion of developments on: (i) multienergy cross-sector assets and behaviours, such as the thermal needs of the community members, new resources (thermal and other controllable loads and devices with non-energy specific functions, as EVs), (ii) the consideration of new business models for the community and its members, including the provision of flexibility for commercial balancing and system services, and (iii) the consideration of shared assets and benefits sharing mechanisms.

TE-3 - CRP social engagement management platform

Currently, the Citizen Renewable Platform (CRP) for social engagement and information exchange can facilitate the progression of communities through an Energy Master Planning exercise. The future state of CRP would allow for automated insights on behaviour change or low carbon technology choices for individuals. This will link citizens to service providers and opportunities for automated enrolment in utility flexibility/DR services (TE-16). In ENPOWER, CRP will enable a digital active platform as an integrated technology solution. It will support and enable a citizen to educate, plan and implement their own unique journey towards low carbon and resilient energy solutions. It will unlock flexibility resources which create energy services to the community, DSO/TSO and wholesale market, while also realising part of a combined community effort to becoming energy efficient, resilient and renewable.

TE-4 - Energy Data Space compliant tools for sovereign data management, sematic interoperability and exploitation

ED and DST have been actively involved in H2020 OneNet project and the development of the OneNet connector deployed as the OneNet edge level middleware. It is essentially developed to facilitate interoperability among different system and platforms, allowing them to exchange data and information in a secured and trusted manner towards the vision to create a single connected grid for Europe. In ENPOWER, the developed Energy Data Space compliant tools will exploit the interconnectivity with local business platforms. They will explore potential data services that will facilitate the empowerment of consumers and will be supported by harmonised and extended Smart Grid Data Models (family of CIM IEC standards), business DR standards (OpenADR2.0), ontologies (SAREF), and languages (EFI). The interfaces to allow connectivity with other platform will adopt open APIs within adapted extensions of the FIWARE NGSI v2 ETSI standard Context broker, while leveraging the information model and the recommendations of IDSA refence architecture model and GAIA-X.

TE-5: DLT/Blockchain/smart contracts multi-purpose marketplace for increased Trust & Sovereignty and for P2P tokenised assets sharing and compensation

DST has developed within H2020 eDREAM, SOFIE, PlatONE, BD4NRG a decentralised DLT/Blockchain/smart contracts multi-purpose solution, based on a Proof-of-Authority (PoA) permissioned blockchain adaptation, in order to support (i) Hybrid IoT off-chain versus on-chain energy data notarisation and tamper-proof shared data assets, by leveraging on more energy-efficient protocols (such as Lightning protocols) and (ii) Digital P2P marketplace for tokenised heterogeneous energy asset sharing and compensation. In ENPOWER, the solution will be advanced the towards multi-purpose scenarios by (i) supporting Trust and Sovereignty by adapting and integrating the DST solution to manage Data Usage Policies automatic definition and management through Smart Contracts, traceability and provenance, multi-party data assets tamper-proof sharing, and non-reputability of the transactions during logging and clearing processes, and (ii) expanding the above solution to allow the participation as tokenised assets, ranging from data sets, data services, data storage resources, computing resources, with a view to allow P2P data/assets/services exchange and reciprocal compensation. In particular, the latter application will enable an increasing end-user' participation in personal energy data sharing either individually or within the framework of Data Cooperative.

TE-6: Digital Twins for consumer activation
INESC TEC developed flexibility-centric DTs assets like thermoelectric water heaters, heat pumps, behind the-meter and community battery storage and EV, based on data-driven and physics-informed flexibility models developed and demonstrated in past and on-going National (Baterias 2030, Flexergy) and EU projects (H2020 MATRYCS, BD4NRG, InteGrid, InterConnect, I-NERGY). In ENPOWER, it is expected to enhance the DTs, by: (i) Integrating business and social dimensions (on the top of the pre-existing technical dimension from past projects), as well as heating and mobility sectors, to create an accurate virtual representation of flexibility, providing planning functionalities for DR services at the individual, community, and aggregated level, and (ii) applying seamlessly integrated/interoperable in the Energy Data Space (TE-3).

TE-7: Consumers clustering and segmentation tools
NTUA has developed specific clustering models for the segmentation of consumers in the context of its state-of-the-art AI Library (as part of the H2020 MATRYCS and BD4NRG). In ENPOWER, the aim is to further extend the features of the developed models and to introduce new AI-based models of different nature, in order to achieve a better behavioural segmentation of consumers and, ultimately, to detect and semantically interpret the socioeconomic characteristics of each segment. This will enhance the decryption and deeper understanding of consumption patterns, attitudes and preferences, towards the goal of limiting consumption and managing DR in a prosumer's society. The enrichment of the models will be conducted by NTUA, in collaboration with UNIBAS, combining cross-sectoral fields of expertise to structure a solid clustering methodology based on a complete set of social-economic, gender, geographic, socio-cultural, and socio-political factors.

TE-8: FATEC - Flexibility Assessment tool for EnCs
The FATEC tool has been developed by INESC TEC, under the scope of the InterConnect project, and applies causal modelling to assess (and rank) the consumption flexibility of individual or aggregated consumers. It is based on relating the consumption data with the DR economic and non-economic incentives by taking out the influence of the main confounders. In ENPOWER, the FATEC tool will be extended by including: (i) means to compare and evaluate the aggregation levels and effectiveness of the aggregated flexibility amongst different pilots under the ENPOWER project, and (ii) extend the elasticity assessment tool to design tailored DR strategies for each consumer within the community (or each community), based on elasticity profiles and performance.

TE-9 Self-consumption optimisation tool
Data-driven tools composed of state-of-the-art libraries of ML/DL models have been developed by NTUA (within the context of H2020 MATRYCS, BD4NRG and I-NERGY projects) and GEARS (as part of its business activities). These tools are based on implementations of forecasting techniques for different energy problems, including supervised (regression and classification algorithms) and unsupervised learning methods (clustering), as well as artificial neural

networks (ANNs). In ENPOWER, the aim is to increase the accuracy of the services, by training a large set of ML/DL models utilising a rich dataset of heterogeneous static and dynamic data (e.g. from the Greek and Hungarian pilots). Emphasis will be given on delivering a self-consumption optimisation tool for consumers and EnCs, which can bring simultaneous value and benefit different stakeholders to draw meaningful connections between events and bear near real-time situational awareness.

TE-10	Closed-loop optimal load control and intelligent monitoring of electric appliances for residential users

A state-of-the-art application for smart monitoring of household electric appliances has been developed within the context of ATOM national Greek project and H2020 BRIGHT and SAAM that enables several functionalities providing responsiveness, adaptivity, ubiquity and transparency in the context of a smart home environment. In ENPOWER, a DL-based energy disaggregation component will be integrated as a combination of smart metering and sub-metering incorporated in the household electric appliances application, aspiring to itemise consumers' energy consumption data for each individual appliance. Users will be capable of not only monitoring their household appliances, but also of inspecting consumption patterns during different periods of the year and hours of the day, along with tailor-made recommendations on how to limit their consumption preserving high levels of quality of life. The potential benefits of the updated application can be spotted in the mapping of household consumption patterns to high RES-based production intervals in order to maximize the self-consumption of renewable energy (TE-6).

TE-11: V2G-based flexibility management platform for providing incentives to communities of EV drivers

The EV Loader application has been developed by PARITY. It is an EV Charging Station Management Platform (including an app for the EV drivers) that provides real time data related to charging stations and manages future reservations on publicly accessible charging stations. In ENPOWER, the EV Loader will be enriched with a smart charging module, which will be able to investigate smart charging load management patterns, such as Load Valley Filling (a form of load management that increases the off-peak loads), Peak Clipping (a form of load management that decreases the charging during peak loads), Stimulation (charging at times of higher RES production). The EV Loader will be further enhanced to support Vehicle-to-Grid (V2G) transactions when compatible hardware is available. Improvements integrated within the scope of ENPOWER, will enable PARITY to introduce and test the first modular solution for V2G transactions that complies with ISO 15118-20, the new EU Standard for EV charging transactions. New functionality delivered within ENPOWER will incentivize users to shift their charging schedule or discharge their vehicle to support the grid.

TE-12: OSTEC-Optimised Scheduling Tool for EnCs

A centralised energy management tool for EnCs has been developed by INESC TEC under the scope of national projects, namely the Digital CER, Baterias2030 and Flexergy. The tool comprises a set of algorithms being capable of providing optimal operating schedules for individual and community flexible assets (e.g., battery storage systems, flexible loads such as EV chargers, HVACs or heat pumps), accounting for the maximisation of different objectives (e.g., economic revenues, self-consumption, community trading, and provision of ancillary services). In ENPOWER, this tool will be improved by including additional resources and functionalities, accounting for community members behaviors (e.g., comfort requirements), as well as new business models with shared assets combined with the work performed in SITEC tool, with special focus on storage systems' degradation impact. Within these developments, the OSTEC tool will take the opportunity to improve some of the inputs, considering the business models addressed in T5.1 and the flexibility modelling and forecasting from T5.2.

TE-13: AI-Powered Virtual Energy Manager (WIS4Households)

WATT-IS has developed an AI-powered user engagement platform (Web & mobile App) focused on the promotion of energy efficiency at the residential level (WIS4Housholds) that will be made available to the community participants that will incorporate information regarding i) its own energy consumption disaggregated by the main appliances through the application of Load Disaggregation modules; ii) Benchmarking with other similar peers; iii) AI-powered targeted energy efficiency recommendations; iv) recommendations to become a prosumer participant through optimal dimensioning of solar PV solutions. Through ENPOWER, WATT-IS will adapt and improve this solution targeting EnCs participant needs, but also adding additional modules that will make possible for an effective such as, i) specific information regarding the energy the participant is sharing (if he is a prosumer) or was shared to him by other participants; ii) DR activities he may be involved in; iii) the impact created by him in DR activities he has enrolled.

TE-14: Nudging Apps for near real time closed loop consumers activation

Building on the outcomes of project serve-U an adjoint mobile app ('nudging app') with consumer dashboard will be further developed to serve as information channel for their users and EnCs within ENPOWER framework. Besides general status infos, e.g. recent generation / consumption / balancing data there will be individual and community forecasts to be broadcasted to customers / community members together with calls to action and guidance for consumers to react on the forecasted situation and help optimize the community energy use, balance, economy or other KPIs ('nudging'). The functionalities of 'nudging' app include: provide recent and forecast values of generation and consumption to users, offer advice to change use of energy, provide answering channel for participants (Button 'Sure, I can react and help' / 'No, sorry, no option for me'). Communication channel will also include community dialogs / online event notifications for feedback and will continually improve app UX. While nudging app will be directly deployed in Austrian demo and Hungarian early adopter fully, the design and of UX will also be provided to other 3 pilots to accelerate SSH engagement and DR programme.

TE-15: Blockchain-based hybrid coalition-based flexibility aggregation tool

Within H2020 BRIGHT a hybrid TRL 5/6 DLT/Blockchain/Smart contracts based tools for optimal community-members flexibility aggregation and VPP tool have been developed, which are able to reconciliate and take into due consideration the typical aggregation top down consumers preferences and aggregation potential encapsulated via Smart Contracts with a P2P anticipated information broadcasting and sharing among member of local communities combined with dynamic and on-the-fly setting up of temporary coalitions of consumers. COMS has developed within H2020 PHOENIX a TRL6 blockchain-based solution for traceable privacy/confidentiality protection enforcement that allows to manage rules, policies, consents and permissions associated with (i) data access to support data driven services, and (ii) control interfaces to aggregate and automate demand-response (TE-12). In ENPOWER we will further advance the tools by (i) incorporating more sophisticated multi-dimensional financial and beyond financial consumers preferences; (ii) integrating with data space compliant interoperability and privacy/confidentiality /sovereignty-preserving technology enablers, (iii) integrating with Digital Twins for consumer flexibility modelling and aggregation; (iv) provide an extensive field validation (e.g. in the Portuguese and Irish pilots).

TE-16: P2P digital tools and platforms for consumer activation and social engagement
OurPower is a nation-wide market driven citizen engagement platform for RES power, operating in Austria, which aims to provide citizens full market access and make it as simple and attractive to use, and as economic as possible. In ENPOWER, the OurPower platform will be further developed to promote principles, such as self-generation, efficient use of RES-based energy, increase of energy savings, collective generation and sharing. More functionalities will be added to the platform, concerning engagement components for power sellers and increased incentives towards enhancing social participation and increasing awareness. Also, integration with TE-3 blockchain platform providing P2P data/data services to further enable an increasing end-user' participation within the framework of Data Cooperative will be analysed and partially deployed. The replicability opportunities will be inspected aiming to generalise and reproduce the platform in different environments, varying in terms of population and geographical characteristics – customisation for Hungarian market, adding a unique feature of cross-border EnC marketplace, building on H2020 project SHAREs project utilising OurPower platform between two countries (AT and HU). Associated with this platform, two sub-components will be further developed (TE-13).

TE-17: P2P energy markets designs and algorithms
Recently, INESC TEC has been developing a set of algorithms exploring local energy and flexibility market designs with the corresponding clearing and settlement algorithms according to different regulatory alternatives for self-consumption (demonstrated in operational environments in National Project Digital CER, and in H2020 POCITYF and InterConnect projects). In ENPOWER, it is expected to solidify the developed market designs and algorithms by integrating, adapting and tuning the algorithms to the specificities of realistic environments, with special focus on flexibility provision, agents' relationship, and balancing responsibilities.

TE-18: Privacy preserving tools for automated interoperable DR
A number of digital tools and infrastructure components for allowing the instantiation of automated DR are available, including the EPRI's Open Demand Side Resource Integration Platform (openDSRIP) and the Open Distributed Energy Resources Management System (OpenDERMS), and COMS's Universal Secure Gateway (USG) developed within H2020 PHOENIX and BRIGHT. The openDSRIP and OpenDERMS provide platforms for implementation and testing of distributed resource and demand side resources integration, management, optimisation, and aggregation. They readily provide support for industry standard communications and information exchange (i.e. OpenADR, CTA 2045). USG is a hardware and software solution that aims at (i) interconnecting the existing energy system assets, (ii) enhancing security over legacy protocols, (iii) providing a GDPR compliant privacy preservation of users participating in demand-response campaigns (TE-9), and (iv) adopting standardised APIs to interface the traditionally disparate systems. In ENPOWER, the abovementioned platforms will be leveraged into an integrated interoperable automated DR solution, as a complete and sovereign technical solution that (i) enables to deploy a plug & play edge-level solution for the aggregation and management of devices participating to the DR scheme, (ii) coordinates flexibility with the power grid and the market (schedules, tariffs, etc.), and (iii)

supports dynamic P2P micro-contract settlements based on near real-time smart metering data. Additionally, the platform will incorporate smart flexibility services that will be given to the community (TE-5, TE-6, TE-13), DSO/TSO (TE-8) and wholesale market entities, supporting to realise the community effort to become energy-efficient, energy-secure and self-sufficient.

The following table presents mapping for TEs per ENPOWER pilot site:

Table 7: Technology Enablers (TEx) in ENPOWER pilots

TE #	TE Description	Pilot					
		Austria	Portugal	Greece	Ireland	Hungary	Spain
TE-1	Interactive decision support tool for EnC planning						
TE-2	SITEC-Sizing tool for EnCs						
TE-3	CRP social engagement management platform						
TE-4	Energy Data Space compliant tools for sovereign data management, sematic interoperability and exploitation						
TE-5	DLT/Blockchain/smart contracts* multi-purpose marketplace for increased Trust & Sovereignty and for P2P tokenised assets sharing and compensation						
TE-6	Digital Twins for consumer activation						
TE-7	Consumers clustering and segmentation tools						
TE-8	FATEC - Flexibility Assessment tool for EnCs						
TE-9	Self-consumption optimisation tool						
TE-10	Closed-loop optimal load control and intelligent monitoring of electric appl. for residential users						
TE-11	V2G-based flexibility management platform for providing incentives to communities of EV drivers						
TE-12	OSTEC-Optimised Scheduling Tool for EnCs						
TE-13	AI-Powered Virtual Energy Manager (WIS4Households)						
TE-14	Nudging Apps for near real time closed loop consumers activation						
TE-15	Blockchain-based hybrid coalition-based flexibility aggregation tool						
TE-16	P2P digital tools and platforms for consumer activation and social engagement						
TE-17	P2P energy markets designs and algorithms						
TE-18	Privacy preserving tools for automated interoperable DR						

3.5 List of HLUCs

In this section, preliminary HLUC descriptions have been provided for identified HLUC implementation. There will be further developed and modified accordingly during ENPOWER tools development.

3.5.1 HLUC1 EnC clustering and segmentation

Brief Description	Various energy services such as control services, demand side management or automatic fault detection require detailed prediction of energy consumption at different levels and for different end-users. Thus, the prediction of energy is a supporting service that is an input for other services in ENPOWER. Predictions must be robust to uncertainty and account for missing or incorrect data. However, it is not feasible to train a predictive model for every customer. HLUC is combining cross-sectoral fields based on the complete set of socio-economic, geographic, socio-cultural, and socio-political factors.
Actor(s)	Aggregator EnC manager Flexibility manager Services related to end customers Market operator
Priority	high (must do)
Technology Enabler	Interactive decision support tool for EnC planning (TE-1), Consumers clustering and segmentation tools (TE-7)
Trigger	Request for clustering of end customers and their flexibility potential
Pre-conditions	AI based library models established
Post-conditions	DR potential of EnC end customers based on complete set of socio-economic, gender, geographic, socio-cultural, and socio-political factors.
Basic Flow	Receive historical and real-time data (energy consumption of buildings or assets, weather data, etc.) and responses for surveys and questionnaires. Communicate the output command to other HLUC (control services, performance assessment, smart control, etc.).

3.5.2 HLUC2 Flexibility assessment of EnC

Brief Description	HLUC estimates the potential flexibility of EnC based on AI library models (integrating and expanding them) including means to compare and evaluate the aggregation levels and effectiveness of the aggregated flexibility amongst different pilots.
Actor(s)	Utility/DSO EnC manager Market operator
Priority	high (must do)

Technology Enabler	FATEC Flexibility Assesment tool for EnCs (TE-8), SITEC-Sizing Tool for EnCs (TE-2)
Trigger	Request for estimation of flexibility potential
Pre-conditions	Flexibility and DR data models/ontologies generated in scope of T3.3
Post-conditions	Flexibility potential of EnC end customers based on complete set of socio-economic, gender, geographic, socio-cultural, and socio-political factors.
Basic Flow	Step 0. (market operator, DSO) Publish flexibility need. Step 1: Forward flexibility needs to platform. Step 2: Calculate flexibility potential of flexibility service provider (DER operator, flexibility service provider). Platform calculated the results of assessment to see if activations would cause further imbalance or congestions and therefore counter actions would be needed. Step 3: Forward flexibility potential Step 4: Prequalify EnC operator (Flexibility Service Provider). Based on the information submitted in EnC flexibility potential, platform prequalifies the ability of EnCs to deliver flexibility with respect to market and System Operators' needs.

3.5.3 HLUC3 Digital Twins for consumer-aware optimal flexibility planning

Brief Description	Plan and scale up the power schedule of a set of DR services across multiple energy carriers. Integrate flexibility capable assets such as thermoelectric water boilers, heat pumps, behind-the-meter and community storage and EVs in wholesale electricity markets based on direct methods (active consumer participation in flexibility markets) and indirect methods (implicit DR and community driven products such as net-metering). Support direct and indirect driven end-users and aggregators as they quantify and possibly monetise their flexibility by calculating their gains. This DT offers multiple variations developed for the pilots.
Actor(s)	Aggregator EnC manager Flexibility manager DER owner Market operator
Priority	high (must do)
Technology Enabler	Digital Twins for consumer activation (TE-6)
Trigger	Gains for customers depending on DR / energy type. For Implicit DR gains are calculated based on appropriate tariffs (market based or sustainability driven green tariffs). For Explicit DR gains are calculated based on incentives to mitigate exogeneous signals (congestion, balancing market prices).
Pre-conditions	Depending on the triggers, short-term forecasting of market fundamentals, consumption, weather conditions will be calculated. DR

	optimisation algorithms will determine consumption schedules based on real-time smart meter and smart appliance data depending on the selected triggers as identified by each pilot sub-case. Impact of DR in larger populations and consumer segments should be evaluated. RES and Storage assets are expected to be modelled. Smart Monitoring data from consumers and outcomes (schedules) of DR algorithms. Customer clustering. Data from Market operators, or DSO depending on the subcase for trigger definition. Publicly available weather monitoring data for trigger definition.
Post-conditions	Step 0. EnC data collection and integration
Basic Flow	Step 1: Determine flexibility potential and quantify possible DR gains and customer / building / community / system level. Step 2: Simulate implementation of DR products to generate a schedule for each user based on triggers. Multiple DR algorithms will be implemented depending on the HLUC variation and pilot specific needs. Step 3: Model any RES / Storage assets. Step 4: Scale up application of DR products. Step 5: calculate their adoption rate, monetary gains, environmental gains based on the set of given KPIs

3.5.4 HLUC4 Grid connected smart control and interoperability

Brief Description	Various energy services such as control services, demand side management or automatic fault detection require detailed prediction of energy consumption at different levels and for different end-users. Thus, the prediction of energy is a supporting service that is an input for other services in ENPOWER. Predictions must be robust to uncertainty and account for missing or incorrect data. However, it is not feasible to train a predictive model for every customer. HLUC is combining cross-sectoral fields based on the complete set of socio-economic, geographic, socio-cultural, and socio-political factors.
Actor(s)	Aggregator EnC manager Flexibility manager Services related to end customers Market operator
Priority	high (must do)
Technology Enabler	AI-based individual and building-level consumers clustering and market segmentation algorithms (TE-1)
Trigger	Request for clustering of end customers and their flexibility potential
Pre-conditions	AI based library models established
Post-conditions	DR potential of EnC end customers based on complete set of socio-economic, gender, geographic, socio-cultural, and socio-political factors.
Basic Flow	Receive historical and real-time data (energy consumption of buildings or assets, weather data, etc.) and responses for surveys and questionnaires.

	Communicate the output command to other HLUC (control services, performance assessment, smart control, etc.).

3.5.5 HLUC5 Community centred services for increased share of self-consumption

Brief Description	In order to increase share of self-consumption and thus optimise EnC, tools developed are based on implementation of forecasting techniques for different energy problems (supervised and unsupervised learning methods, as well as artificial neural networks. In this HLUC the aim is to increase accuracy of services by training a large set of ML/DL models utilising a rich dataset of heterogenous static and dynamic data – ie. Greek and Hungarian pilots in order to deliver a self-optimisation consumption tool for consumers and EnCs
Actor(s)	EnC manager Flexibility manager Services related to end customers
Priority	high (must do)
Technology Enabler	Self-consumption optimisation tool (TE-9)
Trigger	Request for EnC optimisation of self-consumption
Pre-conditions	AI based library models established, large datasets provided
Post-conditions	Optimised and improved EnC consumption complete set of socio-economic, gender, geographic, socio-cultural, and socio-political factors.
Basic Flow	Receive historical and real-time data (energy consumption of buildings or assets, weather data, etc.). Communicate the output command to other HLUC (control services, performance assessment, smart control, etc.). Potential steps: • Analyse pilot’s end-users' characteristics • Calculate the energy consumption of each home under different heating balance settings employing the tool • Identify households with high potential energy savings • Activate DR in the selected households • Quantify the achieved improvement in self-consumption

3.5.6 HLUC6 P2P renewable marketplace for energy and flexibility demand

Brief Description	HLUC initiates flexibility activation on RES trading platform which selects bids considering the amounts of energy/capacity needed, maximum price and availability. Delivery of notification of activation requests to the EnC as a Flexibility Service Provider in a reliable and timely manner according to the relevant terms and conditions applicable to pilot site.
Actor(s)	EnC manager Market operator

Priority	high (must do)
Technology Enabler	P2P digital tools and platforms for consumer activation and social engagement (TE-16), P2P energy markets designs and algorithms (TE-17)
Trigger	Request flexibility activation
Pre-conditions	The P2P marketplace is operational with capabilities for participant registration, profile management and analysis, flexibility activation and account settlement. . Flexibility and DR data models/ontologies that have been established will be used.
Post-conditions	Activation requests are notified and confirmations obtained, schedules optimized and activated, ongoing operations monitored and adjusted, and finally, accounts are settled
Basic Flow	Steps • Registrate participants and create detailed profiles • Aggregate and list available flexibility on the marketplace • Analyze flexibility demand • Manage bid submissions • Evaluate and select bids • Notify activation requests • Obtain activation confirmations • Optimize schedules and activate • Monitor and adjust • Settle accounts

3.5.7 HLUC7 Nudging for near real-time EnC consumers activation

Brief Description	In this HLUC all the end-users of the nudging applications will interact with the different user interfaces (UI) conceived using a user-centered approach that will adapt to the level of interaction and automation each user demands from the system. The user interfaces will be used by the different end-users considered: building managers, occupants, grid operators and citizens/communities. Each nudging user interface will adapt to the different profiles for each of the users so the different functionalities considered for each of them are presented in an accessible way that can be adapted within user needs. The occupants will be the most favored by these user-centered and self-learning algorithms requiring fewer manual interventions as the services that will appear will be the ones that are needed and that simplify the occupants' life. DEDALUS user interfaces will consider the different aspects and needed functionalities for each of the end-users' profiles so they will not see content that is not necessary to complete their related functionalities. The objectives of this HLUC are related to the user satisfaction when using applications and:

	1. Should be easy to use and accessible 2. Should only have each user profile related functionalities 3. Should adapt to the different users
Actor(s)	EnC manager Services related to end customers Market operator
Priority	high (must do)
Technology Enabler	CRP social engagement management platform (TE-3), Nudging Apps for near real time closed loop consumers activation (TE-14)
Trigger	Request from flexibility operator to activate DR
Pre-conditions	The user interfaces depend on other HLUCs so data can be presented to the user when using the application. So, the following steps are necessary to implement the different features within the application: • Identify each actor (building managers, occupants, grid operators and citizens/communities) requirements • Receive the data that will be collected, processed, and stored by the application and • identify the different functionalities needed for each of the profiles that will be created on the application (HLUC1) Involve the actors in the development of the application interfaces
Post-conditions	Dashboards to present all the data from HLUC01 and this HLUC and the different data considering energy profile, local weather data, building energy, energy flows and energy consumption.
Basic Flow	Pre-Steps: • Collect and analyse the details for each pilot site (existence of nudging App, details about users/buildings, baseline consumption, flexibility ability, etc.) • Use input by the segmentation questionnaires as well as by the facility manager questionnaires • Realize the co-creation workshops for every pilot site • Collect feedback from the co-creation workshops • Design nudging interventions based on the above steps Main flow: • Deploy nudging services

3.5.8 HLUC8 Flexibility management providing incentives to communities of EV drivers

Brief Description	EV charging management platform (including an app for EV drivers) provides real time data related to charging stations and manages future reservations on publicly accessible charging stations. In ENPOWER, this UC will be enriched with smart charging module which can investigate smart charging load management patterns, such as Load Valley filling (load management that decreases charging during peak loads). It will also

	facilitate vehicle-to-grid transactions and incentivise users to shift charging schedule or discharge their vehicle to support the grid.
Actor(s)	EnC manager Services related to end customers (EV) DSO Market operator
Priority	high (must do)
Technology Enabler	V2G-based flexibility management platform for providing incentives to communities of EV drivers (TE-11)
Trigger	Request to shift charging schedule or discharge their vehicle to support the grid
Pre-conditions	The following steps are necessary to implement the different features within the application: • Identify each EV owner requirements • Receive the data that will be collected, processed, and stored by the application and • identify the different functionalities needed for each of the profiles that will be created on the application (HLUC1) • Involve the actors in the development of the application interfaces
Post-conditions	Dashboards to present all the data from HLUC01 and this HLUC and the different data considering EV profile, energy flows and energy consumption.
Basic Flow	Receive historical and real-time EV data (energy consumption, charging locations, load profiles, etc.). Communicate the output command to other HLUC (control services, performance assessment, smart control, etc.).

4. Pilot Sites Gap Analysis

4.1 Pilot 1 Austria - Front Runner

4.1.1 Business Motivation

OurPower Energiegenossenschaft SCE (European Cooperative) is based in Vienna, operating a P2P marketplace for matching RES electricity generated by its members with consumers. At the nationwide level, OurPower enables P2P based on electricity markets standard procedures, i.e. economic valuation of load profiles (no smart meters necessary). OurPower has 520 members nation-wide. The main challenge is to use the recently established regulation for EnCs in Austria (RECs and CECs), in order to grow substantially as a cooperative synergy enabler and service provider for a cascading scheme of communities [e.g. collective investment and sharing of all types of RES capacity, energy savings, and data aggregation services (Energy Data Cooperative)].

4.1.1 Scope

OurPower association gathers 12 EnCs, and one of them will participate in ENPOWER as a pilot (sub) community: Energiegemeinschaft (Regional EnC) Dreißgen-Spörbichl (REC DS), with operating region Mühlviertel, Upper Austria. REC DS will become OurPower's first active REC with support of ENPOWER development. As a first step, 25 consumers/prosumer plus the Spörbichl windfarm will be aggregated (all are already OurPower users). Growth to at least 150 participants of this REC, and integration of further generation capacity of PV systems in the same grid region will take place in the first two years. To activate REC participants, data about power status, such as generation and consumption forecasts would be provided. A web-based interface and a mobile 'nudging app' would be developed to being deployed in operational environment with users. Based on outcomes from previous phase, the ENPOWER interactive tool will be applied to evaluate possible gains, and eventually propose installation of adequate automated control systems, flexibilities, storage capacity, etc. We will model flexibility management and forecast and create flexibility market mechanisms with the provision of a model for financial incentives to flexibility owners as a motivation for future flexibility efforts and collaborations.

4.1.1 Existing technologies / infrastructure

OurPower operates a P2P marketplace platform with a unique accounting and billing system (cancelling the former electricity supplier, balancing, trading of surplus generation). It provides all necessary services to allow RES electricity generators to sell their electricity to any end consumer in Austria. Nearly 800 customers with annual consumption 4,6 GWh/a buy electricity from marketplace, thereof 620 households, 113 farmers and 48 SME. Generators set their energy price and consumers, who typically choose 3 different generators ('power sellers') for their supply, get information exact to the single kWh, what they pay to each of them. OurPower marketplace has 200 active Sellers, annual production 7,0 GWh/a (plus 35 generators in preparation) - thereof 107 prosumers (PV up to 10kWp) - 61 medium size PV, 5 larger PV (up to 500kWp), 1 utility size PV 2 MWp, 11 small hydro power (up to 120 kW), 1 wind farm (1,2 MW), 1 agro biogas (17 kW).

4.2 Pilot 2 Portugal - Front Runner

4.2.1 Business Motivation

Although the process of fully establishing the regulatory framework of the communities is still under way, Portugal has a long-standing tradition of energy cooperatives, of which CEVE (on a local scale) and COOPERNICO (with a national/regional reach and focused on RES-based projects), are prime examples. CEVE, acting as DSO and as a last resource retailer, currently serves more than 9.000 consumers (8.245 residential, 621 small businesses and services, 187 industrial) with a 6.000 hectares concession area, covering 14 rural parishes (9 in the municipality of Vila Nova de Famalicão and 5 in the municipality of Barcelos). COOPERNICO is acting also as a 'cooperative ESCO' and retailer that has 2.300 members, mostly within the residential and services sectors. For CEVE, the challenge is to integrate downstream investments in RECs and collective RES self-consumption promoted by association of independent prosumers connected to its LV grids, optimise self-consumption in its grid (improving total expenditure), and create synergies with cooperative e-mobility offer, as well as to evolve its organisational model towards the CEC model (front runner of Directive 2019/944 in Portugal). While for COOPERNICO, the challenges are to engage, up to the national energy market participation level, citizens as active (and flexible) participants and establish new business models that valorise and aggregate surplus of PV self-consumption.

4.2.1 Scope

The Portuguese pilot will demonstrate and evaluate different community models, in particular collective RES self-consumption (i.e. joint ownership of energy assets), REC (with dynamic energy sharing and multi-services exchange) and LEC (evolution of the CEVE model with new and local DR products and offering new energy and non-energy services to cooperative members), leveraging on the existing business models, infrastructures, and platforms of both CEVE and COOPERNICO. The pilot will include 60 members from CEVE, and around 50 to 100 members of COOPERNICO. We will cover different contexts and geographical scopes, exploring different configurations of (local) RES, and individual and collective consumption. We will demonstrate and quantify the impact of energy services (e.g. energy consumption benchmark, targeted efficiency recommendations, DR activities, flexibility) provided within EnCs in increasing the energy resilience. We will allow for the provision of non-energy services related with maintenance and replacement of assets, by using, processing, and sharing demand and generation data from metering (Energy Data Cooperatives). Incorporation of e-mobility and charging infrastructure within EnCs, for collective use of the community or also including provision of charging services for users outside the community, will be analysed within the different types of EnCs. We will allow aggregation to manage RES surplus available from all prosumer participants, from the local (CEVE) to the national (COOPERNICO) geographical scope, to effectively activating the energy aggregator role, which could be taken up by COOPERNICO. ENPOWER will allow for an optimised balancing mechanism of energy flows that will allocate the energy shared among all EnC participants contributing to the increased use of local resources. P2P sharing of local RES electricity within the communities will also be explored, to gage the benefits accrued in relation to other options, such as aggregation to sell in electricity markets. Further assessments of the potential flexibility of the community members will be characterised through casual models which will determine their elasticity to different types of economic and non-economic incentives. This will lead to targeted programs with consumer-specific incentives that will increase the participation of community members in flexibility services.

4.2.1 Existing technologies / infrastructure

COOPERNICO has over 2,1 MWp installed PV capacity in projects located in different parts of the country. CEVE has approximately 70% of its distribution grid equipped with smart meters, with the smart metering data is concentrated in the MV/LV substation. The CEVE grid encompasses 77 small production units and 68 self-consumption units. A complete cloud-based data infrastructure is already being used and will be made available to the consortium to gather smart metering data from the EnC participants. A low-cost IoT device that connects to the Portuguese smart meters can also be made available to gather in real time (being exported to WATT-IS cloud-based data collection engine) the power injected and exported to the grid.

4.3 Pilot 3 Greece – Front Runner

4.3.1 Business Motivation

Chalki island has 592 electricity customers, off which 482 are households, 96 are small business and 14 are public authorities. These customers are served by 11 different electricity suppliers and have an annual electricity consumption about 1.600 to 1.700 MWh. The island, in the southeastern Aegean, near Rhodes, is powered mainly by diesel generators installed on its larger neighbour island. Neither Rhodes nor Chalki are connected to the mainland grid. Excess electricity can be fed into the network of the neighbouring island of Rhodes via the existing undersea cable. In this context, ChalkiON EnC is interested to optimally manage the locally generated energy with increasing share of RES, while avoiding power outage above all in the summer. The infrastructure is already up and running and the EnC is about to be legally established and now is working on engaging citizens. In ENPOWER, the role of citizens needs to be gradually evolved from consumers to prosumers by steadily turning the island into 100% green, sustainable and autonomous destination.

4.3.2 Scope

In this pilot, we will demonstrate how aggregated flexibility from prosumers and smart active consumers organised in a local community and supported by an independent aggregator (GEARS) can provide services to the grid network operator to mitigate distribution grid congestion problems. We will achieve enhanced flexibility management of the island's flexible assets in a transforming environment, especially during the summer period, when energy needs are increasing because of tourism, through exploiting the flexibility from air conditioning/heat pumps-based cooling from residential houses and tourist apartments, e-mobility sector (via EVs and e-boat smart charging and vehicle-to-grid (V2G) storage), water network (via smartened water pumping). More specifically, smart charging of EVs combined with V2G features, can contribute significantly to decrease RES curtailment and consequently increase the self-sufficiency of the island (e.g. pricing changes communicated to EV drivers via EV Loader app to incentivise EV owners charge during time intervals with surplus RES production at a lower cost). We can directly affect household consumption behaviours, through DR mechanisms and incentives, especially during summer period (e.g. managing in smarter ways the use of air conditioning/heat pumps). Thus, agile grid management can be encouraged, mapping household consumption patterns to high RES-based production intervals to exploit renewable energy. We aim also at the improvement of water management, in collaboration with the water network operator. A local flexibility hybrid data-driven VPP will be setup and operated by GEARS aggregator, which will allow flexibility providers and consumers to trade localised and/or aggregated flexibility. Local trading will be based on the option of exchanging flexibility with other energy (e.g. flexibility device maintenance) and non-energy assets (e.g. social services/assets, like reduced price for more vulnerable people, or social services like care services for elderly people)

4.3.3 Existing technologies / infrastructure

1 MW solar PV farm that provides electricity to the members of the EnC (through virtual net metering), electric vehicles and corresponding chargers, smart-lighting systems, 5G telecommunications network and electric boats that use energy from the sun through their built-in solar panels. In addition, up to 60 residential houses and tourist apartments with installed air conditioning/heat pumps units and available control system, the water pumping system and the desalination power plant of the island and 1-2 V2G chargers will be exploited as flexible assets.

4.4 Pilot 4 Ireland - Front Runner

4.4.1 Business Motivation

Rural regions like the Dingle peninsula pose a particular challenge to grid operators/planners, on both social and technical levels (e.g. engagement of citizens, technology integration on the grid edge complex particularly in Dingle with significant congestion issues on the MV network) Trials for flexibility services for the distribution network to manage increasing electrification are currently being designed and implemented through ESBs National Network, Local Connections programme.

4.4.2 Scope

This pilot will focus on 3 activities, which cut across the residential, agriculture, and transport sectors and address the technical and social layers of the community, as follows: (1) Increasing local energy system flexibility through the agricultural sector, aiming to apply the Citizen Renewable Platform (CRP) and SSH approach to increase the active participation of farmers in the energy transition in order to increase the capacity of renewable generation and flexible technologies available for DR and grid services locally and upstream, while enhancing energy efficiency, and reducing costs and carbon emissions; (2) Data-driven approaches for improving the self-energy sufficiency and resilience of the local EnC, by understanding the energy consumption of the community members, the generation profiles, and the response of citizens to engagement, communication approaches, and potential incentive opportunities via services. This activity will explore the co-design of effective services, the respective business case, and the types of engagement strategies and incentives that can inform and activate energy citizens to become prosumers and support the local EnC to decarbonise and face disruptive events that can affect the energy supply through the main grid. The developed Digital Active Platform will provide suggested energy scheduling for the local resources taking into account the forecasting from generation and consumption, and disruptive events that are expected by the DSO (e.g. extreme weather conditions), enabling the EnC to prepare the local resources to deal with the consequences of such events (e.g. reduce energy consumption from lesser important appliances, ensure full charging of EVs to support the electric grid).

4.4.3 Existing technologies / infrastructure

The Dingle Peninsula has existing technologies deployed (Solar PV: 25 Installs, 71.4 kW (68.8 MWh); Retrofit: 3 Deep Retrofits, 1101 Homes with >= 1 measure, LEDs; 59 Heat Pumps; 43 Solar Heating; 20 Batteries with Management Systems; 15 Smart EV chargers (of which 5 are V2G); 50 Smart Meters; LV/MV monitoring system; 5 homes with energy management systems; DMS (with some automation of overhead MV Network) as well as the following societal infrastructure already established: Dingle Peninsula 2030 Sustainable EnC; West Kerry Dairy Farmers Sustainable EnC; Dingle Innovation Hub; Emerging Dingle Peninsula 2030 Tourism Sustainable EnC; Sustainable Travel working groups.

4.5 Pilot 5 Hungary – Early Adopter

4.5.1 Business Motivation

Békéscsaba municipality (BCS) focuses on decarbonisation with a complex energy program ('Smart Microgrid Phase I-II'). BCS has installed energy infrastructure to promote local energy generation and consumption. The smart meter rollout in Békescsaba city is continuous and shall be the first Hungarian city with a full electricity smart meter rollout. As a next phase, the municipality went through the planning process to install more energy generation, storage, and distribution assets. The next phase will involve local municipality buildings, industrial complexes and citizens as part of an EnC. However, the concept of EnCs with consumer engagement is relatively new in Hungary and even though there have been some initiatives to create such communities recently, these are still under preparation.

4.5.2 Scope

The aim of this pilot is to build up an EnC and to enhance community engagement in Békéscsaba together with the Austrian OurPower and Hungarian ENASCO. OurPower will help with the knowledge transfer regarding the social aspects and how to engage citizens and industrial players, and Békéscsaba will leverage OurPower's P2P marketplace and its Nudging app. Moreover, Békéscsaba will replicate selected solutions from Chalki island pilot.

4.5.3 Existing technologies / infrastructure

Smart Grid Phase I-II: Phase I is already completed in 2021, with operated Smart Grid real time monitoring platform operated by ENASCO. The smart grid system includes solar panel (1.3 MWp), Li-ion energy storage (1.2 Mw/ 2.4 MWh), DC EV charging station (90 kW) and Smart Grid Control Center (for supervising the smart grid infrastructure/elements and cost optimisation); Phase II. has reached the ready to build status with two sites: a) solar PV system (1 MWp), energy storage unit (1 MWh) and b) solar PV system (2 MWp) and energy storage unit (2 MWh). The local public transit company will establish the electric bus chargers on this site and will be the main consumer of the electricity produced (as part of the EnC). Existing infrastructure also will include smart meters needed for DR/nudging for selected number of users.

4.6 Pilot 6 Spain - Early Adopter

4.6.1 Business Motivation

DSOs are pivotal to the energy transition since they handle the flexibility resources of several aggregators (batteries, EV charging stations), large prosumers and residential prosumers. A coordination of all flexibility resources from the perspective of the local distribution network should be achieved and provide the DSO with appropriate tools to monitor the deployment of flexibility resources installed by different actors.

4.6.2 Scope

We will investigate the role of small DSO (CUERVA) as EnC Developer, targeting a village Fornes. There is a close relationship between the community developer (Vergy), the local DSO (Cuerva) and the public administration (Fornes Town Council). It is mainly a residential community with possibility of incorporating some small businesses. Actors involved consist of Utility provider, City hall office, school, medical service and a swimming pool. Energy community is planned to be legal. It will consist of 30-80 users (still in the process of being set up). It is part of the CUERVA's Living Lab; therefore, the grid is fully digitalised with the deployment of sensors and devices that provide data in real time. CUERVA will work with the town council to establish a Green Community. For that purpose, a small PV plant in each public supply point will be installed in order to share the energy between the participants of the Green Community. CUERVA, in close collaboration with TT (affiliated partner, in charge of the Living Lab community) will apply EnC planning and gamification activities, aiming at the prosumer engagement. Data-driven services, initially tested in the Portuguese and Irish pilots, will be replicated.

4.6.3 Existing technologies / infrastructure

It consists of a 58kW photovoltaic plant installed on the roof of the town hall offices. It is planned to expand this power up to 100 kW. Digitalisation (advanced LV/MV supervisor in each secondary substation; Feeder mapping of each supply point; DT of each LV grid; Smart meter in each supply point.

4.7 HLUC Analysis and Mapping

The following section represents results from conducted pilot site workshops and preliminary assessment of use case deployment. The following table indicates where the frontrunner pilot sites as well as replicator require technological enablers, that underpin development of ENPOWER tools in WP3 and WP4.

Based on the interviews during workshops conducted with pilot sites and TE developers, the following table provides preliminary mapping of HLUCs per pilot site:

Table 8: HLUC mapping per pilot site

HLUC #	HLUC Description	Pilot					
		Austria	Portugal	Greece	Ireland	Hungary	Spain
HLUC1	EnC clustering and segmentation						
HLUC2	Flexibility assessment of EnC						
HLUC3	Digital Twins for consumer-aware optimal flexibility planning						
HLUC4	Grid connected smart control and interoperability						
HLUC5	Community centred services for increased share of self-consumption						
HLUC6	P2P renewable marketplace for energy and flexibility demand						
HLUC7	Nudging for near real-time EnC members activation						
HLUC8	Flexibility management providing incentives to communities of EV drivers						

The following is a summary per pilot site.

Pilot 1 (Austria):

Owner: OurPower (supplier), with additional support from Blueprint (integration support) and COMS (for security and privacy)

Analysis: This pilot focuses on P2P renewable EnC real time marketplace for energy and flexibility demand versus supply near time information sharing and matching.

This pilot will implement HLUC 1, 2, 5, 6 and 7. Particular focus will be on HLUC 6 and 7, where it is Front Runner and Multiplier – as it implements these in Hungarian pilot site. Assessment has shown that the pilot has infrastructure and systems included that allow deployment of planned use cases. The success of measures will be demonstrated by increasing participation in P2P marketplace.

Pilot 2 (Portugal)

Owner: CEVe, WATT-IS, COPERNICO

Analysis: This pilot focuses on integrating cross sector local collective self-consumption with virtual community flexibility. The pilot will implement HLUC 1, 2, 3, 4, 5, showcasing interoperability aspects.

Pilot 3 (Greece):

Owner: ChalKION, HAEE, GEARS, PARITY

Analysis: The pilot will implement HLUC 1, 2, 3, 4, 8 with particular focus on HLUC 8 – where Greek pilot will implement novel EV charging citizen incentives for flexibility provision.

Pilot 4 (Ireland):

Owner: EPRI, MAREI, DCSix, DINGLE, ESB

Analysis: The pilot introduces services aimed at cross sector social value community-centred services for enhancing grid flexibility and paving the way for increased share of self-sufficiency. The pilot will implement HLUC 1 through 5.

Pilot 5 (Hungary) - replicator:

Owner: ENASCO, BCS

Analysis: This pilot introduces advanced municipality smart grids center developing citien-driven EnC – with municipality driven P2P market for a new local community. The pilot will implement HLUC 1, 2, 5, 6, 7, with limited potential for 8.

Pilot 6 - (Spain) - replicator:

Owner: CUERVA, CC

Analysis: This pilot is enabling small size DSO to act as an EnC developer. This pilot is implementing HLUC 1-4 as multiplier. Gap analysis has not revealed any major obstacles for implementation.

In addition, the following table presents an overview of legal and regulatory gaps identified for HLUC implementation:

Table 9: Legal barriers and gaps for HLUC implementation

National legal barriers and regulatory gaps	
Austria	Currently the participation of wind turbines in EnCs is too complicated – EnC needs to be owner (in peer-to-peer contracts this might not be the case in future). Wind farm (1,2MW) capacity and the size of EnC is mismatched, making it uneconomic to sell small portions to EnC with different load profile. Even though Austrian regulation allows for virtual decoupling of part of wind farm. Solar is easier because it is more or less the same size. According to the upcoming EIWG (Elektrizitätswirtschaftsgesetz) it should no longer be required for EnC to own generation. The law is in consultation.
Hungary	There are regulatory gaps, and the current regulation is not sufficient for EnCs. Practical experience shows that the legal environment, and inflexibility of regulations are the main obstacles to the establishment of EnCs. Sharing based EnCs are not yet possible due to the regulatory environment. Energy can only be shared between properties with the same parcel number. As the regulatory environment is not sufficiently developed and not ideal for the development of EnCs, it is therefore more typical in Hungary today to have only community energy initiatives with the potential to become real and functioning EnCs, if the regulatory environment is more supportive.
Greece	To the best of our knowledge, existing regulations do not have an impact on this pilot implementation.

	A discount in the cost for grid usage could be applied for the energy that is consumed according to demand-response suggestions.
Ireland	Number of barriers in agricultural sector linked to TAMs grants, if these can be resolved they could encourage more optimal deployment (grid connection efficiencies needed). No real system to support community PV for grid export to support weak areas of the grid – systems needed to encourage and support this. Anecdotally, out of 60 grant applications submitted, only one met the criteria – support needed to complete grants. Would be better if PV grants were managed by SEAI and not Dept of Agriculture. Farmers looking at saving €2k in energy could face much higher costs for measures identified through a farm inspection and so many are reluctant to apply for these grants. SEA Ireland gives grant of 30% for solar which tourism industry can avail of. Agri sector can get 60% grant, but there is a stipulation that they may not export any energy on to the grid. Tourism on other hand can export. So agriculture needs to invest in a battery too if they are to make it worthwhile. This may put some off, and it may distort the optimal deployment of technology. For instance, it might put users off installing a heat pump and P solution, and thereby propagate gas heating. The restriction is probably based on making connection simpler. Unlocking DSR, farmers and metering: The minimum connection to be able to participate is falling over time. Need right metering. Getting better, but still could be a barrier, at least in theory.
Portugal	There are no legal barriers in the setup of the Portuguese pilots as the regulatory framework that defines the renewable EnCs (REC) or collective self-consumptions already exists. However, the registration process of a community is a lengthy process, which will delay the legal approval and establishment of the Portuguese RECs. The current legal framework still lacks the definition of enabling the integration of smart EV charging within a REC as the DSO is still not able to associate the energy flows within the smart chargers.
Spain	Demand response for EnCs: The first of the regulatory priorities is to guarantee the participation of demand flexibility in all markets. A working group in Catalonia (CEEC) [1]highlights as priority measures to guarantee this participation the following: • Eliminate the minimum 1MW capacity units for demand response programmes; and make it possible to aggregate them (not it is not possible to aggregate them which limits the possibility of EnCs to participate) • Guarantee participation: which must go accompanied with capacity payment for the different services • Aggregator role defined in law and ways of aggregating demand: • The second regulatory priority is the aggregation of distributed energy resources: smaller resources, with a flexible capacity of less than 1MW. • As a third priority, the development of the figure of the independent aggregator in Spain is needed. The CEEC working group document also highlights that Spain needs to ensure the correct development of the independent aggregator, such as defining a methodology to validate

[1] [CEEC, report https://media.timtul.com/media/clustereficiencia/Informe%20CEEC%20(pag_inidividuals)_20230214150556.pdf]

	flexibility activations (baseline) and ensuring that the independent aggregator can participate in all markets in a non-discriminatory manner. • Lack of technical ways to dynamically inform about energy exchanges (p2p) within the EnC: • Coefficients should be changed dynamically, and a system should be in place to communicate it (automatically) from the Aggregator to the DSO/TSO and avoid long waiting and time. Other markets (ancillary services: secondary aFRR, tertiary mFRR, or Planning Reserve) have also problems and need to be accompanied for the following measures: • The same document also calls for eliminating the 200 MW requirement for secondary market programming units, as occurs in other countries, and bringing the closing of the offer (secondary markets for ancillary services) closer to the delivery of flexibility. • Pay for capacity plan (regardless of the use of tertiary mFRR): to encourage the participation and ensure long-term investments; Harmonize the resolution of energy and flexibility products at the same granularity (quarter-hour) • Activation times: There is no control over the processing times for companies to expedite the procedure, which can take between 1 and 4 months. • Lack of information for the DSO: When documentation is rejected, the reasons are not specified; sometimes, the same documentation is rejected without any reason, and later accepted without any modifications being made. • Lack of information on electricity bills for customers with some retails: They cannot know how much has been deducted for self-consumption; they lack information.

The design of the Use Cases was in general compliant with regulations from the start. The only barriers identified (as of February 2024) are the following:

The P2P trading in particular with smart contracts cannot go ahead in majority of pilot sites as there is no process currently in place to inform the grid operator of any P2P agreements between participants, but solutions are being considered by the consortium in those pilots where tools are already implemented via previous projects.
The grid services cannot for now be provided directly by the EnC to the DSOs or TSOs in a number of pilots but can be provided to the members of the EnC to make the local grid more reliable and hence self-consumption HLUC are in focus in those pilot sites.

Conclusions

This report reflects the work developed within the scope of the subtask T2.1 with objective to assess possibilities of the ENPOWER High Level UCs in pilot sites.

The IEC 62559 standard was adopted as a methodology to define and describe the ENPOWER UCs. This IEC standard provides a template that helps to define the set of (inter)actions that will be developed and implemented over the course of a project. We adapted this template to suit the characteristics of the ENPOWER project better highlighting the high-level requirements and specifications for the early stage of ENPOWER development and to contribute to the basis of the work being developed within WP2, as well as in the other work packages (WP). Also due to the use of this methodology and before the activities of definition and description of the HLUCs, we were able to identify five broad Domains. These Domains are also guided the processes of defining the ENPOWER HLUCs.

In addition, we have also presented the list of the ENPOWER actors. This list of actors proved to be essential for a harmonious description of the HLUCs across the different partners involved in the process.

A final list of 8 HLUCs was defined for the ENPOWER project and the main characteristics and requirements of each HLUC were presented in Section 3, namely their scope and objectives, description, required ENPOWER pre-conditions and basic steps.

This report also presents gap analysis and description of individual pilot sites in ENPOWER project. It may be observed that while data UCs and development of ENPOWER platform support all pilot sites, other market/performance domains with multiple energy vectors will only be applied in selected pilot sites.

Finally, mapping of the most important HLUCs that will be deployed in each demonstration site is presented. The results of this preliminary exercise will be fundamental for planning the activities of each ENPOWER demonstration site, mainly the selection and implementation of the most important ENPOWER services and HLUCs in each EnC.

References

[1] Langthaler O (2021) Developing a well-rounded LEC architecture that integrates well into the grid. ComForEn 2021.

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[3] European Commission Clean Energy For All Europeans package, https://energy.ec.europa.eu/topics/energy-strategy/clean-energy-all-europeans-package_en,

[4] European Commission The European Green Deal, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[5] IEC 62559-2:2015: Use case methodology—Part 2: Definition of the Templates for Use Cases, Actor List and Requirements List (2015)

ANNEX 1 – Questionnaires from Pilots Sites

Austrian Questionnaire

Energy Community Questionnaire:

1. **Community Type:** Please specify the type of energy community you are part of (e.g., residential community, commercial community, mixed-use community, etc.).

R: Currently: commercial community with wind turbines (one producer and one consumer)

Due to practicality: change to a mixed-use community with photovoltaics and without wind turbines (maybe they are integrated by the OurPower marketplace or ElWG peer-to-peer contracts)

2. **Primary Members:** Describe the primary members or occupants within your energy community (e.g., residents, businesses, institutions, etc.).

R: SME: wind turbines - business that was initiated by crowd-financing; residents: photovoltaics (small scale); Consumption: residents and SME

3. **Community Structure:**

    1. How is your energy community organized, and what is the size of your community?

    2. Are there specific roles or responsibilities assigned to community members regarding energy management?

R: Organised as an association

Currently three members (planned: members could be residents and SME supplied by the transformer station – up to 10.000 residents (5 municipalities) and two commercial areas); At least one OurPower employee has a role and responsibility at the association.

4. **Member Engagement:**

    1. How engaged are community members in energy-related activities and decision-making?

    2. What strategies do you use to educate and involve community members in demand response initiatives?

R: Currently: three members with roles of the association, but no further engagement

After the change to photovoltaics, we want to use the Serve-U app for education, engagement and demand response

5. **Infrastructure:** What is the infrastructure of your energy community?

R: Smart meter, photovoltaics, wind turbines, heat pumps, small scale energy storages for households

6. **Occupancy Patterns:** How is the energy community typically occupied? Provide details regarding regular occupancy hours and patterns.

R: Exact information is not available, although it is a mix of 9-to-5- workers and stay-at-home people

7. **Comfort Contributors:** Identify key factors or parameters that contribute to comfort within your community (e.g., thermal conditions, acoustic conditions, visual conditions, air quality).

R: No information available

8. **Existing Monitoring Systems:** Do you currently have systems or sensors in place to measure comfort-related parameters, such as thermal conditions, acoustic conditions, visual conditions, and air quality? Specify the type of instrumentation used.

R: No information available

9. **Data Handling:** Describe your current approach to handling and analyzing data related to indoor environmental conditions. Choose from options like utilizing a Community Management System (CMS), manual monitoring, using standalone IoT devices, engaging external services, or other methods.

R: Smart meter: 15-minutes energy consumption/production of each smart meter; DSO prepares energy data in 15 minutes resolution of each day at the day afterwards (currently the data is available in EDA portal https://www.eda.at/anwenderportal as an Excel export; but it could be sent directly by the DSO via Ponton X/P as a xml to a server)

no in-house information

10. **Future Sensor Installations:** Are you considering installing additional sensors in the future? If yes, specify the parameters you would like to monitor.

R: Future sensor installations are currently not planned

11. **Data Security and Privacy:** Are there specific requirements or considerations regarding data security and privacy within your energy community?

R: No specific requirements, just general regulatory requirements.

12. **Partnerships and Agreements:** Do you have existing partnerships or agreements with the Distribution System Operator (DSO) or Aggregator that need to be considered during the implementation of energy-related initiatives?

R: No partnerships or agreements, but regular grid usage contracts and energy supply contracts

13. **Assessment of Energy Savings:** How do you assess the potential for energy savings within your energy community, especially for demand response (DR) purposes?

R: We simulate the energy community in advance with standard load profiles; We do not have experience with demand response and its effect on energy savings currently

14. **Energy Generation:**

    1. What types of renewable energy sources are available within your community?

    2. Do you have any plans to expand or diversify your energy generation capabilities?

R: Commercial community with wind turbines (1,3 MW)

We want to change it to a mixed-use community with photovoltaics (small scale, maybe two ~100 kWp systems)

There are no plans to expand energy generation capabilities currently.

15. **Energy Storage:**

    1. Do you currently use energy storage solutions, such as batteries, within your community?

    2. Are there plans to implement additional energy storage systems in the future?

R: No energy storages are used currently

Community energy storages are currently not interesting (grid fees twice - for charge and discharge)

Small scale energy storages for household could be adressed by demand response.

16. **Grid Interaction:**

    1. How is your community currently connected to the energy grid?

    2. Are there any challenges or opportunities related to grid interaction that you would like to address?

R: The community is directly connected to the grid

Wind turbines cannot be forecasted good enough for grid interactions including energy communities (difficult for large producers – photovoltaics, wind and hydro – to participate in energy communities because of the difficult forecasting in addition to the „pre" energy consumption of the community)

17. **Technology Infrastructure:**

    1. What technologies or platforms are currently in use for managing energy consumption and demand response?

    2. Are there any specific technological needs or gaps that your community identifies?

R: We do not have the required technology infrastructure for demand response

We need real time data and forecasts (DSOs need to be more reliable and AI is necessary) – AI in combination with energy communities will be tested in another project this year.

18. **Demand Response Experiences:**

    1. Have you participated in demand response programs before, and if so, what were the outcomes?

    2. Are there any lessons learned from previous demand response activities that can inform future initiatives?

R: Serve-U app: We were able to test an app for demand response in the OurPower community and collect data for the design and UX (including two workshops with UNIBAS in WP2)

Regarding the performance of demand response, we do not have any experience

19. **Collaboration and Partnerships:**

    1. Are there collaborations or partnerships with external entities, such as utilities or government agencies, that support your demand response efforts?

    2. Are there opportunities for collaboration with neighboring communities or energy projects?

R: Nothing

20. **Regulatory Environment:**

    1. How do existing regulations impact your community's ability to engage in demand response?

    2. Are there regulatory changes or support that would enhance your community's participation in demand response programs?

R: Currently the Serve-U app is not used, but it will be

Upcoming ElWG (in discussion/consultation since 12.01.2024): aggregator for automatic demand response and maybe additional peer-to-peer contracts.

Currently the participation of wind turbines in energy communities is too complicated – energy community needs to be owner of energy community (in peer-to-peer contracts this might not be the case in future)

21. **Feedback Mechanisms:**

    1. How do you collect feedback from community members regarding their energy preferences and experiences?

    2. What mechanisms are in place for continuous improvement based on user feedback?

R: We are monitoring our first energy communities (trading started in 2023), so the feedback is currently focused on billing and visualisation

Portuguese Questionnaire

Energy Community Questionnaire:

22. **Community Type:** Please specify the type of energy community you are part of (e.g., residential community, commercial community, mixed-use community, etc.).

R: Mixed: residential and commercial.

23. **Primary Members:** Describe the primary members or occupants within your energy community (e.g., residents, businesses, institutions, etc.).

R: CEVE Pilot (local DSO): Residents, businesses, and institutions. Here they do have participants. They do have nformal groups. COOPERNICO Pilot (energy cooperate / retailer, not very good structured): residential, they still have to recrute

Legal framework soes´nt allow a framework. Countrywide they try to set up.

Legislative problems: for registration no resources, 2022 submissions, they don´t hear back from them.

24. **Community Structure:**

    1. How is your energy community organized, and what is the size of your community?

    2. Are there specific roles or responsibilities assigned to community members regarding energy management?

R: CEVE, the local DSO, will develop and execute the energy management of the community. COOPERNICO may either be the responsible or support a legal entity for the energy management of their community.

25. **Member Engagement:**

    1. How engaged are community members in energy-related activities and decision-making?

    2. What strategies do you use to educate and involve community members in demand response initiatives?

R: **Currently, there are no legal Portuguese EC. Clarify if it is already for existing EC.**

CEVE has been promoting initiatives on the community to increase energy literacy. Such examples are the ECOVALE project, where workshops and training sessions have been undertaken to increase energy awareness in the region of Pilot 1. Further workshops and training sessions will be performed in a more targeted way to the EC.

COOPERNICO has undertaken several initiatives around the country, namely forming local groups around the country where energy topics are discussed and sessions with idealization and incubation of ECs.

26. **Infrastructure:** What is the infrastructure of your energy community?

R: In CEVE Pilot:

- 30kWp PV unit installed to support the REC.

- 7 apartment blocks; 19 houses; 2 blocks of 5 townhouses; 4 commercial units.
- Energy Storage capacity: 10 kWh.
- Up to 50 IoT real-time collection devices (WIS-Connector) of Smart Metering data
- 1 public EV charging station.
    - 5-10 DR activated consumers.

Possible involvement in the pilot (to be evaluated):

- Same street: 4 private self-consumption PV units (14.72kWp) in the same street.
- Same substation: 10 private self-consumption PV units (36.8kWp) and 2 private micro production PV units (11.04kWp).
- Extra 30kWp capacity to be added.

In COOPERNICO Pilot:

- 10 DR activated consumers for advanced Testing and potentially storage testing.
- 100 Customers to test Behavioural Demand Side Flexibility.
- Development of National wide Citizens Energy Community (CEC) model with 50 to 100 engaged participants.
- Wide and heterogenous participants.

Data access is not an issue. Consent form at the beginning for data sharing.

Thermal comfort is to be measured.

27. **Occupancy Patterns: How is the energy community typically occupied? Provide details regarding regular occupancy hours and patterns.**

R: In CEVE pilot: due to the heterogeneity of the group, different occupation profiles exist.

In COOPERNICO Pilot: typically, residential consumers with varying profiles.

28. **Comfort Contributors:** Identify key factors or parameters that contribute to comfort within your community (e.g., thermal conditions, acoustic conditions, visual conditions, air quality).

R: Thermal conditions are the primary.

29. **Existing Monitoring Systems:** Do you currently have systems or sensors in place to measure comfort-related parameters, such as thermal conditions, acoustic conditions, visual conditions, and air quality? Specify the type of instrumentation used.

R: Through the smart meters, we can access consumption and export load (when DER exists) and we envision the installation of 50 IoT real-time collection devices from the HAN (home area network) port of the smart meters in COOPERNICO Pilot. Additionally, we will monitor PV production from the inverter and any data from EV charging stations.

Data analytics (load disaggregation - NILM) will quantify specific loads such as thermal loads. No temperature sensors were considered.

30. **Data Handling:** Describe your current approach to handling and analysing data related to indoor environmental conditions. Choose from options like utilizing a Community

Management System (CMS), manual monitoring, using standalone IoT devices, engaging external services, or other methods.

R: N.A.

31. **Future Sensor Installations:** Are you considering installing additional sensors in the future? If yes, specify the parameters you would like to monitor.

R: 50 IoT devices (WIS-Connector) will be installed in COOPERNICO's Pilot.**

32. **Data Security and Privacy:** Are there specific requirements or considerations regarding data security and privacy within your energy community?

R: For CEVE Pilot, smart meter data will be accessed directly through an integration between Watt-IS and CEVE data infrastructure. Consent will be given by end clients.

In COOPERNICO Pilot, smart meter data can only be accessed with the express consent of the end user through the Portuguese main DSO Web portal (E-REDES) and specifying the legal entities that can access such data. For the cases where WIS-Connector will be installed, that installation will only be done with the express consent of the end user and through their direct request to access the HAN port through E-REDES portal. Data can also be accessed through COOPERNICO's APIs and with clients' approval.

Within the data infrastructure, the legal RGPD requirements are in place.

33. **Partnerships and Agreements:** Do you have existing partnerships or agreements with the Distribution System Operator (DSO) or Aggregator that need to be considered during the implementation of energy-related initiatives?

R: CEVE is already the DSO within their actuation range, thus providing access to the smart meter data of the involved clients. Other partnerships are not required. All processes of data integration of smart meters with national Portuguese DSO, E-REDES, are already done.

34. **Assessment of Energy Savings:** How do you assess the potential for energy savings within your energy community, especially for demand response (DR) purposes?

R: A baseline will be defined for all members, where load consumption will be modelled against the primary variables that influence consumption (e.g. weekdays, temperature, type of technology at home). With that, it will be possible to quantify the consumption in a regular scenario vs. a scenario where a DR strategy was in place.

35. **Energy Generation:**

    1. What types of renewable energy sources are available within your community?
    2. Do you have any plans to expand or diversify your energy generation capabilities?

R: In CEVE Pilot: a 30kWp PV unit to support CER with 10 kWh of energy storage capacity and further installations are being considered:

- 4 private self-consumption PV nits (14.72kWp) in the same street and
- 10 private self-consumption PV units (36.8kWp) and 2 private micro production PV units (11.04kWp) in the same substation.

- Extra 30kWp capacity to be added.

In COOPERNICO Pilot, there are no quantified PV systems, but they are expected within the community.

36. **Energy Storage:**

    1. Do you currently use energy storage solutions, such as batteries, within your community?

    2. Are there plans to implement additional energy storage systems in the future?

R: In CEVE Pilot, a 10kWh storage system is considered. No additional storage is envisioned.

37. **Grid Interaction:**

    1. How is your community currently connected to the energy grid?

    2. Are there any challenges or opportunities related to grid interaction that you would like to address?

R: For CEVE, there are no challenges as the grid is already integrated. In COOPERNICO, no challenges are expected. However, there are some limitations regarding the sharing keys of the excess energy. Due to the recent development of the definition and implementation of energy communities, there are challenges in the transcription of regulatory work into technical capability/infrastructure.

38. **Technology Infrastructure:**

    1. What technologies or platforms are currently in use for managing energy consumption and demand response?

    2. Are there any specific technological needs or gaps that your community identifies?

R: The pilots are not yet active, so there are no current management platforms. However, the ECs will have a management platform for the community, allowing for the various needs of the community, such as management of the load transactions and managing the participants. Further to this, a user engagement platform (WIS4Households) will be available for all participants, where they will benefit from features to help them better manage their consumptions.

39. **Demand Response Experiences:**

    1. Have you participated in demand response programs before, and if so, what were the outcomes?

    2. Are there any lessons learned from previous demand response activities that can inform future initiatives?

R: The main experience that can be shared concerns variable energy tariffs, which encourage consumption during off-peak periods.

40. **Collaboration and Partnerships:**

1. Are there collaborations or partnerships with external entities, such as utilities or government agencies, that support your demand response efforts?
2. Are there opportunities for collaboration with neighbouring communities or energy projects?

R: There is an opportunity to evaluate a possible collaboration with ERSE (Portuguese Regulator) where the outcomes of this project may help in the further definition and fine-tuning of the regulatory framework to encourage the creation of ECs.

41. **Regulatory Environment:**

    1. How do existing regulations impact your community's ability to engage in demand response?
    2. Are there regulatory changes or support that would enhance your community's participation in demand response programs?

R: Currently, there are two pilots undergoing in Portugal: FIRME and Consumidores Eletrointensivos. The regulatory framework for flexibility is still very infant and so there are no clear facilitations on this to encourage the participation of our EC in DR programs.

42. **Feedback Mechanisms:**

    1. How do you collect feedback from community members regarding their energy preferences and experiences?
    2. What mechanisms are in place for continuous improvement based on user feedback?

R: There are two platforms that will be available:

WIS4Communities. This platform is designed to manage the energy community. All required features to quantify transactions and the participants will be available.

WIS4Households: This platform is designed for the end user, where several features will give higher insights and feedback to the end users.

There are no clear frameworks in terms of DR programs

__Questions from RAP:__

1) Do you expect any national legal barriers to implementing your pilot project/use case?
If yes, please list them and explain how they pose a barrier to your activities

There are no legal barriers in the setup of the Portuguese pilots as the regulatory framework that defines the renewable energy communities (REC) or collective self-consumptions (ACC) already exists. However, the registration process of a community is a lengthy process, which will delay the legal approval and establishment of the Portuguese RECs.

2) Are there any aspects of your pilot project / use case where a fitting legislative framework is missing?(regulatory gaps)

If yes, please list them and explain why and how this legal gap hinders your pilot project/ use case.

Yes, the current legal framework still lacks the definition of enabling the integration of smart EV charging within a REC as the DSO is still not able to associate the energy flows within the smart chargers.

Additional input from Meeting:

You will demonstrate how aggregated flexibility from prosumers can provide services to the grid network operator to mitigate distribution grid congestion problems

1. Do you expect any national legal barriers to implementing your pilot project/use case?
   If yes, please list them and explain how they pose a barrier to your activities
   They are not responding
   Registration process being completed and making possible
   Energy exchange mechanisms are not implemented.
   DSO need to provide to allow the energy community to operate on its own.
   DSO need to get approval, once we submitted all information, no feedback back.
   First one is always hard to get
2. Are there any aspects of your pilot project / use case where a fitting legislative framework is missing? (regulatory gaps)
   If yes, please list them and explain why and how this legal gap hinders your pilot project/ use case
   Everything is possible in Portugal, but no answer from the Government, probably not enough capacity from administration.

Technical enablers:

How would you rank them in terms of their feasibility?

2, 8, 12, 17 we can manage and apply them.

13 for sure because its ours

Others we have to check

4-6 related to WP4 we need to start WP4 that is not started yet. We need to talk with Dst. Some issues that we detected. There are some concerns related to the interoperability.

Greek Questionnaire

Energy Community Questionnaire:

43. **Community Type:** Please specify the type of energy community you are part of (e.g., residential community, commercial community, mixed-use community, etc.).

R: Civic - residential community

44. **Primary Members:** Describe the primary members or occupants within your energy community (e.g., residents, businesses, institutions, etc.).

R: Residents (Chalki and Rhodes), Municipality (legal entity) and business owners

45. **Community Structure:**

    1. How is your energy community organized, and what is the size of your community?
    2. Are there specific roles or responsibilities assigned to community members regarding energy management?

R: 1. 178 members, 5-member board for administration and representation
2. No specific roles assigned beside the board members.

(Board members: President, Vice president, Cashier, Secretary and Public Relations)

46. **Member Engagement:**

    1. How engaged are community members in energy-related activities and decision-making?
    2. What strategies do you use to educate and involve community members in demand response initiatives?

R: 1. Board members decide on most day to day activities and issues. If a more general matter has to be addressed then a General Assembly is held.

2. So far few strategies are effective. We expect, through ENPOWER, to better organise our members response to supply / demand balance.

47. **Infrastructure:** What is the infrastructure of your energy community?

R: We have an 1 MWp PV plant, operating normally.

48. **Occupancy Patterns:** How is the energy community typically occupied? Provide details regarding regular occupancy hours and patterns.

R: During summertime (June – September), we expect that peak load occurs between 16:00 - 21:00.
During winter period, there is no clear variation in the demand load within a 24h period.

Metering devices need to be installed on the grid entry-point to have accurate and detailed data about energy consumption.

49. **Comfort Contributors:** Identify key factors or parameters that contribute to comfort within your community (e.g., thermal conditions, acoustic conditions, visual conditions, air quality).

R: The PV plant has no direct impact (visual, thermal, acoustic or air-quality).

50. **Existing Monitoring Systems:** Do you currently have systems or sensors in place to measure comfort-related parameters, such as thermal conditions, acoustic conditions, visual conditions, and air quality? Specify the type of instrumentation used.

R: No significant chage occured (because prior to the installation oft he PV plant, no conventional power plant was operating on the island).

51. **Data Handling:** Describe your current approach to handling and analyzing data related to indoor environmental conditions. Choose from options like utilizing a Community Management System (CMS), manual monitoring, using standalone IoT devices, engaging external services, or other methods.

R: Currently we do not have a system in place that collects and analyzes data related to indoor environmental conditions.

A CMS as described above would be preferable, if it could cover and adequate range of households and businesses. Also standalone IoT devices would be preferable because of their ease of installation and operation.

52. **Future Sensor Installations:** Are you considering installing additional sensors in the future? If yes, specify the parameters you would like to monitor.

**R: Grid quality and characteristics measurement devices. (voltage, amperage, power, reactive power, cosϕ, frequency, harmonics etc)
Climate conditions monitoring (solar radiation, temperature, humidity, wind speed and direction, rainfall, basic pollutants)
Consumption through smart meters on specific installations (time series of power consumption)**

53. **Data Security and Privacy:** Are there specific requirements or considerations regarding data security and privacy within your energy community?

R: No direct connection between data collected and end-user is present, safeguarding the anonymity of our members.

54. **Partnerships and Agreements:** Do you have existing partnerships or agreements with the Distribution System Operator (DSO) or Aggregator that need to be considered during the implementation of energy-related initiatives?

R: We have agreements with the Grid Operator and two Energy Suppliers.

55. **Assessment of Energy Savings:** How do you assess the potential for energy savings within your energy community, especially for demand response (DR) purposes?

R: We estimate that energy savings can be substantial. Members of the community are expected to participate and schedule their energy intensive activities in accordance with the suggestions of the demand- response system.

56. **Energy Generation:**

    1. What types of renewable energy sources are available within your community?

    2. Do you have any plans to expand or diversify your energy generation capabilities?

    R: 1. Solar PV is the sole renewable energy source within our community. 2. Yes, we will try to add other PV stations in our capacity. Also a wave energy station is studied and expected to be installed within the next 2 years. In the long term, offshore wind energy is examined, following national initiatives in this field.

57. **Energy Storage:**

    1. Do you currently use energy storage solutions, such as batteries, within your community?

    2. Are there plans to implement additional energy storage systems in the future?

R: 1. No energy storage system is present at the time. 2. Yes, we are examining the utilization of a H2 storage system.

58. **Grid Interaction:**

    1. How is your community currently connected to the energy grid?

    2. Are there any challenges or opportunities related to grid interaction that you would like to address?

R: 1. Direct connection on a 20kV transmission line.

2. There is a limitation in the maximum power transmission through the submerged cable. If additional RES power plants are to be implemented on the island of Halki, the submerged cable connection needs to be upgraded.

59. **Technology Infrastructure:**

    1. What technologies or platforms are currently in use for managing energy consumption and demand response?

    2. Are there any specific technological needs or gaps that your community identifies?

R: 1. No such systems are present today. 2. Metering systems need to be installed on key points of the island electrical grid.

60. **Demand Response Experiences:**

    1. Have you participated in demand response programs before, and if so, what were the outcomes?

2. Are there any lessons learned from previous demand response activities that can inform future initiatives?

R: 1. We haven't participated in such types of programs in the past.
2. n/a

61. **Collaboration and Partnerships:**

    1. Are there collaborations or partnerships with external entities, such as utilities or government agencies, that support your demand response efforts?

    2. Are there opportunities for collaboration with neighbouring communities or energy projects?

R: 1. No.
2. We could collaborate with the grid operator, so as for them to have a real-time monitoring of our PV station production. Also, if other communities are operating on the island of Rhodes (with which we are interconnected) we could collaborate with them.

62. **Regulatory Environment:**

    1. How do existing regulations impact your community's ability to engage in demand response?

    2. Are there regulatory changes or support that would enhance your community's participation in demand response programs?

R: 1. To the best of our knowledge, existing regulations do not have an impact on this matter.
2. A discount in the cost for grid usage could be applied for the energy that is consumed according to demand-response suggestions.

63. **Feedback Mechanisms:**

    1. How do you collect feedback from community members regarding their energy preferences and experiences?

    2. What mechanisms are in place for continuous improvement based on user feedback?

    R: 1. Through the usual means of communication. No exclusive process is present at this time.
    2. We do not have relative mechanisms.

1. Do you expect any national legal barriers to implementing your pilot project/use case?

    If yes, please list them and explain how they pose a barrier to your activities.

There might be difficulties installing the meters on the grid. The sole entity that can install such systems is the grid operator (DEDDIE / HEDNO) and it might require time and special licences.

Additionally, we will not be able to implement V2G projects, since the installation of adequate chargers will not be allowed. We were informed that such devices will be considered as small RES plants and since there is no electrical space in our grid systems, such installations are not permitted.

2. Are there any aspects of your pilot project / use case where a fitting legislative framework is missing? (regulatory gaps)

   If yes, please list them and explain why and how this legal gap hinders your pilot project/ use case.

I believe there are no provisions for small scale energy storage systems, especially those with innovative and not commercial technologies. Such systems would be a great addition to the pilot project.

Irish Questionnaire

Energy Community Questionnaire:

64. **Community Type:** Please specify the type of energy community you are part of (e.g., residential community, commercial community, mixed-use community, etc.). Agriculture, Tourism and Hospitality and Transport sectors.

R:

65. **Primary Members:** Describe the primary members or occupants within your energy community (e.g., residents, businesses, institutions, etc.). Businesses, SMEs e.g. farms and tourism providers; transport initiatives work cross-sectorally and apply to all society.

R:

66. **Community Structure:**

    1. How is your energy community organized, and what is the size of your community? 2 x Sustainable Energy Communities (SEAI). The West Kerry Dairy Farmers SEC has 130 members and the T&H SEC has 120 members (potentially 300). The transport community doesn't have a formal structure but there are 160 citizens engaged in sustainable mobility actions.

    2. Are there specific roles or responsibilities assigned to community members regarding energy management? Within the two SECs there is a defined structure of community champion and project coordinator. These roles are supported by steering groups and a management team in the case of the T&H SEC. Documentation on seai.ie on governance and role of steering groups for SECs.

R:

67. **Member Engagement:**

    1. How engaged are community members in energy-related activities and decision-making? Highly engaged. We have just undertaken a process of collective purchasing of Solar PVs (with some battery storage) for both SECs and in both cases the steering group members were fully involved in analysing quotes and determining the most suitable suppliers. More of a role for batteries in Agriculture sector, this is linked to available supports (TAMs grants) and constraints on obtaining payments for energy exported to the grid. Tie-in to ESBN National Network, Local Connections project – should ready ourselves for incentives that may emerge through this.

    2. What strategies do you use to educate and involve community members in demand response initiatives? Power off and save initiative. Only 2-3 businesses large enough to avail of this. National campaigns from suppliers.

R:

68. **Infrastructure:** What is the infrastructure of your energy community? Refer to kick-off presentation, consider anything new and anything that needs to be develop.

The Dingle Peninsula has existing technologies deployed (Solar PV: 25 Installs, 71.4 kW (68.8 MWh);
Retrofit: 3 Deep Retrofits, 1101 Homes with >= 1 measure, LEDs; 59 Heat Pumps;
43 Solar Heating;
20 Batteries with Management Systems;
15 Smart EV chargers (of which 5 are V2G);
50 Smart Meters; LV/MV monitoring system;
5 homes with energy management systems; DMS (with some automation of overhead MV Network)
as well as the following societal infrastructure already established:
Dingle Peninsula 2030 Sustainable Energy Community;
West Kerry Dairy Farmers Sustainable Energy Community;
Dingle Innovation Hub;
Emerging Dingle Peninsula 2030 Tourism Sustainable Energy Community;
Sustainable Travel working groups.

R:

69. **Occupancy Patterns:** How is the energy community typically occupied? Provide details regarding regular occupancy hours and patterns. Agriculture (dairy): energy mainly needed during peak morning and evening hours and seasonality is a significant factor i.e. energy demand drops off between Dec and Feb. Diesel emerged as a significant demand which is driving the consideration of the development of biogas;

    T&H - Very seasonal in this sector also with energy demand drop off Dec – Feb. During the season, there is highest demand at evening time (people preparing to go out and when they are out). This coincides with national peak demand. Electrification of heat: conflicting incentives – Solar PV more financially attractive than heat pumps. Most businesses use kerosene or LPG to heat water. Most use LPG. Calor (only provider) offer green equivalent LPG.

R:

70. **Comfort Contributors:** Identify key factors or parameters that contribute to comfort within your community (e.g., thermal conditions, acoustic conditions, visual conditions, air quality). Retrofits will be a focus of the Tourism and Hospitality SEC. We have a case study where one pub/restaurant business completed a full retrofit and reports significantly increased comfort levels (thermal conditions) and the ability to extend their season to open in wintertime as it is now much easier to heat the building.

R:

71. **Existing Monitoring Systems:** Do you currently have systems or sensors in place to measure comfort-related parameters, such as thermal conditions, acoustic conditions, visual conditions, and air quality? Specify the type of instrumentation used. Not that we are aware of presently.

R:

72. **Data Handling:** Describe your current approach to handling and analysing data related to indoor environmental conditions. Choose from options like utilizing a Community Management System (CMS), manual monitoring, using standalone IoT devices, engaging

external services, or other methods. All businesses currently have their own individual approach to indoor environmental conditions. Mostly manual monitoring

R:

73. **Future Sensor Installations:** Are you considering installing additional sensors in the future? If yes, specify the parameters you would like to monitor. Not yet

R:

74. **Data Security and Privacy:** Are there specific requirements or considerations regarding data security and privacy within your energy community? Yes, we have collected a significant amount of data across the energy communities through surveys and energy monitoring devices. We have committed to only sharing this data in anonymised and aggregated formats. It will be important to develop clear understanding and agreements with participants on the use of their data for this project.

R:

75. **Partnerships and Agreements:** Do you have existing partnerships or agreements with the Distribution System Operator (DSO) or Aggregator that need to be considered during the implementation of energy-related initiatives? We are currently working through a process to identify the datasets that will be required to support analysis and model building. These will be forming the basis of a data sharing agreement with the DSO, ESB Innovation and also with community participants. Included in this will need to be sections clarifying the sharing and use of the data with Enpower project partners. A data sharing workshop is planned with community members in mid-February to seek inputs to refine draft agreements.

R:

76. **Assessment of Energy Savings:** How do you assess the potential for energy savings within your energy community, especially for demand response (DR) purposes? Energy masterplans have been completed for both SECs and these capture the full potential for energy savings across a wide range of measures. For the transport sector, baseline surveys are underway to quantify mobility modes across the peninsula. Reduced energy for transport will be linked to increase use of public transport and increased walking and cycling journeys – these will be quantified again in late 2025 to monitor progress.

R:

77. **Energy Generation:**

    1. What types of renewable energy sources are available within your community? The main focus is on Solar PV and development of biogas.

    2. Do you have any plans to expand or diversify your energy generation capabilities? Limitations on the electrical grid capacity and lack of proximity to the national gas grid will be restrictive but if we can produce biomethane for a local transport market we can create opportunity to expand. Wind turbines are not permitted under current

local authority plans. Development of small scale hydro is of interest to some community members.

R:

78. **Energy Storage:**

    1. Do you currently use energy storage solutions, such as batteries, within your community? Mainly in domestic settings. They are also an important part of the solution for dairy farmers as their load profile peaks early morning and late evening when milking occurs. They need to store the energy generated midday or at cheaper electricity rates overnight for use at these times.

    2. Are there plans to implement additional energy storage systems in the future? Yes, within the dairy sector.

R:

79. **Grid Interaction:**

    1. How is your community currently connected to the energy grid?

    2. Are there any challenges or opportunities related to grid interaction that you would like to address? Grid capacity is limited on the peninsula, investment has been made in recent years to upgrade from 10kV to 20kV lines and to use sensor technology to improve resilience in the face of Atlantic storms. Transformer upgrades will likely be needed into the future as we increase electrification of heat and transport, but these will be scheduled in a national context and are likely to be after the lifetime of this project.

R:

80. **Technology Infrastructure:**

    1. What technologies or platforms are currently in use for managing energy consumption and demand response? Wattrics system monitors energy use and provides members with real-time information. The Citizen Renewable Platform to be developed through this project.

    2. Are there any specific technological needs or gaps that your community identifies?

81. **R: Demand Response Experiences:**

    1. Have you participated in demand response programs before, and if so, what were the outcomes?

    2. Are there any lessons learned from previous demand response activities that can inform future initiatives?

R: According to the Irish framework, demand response is mainly based on the concept of the Demand Side Unit., which can provide services to the transmission grid. A Demand Side Unit (DSU) refers to either an individual demand site or a cluster of demand sites that possess the ability to decrease their electricity consumption upon instructions from the National Control Centre (NCC). DSUs enable participants to submit bids for demand reductions in the overall wholesale Single Electricity Market (SEM), comparable to a generator bidding for operation. These units offer adaptable demand-side reductions, as the system operator has real-time visibility into their availability and can directly summon the units to fulfil the successfully bid demand reduction.

A Dispatch Instruction, which is a request to curtail electricity demand, can be issued at any time, day or night, provided that a DSU has indicated its readiness for reduction. The DSU must be capable of sustaining the demand reduction for a minimum of two hours, employing strategies such as plant shutdown or on-site generation. Entities can establish their own Demand Side Unit or engage with an existing DSU to bid on their behalf.

Currently, DSUs primarily consist of commercial and industrial electricity consumers. However, the anticipated deployment of smart meters at the residential level over the next five years is expected to broaden the potential market for DSUs.

Source: EirGrid (TSO in Republic of Ireland): https://www.eirgrid.ie/industry/becoming-customer/demand-side-management

Apart from that, pilots are taking place at the distribution level. The underlying idea is to test flexibility services for domestic, commercial, industrial, and small and medium enterprises connected to the distribution grid.

Example of pilots on flexibility for the distribution grid: https://www.esbnetworks.ie/who-we-are/national-network-local-connections-programme/flexibility-services/pilot-of-scale

82. **Collaboration and Partnerships:**

    1. Are there collaborations or partnerships with external entities, such as utilities or government agencies, that support your demand response efforts?

    2. Are there opportunities for collaboration with neighboring communities or energy projects?

R:

83. **Regulatory Environment:**

    1. How do existing regulations impact your community's ability to engage in demand response? Number of barriers in agricultural sector linked to TAMs grants, if these can be resolved they could encourage more optimal deployment (grid connection efficiencies needed). No real system to support community PV for grid export to support weak areas of the grid – systems needed to encourage and support this. Anecdotally, out of 60 grant applications submitted, only one met the criteria – support needed to complete grants. Would be better if PV grants were managed by SEAI and not Dept of Agriculture. Farmers looking at saving €2k in energy could face much higher costs for measures identified through a farm inspection and so many are reluctant to apply for these grants.

2. Are there regulatory changes or support that would enhance your community's participation in demand response programs? (see above)

R:

84. **Feedback Mechanisms:**

1. How do you collect feedback from community members regarding their energy preferences and experiences? Both SECs hold regular meetings, knowledge sharing events and workshops with their members; significant surveys and audits have been carried out for the SECs and more recently for the general public for transport preferences.

2. What mechanisms are in place for continuous improvement based on user feedback? Refinements are continuously made based on workshop outputs and member feedback. For the vast majority of our activities, we undertake a reflective learning process to capture what worked and didn't work and what can be improved on for the future. For small events, this can be a simple de-brief – for larger scale activities, this results in a full learning brief.

R:

1. Do you expect any national legal barriers to implementing your pilot project/use case?
   If yes, please list them and explain how they pose a barrier to your activities

2. Are there any aspects of your pilot project / use case where a fitting legislative framework is missing? (regulatory gaps)
   If yes, please list them and explain why and how this legal gap hinders your pilot project/ use case

In Ireland, the Commission for Regulation of Utilities is "currently developing an enabling regulatory framework to empower active consumers and energy communities to participate in energy markets."

This is not yet in place and there is no regulatory framework for peer-to-peer energy sharing which is a gap that could be restrictive.

We are currently awaiting the publication of the National Biomethane Strategy and related supports and this will be critical to the local development of biogas which can support both the agriculture and tourism and hospitality communities.

The Irish pilot will support the development of solutions that allow for the exploitation of flexible services at the distribution level. This initiative will encourage Dingle local community to participate in the provision of services by using their assets, such as solar PV, heat pumps, batteries, and energy storage systems. This is aligned with the Clean Energy Package (CEP), which granted consumers the right to access all electricity markets and be remunerated for their flexibility. However, Member States are still to implement such provisions in national legislation.

Hungarian Questionnaire

Energy Community Questionnaire:

Community Type: Please specify the type of energy community you are part of (e.g., residential community, commercial community, mixed-use community, etc.).

R: Mixed-use energy community, with very strong municipality driven features.

Primary Members: Describe the primary members or occupants within your energy community (e.g., residents, businesses, institutions, etc.).

R: Municipality and public buildings. The municipality established a fully municipality owned company (Bekescsaba Energia Esco Ltd.) that is the management organisation of the energy community (it is a non-official energy community, however it works as a local grid). The focal point of the energy community is the complex smart-grid assets installed by the community.

Community Structure:

How is your energy community organized, and what is the size of your community?

The energy community extension is in progress. Right now, the municipality and its buildings are part of the energy community. Formal establishment is not in progress yet, in case we clarify the legal background and find the proper business model, we are willing to do so.

Are there specific roles or responsibilities assigned to community members regarding energy management?

R: No, not yet.

Member Engagement:

How engaged are community members in energy-related activities and decision-making?

What strategies do you use to educate and involve community members in demand response initiatives?

R: We are working on member engagement practices and plans.

Infrastructure: What is the infrastructure of your energy community?

R: The smart grid system includes solar panel (1.3 MWp), Li-ion energy storage (1.2 Mw/ 2.4 MWh) and Smart Grid Control Centre. **Phase II.** has the building permit to a solar PV system (1,3 MW) and a Li-Ion energy storage system (1,2 MW/2,4MWh).

Occupancy Patterns: How is the energy community typically occupied? Provide details regarding regular occupancy hours and patterns.

As the buildings are per today public buildings, the occupancy pattern is the following:

We provide energy for public buildings (a sport hall and a fencing hall) and for a non-public bus charger (150 kW). The sport hall typically occupied from 6.00-20.00, but as it contains sport loggings as well, it has 0-24h portal service.

Comfort Contributors: Identify key factors or parameters that contribute to comfort within your community (e.g., thermal conditions, acoustic conditions, visual conditions, air quality).

R: Thermal condition is the most important comfort contributor. Geothermal system is under construction in the city, which will provide heat energy for the sport hall and for the fencing hall. In the buildings the thermal conditions and the visibility factors are essentials.

Existing Monitoring Systems: Do you currently have systems or sensors in place to measure comfort-related parameters, such as thermal conditions, acoustic conditions, visual conditions, and air quality? Specify the type of instrumentation used.

We don't have a monitoring system in place.

Data Handling: Describe your current approach to handling and analysing data related to indoor environmental conditions. Choose from options like utilizing a Community Management System (CMS), manual monitoring, using standalone IoT devices, engaging external services, or other methods.

R:

Future Sensor Installations: Are you considering installing additional sensors in the future? If yes, specify the parameters you would like to monitor.

R: Yes, occupancy sensors will be installed to buildings. Beside occupancy sensors we plan to install smart public lightings around the sport hall, IoT lightings in the building and more smart power meter within the building.

Data Security and Privacy: Are there specific requirements or considerations regarding data security and privacy within your energy community?

R: We have the data security and privacy requirements as defined by law. However, we face obstacles with citizen consumption and behaviour analysis due to these requirements.

Partnerships and Agreements: Do you have existing partnerships or agreements with the Distribution System Operator (DSO) or Aggregator that need to be considered during the implementation of energy-related initiatives?

R: Not yet, but we are working on one contract to the energy purchase and additional one to the selling.

Assessment of Energy Savings: How do you assess the potential for energy savings within your energy community, especially for demand response (DR) purposes?

R:

Energy Generation:

What types of renewable energy sources are available within your community?

Yes. 1.3 MWp PV system

Do you have any plans to expand or diversify your energy generation capabilities?

Yes, further 1 MWp and 2 MWp PV systems will be installed at two sites. A further 1,4 MWp solar system is planned. A geothermal system is under construction, the heat centre will be one the site of SGI, powered by the Smart Grid.

R:

Energy Storage:

Do you currently use energy storage solutions, such as batteries, within your community?

Yes, we installed an energy storage system. Size: 1.2 MW/2.4 MWh

Are there plans to implement additional energy storage systems in the future?

Yes, we have building permits for an extension of storage facilities. Size: 1 MWh and 2 MWh (2 sites)

R:

Grid Interaction:

How is your community currently connected to the energy grid?

Individuals have unique grid access points (point of delivery) - all members have access to the public DSO grid. Within the smart grid, the sport hall and fencing hall is connected indirectly to the grid, as the Smart grid is connected to the grid, and the smart grid provide the energy for the local consumers(sport hall, fencing hall, bus charger now, geothermal heat centre in the future).

Are there any challenges or opportunities related to grid interaction that you would like to address?

R: Yes, there are severe challenges in the implementation - the regulatory environment is not in favour of energy communities. We cannot distribute energy between members - it is a legal right of the energy trader to deliver energy between PODs and energy generators. The community does not have legal right to act as an energy trader.

Technology Infrastructure:

What technologies or platforms are currently in use for managing energy consumption and demand response?

In the smart grid system, we have SCADA and energy consumption/generation forecasting system.

Are there any specific technological needs or gaps that your community identifies?

No.

R:

Demand Response Experiences:

Have you participated in demand response programs before, and if so, what were the outcomes?

No, the community utilizes the energy infrastructure to achieve the largest monetary yield: right now, energy arbitrage (intra-day) provides the largest monetary yield.

Are there any lessons learned from previous demand response activities that can inform future initiatives?

R: Yes, business models that we create with hypothesis systems and personal beliefs may be totally different in practice. We did our energy asset to participate in the ancillary services market. But the market changed a lot, and we are better off with a totally different use case.

Collaboration and Partnerships:

Are there collaborations or partnerships with external entities, such as utilities or government agencies, that support your demand response efforts?

Are there opportunities for collaboration with neighbouring communities or energy projects?

R: We have contacts with other Hungarian energy community initiatives and projects, and we are working on collaboration possibilities with the utility and government.

Regulatory Environment:

How do existing regulations impact your community's ability to engage in demand response?

Are there regulatory changes or support that would enhance your community's participation in demand response programs?

R: There are regulatory gaps, and the current regulation is not sufficient for energy communities.

Practical experience shows that the legal environment, and inflexibility of regulations are the main obstacles to the establishment of energy communities. Sharing based energy communities are not yet possible due to the regulatory environment. Energy can only be shared between properties with the same parcel number. As the regulatory environment is not sufficiently developed and not ideal for the development of energy communities, it is therefore more typical in Hungary today to have only community energy initiatives with the potential to become real and functioning energy communities, if the regulatory environment is more supportive.

Feedback Mechanisms:

How do you collect feedback from community members regarding their energy preferences and experiences?

What mechanisms are in place for continuous improvement based on user feedback?

R: As the energy community has not yet been established, we do not currently collect this information.

1. Do you expect any national legal barriers to implementing your pilot project/use case?

   If yes, please list them and explain how they pose a barrier to your activities

Yes, there is one important legal barrier to our pilot: peer-to-peer energy trading is not allowed in Hungary for micro-generators. Micro-generators up to 49.9 kW built-in AC side capacity can only use the net-metering scheme.

2. Are there any aspects of your pilot project / use case where a fitting legislative framework is missing? (regulatory gaps)

   If yes, please list them and explain why and how this legal gap hinders your pilot project/ use case.

Yes, we can only introduce peer-to-peer energy trading schemes within the energy community if the regulation allows energy trading for micro-generators. In addition to allowing energy sales for microgenerators, consumers without rooftop solar shall be able to buy electricity directly from microgenerators. Such a system has many legal and energy market barriers: households and small companies are in the universal services system that guarantees good prices. How can households opt out from the universal system and consume renewable energy at daytime and going back to the universal service system at night.

Spanish Questionnaire

Energy Community Questionnaire:

85. **Community Type:** Please specify the type of energy community you are part of (e.g., residential community, commercial community, mixed-use community, etc.).

R: Mainly residential community. Possibility of incorporating some small businesses.

Utility provider. City hall office, school, medical service and a swimming pool.

PV planned plan to increase to 100 kW.

Energy community is planned to be legal.

86. **Primary Members:** Describe the primary members or occupants within your energy community (e.g., residents, businesses, institutions, etc.).

R: The main users will be the residents of the village.

87. **Community Structure:**

    1. How is your energy community organized, and what is the size of your community?
    2. Are there specific roles or responsibilities assigned to community members regarding energy management?

R: It will consist of 30-80 users (still in the process of being set up).

88. **Member Engagement:**

    1. How engaged are community members in energy-related activities and decision-making?
    2. What strategies do you use to educate and involve community members in demand response initiatives?

R: No user shall have a predominant role over another. Each will pay a fixed fee according to the kW allocated to them. All will have the same role.

89. **Infrastructure:** What is the infrastructure of your energy community?

R: It consists of a 58kW photovoltaic plant installed on the roof of the town hall offices. It is planned to expand this power up to 100 kW.

90. **Occupancy Patterns:** How is the energy community typically occupied? Provide details regarding regular occupancy hours and patterns.

R: The consumption will be determined, on the one hand, by that of public buildings, which will mainly consume during the day, throughout the working day. On the other hand, the consumption of the 50-80 residential users is considered, who are assumed to have a typical residential consumption curve, with a valley zone during nighttime hours, and two peaks: one in the early afternoon hours (approximately between 13:00-16:00) and another peak zone in the early evening hours (approximately between 20:00-23:00).

91. **Comfort Contributors:** Identify key factors or parameters that contribute to comfort within your community (e.g., thermal conditions, acoustic conditions, visual conditions, air quality).

R: The main contributor is the thermal conditions. The area where the energy community is established is characterized by a very warm climate in the summer months (an average of 34°C in July and August) and a cold climate in winter (with an average of 5°C in the months of December to February).

92. **Existing Monitoring Systems:** Do you currently have systems or sensors in place to measure comfort-related parameters, such as thermal conditions, acoustic conditions, visual conditions, and air quality? Specify the type of instrumentation used.

R: No devices currently. Start to monitor the device in the public building.

93. **Data Handling:** Describe your current approach to handling and analysing data related to indoor environmental conditions. Choose from options like utilizing a Community Management System (CMS), manual monitoring, using standalone IoT devices, engaging external services, or other methods.

R: The ideal solution would be IoT sensors that monitor environmental conditions.

94. **Future Sensor Installations:** Are you considering installing additional sensors in the future? If yes, specify the parameters you would like to monitor.

R: Wireless Sensor Networks (WSN) will be installed to monitor the energy consumption of various household appliances in some homes within the energy community. These sensors will be set up to measure consumption in HVAC devices, allowing for the potential implementation of a demand response in the future based on local flexibility services. Initially this will be done in public buildings, in the future it is planned to extend it to private homes.

95. **Data Security and Privacy:** Are there specific requirements or considerations regarding data security and privacy within your energy community?

R: The owner of the data is Vergy and CUERVA. There are no major considerations beyond the need to anonymize the data.

96. **Partnerships and Agreements:** Do you have existing partnerships or agreements with the Distribution System Operator (DSO) or Aggregator that need to be considered during the implementation of energy-related initiatives?

R: The community developer (Vergy) and the local DSO (CUERVA) are partners within the same business group. The role of the aggregator is not yet developed in Spain, although it is already known that the DSO itself cannot exercise it.

97. **Assessment of Energy Savings:** How do you assess the potential for energy savings within your energy community, especially for demand response (DR) purposes?

R: It is expected to reach at least 30% of self-consumption in the whole community.

98. **Energy Generation:**

  1. What types of renewable energy sources are available within your community?
  2. Do you have any plans to expand or diversify your energy generation capabilities?

R: There is a 58kW photovoltaic plant, and there are plans to expand it to 100 kW.

99. **Energy Storage:**

  1. Do you currently use energy storage solutions, such as batteries, within your community?
  2. Are there plans to implement additional energy storage systems in the future?

R: A battery (whose capacity is yet to be defined) will be installed, along with a V2G (Vehicle-to-Grid) charger for electric vehicles. The V2G charger can function both as a storage system and as an additional tool in demand control. It will have an output of 22 kW.

100. **Grid Interaction:**

  1. How is your community currently connected to the energy grid?
  2. Are there any challenges or opportunities related to grid interaction that you would like to address?

R: The energy community is connected to CUERVA's distribution network and is also part of an area known as the Living Lab, which has been digitized to obtain real-time data on consumption and generation in the network. In total, there will be 320 supply points in the community.

101. **Technology Infrastructure:**

  1. What technologies or platforms are currently in use for managing energy consumption and demand response?
  2. Are there any specific technological needs or gaps that your community identifies?

R: Currently, demand control is not yet in place. However, the HVAC devices in the homes will be used to manage consumption and enable demand control in the future.

102. **Demand Response Experiences:**

  1. Have you participated in demand response programs before, and if so, what were the outcomes?
  2. Are there any lessons learned from previous demand response activities that can inform future initiatives?

R: There has been no prior participation in demand control programs.

103. **Collaboration and Partnerships:**

1. Are there collaborations or partnerships with external entities, such as utilities or government agencies, that support your demand response efforts?
2. Are there opportunities for collaboration with neighbouring communities or energy projects?

R: There is a close relationship between the community developer (Vergy), the local DSO (CUERVA) and the public administration (Fornes Town Council). In addition, there are plans to expand the installed PV capacity of the community to 100 kW.

104. **Regulatory Environment:**

1. How do existing regulations impact your community's ability to engage in demand response?
2. Are there regulatory changes or support that would enhance your community's participation in demand response programs?

R: At present, legislation does not yet facilitate demand control at the local level. In fact, it is not very developed, and there is currently no mechanism for economic compensation for customers participating in demand control (i.e. selling flexibility to the grid) - the pilot would need to align with current regulation here. It is anticipated that in the future, legislation will continue to evolve in this regard to facilitate small-scale demand control, especially through energy communities.

105. **Feedback Mechanisms:**

1. How do you collect feedback from community members regarding their energy preferences and experiences?
2. What mechanisms are in place for continuous improvement based on user feedback?

R: There is constant and close communication between the community developer (Vergy), the town hall (Fornes), and the residents who will be part of the community. Information is collected through direct communication, and there is also the possibility of conducting surveys.

Questions from RAP:

0. General preliminary considerations

This is the general context of Spanish regulations related to energy communities:

106. Self-consumption regulation: RDL 244/2019, and OrdenTED/1247/2021: both make rules and regulations for collective self-consumption. The latter law specifies the possibility of providing hourly coefficients on how energy is shared among shareholders of a PV installation. The value of the distribution coefficients can be modified with a periodicity of no less than four months, after notifying the person in charge of the corresponding reading with sufficient advance notice (which is the DSO).

107. PNIEC – 1.13(Jan-2020): National action plan of energy and climate --> includes the development of Local Energy Communities: Introduces the concept of local energy community (renewable energy community and citizen energy community) and promotes the normative development of the concept.

108. RDL 23/20 – Renewable Energy Communities (Jun-20): Transposition of the REC figure (EU DIRE 2018/2001) (introduces it as a subject of the Electricity Sector).
109. MITECO – Public Consultation on Local Energy Communities (Nov-20):Public consultation to incorporate the figure of Local Energy Communities.
110. PRTR – C7.R3. Development of Local Energy Communities (Jan-21):€100 million aid package for energy communities.
111. Renewable Energy Auction (Sep-21):Reservation of 300 MW for locally distributed photovoltaic installations (only 5.75 MW were awarded).
112. Regional aid and subsidy programs and regulations (2022/2023):REC and CEC as beneficiaries of subsidy programs (CE-IMPLEMENTA and other regional programs) / Aragon; Navarra. Local tax bonifications are being awarded in many municipalities for promoting collective PV self-consumption installations (more incentives to these ones rather than individual ones), which promotes energy communities indirectly.
113. Action Plan for Energy Security (Plan+SE) (Oct-22):Measure 35. Approval of an RD regulating REC.
114. Public consultation (Apr 23 – May 23) for the regulatory development of REC and CEC.
115. RDL 5/23 (Jun - 23): Transposition of the CEC figure (EU DIRE 2019/944) (introduces it as a subject of the Electricity Sector) and some regulatory principles (e.g. increases the power for community EV charges from 250kW to 3MW that have access to simplified procedures).
116. Draft of PNIEC 2 : update on national action plan of energy and climate. Not approved yet but it increases the amount of RES, etc.

RDL= royal decree law; REC= Renewable energy community; CEC =Citizen energy community; MITECO= Ministry for the energy transition and demographic challenges.

117. Do you expect any national legal barriers to implementing your pilot project/use case? If yes, please list them and explain how they pose a barrier to your activities.

- Demand response barriers: flexible assets need to be of minimum 1 MW capacity to participate in markets (RDL 17/2022 https://www.boe.es/buscar/act.php?id=BOE-A-2022-15354). They need to be a single unit, they cannot be aggregated (unless is a regulatory sandbox). Plus, it takes time and a lot of procedures to participate (participation in auction, etc.) which cannot be done by "citizens" themselves (no experts).
- Determination of collective self-consumption coefficients: this can be done hourly but needs to be submitted with 4 months in-advanced, which does not allow to dynamically change them in real time --> limits benefits of the users.
- Aggregator barriers: there is no figure of aggregator.
- Permits and licenses: Obtaining the necessary permits and licenses to build and operate renewable energy facilities can be a lengthy and complex process, which discourages the participation of local communities.
- Complicated regulations and procedures: The process to activate shared self-consumption can be complex and subject to specific regulations that may vary by jurisdiction. This can make it difficult for consumers to understand how to activate shared self-consumption and comply with legal requirements.
- Administrative barriers: Administrative procedures and bureaucracy can slow down the activation process of shared self-consumption, resulting in delays and frustration for consumers

118. Are there any aspects of your pilot project / use case where a fitting legislative framework is missing?(regulatory gaps). If yes, please list them and explain why and how this legal gap hinders your pilot project/ use case.

- Demand response for energy communities:
- The first of the regulatory priorities is to **guarantee the participation of demand flexibility in all markets.**

  A working group in Catalonia [CEEC, report: https://media.timtul.com/media/clustereficiencia/Informe%20CEEC%20(pag_inidividuals)_20230214150556.pdf] highlights as priority measures to guarantee this participation the following:

- Eliminate the minimum 1MW capacity units for demand response programmes; and make it possible to aggregate them (not it is not possible to aggregate them which limits the possibility of energy communities to participate)
- Guarantee participation: which must go accompanied with capacity payment for the different services.
- Aggregator role defined in law and ways of aggregating demand:
- The second regulatory priority is the aggregation of distributed energy resources: smaller resources, with a flexible capacity of less than 1MW.
- As a third priority, the development of the figure of the independent aggregator in Spain is needed. The CEEC working group document also highlights that Spain needs to ensure the correct development of the independent aggregator, such as defining a methodology to validate flexibility activations (baseline) and ensuring that the independent aggregator can participate in all markets in a non-discriminatory manner.
- Lack of technical ways to dynamically inform about energy exchanges (p2p) within the energy community:
- Coefficients should be changed dynamically and a system should be in place to communicate it (automatically) from the Aggregator to the DSO/TSO, and avoid long waiting and time.

- Other markets (ancillary services: secondary aFRR, tericiary mFRR, or Planning Reserve): have also problems and need to be accompanied for the following measures:
- The same document [CEEC, report: https://media.timtul.com/media/clustereficiencia/Informe%20CEEC%20(pag_inidividuals)_20230214150556.pdf] also calls for eliminating the 200 MW requirement for secondary market programming units, as occurs in other countries, and bringing the closing of the offer (secondary markets for ancillary services) closer to the delivery of flexibility.
- Pay for capacity plan (regardless of the use of terciary mFRR): to encourage the participation and ensure long-term investments; Harmonize the resolution of energy and flexibility products at the same granularity (quarter-hour)

- Activation times: There is no control over the processing times for companies to expedite the procedure, which can take between 1 and 4 months.

- Lack of information for the DSO: When documentation is rejected, the reasons are not specified; sometimes, the same documentation is rejected without any reason, and later accepted without any modifications being made.

- Lack of information on electricity bills for customers with some retails: They cannot know how much has been deducted for self-consumption; they lack information.

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