D1.4 – Recommendations for new market roles, participants and innovative incentives schemes

COMMUNITAS

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D1.4 – Recommendations for new market roles, participants and innovative incentives scheme

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Glossary:

Acronym	Full name
B	Business use cases
CCP	COMMUNITAS Core Platform
CPP	Critical Peak Pricing
D	Deliverable
DER	Distributed Energy Resources
DR	Demand Response
DSO	Distribution System Operator
EC	Energy Community
ECPT	Energy Community Planning Tool
EMS	Energy Management System

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EU	European Union
ESCO	Energy Service Company
EV	Electrical vehicle
GGO	Granular Guarantees of Origin
GoO	Guarantee of Origin
IAT	Investment Advisor Tool
ICT	Information and communication technology
IEQ	Indoor environmental quality
IS	Innovative Solution
KPI	Key performance indicator
LCA	Life-cycle assessment
LCC	Life-cycle cost
NFT	Non-fungible token
NILM	Non-intrusive load monitoring
P2P	Peer-to-peer
PPA	Power purchase agreement
PV	Photovoltaics
REC	Renewable Energy Community
RED	Renewable Energy Directive
RES	Renewable Energy Source
RTP	Real-time Pricing
RTR	Real-time Rebates
SME	Small Medium Enterprise
T	Task
ToU	Time-of-Use
TRL	Technology readiness level
TSO	Transmission System Operator
V2G	Vehicle-to-grid
VPP	Virtual Powerplant
W	Watt (or kW – Kilo Watt, or MW – Mega Watt)
Wh	Watt-hour (or kWh – Kilo Watt-hour, or MWh – Mega Watt-hour)
WP	Work Package

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Executive summary

This deliverable, titled "Recommendations for New Market Roles, Participants, and Innovative Incentive Schemes," signifies a pivotal milestone in the COMMUNITAS project. It acts as a critical bridge between the context definition work in T1.1 and T1.3, focusing on identifying emerging energy market roles, new participants, and inventive incentive schemes tailored to engage active consumers.

Section 2, dedicated to Market Design Requirements, draws upon stakeholder insights (T1.1) and business-level use cases (T1.3) to define the essential market design prerequisites for COMMUNITAS. It also introduces various energy community archetypes, including local energy markets, community flexibility aggregation, and e-mobility cooperatives.

The section on Emergent Market Roles and Participants (Section 3) highlights key roles such as the Energy Community (EC) manager and aggregators, emphasizing the significance of active citizen participation in reshaping the energy market.

Novel Incentive Schemes delve into creative approaches to pricing and incentives, moving beyond conventional models. It also explores strategies for effectively engaging consumers and identifies financing opportunities for community-based energy projects.

The Business Opportunities section expands on the potential in innovative digital tools. Here, we explore how cutting-edge digital technologies and tools can empower energy communities. These tools open doors to more efficient management of energy resources, enhanced communication with consumers, and data-driven decision-making. In addition, we introduce the essential COMMUNITAS key tools, including the Guarantee of Origins, which is pivotal in establishing transparency and trust in the energy market.

Lastly, the main outcome of this deliverable is the Steering Recommendations. It offers guidance for legislators to create a conducive environment for energy community development. Distribution System Operators (DSOs) and Transmission System Operators (TSOs) receive recommendations to adapt to evolving market dynamics. Cooperatives and citizen initiatives discover actions to maximize their impact, and energy service companies gain insights into adapting to the changing landscape. Case studies and best practices are showcased for implementation.

The deliverable D1.4 is part of a series of deliverables relating to the Work Package 1 of COMMUNITAS, including D1.1 – “COMMUNITAS Knowledge Base: concept and development roadmap” (due date at Month 7), D1.2 – “Best practices in citizen engagement for ECs and Methodology for citizen and consumer engagement and value-based proposition design in ECs” (due date at Month 9), and D1.3 – “Use cases: requirements, specifications and KPIs” (due date at Month 9).

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1. Introduction

1.1. Objectives

The Deliverable 1.4 – "Recommendations for new market roles, participants and innovative incentives schemes" provides guidance for new market roles, participants, and innovative incentive schemes within the COMMUNITAS project. It aims to identify and define the emerging roles and participants in the energy market, as well as propose novel incentive schemes that effectively engage active consumers. This deliverable serves as a crucial foundation for anticipating and meeting the market design requirements necessary for the successful deployment of COMMUNITAS' solutions in various work packages. In essence, it sets the stage for the project's market-oriented approach and helps guide the transformation of the energy market landscape to align with the project's goals and objectives.

1.2. Structure of the document

The core of the deliverable is structured in the following sections:

- Section 2 – Market Design Requirements: This section encompasses several subsections that contribute to defining market design prerequisites. These subsections utilize insights from stakeholders and expand upon business-level use cases. They also explore various energy community archetypes.
- Section 3 – Emergent Market Roles and Participants: Within this section, the document identifies and defines key roles within the evolving energy market, emphasizing the importance of active citizen involvement.
- Section 4 – Novel Incentive Schemes: Delves into creative approaches to pricing and incentives beyond traditional models, discussing strategies for effectively engaging consumers and exploring financing options.
- Section 5 – Business Opportunities: This section underscores the potential of innovative digital tools for energy communities and introduces essential COMMUNITAS key tools.
- Section 6 – Steering Recommendations: This section offers actionable guidance for various stakeholders, providing recommendations for creating an environment conducive to energy community development, adapting to evolving market dynamics, maximizing impact within the changing energy landscape, and adapting to shifting market dynamics. It also showcases case studies and best practices to illustrate the implementation of the recommendations in real-world scenarios.

1.3. Relation to other tasks

D1.4 is a document describing the activities conducted in T1.4 and is related to all other deliverables in WP1. The information contained in this document will be assessed for the developments in WP2 and WP3 regarding the anticipation of market design requirements. Furthermore, it is considered the first step of a market-oriented process, to be placed throughout the project, specifically in the development of the DR service (T3.3, regarding measures beyond marginal pricing), the definition of business models (in T6.2 and T6.3), and policy and regulation recommendations (in T7.4).

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2. Market design requirements

2.1. Stakeholder insights

During the activities of T1.1 of COMMUNITAS, a series of workshops were held, with stakeholders of the countries in which the project pilots are located, to gather their requests and needs for the development of COMMUNITAS tools. Several key findings emerged from the different countries. In Croatia, the primary needs expressed were related to energy cost savings, public consultations, building trust in energy communities (ECs), technical knowledge, and tools for EC operation. Denmark, while lacking a clear legal framework for ECs, showed interest in possibilities such as solar cell roofs, electrification of fossil-based heat supply, and various tariff models for ECs. In Greece, participants were unfamiliar with ECs but expressed interest in reducing energy bills, seeking knowledge about energy consumption and customized data visualization. Italy's discussion revolved around incorporating local action groups into the EC concept, sharing energy, energy storage, third-party producers, and clarifying legislation. Portugal emphasized the need for expert answers, legislative assistance, access to funding programs, price comparisons, and the dissemination of information about ECs. Spain focused on economic savings, renewable energy installations, clarity of information, and the long-term sustainability of EC projects. The Netherlands identified various needs, such as financial and administrative support, grid connection contracts, tools for balancing supply and demand, and lightweight solar panels. Each country's recommendations and proposed innovative solutions addressed specific challenges, from building trust in Croatia to optimizing grid connections in Denmark, clarifying EC legislation in Italy, and simplifying information dissemination in Portugal. These insights will be valuable in guiding the development of the COMMUNITAS tools to meet the diverse needs and challenges of EC stakeholders in different countries.

A more comprehensive description of requests, needs and insights are:

Croatia: In Croatia, the workshops revealed that the main stakeholders involved were policymakers, academics, and citizens. Their primary concerns revolved around energy cost savings, which served as the main driver for forming energy communities. There was also a strong desire for public consultations, meetings, and information sessions to build trust and knowledge about the benefits of engaging in energy communities. Participants emphasized the need for technical knowledge and expertise to establish these communities successfully, as well as tools for their effective operation. One notable barrier was a lack of trust and limited understanding of ECs, which was identified as a primary obstacle. To address this, the recommendations included the creation of information points for public consultations and information sessions to build trust and understanding.

Denmark: Denmark's unique legislative position regarding ECs played a significant role in shaping the discussions. The absence of a direct legal definition of ECs in Danish law led to the need to describe how and why they are defined in Danish law. The country's stakeholders expressed various needs for communities "behind the meter," such as the possibility of solar cell roofs, electrification of fossil-based heat supply, and clear tariff models. On the other hand, communities "sharing via the grid" required a framework for a tariff model, grid connections, and different types of tariffs. A notable concern was the lack of policies to promote local self-production, especially in the context of renewable energy installations. The workshops pointed out the importance of grid companies and tariff models, and they emphasized the significance of geographical differentiation in tariff models.

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Grid connection contracts and taxation policies played a crucial role in shaping the needs and recommendations.

Greece: Greece's workshops revealed that most participants were unfamiliar with the concept of energy communities, and their main motivation for participation was the potential to reduce energy bills. Participants expressed a strong desire for knowledge about energy consumption, along with customized data visualization tools to monitor and extract information. Additionally, there was a significant interest in renewable energy sources and electric vehicle (EV) charging. The lack of familiarity with the EC concept was a key insight, and there was a strong emphasis on knowledge dissemination to create a sense of community working toward common energy goals.

Italy: In Italy, discussions in the workshops brought up the concept of Local Action Groups in connection with energy communities. Participants expressed a range of needs, including the integration of already installed systems into the Renewable Energy Community (REC), division of incentives between shared and self-consumed energy, discussion of energy storage, and the role of third-party producers. The need for clarity regarding legislation and regulation of incentives was also a significant concern. Notably, participants emphasized the regulatory and bureaucratic aspects that had not yet been fully defined in Italian law. This underscored the importance of understanding and integrating regulatory and legislative aspects to enable the successful development of ECs.

Portugal: In Portugal, the workshops revealed a neighbourhood association's keen interest in comprehending and establishing an EC within their community. This enthusiasm stems from the growing number of young residents who are joining their community and expressing a desire for innovative, sustainable solutions for their neighbourhood. Additional participants, including energy cooperatives, the environmental department of Cascais Municipality, and a managing EC company, underscored diverse requirements, which include the need for expert responses to common queries, support with legislative matters, access to funding initiatives, cost evaluations for renewable energy investments across different manufacturers, collaboration with neighbouring municipalities, and insights into existing ECs. A pivotal revelation was the necessity for readily available, transparent information and documentation, along with the potential role of municipalities in delivering impartial responses to frequently asked questions. Moreover, the significance of promotional campaigns to disseminate information and kindle interest in ECs was emphasized.

Spain: Spain's participants emphasized the potential for additional economic savings from EC activities, the installation of renewable energy sources, and the importance of information availability and clarity. The longevity and sustainability of the EC projects, both economically and in terms of social and environmental benefits, were of paramount concern. Members of the energy community discussed the integration of EC visualization into their existing energy billing applications and highlighted the value of providing scholarships to students to empower the community and contribute to its growth.

The Netherlands: The Dutch energy community identified a broad spectrum of needs and wishes, ranging from financial, legal, and administrative support to supply, purchase, and administration of power in private distribution networks. Participants sought tools for optimal matching of demand and supply in a system with distributed energy resources, as well as the development of new contracts to facilitate various aspects of ECs. Several technical and financial aspects were critical in the Dutch context, including handling energy sources for district heating, exploration of various energy options,

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and the role of investment advisor tools in assessing the feasibility of specific energy systems. The Netherlands' advanced stage in EC development called for solutions that would enhance and optimize existing organizational processes.

2.2. Business level use cases

One of the main goals of COMMUNITAS is to develop sustainable business models for the entities engaged in Energy Communities. This is identified as a success metric for the project, as a minimum of 8 business models need to be formulated, with at least one specifically addressing the alleviation of energy poverty.

While Technical Use Cases are directly associated with each of the innovative solutions to be developed in the project, Business Use Cases (BUC) are connected to the business prospects that may emerge from the implementation of COMMUNITAS tools for each of the actors involved.

As seen in deliverable D1.3, using an approach based on the IEC 92559 Use Case methodology, a total of 13 technical Use Cases have been identified. Each of these represents an innovative solution that will undergo implementation, testing, and demonstration within the various pilot sites mentioned earlier and included in the project. The description of these technical solutions, presented as Use Cases, along with the involved actors (presented in detail in the deliverable D1.3), enables the identification of potential business opportunities to be created and developed throughout the project's duration and beyond its completion (Business Use Cases).

The identified list of Business Use Cases (BUC) is provided in Table 1.

Table 1 - Identified business use cases

BUC ID	BUC Name	DUC Description
BUC1	Energy Community as Flexibility provider	Energy Community as flexibility provider to DSO for ancillary systems provision as congestion management.
BUC2	Energy Community as an ESCO offering energy management services	Energy Community as an Energy Service Company (ESCO) offering energy management services to community members, such as energy awareness, self-balancing on community level or optimisation of self-consumption index.
BUC3	Energy Community as a Retailer, including Guarantees of Origin certificates	Energy Community as a Retailer supplying the community members with energy and potentially participate in the wholesale market (or through bilateral contracts) with the locally aggregated energy surplus, including Guarantees of Origin.
BUC4	Energy community optimized operation via P2P energy and flexibility markets	Energy Community optimized operation via P2P energy and flexibility trading based on locally produced energy and using locally developed P2P market and tokens.

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BUC5	Prosumer Engagement in Implicit Demand Response	Prosumer engagement in Implicit Demand Response for local energy profile optimization (Time-of-Use optimization).
BUC6	Energy Community as facilitator for the creation of new Energy Communities	Energy Community as an enabler to replication solutions based on best practises and gathered knowledge.
BUC7	Investment Advising solutions for Energy Community members	Promoting environmental and social sustainability by disseminating best practises and energy investment solutions.
BUC8	Health, well-being, and sustainable finance services for energy community members	Mitigation of energy poverty, energy efficiency awareness and contributions to well-being and health through optimal energy related measures.

This list will subsequently undergo validation and refinement during the course of the project as the project progresses, and the tools are developed and tested.

2.3. Archetypes of energy communities

Energy communities are for the most part referred to in a general manner, but in many contexts, it may become important to distinguish between different archetypes, i.e., different association schemes, activities and goals, so that the developed solutions and incentives are well tailored to each community. Understanding the differences will also allow for a better identification of the most innovative solutions. Table 2 holds eight energy community archetypes which encompass most of the activities which may currently be interesting for an energy community, whether or not these are already legally possible. A particular community may also fit more than one of these archetypes.

Table 2 - Summary of energy community archetypes

Archetype	Description
Energy cooperative	Citizen-led initiatives with democratic control and collective funding and ownership of energy systems.
Community prosumerism	Communities of place created by consumers in order to benefit from special financing conditions, gain dimension to participate in flexibility markets, benefit from collective energy efficiency initiatives or participate in local energy markets.
Local energy markets	Prosumerism-driven communities that promote P2P energy trading in a fully decentralised way or through intermediate entities.

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Community collective generation	Shared generation, usually PV, installed on the rooftop of multi-tenancy buildings or near consumption sites, with the power output being shared among several customers.
Third party-sponsored communities	Energy community projects supported by utilities or other companies, who bear the financial effort and risk, and are remunerated through long-term PPA with customers.
Community flexibility aggregation	Demand response programs to exploit customers' flexibility, which can be managed by community aggregators, and then grouped by a larger aggregator.
Community ESCO	Partnerships between energy communities and external companies to provide renewable energy supply and/or energy efficiency services.
E-mobility cooperative	Cooperatives providing public transportation, car-sharing or car-pooling services. Electric vehicles can also be exploited as flexibility services.

This categorization allows us to identify the most innovative archetypes, the benefits they may bring, and any challenges they face. In that sense, the following sub-chapter focus on three archetypes, such as local energy markets, community flexibility aggregation and e-mobility cooperatives.

2.3.1. Local energy markets

The concept of a local energy market appears as the way in which prosumers can actively participate in the energy market, by allowing consumers and prosumers to trade energy with each other within a given geographical location through peer-to-peer (P2P) transactions. P2P transactions can be negotiated directly between the two parties involved, or through an intermediary third party. P2P markets typically have a competitive structure where buyers and sellers negotiate the transactions. P2P trading has the potential to help boost the decentralisation of the energy market, as well as help improve the local balance between generation and consumption, improving grid conditions.

Participants in P2P markets can range from small residential consumers/prosumers to somewhat larger ones such as buildings or microgrids. P2P markets place the most emphasis on the participation of smaller players, and when compared with other market arrangements are less concerned with the inclusion of retailers, grid operator and pure generators. P2P markets tend to be studied mostly with small market scales (<50 participants), raising questions about their scalability.[1] Successful P2P trading requires a sufficiently large number of participants, and that some of those participants necessarily

[1] Capper, T., Gorbatcheva, A., Mustafa, M. A., Bahloul, M., Schwidtal, J. M., Chitchyan, R., Andoni, M., Robu, V., Montakhabi, M., Scott, I. J., Francis, C., Mbavarira, T., Espana, J. M., & Kiesling, L. (2022). Peer-to-peer, community self-consumption, and Transactive Energy: A systematic literature review of Local Energy Market Models. *Renewable and Sustainable Energy Reviews*, *162*, 112403. https://doi.org/10.1016/j.rser.2022.112403

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generate surplus energy, to ensure that supply and demand bids can be matched a significant portion of the time [2].

A high-performance information system is required for P2P markets, enabling all participants to communicate with each other so that trading can take place. These systems must have solid security to be able to avoid any private information leak and ensure that the financial transactions are secure. This aspect is generally approached through blockchain technology: before blockchain, this type of safe transaction would have to operate through a centralised trusted intermediary, while blockchain now allows for secure transactions in a decentralised system.

Rules for placing bids and payment rules must be clearly defined. Participation in these markets can and should be partly or wholly automated, to avoid the need for micromanagement from the participants. An Energy Management System (EMS) can place bids on behalf of a participant, with their best interest in mind, having access to the participant's generation and demand profiles as well as real-time market information[2].

Besides the virtual layer where transactions occur, the physical layer of a local energy market, i.e., local grid conditions, must also be closely watched. A physical model of the local grid is necessary to ensure voltage violations and reverse power flows are avoided, and that network power losses are minimised.[2]

2.3.2. Community flexibility aggregation

Communities can engage in demand response programs, leveraging the community's scale to achieve a large enough flexibility to allow for participation in flexibility markets, which can be done through an aggregator. Current EU directives strongly encourage aggregation, and although there may currently be some regulatory barriers, there are several ongoing pilot projects leveraging flexibility through aggregation, so we can expect to see an uptick in this kind of activity in the coming years. The energy community's flexibility can be aggregated by a community aggregator, and in turn there may be a larger aggregator grouping flexibility collected from several communities/industries/etc. This flexibility may be exploited through direct (partial or total) control of some assets by the aggregator, or through sending dynamic pricing signals to participants. These activities also require robust ICT infrastructure, such as sensors, smart meters, Energy Management Systems, monitoring apps, etc., whose financial burden should be mostly or entirely on the aggregator's responsibility.

2.3.3. E-mobility cooperatives

E-mobility cooperatives are groups of citizens, public entities, SMEs, etc., coming together to provide electric mobility in the form of community public transportation, car-sharing or car-pooling services. The cooperative's electric vehicles can additionally be exploited as flexibility resources, through charging scheduling or through vehicle-to-grid (V2G) technology. However, this requires a sufficiently large EV fleet, and with arrivals of EVs to charging points evenly spaced throughout the day. In addition, V2G may currently still face some regulatory barriers. DER also synergise well with EVs, which

[2] Tushar, W., Saha, T. K., Yuen, C., Smith, D., & Poor, H. V. (2020). Peer-to-peer trading in Electricity Networks: An overview. *IEEE Transactions on Smart Grid*, *11*(4), 3185–3200. https://doi.org/10.1109/tsg.2020.2969657

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can be used as energy storage for excess generation. A relevant resource here is The Mobility Factory[3], a platform for e-mobility cooperatives which currently groups 18 different European e-mobility cooperatives. Different cooperatives include different services such as car-sharing, carpooling and EV rentals, and some are also involved with non-mobility initiatives such as financing PV installation.

3. Emergent market roles and participants

3.1. EC manager

The EC manager is one of the main emergent market roles with the introduction of the REC concept. The fact that the transposition of the Renewable Energy Directive in several countries mandates the existence of an EC manager associated with each EC showcases the importance that the legislators predict that the EC managers will have in the future of the energy grid. By making it mandatory, the legislators are also promoting the consolidation of this new market role in the system and promoting emerging business opportunities for businesses that have the necessary expertise to execute this role.

Overall, the responsibilities of the EC manager can vary from country to country, but its main responsibility is typically associated with the management of the energy distribution within the communities. In several countries, the attribution of the energy generated on-site can be allocated according to a key system, sometimes denominated as energy sharing coefficients. These energy sharing coefficients allow the EC manager to determine the amount of "virtual" energy that goes to each member of the community. Although this is only a financial operation because the EC manager cannot in fact control to each household the energy flows, it is of major importance to reflect in the energy bills of each member of the community. This key system can also be used to promote certain behaviours by allocating a larger share of energy to the members who contribute towards the promoted objectives. This means that, the EC manager could in fact also work as an aggregator and promote demand-side management, and thus provide more value to the energy communities.

The EC manager should be able to make the bridge between the community and the legal authorities that manage the electrical system so that grid balancing is achieved. Since energy community membership is on a voluntary basis, the EC manager should have the capacity to add or remove members of the community at any time in order to be able to make a correct balance between the on-site energy generation and the energy consumption from the community members.

Another usual responsibility of the EC manager is to maintain the correct operation of the energy community, namely by guaranteeing the continuous operation of the energy assets of the community through maintenance and operation activities. As an expert on the energy sector, it should also be the responsibility of the EC manager to contribute to knowledge sharing within the community and to advise the community on how to increase their levels of self-consumption and energy efficiency. Despite the importance of these topics, the authors of this deliverable did not find circumstances under which these responsibilities are legally attributed to the EC manager. The legislation on the responsibilities of the EC manager is typically broad, stating that the full list of responsibilities should

[3] https://themobilityfactory.coop/

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be defined by the energy communities themselves in an internal regulation – an internal document that defines rules according to the legal status of the energy community, affecting all its members. Internal regulations should result from an agreement of all members to ensure effective management of the community but usually it requires legal support.

3.2. Aggregator

The aggregator figure is responsible for the clustering of multiple energy assets so that they operate as a single entity – a Virtual Power Plant (VPP), operating similarly to a conventional power plant. These energy assets can be generation (both traditional power plants and DER), flexible loads (loads that can be shifted in time such as HVAC and certain appliances, as well as EV charging) participating through demand response schemes, and energy storage, such as batteries, or EV batteries if V2G is possible[4][5][6].

Small producers, consumers and prosumers are generally unable to play certain roles in the energy system such as participating in energy markets and providing ancillary services, because they lack the necessary scale. Aggregation has the goal of gathering sufficient total capacity to allow small players to play these roles, through one single entity – the VPP. These small participants can be monetarily compensated through this arrangement, while DSOs and TSOs benefit from the added grid stability[4].

Participants from more widespread geographic locations can be aggregated to form a Commercial VPP which focuses on participating in energy markets, optimising their behaviour considering market conditions to maximise value. On the other hand, in order to provide some types of ancillary services, aggregated participants must be from within a smaller geographical location, forming a Technical VPP. Typically, Technical VPPs will be operated by the DSO[7][8].

Based on their control architecture, VPPs can be of three types. A single central agent can aggregate all encompassed resources directly, without intermediaries, in which case we have a centralized control architecture. Alternatively, there can be local VPPs controlling a limited number of resources within the same geographical location, while a larger, regional VPP, in turn controls several local VPPs. This is decentralised or hierarchical control and it can be a good fit for energy communities – an energy

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[4] Baringo, L., & Rahimiyan, M. (2020). *Virtual power plants and electricity markets: Decision making under uncertainty*. Springer International Publishing.

[5] van Summeren, L. F. M., Wieczorek, A. J., Bombaerts, G. J. T., & Verbong, G. P. J. (2020). Community energy meets smart grids: Reviewing goals, structure, and roles in virtual power plants in Ireland, Belgium and the Netherlands. *Energy Research & Social Science*, *63*, 101415. https://doi.org/10.1016/j.erss.2019.101415

[6] Liu, C., Yang, R. J., Yu, X., Sun, C., Wong, P. S. P., & Zhao, H. (2021). Virtual power plants for a sustainable urban future. *Sustainable Cities and Society*, *65*, 102640. https://doi.org/10.1016/j.scs.2020.102640

[7] Naval, N., & Yusta, J. M. (2021). Virtual Power Plant models and electricity markets - A Review. *Renewable and Sustainable Energy Reviews*, *149*, 111393. https://doi.org/10.1016/j.rser.2021.111393

[8] Saboori, H., Mohammadi, M., & Taghe, R. (2011). Virtual Power Plant (VPP), definition, concept, components and types. *2011 Asia-Pacific Power and Energy Engineering Conference*. https://doi.org/10.1109/appeec.2011.5749026

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community be aggregated into a local VPP, but depending on the community's size, this arrangement may yet have too little capacity to be able to perform certain activities. A regional VPP can then coordinate multiple local VPPs to achieve the necessary scale, while still maintaining a large degree of more local decision-making through local VPPs. Lastly, we can have distributed control, in which resources are not directly controlled, and instead the central agent is simply an "information exchange agent", sending data such as market data, weather forecasts, and dynamic pricing to local controllers which in turn decide their own individual strategies[5].

3.3. Active citizen participation

As the significance of ECs within the broader energy system ecosystem gains increasing recognition, the active engagement of citizens assumes paramount importance.

Active citizen participation in ECs entails a process that encompasses the involvement of any citizen in the decision-making and governance of ECs, with an EC manager acting as their representative. This participation can manifest in various forms, including involvement in the planning and development of energy projects, provision of feedback on energy policies, and voluntary assistance in community energy initiatives. Such engagement fosters a clean, affordable, and sustainable energy future for communities.

Active citizen participation plays a pivotal role in ensuring that ECs are designed and operated in a manner that aligns with the needs of their members. Furthermore, it fosters trust and understanding between ECs and their stakeholders. Additionally, it empowers citizens to take an active role in the transition towards a clean energy future.

To become an active participant in ECs, individuals can join an existing energy community, establish a new energy community, or volunteer to contribute to an energy community project. Citizens can also engage by participating in energy community meetings, providing feedback on energy policies, and enhancing their understanding of energy issues. Active citizen participation in ECs offers a multitude of benefits, including:

- Heightened awareness of energy issues;
- Enhanced comprehension of the advantages of ECs;
- Increased support for energy community projects;
- Improved decision-making within ECs;
- Strengthened relationships between ECs and their stakeholders.

Several measures can be implemented to promote active citizen participation in ECs, including:

- Providing information and education about ECs to ensure equitable and inclusive participation;
- Facilitating citizen involvement in ECs to foster innovation and creativity;
- Supporting energy community projects to enhance resilience to climate change;
- Encouraging communication and collaboration between ECs and their stakeholders.

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4. Novel incentive schemes

4.1. Pricing and incentives for demand response (beyond pricing)

Effective pricing mechanisms are the cornerstone of any successful demand response program. These mechanisms not only need to reflect the real-time supply and demand dynamics but also incentivize customers to reduce their electricity consumption during peak periods. One common pricing strategy is Time-of-Use (ToU) pricing, where electricity rates vary based on the time of day. Peak hours are associated with higher prices, motivating customers to shift energy-intensive activities to off-peak times. Critical Peak Pricing (CPP) takes this a step further, imposing significantly higher rates during extreme peak events, which can be especially effective in engaging customers during rare grid stress situations. Real-time Pricing (RTP) is another approach, offering dynamic rates that respond to the immediate supply-demand balance. These pricing strategies empower customers to make informed choices about their electricity usage, aligning it with cost-effective and sustainable practices. Capacity payments are also crucial, offering customers financial incentives for committing to reduce a certain amount of load during peak times, thus ensuring grid reliability and avoiding the need for additional costly infrastructure.

Incentives are instrumental in encouraging customer participation in demand response programs. One effective method is Peak Time Rebates (PTR), where customers receive financial rewards or bill credits for reducing energy consumption during peak hours. This not only mitigates their electricity expenses but also fosters a sense of active involvement in grid reliability. Additionally, Load Curtailment Bonuses serve as powerful motivators for customers to achieve specific load reduction targets during peak events, with rewards that can range from one-time payments to ongoing incentives. Smart thermostat incentives promote the adoption of energy-efficient technologies by offering rebates or subsidies for the installation of these devices, enabling automated energy management, and contributing to a more responsive grid. Furthermore, gamification and community rewards can be implemented to turn demand response into an engaging and community-building endeavour. Contests, challenges, and peer comparisons can create competition and cooperation among customers, leading to greater energy conservation.

Demand response programs can extend their value beyond pricing and incentives by offering services that directly support DSOs. By participating in these programs, customers can help maintain grid stability, reduce the risk of blackouts, and enhance overall grid reliability. For instance, customers with advanced demand response technologies can provide grid services such as frequency regulation, voltage control, and load balancing. These services are crucial for optimizing grid operations and ensuring efficient energy distribution. Additionally, aggregators can act as intermediaries, helping to aggregate the demand response capabilities of multiple customers and sell these services to DSOs and other market participants. Such aggregation facilitates better integration of renewable energy sources and helps manage peak loads efficiently. Moreover, demand response programs can foster a more resilient grid by enabling rapid load shedding during emergencies, which minimizes the risk of cascading failures and ensures critical services continue to function. Overall, offering grid-supporting services in addition to pricing and incentives transforms demand response into a strategic asset for grid operators and contributes to a more robust and sustainable energy infrastructure.

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4.2. Effective engagement strategies

The COMMUNITAS project, by endeavouring to employ a knowledge base and innovative tools and technologies, places a distinct focus on engaging EC members and stakeholders. Deliverable 1.2, arising from task 1.2 of the COMMUNITAS project, encapsulates a comprehensive document based on literature and prior research on Energy Communities, along with frameworks for citizen and consumer engagement and value-based design. This research laid the groundwork for workshops and a social innovation template, shaping the basis for exploratory dialogues within the COMMUNITAS pilots.

A notable outcome of this initiative is the development of a framework for value-based design of pilot activities and services, integrating citizen engagement. This framework serves to empower Energy Communities in creating services and activities, with active member engagement positioned at the core of energy markets. It not only sets the direction for further Social Sciences and Humanities research within COMMUNITAS but is envisioned to evolve into a mature methodology over the course of the project.

Within D1.2, the importance of citizen and consumer engagement is underscored. For ECs to function optimally, active member engagement is deemed vital, both in activities and in growing the community. 'Citizen engagement' involves the inclusive participation of society in transition processes, facilitated by decentralized governance. Simultaneously, 'consumer engagement' focuses on enhancing usability and consumer experience, critical for community development and successful new services.

Insights gleaned from a comprehensive study on EC development processes reveal a dynamic, iterative journey. The developmental framework for ECs follows a non-linear trajectory from initiation to exploitation, navigating the path from inspiration to the establishment of resilient communities. European ECs exhibit both commonalities and differences, influenced by initiation methods, size, composition, organization, communication methods, and cultural factors.

Legal challenges surface, particularly in adhering to strict interpretations of REC definitions. Issues around openness, voluntariness, and the ability to enter/leave underscore the struggles with legislation and associated administrative tasks. The study advocates for tailored engagement strategies for top-down and bottom-up initiatives, recognizing the need to keep members engaged, involve diverse demographics, and establish effective governance structures.

There is a call for more data on the needs, desires, and values of EC members to inform the development of activities and services that foster positive engagement. Additionally, there is a recognized need for educational tools to improve members' understanding of ECs, along with enhancing energy and digital literacy. Clear and honest communication tools are identified as essential to avoid misunderstandings and align expectations within the community.

4.3. Financing opportunities

This section aims at summarising some possibilities for non-traditional funding of local sustainable energy projects, showed in Table 3.

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Table 3. Financing opportunities for local sustainable energy projects.

Name	Description	Advantages
Crowdfunding	Pooling money from individuals/groups who wish to support the project.	Full transparency, fast and simple, democratic
Cooperatives	Not-for-profit democratic community organisation raising money through membership fees.	Community-based and democratic
Energy Performance Contracting	Energy Service Company (ESCO) finances and executes the project and reaps the profits when the project delivers on energy savings.	Up-front financial burden and risk fall on the ESCO and not the client.
Internal contracting ("intracting")	Public authority provides zero-interest loans for the implementation of energy projects.	No interest of banking fees, quick implementation, efficient use of public funds
Green bonds	Issues by public authorities or private entities. Offer a fixed return and the profits must be re-invested in other sustainable projects.	Circularity
Guarantee funds	A commercial lender provides loans, and the risk/loss is absorbed by another entity (guarantor) should the debtor fail to repay them.	Reduced risk for commercial entities
Soft loans	Governments subsidise banks' interest rates for energy projects, allowing to provide low or zero-interest loans.	Can have longer duration than commercial loans.
Revolving funds	After an initial capitalisation, the revolving fund provides loans for sustainable energy projects, whose revenues return to the fund to finance further projects.	Long-term sustainability of public investment, efficient allocation of public funds, creates liquidity.
Third-party financing	A third-party financial entity provides a loan to the building owner, who pays an ESCO for a project. The ESCO offers guaranteed savings to accommodate the repayment of debt.	Minimise risk of repayment since the ESCO manages and absorbs risks.

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5. Business opportunities

5.1. Innovative digital tools

Many different projects throughout Europe have created numerous digital tools aiming to enable or facilitate a number of processes within RECs. It is a useful and very relevant exercise to compile them so as to analyse trends, gaps and emerging opportunities. Table 4 shows a compilation of some of these tools.

Table 4. Innovative digital tools created by other European projects.[9]

Tool name	Project	Country	Purpose	Details
The Mobility Factory platform		Europe (several)	Providing e-mobility sharing services	Platform used by cooperatives within The Mobility Factory. Provides all services needed for sharing electric cars, including reservation, car access, payment, billing and operation backend.
ENTRNCE Trader		Netherlands	P2P trading	Enables producers and consumers to directly exchange electricity with each other within energy communities. Is able to implement energy trading within a community, with other communities, energy exchanges or various third parties.
-	ERIGRID	Italy	Aggregated forecasting tool	Forecast energy generation and consumption in an REC.
EnergyID		Belgium, Italy, France, Portugal, Netherlands	Energy monitoring	Helps RECs and individual consumers collect, analyse and compare their energy, water, waste and transport data. Offers integration with a growing number of PV inverters and smart metering systems.

[9] *Digital Tools for Energy Communities – A Short Guide.* Energy Communities Repository. (2023). https://energy-communities-repository.ec.europa.eu/system/files/2023-05/Energy%20Communities%20Repository%20-%20Short%20Guide%20-%20FINAL.pdf

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PowerShaper		United Kingdom	Demand response / flexibility services	Enables users and aggregator to turn appliances on and off remotely. This allows users to benefit from cheaper energy rates, as well as to receive compensation for their flexibility.
MARS		Croatia	Software platform for energy communities	Helps energy communities collect, calculate, and analyse data on energy production and consumption, both at household and at community level, enabling informed decisions.
	GAIA	Italy, Greece, Sweden	Real-time consumption data analytics	Provides consumption data analytics for schools to help educate students through gamification.
WiseCOOP	WiseGRID		Aggregation management	App to aid aggregators of consumers and prosumers in operating small generators aggregated as a VPP. Includes net metering, demand forecasting and tariff comparison services.
	MERLON	Austria, Spain	Optimisation of local energy systems	Optimisation of local generation and flexibility to avoid curtailment and provide ancillary services.
eco-bot		Italy, United Kingdom, Spain, Germany	Energy efficiency advice	Chatbot providing customers energy efficiency advice based on appliance-level consumption data.
PEAKapp	PEAKapp		Behavioural change for energy efficiency	Mobile app which uses different incentives towards encouraging users to take more energy-efficient behaviours, through dynamic pricing, social comparison and gamification.

This collection is by no means extensive, yet some trends are visible. The most common feature seems to be energy monitoring and analytics, which is possibly due to its relative ease of implementation when compared with others. Some features which begin to appear and may become more covered in the future include forecast & optimisation tools, as well as P2P trading. The latter naturally requires a greater degree of user interactivity, so it is a perfect candidate for app integration. Platforms for

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managing energy communities may also become more widespread, and different communities may prefer apps with different priorities, styles and features, so variety will be welcome.

5.2. COMMUNITAS innovative solutions

The COMMUNITAS innovative solutions (ISs) aim to deliver the objectives set out in the description of action of the project. Initially, there were 12 ISs identified, each relating to the solutions that will be considered for further development during the project in order to increase its TRL. Another solution has been added to the list, the non-energy services. While this solution was not originally proposed as one of the ISs, it reflects the work that will be carried out in the scope of Task 3.4 and its output.

5.2.1. COMMUNITAS Core Platform

The COMMUNITAS Core Platform aims to provide a common framework and dashboard to the COMMUNITAS ISs, with the goal of facilitating the user experience and supporting the deployment of the other ISs. The CCP concept is to function as a modular “one-stop-shop”, where users can access different COMMUNITAS ISs in a seamless experience, bringing more value by combining multiple features without the need to change platforms. To achieve this, the CCP will provide an integrated cloud back-end system for data management and a custom graphical user interface.

To further specify what component the CCP will integrate, work was carried out to define scenarios in which several components are combined to achieve the “one-stop-shop” model. The six scenarios defined are:

- Scenario 1: Renewable Energy Planning Suite for Energy Communities

This scenario combines the planning and investment advisor tool so that EC member can plan their infrastructure and get access to detailed investment and deployment plans. Additionally, the management functionalities will also be added so that the user can begin and continue the process within the same platform. Some of the non-energy services may also be considered for integration, considering the continuous operation of the community. The VERIFY tool should also be incorporated to provide the Life Cycle Analysis and Life Cycle Cost of all the assets planned for the community.

- Scenario 2: Verified energy exchange and supply management

The second scenario combines the technologies that will use blockchain technology into a single framework, allowing users to handle P2P energy trading or sales of Guarantees of Origin. A token marketplace will be put in place to ensure that all users can benefit from the P2P or GoO trading.

- Scenario 3: Load monitoring and forecast and opt of the entire EC at every scale

The third scenario uses a part of the management platform to provide visualization of data and benchmarking capabilities, combining it with the investment advisor to access future opportunities for investment. The optimization of the distributed energy resources component would also be included to enable users to not only see the consumption but actually to optimize it according to the production. The USE tool would provide a definition of indicators that could be used by the investment advisor for the proposal of new assets, and the VERIFY tool would perform the LCA and LCC for the different investments identified.

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- Scenario 4: Decision support for the energy community

Scenario 4 is very similar to scenario 3, except the full capabilities of the management platform are explored in the CCP and the VERIFY tool is replaced with the non-energy services.

- Scenario 5: Inter-EC trading for energy surplus management

In scenario 5, the results of the implementation MultiFase tool are integrated to determine the surplus, which is then used to determine the P2P energy trading and respective tokens to be allocated to each EC member. The VERIFY tool is also integrated.

- Scenario 6: Execution of investment plan by EC manager for renewables

Scenario 6 combines the Management platform with the planning of assets and investment advisor, similarly to scenario 1, however in scenario 6 only the non-energy services are integrated.

More information on the scenarios established for the CCP will be detailed in D2.1 – COMMUNITAS Core Platform architecture and specifications. The CCP will select the scenario that is considered the most appropriate by the consortium and implement it as the core tool of COMMUNITAS.

5.2.2. Energy Community Planning tool

The Energy Community Planning Tool (ECPT) is a software intended for the optimal design of an Energy Community. Thanks to it, users can find the best configuration of the plants (RES and fossil based) to be installed in the EC in terms of size (in kW). The tool also gives as an output the annual costs related to energy and the annual CO2 emissions.

The tool mainly aims to serve the Energy Community Manager in the design/configuration of the assets. Its objectives are:

1. Find the optimal sizes of the RES plants, heating and cooling units and e-mobility charging stations to be installed.

2. Provide aggregated information about yearly CO_2 emissions, production and consumption of energy integrating E-mobility data etc. The tool defines the optimal technology combination, depending on the chosen desired goal (CO_2 reduction, lower overall annual system expenses or decreased dependency on energy imports).

The ECPT models the Energy Community energy exchanges in terms of electricity, heating, cooling and electric mobility and simulates the EC behaviour according to the provided inputs (energy demands, technologies already installed etc.) The solution found by the ECPT depends on the objective set by the user, which could be for instance the minimization of annual costs, or the carbon emission generated by the EC.

Different scenarios can be simulated in the tool and compared to a reference one to have a complete overview and choose the best technology combination for the EC. The user inserts all the inputs needed (e.g., electricity, heating, cooling, and mobility demands, costs, plant sizes etc.) runs the simulation and finally receives as output the optimal sizes of the equipment to be installed, yearly energy balances, and CO_2 emissions. The user can also choose to model the EC only from the electricity point-of-view or use it to compare the results with the sizes of the plants already installed.

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The Energy Community Manager is assumed to be the user of the tool, providing the inputs needed to launch the simulation. The EC Manager would presumably use the tool for both of the two functionalities that the tool is capable of satisfying.

The inputs needed in order to use the tools can be divided into different categories:

- Electricity demand
- Individual heating demand
- District heating demand
- Cooling demand
- Transport demand
- Heat generation
- Power generation supply (from power plants)
- Renewable energy supply
- Cooling supply
- Storages
- Costs

The tool is equipped with three modules, which can help the user retrieve some of the necessary input data if not already at disposal:

- Mapping tool, which can be used for the mapping of demand supply and RES production.
- Assessment tool for identifying heating and cooling distributions, which outputs the hourly distribution of the heating and cooling end-user demand.
- Assessment tool for expansion of district heating, which can calculate district heating costs associated with the grid's expansion.

5.2.3. Energy Community Management Platform

The Energy Community Management Tool aims to simplify energy community management by providing data and defining the energy allocated to each community member. This ensures clarity and objectivity in energy allocation, promoting efficient energy use within the community. The tool follows a structured system with specific terms, ensuring consistency in language use. Additionally, precise word choices and exact metrics and units are employed to eliminate ambiguity and confusion. The document is concise, logical and follows a clear, sequential order while maintaining a formal tone, free from colloquialism or slang. The tool will track the energy production and consumption of each community member and display that information on a dashboard. It will also allow for the definition of an energy sharing coefficient for each member, which will aid in the billing process within the energy community.

The tool enables self-consumption optimization within an energy community through dynamic sharing coefficient allocation among members. This results in certain members benefiting from surplus energy when other members are consuming less than anticipated.

The tool is accessible by two users: community members and community managers, each with their respective levels of access. The tool primarily targets community managers, who can access the individual production and consumption units' data. This information allows them to devise optimal

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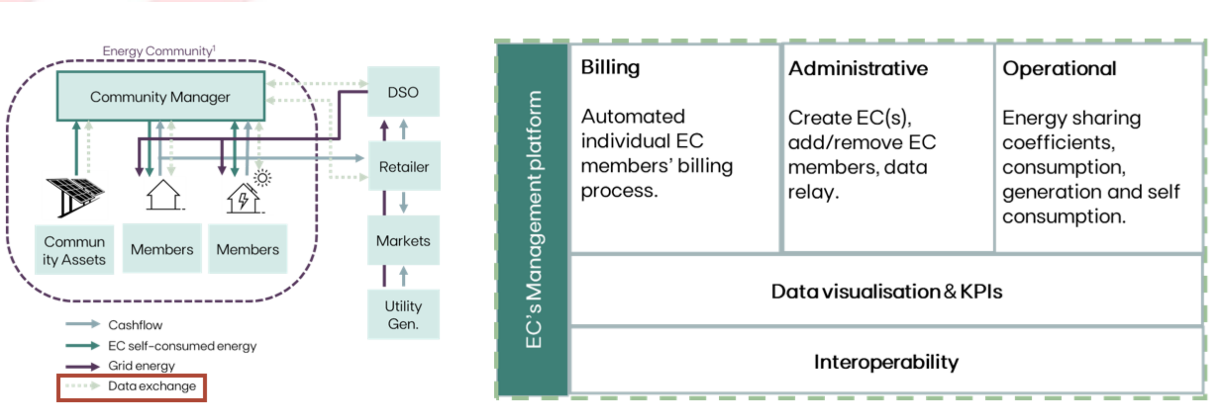
strategies for self-consumption and energy efficiency, like shifting the demand to off-peak hours. The data can indicate system status, generate insights and support decision-making by detecting deviations from expected production or consumption. For members of the energy community, the tool offers a method of visualizing data to raise awareness of energy consumption and provide tips and best practices for increasing household energy efficiency.

Lastly, a feature will provide community engagement via a reward mechanism that compares energy consumption with similar conditions' benchmarks. This shows whether energy use is above or below average and encourages the implementation of energy efficiency measures. To promote greater interaction among community members and with the community manager, this space provides a means to report any detected issues through direct communication with the manager.



5.2.4. Investment Advisor for household- and community-level sustainable investments

This tool gathers real-time and static information concerning energy usage and production, infrastructure, flexibility, user comfort preferences, and energy efficiency goals. The data can be acquired from multiple sources including smart meters, energy audits, user surveys, and community input.

Analysing the gathered data enables the derivation of insights and the generation of sustainable action plans. The analysis may entail recognising chances for energy efficiency, modifying behaviour, and initiating community-level projects for enhancing sustainability and diminishing environmental effects. The tool's generated action plans comprise energy-efficient appliance upgrades, insulation enhancements, utilisation of renewable energy, and community-based schemes for resource conservation or waste reduction, in addition to non-energy actions.

The created action plans are for use by established energy communities or citizen groups who are planning their energy communities and want to investigate additional investments beyond renewable energy sources. The tool advises on investment strategies and objectives that correspond with the requirements, preferences, and aspirations of these communities or citizens towards energy efficiency and sustainability. The tool may also be used by the Energy Community Manager to plan investments at a community scale.

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The IAT promotes sustainability by offering suggestions for taking actions that can diminish greenhouse gas emissions and endorse resource efficiency and sustainable practices within households and communities. It also advocates for data-driven decision-making by using both dynamic and static data to extract insights and develop action plans, ultimately empowering informed investment decisions. The software is designed to adapt to evolving requirements, including regulatory updates, technological advancements, and user needs, to maintain its efficacy in facilitating sustainable investments.

5.2.5. Demand Response and optimal market position

The Demand Response and Optimal Market Position tool, based on the assessment of energy flexibility, aims to implement Demand Response (DR) measures without impacting consumers' comfort levels and quality of service.

Throughout the analysis of consumption patterns per device and the most likely usage periods, a forecast of the energy flexibility available for day-ahead and intraday application will be achieved. These consumption patterns and the consumers' preferences will be acquired through real-time energy consumption data. Despite being a well-known model of monitoring and used in almost every research project and real-life installations, it can be a nuisance to the user, because the installation of one or several devices or sensors in their dwellings and workspaces is required.

By considering the Non-intrusive Load Monitoring (NILM) process, most of these inconveniences about monitoring are solved. This type of monitoring records the changes in voltage and current directly from the household or office's power supply point, deducing the appliances in operation. As such, there's no requirement for the installation of any dedicated monitoring device. Additionally, the outputs from the NILM process are utilized in the Demand Response (DR) process, without consideration of the information source.

Given the characterized energy flexibility, both consumers and the EC manager will receive the optimal market position concerning flexibility utilization and DER dispatch taking into account individual goals and community aspirations. Both stakeholders can benefit from the tool depending on the existing flexibility markets or time-of-use tariffs.

5.2.6. MultiFase – near real-time optimisation of Distributed Energy Resources (DERs)

Two different tools (OptiMEMS and MultiFASE) are developed here and then integrated all in one. On the one hand, OptiMEMS presents an optimal scheduling framework for microgrids on both day-ahead and short-term horizons. The primary inputs, consisting of RES generation forecasts, load consumption, and electricity pricing, are utilized by OptiMEMS. Dynamic optimization is enabled when large deviations occur between the actual values and the forecasts due to the stochastic nature of the forecasts. Real-time adaptations are utilized to maximize the EMS potential while considering grid constraints during the optimization process. OptiMEMS is flexible in terms of the optimization process objective. The user can select between cost minimization, RES integration maximization, self-dependency maximization and more. Finally, the tool's outputs will become the setpoints used as control signals for all controllable assets.

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On the other hand, MultiFASE provides a strong approach for various network categories such as power, gas, or heat, which encourages the collaboration of multiple networks to enhance the efficiency of Power-to-X concepts. The tool's inputs consist of power, gas, and heat network topologies represented in a graph-like structure. This includes parameters like power impedances, gas pipeline constants, and heat pipe resistance coefficients. The tool takes measurements from metering devices like voltage, power flow, and power injection for power networks; flow rate and node pressure for gas networks; and mass flow rate, water density, and temperature for heat networks. MultiFASE considers the technical constraints present in hybrid networks. To minimise a cost function for multiple networks, constructed using equations from various measurements and pseudo-measurements, the weighted least squares method is applied. The tool's outputs will be state vectors for the networks, including power voltage magnitudes and angles, gas node pressures and water density, as well as heat supply and return temperatures.

The integration of both tools will be restricted to only the electrical domain. The following assumptions will be considered: hourly dispatch, calculation once per day (e.g. midnight), and can be seen in Figure 1

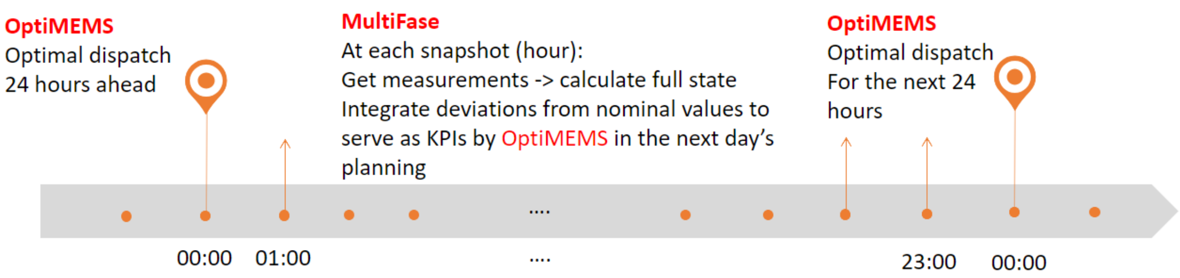

Figure 1 - Assumption of the MultiFase tool

The Demand Response (DR) and Optimal Market Position Tool is designed mainly as a decision support tool, that will implement DR measures without affecting consumers' comfort levels and quality of service.

Real-time energy consumption data from consumers will be analysed per device and the most probable usage periods to achieve a forecast for flexibility available for day-ahead and intraday applications. This monitoring will be done by incorporating the Non-intrusive Load Monitoring (NILM) process. This type of monitoring detects voltage and current fluctuations at the building's power source, allowing deduction of which appliances are in use. As a result, there is no need for any dedicated monitoring device. Additionally, the outputs from the NILM process are utilized in the DR process without considering the information source.

Given the characterised energy flexibility, consumers and the EC manager shall obtain the best market position in flexibility use and distributed energy resources dispatch, considering individual objectives and community ambitions. The main users of the tool will be a potential aggregator that benefits from the day ahead planning to optimize its participation in different energy markets.

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5.2.7. Non-energy services: Health & Wellbeing and Sustainable Finance. A Sustainable Practice Hub

In this case, a plan to enhance health and wellbeing within the European Commission with a focus on improving indoor environment quality (IEQ) and providing access to community-based activities that encourage social connectedness and emotional wellbeing will be developed. These measures aim to address issues faced by various citizen groups and communities throughout Europe.

The collected energy and environmental data will serve as a basis for preventing health risks and assessing and enhancing the well-being of various target communities. These include different building typologies such as households, schools, and offices. Assessing comfort levels and IEQs enables the evaluation of ventilation, indoor pollutants, and thermal comfort. This ensures the well-being of residents and the sustainability of the building without compromising energy performance. In fact, it promotes energy and bill-saving measures.

Establishing a directory of businesses, shops, and organisations dedicated to sustainable practices in their operations aims to bolster local enterprises and educate communities on sustainable alternatives. The promotion of local sustainable businesses will inspire wider uptake of environmentally responsible practices and reinforce the dedication of local businesses to sustainability. Businesses will undergo evaluation based on sustainability criteria which include action plans for reducing carbon emissions, utilization of renewable energies, and promotion of local and organic products. These assessments will determine if they are eligible to be listed in the repository. Listings in the database will be updated regularly to include new businesses that meet the criteria and remove those no longer meeting the requirements.

The non-energy services offer resources for ECs to enhance the quality of life of their members, encourage sustainable practices, and contribute to a sustainable future.

5.2.8. P2P and local energy markets

A peer-to-peer (P2P) energy trading system based on blockchain technology provides a secure and transparent marketplace for community members to exchange and share energy with one another in a decentralised manner. This would provide direct access from citizens to a novel energy market without the need for third-parties, including the community manager.

This P2P platform uses a decentralized system, enabling direct interaction between users without any involvement from a central entity to facilitate their activities or manage their data. Every member of the community can serve as a producer and consumer of energy, resulting in the emergence of "prosumers" who both generate and use energy. Users can produce energy via renewable sources, such as solar panels, store it in batteries and sell any surplus back to the grid or other community members. This allows neighbours to benefit from buying energy from their local area at a reduced cost, guaranteeing that local production is sustained. By establishing a platform for energy exchange, users are provided with the ability to manage their energy production and consumption, while also encouraging the adoption of sustainable energy sources. P2P energy trading has the potential to lower energy costs, promote the adoption of sustainable energy sources, and enhance local energy independence. By enabling individuals and small businesses to trade excess energy directly with each other, the practice fosters a more efficient and decentralised energy market. Furthermore, this

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approach aligns with the low-carbon transition imperative, maximising the use of renewable energy and reducing greenhouse gas emissions.

Furthermore, the system enhances P2P energy transactions maximizing financial benefits for prosumers within an energy community by reducing their electricity bills. The system is based on auctions and bids that take place in an energy market, with payments being settled using smart contracts. More specifically, OpenADR2.0-based smart contract agreement framework for DR energy exchanges will be implemented. Smart contracts and blockchain technology enable secure and transparent transactions, enabling buyers and sellers to independently negotiate prices and quantities. The Market Supervisor oversees the tokens-based marketplace and sets the price boundaries for each auction. Producers initiate sell energy auctions on a smart contract, providing details regarding PV capacity, starting and closing prices, as well as timestamps for bidding and contract phases. Members of the local Energy Community can participate by submitting bids that specify how much they are willing to pay per kWh for excess energy. The starting and closing prices of the auction determine the acceptable bidding range. If a bid equals or surpasses the closing price, the bidder wins. Bidders have the option to revise their prior bids with a higher price.

5.2.9. Fungible & Non-Fungible Tokens solution for P2P energy market trading

The token solution for P2P energy trading intends to solve a common issue of financial settlement associated with P2P. The tokens work as a means remuneration for the users of the P2P energy trading functionality, that cannot be remunerated by other means due to the regulation that does not enable small producers to sell energy, or that requires sellers to constitute legal companies to create receipts, even if the volume of transactions is likely extremely small. These issues have been one of the main barriers to the establishment of P2P energy transactions. The solution will include a relevant smart contract framework for modelling NFTs, which will stir non-monetary incentive mechanisms within P2P energy trading on the EC.

5.2.10. Guaranties of Origin marketplace

This tool is a local market based on blockchain technology that certifies the generation of energy from renewable sources in the local community. It also tracks the energy production process until the expiration date of the certificate. The tool obtains data on energy produced by renewable units within the energy community. It then issues green certificates, known as Guarantees of Origin or GoOs, based on this production.

Each GoO is managed via a distributed database, which in this case is a blockchain network. This network serves as the local Issuing Body, overseeing the lifecycle of each GoO including transfer, cancellation and expiration. As an additional functionality, the tool incentivises EC members to use certified energy instead of energy sourced from the distribution grid. Although the tool serves the community members interests directly, the issuing body is fundamental to oversee the process.

The tool fully complies with national legislation, ensuring that the GoO life cycle aligns with current laws in European countries. The following Figure 2 depicts this life cycle.

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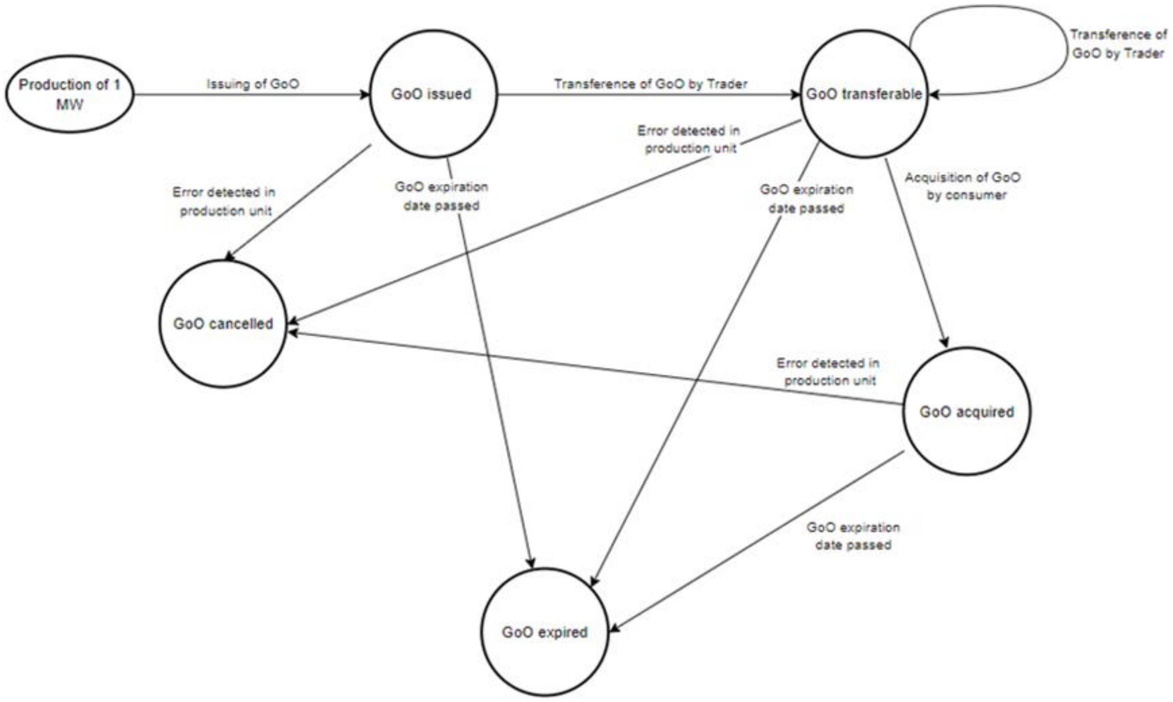

Figure 2 - Guarantee of Origins' marketplace life cycle

Some improvements are aimed to be incorporated in the tool, in accordance with Section 5.2.1. Granular Guarantees of Origin:

- Since the project does not deal with big production systems, but energy communities, lower granularity it is pretended to be included for issuing to that one in the picture, being this multiple of 1Wh.
- The issuance will not align with an entire year's production, but with smaller production periods. This will enable users to access real-time information about the origin of their energy consumption and choose to consume energy that is self-generated or generated by the community, rather than from the external grid.

The blockchain network serves a dual purpose: firstly, it secures certifications by ensuring that shared information, mainly GoOs, cannot be hacked to benefit any participant. Secondly, providing transparency for all stakeholders in the local market by making all operations publicly accessible offers additional benefits. Each participant can plan their future actions accordingly. For example, the EC manager can track production and surplus, and plan for more efficient management of the community. Furthermore, the fast transaction speed enables nearly real-time solutions and facilitates automation.

Granular Guarantees of Origin

Guarantees of Origin (GoOs) were first established in EU Directive 2001/77 and are currently defined by Directive 2018/2001. GOs function as a green certificate verifying that one MWh of energy was

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generated from renewable sources. They are emitted upon the energy being generated, and they can be sold to certify that a company's energy supply comes from renewable sources. After they are bought, GoOs are cancelled, in order to avoid double counting. Despite this, GoOs have raised numerous criticisms, including, precisely, double counting[10], the fact that they do not actually seem to encourage the installation of new renewable energy capacity[11], and the fact that the time energy is generated more often than not does not match the time of consumption, i.e., GoOs fail to reflect the variability of renewable generation – GoOs are valid for one year after issuing and can be claimed at any time during that period.

Granular Guarantees of Origin (GGOs) aim to address the latter, as well as welcome smaller generators to the GoO market. GGOs are special Guarantees of Origin which can certify smaller amounts of energy than traditional GoOs and provide time-based verification (hourly or quarter-hourly) which aims to represent the variability of renewable generation more accurately. Two pilot projects have successfully demonstrated this scheme in the Netherlands[12], and there is an ongoing pilot in the United Kingdom[13].

Implementation of GGOs aims to attach value not only to renewable generation but also to the timing of its production, establishing a correlation between energy prices and certificate prices. The goal is to pose as an incentive to grid-balancing measures, leading services such as energy storage and demand response to become relevant in the GoO market. Adding a dimension related to location to GGOs could also help to ensure grid balance on a more local level, encouraging the purchase of locally generated renewable energy.

GGOs are possible under the current provisional deal for RED III[14], which states that GoOs can now be any multiple of 1 Wh where appropriate and *may* now specify the imbalance settlement period in which the energy was produced, with this being optional.

Adding a timestamp to the certificate enables suppliers to use a Guarantee of Origin only when the generation and consumption times match. This ensures transparency, allowing consumers to choose which energy source they want to use, and make indirect investments as a result. Moreover, a GoO

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[10] Böck, H. (2023, May 11). *How Iceland sold the same Green Electricity twice*. Industry Decarbonization Newsletter. https://industrydecarbonization.com/news/how-iceland-sold-the-same-green-electricity-twice.html

[11] Galzi, P.-Y. (2023). Do green electricity consumers contribute to the increase in electricity generation capacity from renewable energy sources? Evidence from France. *Energy Policy*, *179*, 113627. https://doi.org/10.1016/j.enpol.2023.113627

[12] Eneco. (2022, February 24). *Hourly certification of renewable electricity a step closer*. https://news.eneco.com/hourly-certification-of-renewable-electricity-a-step-closer/

[13] *Nord Pool Connection: Tracking Power by the Hour—New System Launched*. Nord Pool. (n.d.). https://www.nordpoolgroup.com/en/message-center-container/newsroom/newsletter/2022/05/nord-pool-connection/

[14] Council and parliament reach provisional deal on renewable energy directive. (n.d.). https://www.consilium.europa.eu/en/press/press-releases/2023/03/30/council-and-parliament-reach-provisional-deal-on-renewable-energy-directive/

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enables tracking the location and age of the installation, guaranteeing not only environmentally friendly energy but also an efficient source of production. ENTSO-E - European Network of Transmission System Operators for Electricity - identifies two critical factors to consider[15]:

- Hourly or quarterly granularity achieves a 44/7 GoO system, reflecting real-time production and consumption values of green energy.
- Granularity can also enable the introduction of energy prices based on the location of the GoO system, providing incentives for developing, producing, and consuming efficient renewable energy sources.

5.2.11. Telemetry data anomaly detection toolkit

In COMMUNITAS, a large amount of data will be collected from the pilot sites in order to, first, develop and validate the solutions, and afterwards, to implement the solutions in real-life conditions. It is normal that these data collection points have faults such as loss of data for short periods of time, or faulty detection from sensors that results in abnormal information. Due to these conditions, it is essential that COMMUNITAS solutions can handle this misinterpretation of real conditions and do not react inappropriately to such events.

One of the solutions being developed in COMMUNITAS is a data analysis functionality that will analyse all telemetry data and use machine learning techniques and a visual interface to detect and show the anomalies in the data that is being collected. This tool mainly serves the community manager as an early-detection system.

5.2.12. VERIFY – A web-based platform enabling LCA/LCC of projects

VERIFY is a tool that will enable communities to easily have access to a life cycle analysis and through which their members will be able to identify environmental gains achieved through the implementation of renewable energy systems or other activities/assets deployed in their energy communities that might have an environmental impact.

The tool will enable community members to evaluate environment related KPIs which may contribute to a process of decision-making. Furthermore, the tool will perform a life-cycle cost calculation that can also provide an idea of financial aspects related, not only to the purchase and installation of assets, but also related to their manufacturing, operation, and disposal at the end of the equipment life. The LCA/LCC assessments may also contribute to steering other COMMUNITAS tools by integrating these aspects, that are often hidden, into their calculation/optimization parameters.

5.2.13. USE – A platform enabling the uniform evaluation of projects

USE is a framework that incorporates different indicators, such as technical, environmental, economic, or social, so that it is possible to have an overview of the impact, performance, and sustainability

[15] https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Publications/Position%20papers%20and%20reports/2022/entso-e_pp_guarantees_of_origin_220715%20for%20publication.pdf

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potential of energy communities. By applying a weight structure to different KPIs according to the objectives of the communities, the tool is able to create a score index for the current or future energy community.

This information is then explained and simplified in a visual interface that provides the user a method of continuously understanding the score of their energy community, assessing how it is progressing and how it can increase the score, leading to the increase in the impact, performance, and sustainability of different energy communities. This could benefit both the community members and the community manager.

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6. Steering recommendations (create, operate, expand ECs, make citizens active participants)

6.1. For regulators/legislators

Regulators and legislators are main stakeholders when it comes to the promotion of energy communities, emergent markets, and citizen participation. To achieve these goals, it is essential that legislation is not a blocker to progress and innovation. Regulators across Europe have been establishing regulatory sandboxes in the energy sector to promote the demonstration of early technologies that are not properly defined in the regulation. Several countries have experience with regulatory sandboxes, although their level of success is difficult to determine[16]. Despite this, regulatory sandboxes have the potential to shape future regulation with actual practical experiments that take into consideration real-life conditions. As such, the first steering recommendation is:

- Establish a framework that allows the set-up of regulatory sandboxes in the energy sector, enabling the demonstration of innovative technologies.

An expert analysis is necessary to implement proper regulatory sandboxes and to ensure that they are not used other than to demonstrate innovative technologies. Due to these challenges, it is important to explore the examples and best practices of implementation from other countries that have successfully implemented these solutions.

As an output of D1.1 – COMMUNITAS Knowledge Base: concept and development roadmap, it was noted that some countries assessed by COMMUNITAS (namely Croatia – where the term "energy communities" exist in the national Law but the following Acts that would actually enable the implementation of energy communities are still missing) still have not transposed the results of the Renewable Energy Directive and as such, officially, energy communities are still not existent in the country. To promote the decentralization of the power systems and citizen participation it is fundamental that all countries that have not done so, transpose the Renewable Energy Directive into national regulation.

- Transpose the Renewable Energy Directive into national regulation and take into consideration the examples of transposition from countries such as France, Belgium, Germany, or Italy, which are considered by RESCOOP[17] as examples of correct transposition of the directive.

However, the practical implementation of the energy communities has revealed itself to be more complex than just following the Renewable Energy Directive. Another steering recommendation would be to create a legal framework with developing a standardized model with the inclusion of the

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[16] European Commission, Directorate-General for Energy, Gorenstein Dedecca, J., Ansarin, M., Afrodit Adsal, K. et al., Regulatory sandboxes in the energy sector – Final report, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2833/848065

[17] According to RESCOOP transposition tracker: https://www.rescoop.eu/transposition-tracker

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EC manager, as the stakeholder that promotes the correct management of communities and the existence and expansion of the energy community.

- Within the regulation on the definition of Energy Communities, the role of the EC manager should be defined and incorporated, in order to ensure effective operation and maintenance of the community assets.

To accelerate the process of setting up energy communities, the regulators/legislators need to define some basic responsibilities for the EC manager, such as managing the sharing of energy between members, the process of adding or removing members from the EC, and being mandatory to establish an internal regulation that defines situations such as meetings, quorum, voting, conflict resolution, and other relevant aspects. It should be stated that there should be a contact point established between the local DSO and the EC managers, stating rules as well on the maximum response times between the two parties. If, due to the national legislation, it is important for the EC manager to have contact with other legal authorities, for example, the authority that has the competence to approve the integration of new renewable energy assets, these should also be predicted in the legislation to facilitate contact between the parties involved. Furthermore, the legislators should take into consideration providing recommendations on additional roles for the EC manager, that can then be implemented through the internal regulation. These suggestions include the knowledge sharing capacity of the EC manager on energy efficiency and self-consumption, and that the EC manager should also work on the role of advisor to the community to support its expansion and installation of new assets.

COMMUNITAS has the potential to support this process, through its knowledge base, different information will be shared on rules that need to be considered when defining the internal regulation.

Finally, we bring attention to the emergent local flexibility markets that are already a reality in several European geographies. The EC managers could perform the role of representing an energy community in such markets. In order to have future proof regulation, it should be considered how EC managers can enter and represent energy communities in these emergent markets and promote demand-side management. As a final steering recommendation for regulators/legislators we recommend:

- Create rules on the participation of Energy Communities and Aggregators in local flexibility markets, making future-proof legislation that anticipates the role of such emergent markets in the power systems.

Through the experimentation on Demand Response, COMMUNITAS may also support the definition of these recommendations, based on real-life experiments conducted during the project. These will be mapped in D4.3 – Report on policy and regulatory pilots experimentation.

6.2. For DSO’s and TSO’s

DSOs and TSOs should actively engage citizens in understanding the potential savings associated with joining RECs. This involves not only raising awareness but also pivoting their business models to address consumer preferences. Innovative strategies need to be developed to accommodate the growing interest in ECs, ensuring that the grid infrastructure aligns with the changing desires of consumers seeking more sustainable and cost-effective energy solutions.

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As mainly responsible for low and medium voltage grid assets, DSOs wield considerable influence in shaping the trajectory of local energy markets. It's imperative for them to lead discussions around the creation and sustenance of these markets. By prolonging the life of grid equipment through strategic market formation, premature obsolescence can be avoided, fostering a more sustainable energy infrastructure, also delaying investment on grids' assets (maintenance, replacement etc.)

TSOs and DSOs must take a proactive role in fostering the creation of aggregation entities, especially in the context of Virtual Power Plants (VPPs) and their diverse variations. By ensuring the needs of these entities in terms of grid performance are met, and ideally surpassed, they can bolster grid stability and efficiency. This leadership role involves understanding and accommodating the dynamic requirements of aggregation entities within the larger energy ecosystem.

Encouraging the adoption of demand response programs among consumers is crucial. TSOs and DSOs can play an important role by not only promoting but actively facilitating these programs. By providing ancillary services such as grid stability and blackout risk reduction, they not only enhance grid reliability but also empower consumers to actively participate in shaping a more resilient and responsive energy landscape.

COMMUNITAS may support DSO's and TSO's with the report on policy experimentation, namely capitalizing on the Multifase and OptiMEMS tools for assessment of the distribution grid at local level, but also with the experimentation on Demand Response.

6.3. For cooperatives and citizen initiatives

There is no doubt that cooperative principles are one of the bases for citizen participation, linking social and ethical aspects in the business commitments, respect for the environment and social cohesion in a sustainable environment. Cooperatives have been demonstrating a high degree of effectiveness in their activities as an instrument of the social economy, promoting business grouping for the best provision of services and marketing of products with the greatest possible efficiency.

Managing a cooperative company requires capable and dedicated people, who know how to combine obtaining the maximum possible benefit for their members, with the practice of the principles of the social economy and the provision of fundamental services such as vocational training.

The promotion of energy communities from cooperatives is an opportunity to contribute to the achievement of climate objectives, but also provides local benefits. These democratic governance projects led by cooperatives or non-profit organisations support local politics and their partners by:

- Improving energy efficiency and thus reducing energy poverty.
- Involving citizens by allowing more active participation that will encourage them to collaborate in other activities.
- Promoting local economic development through the circular economy.

Cooperatives can support the promotion of Energy Communities by committing to the modernization and promotion of the entity in terms of innovation. Cooperatives can now take another step in their service vocation by offering a response to the energy needs of their members.

Many COMMUNITAS outcomes are aiming at providing tools for citizens that must enable citizens to take informed decision, even if they are not experts in energy topics. Tools such as the Knowledge

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Base or the Investment Advisor can be powerful allies of citizen-led initiatives, where citizens may at the very least but able to use these tools to fact-check tenders and information provided by third-parties.

Beyond what is indicated, in the development of energy communities, local leadership is essential to have the trust of community members and their involvement in the model. To maximize the impact of energy communities at a local level, it is vitally important that all actors present in the territory participate, in one way or another, including city councils, SMEs, local businesses, associations, organizations and of course citizens.

6.4. For energy service companies

For energy service companies (ESCOs), establishing trust and ensuring transparency in business models is paramount to fostering positive relationships with customers. Additionally, maximizing the impact of energy-saving projects through efficient bundling is crucial. Some key recommendations to address these challenges are:

- Transparency and Trackability: Emphasizing clear communication and the methodologies/ processes involved in Energy Communities projects to clients. Foster trust through communication by regularly updating customers on their energy savings. By implementing robust tracking systems that allow customers to monitor and verify energy savings in real-time, the clients feel more of a sense of involvement and reinsurance of their assets. For instance, using technology and leveraging innovative technologies such as accessible management platforms or blockchain creates an immutable and transparent record of energy savings.
- Collaboration and Aggregation: Develop strategies to bundle individual projects, creating business models that benefit ESCOs and customers. Promoting Energy Communities also involves encouraging collaboration among diverse stakeholders for a more significant impact. It might be worth exploring joint initiatives, for example, collaborating with other ESCOs or relevant organizations to collectively address challenges and capitalize on shared resources.
- Engagement and Education: Educate Stakeholders by conducting awareness campaigns to educate customers and stakeholders about the benefits and intricacies of energy community business models. Highlight the social and environmental impact of projects within the community, fostering a sense of shared achievement and responsibility.
- Leverage Supportive Tools: Integrate tools and technologies into the projects to enhance efficiency and effectiveness. Provide user-friendly platforms and customer support to guide clients in understanding and optimizing their energy consumption.

By prioritizing transparency, embracing the energy community concept, and leveraging supportive tools, ESCOs can not only build trust but also achieve a more significant and lasting impact in the realm of energy efficiency. These recommendations aim to create a foundation for sustainable and collaborative approaches that benefit both ESCOs and their valued clients.

COMMUNITAS may be a very good ally of ESCOs. By using the Energy Management Platform on a daily-basis, Energy Communities will easily be able to track their energy savings and how the energy is being split through the community. Empowering citizens with this information may enable ESCOs to explain their business model more easily and how energy savings are calculated, hence increasing the

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trust of clients, which is a major issue for ESCO business models. Furthermore, the use of the Energy Management Platform will facilitate the application of ESCO business models as ESCOs will have all information needed to assess the performance of the community aggregated in a single location.

6.5. Case studies and best practices in implementation

In Portugal, the energy regulator (ERSE) started in 2021 with a pilot project initiative to test innovative solutions relating to self-consumption and electrical vehicle charging. Until the release of this deliverable, 6 pilot projects have been approved by ERSE to test different solutions.

One such project was submitted by EDP in the scope of H2020 POCITYF project, to test innovative features relating to energy sharing and P2P trading. Although the implementation of such project had to overcome several other difficulties, the pilot project initiative allows EDP to carry out a plan that would be theoretically impossible until there was a change in regulation. In the meanwhile, the regulator has changed the regulation and the scope of the pilot project is now possible with the current regulatory framework, meaning that anyone can implement it without the need to set-up a pilot project. Despite this, the implementation of dynamic energy sharing, and P2P energy trading is a very complex topic that needs to be addressed with several stakeholders. The pilot project allowed to make a bridge with E-REDES (the local DSO) in order to fine tune the methodology for implementing these innovative sharing practices. Although the project is not fully implemented to date, the Portuguese regulator initiative of establishing pilot projects seems to be a success in terms of shaping and improving current regulation to enable more innovative practices.

In Belgium, CLEF[18] (Coopérative Leuzoise pour les Énergies du Futur) was created in 2008, founded by a community of individuals with a vision to infuse communal ownership into a local wind park initiative led by a private developer in Wallonia, Belgium. Starting with an initial set of 60 members who invested in the wind project, CLEF expanded its horizons to explore various renewable energy possibilities such as wind, solar, and hydro in the region. Its core mission is to ensure that renewable energy initiatives directly benefit the local citizens while emphasizing active citizen involvement in the shift towards cleaner energy. CLEF advocates that the production of renewable energy should be a collective endeavour accessible to all.

Currently, CLEF has a diverse array of initiatives spanning wind power, biogas, photovoltaic, hydraulic systems, collective self-consumption, and storage of renewable electricity. Additionally, numerous projects are in the pipeline, with some already operational while others are in development stages. CLEF actively establishes certain projects while also engaging in collaborations that incorporate community investment into external initiatives. Together, the community has achieved a collective energy generation capacity of 14 MW. Furthermore, they anticipate the approval for a park hosting 6 wind turbines, where two will be exclusively owned by citizens, while the remaining four will remain under private ownership.

Among their innovative activities, CLEF is leading a floating solar park endeavour and a project dedicated to investigating hydrogen production and storage. Collaborating with universities in

[18] https://ec-repository.com/repository/community/27758

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Norway, Brussels, and Iceland, they're exploring innovative energy solutions[19]. Moreover, CLEF is presently collaborating with a developer to facilitate community ownership of 30% in a substantial offshore wind farm. Concurrently, they're developing energy-sharing projects tailored for social housing. To visualize CLEF's footprint, refer to the image below detailing the locations of their projects as of 2021.

Over the past 15 years, CLEF has cultivated a diverse project portfolio, amassing a working capital exceeding 5 M€. Leveraging fruitful collaborations with local municipalities and developers has been instrumental in uncovering new prospects and initiating fresh ventures. Members engage in these projects by purchasing shares, with a minimum investment threshold set at 250 € and a maximum capped at 10,000 €, ensuring a diverse membership base. Typically, members receive dividends ranging between 2 and 4 percent annually on their investments, with a maximum ceiling of 6 percent due to the "cooperative agreement" regulations.

In Greece, during the COVID-19 pandemic, Apostolina Tsaltampasi, President of the Greek Association of Women Entrepreneurs, discovered alarming statistics from Greenpeace revealing that only 2% of the workforce in the Global Energy Field comprises women. Recognizing the lack of training in energy democracy for women, Apostolina initiated a project aimed at educating and involving women in energy-related matters. This project intended to provide financial incentives to businesses led by women, educate them on Green Consumption, and foster inclusion and social cooperation. Identifying the underrepresentation of women not only in energy communities but also in the Greek energy industry, Apostolina launched WEnCoop[20], a concept aimed at empowering women to participate actively in the energy transition. The organization focused on two main areas: supporting female entrepreneurs in economic engagement and fostering community energy activities.

WEnCoop experimented with various energy community models, eventually opting for simple photovoltaic projects on purchased land to yield tangible results quickly, fostering trust among members and the broader society. The organization educated over 500 women on energy efficiency and collaborated with the Greek Energy Institute despite initial resistance, further solidifying their determination to make an impact. WEnCoop successfully raised 500,000 € through community investment, acquiring land in Greece's Khalkidhiki area and strategically positioning itself near upcoming electricity grid developments. The investment opportunity began at 500 €, allowing higher-income women to support low-income women's share purchases. Beneficiaries anticipate returns on their investments over a 7-year period, while committing to ongoing education and mutual support, fostering a community-driven social innovation built on trust.

At a larger scale, WEnCoop is developing an extensive Community Support model set for launch in 2023. Initially starting with 60 female members, the organization secured its statute in July 2021 and secured the first permit for a 1 MW solar park on their land by September 2021. Facing scepticism from installers, contractors, and banks due to its women-led nature, WEnCoop navigated challenges, securing a 2.8 M€ loan through negotiations and personal guarantees from select members. Their first 1 MW solar project is operational, with two more licensed for construction and a fourth in the licensing

[19] www.h2coopstorage.eu

[20] https://ec-repository.com/repository/community/26498

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process. Concurrently, WEnCoop is pioneering Greece's inaugural net-billing project for their fifth endeavour, marking a significant milestone in the country's energy landscape.

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