APRIL
2025

Advancing Energy Communities in Bulgaria

REGULATORY FRAMEWORK, VIRTUAL NET METERING, AND CAPACITY BUILDING FOR A SUSTAINABLE FUTURE

Supported by the Norway Grants 2014-2021, in the frame of the Business Development, Innovation and SMEs Programme in Bulgaria

Iceland Liechtenstein Norway grants

CHAMBER OF THE ENERGY COMMUNITIES IN BULGARIA

CSD

REPUBLIC OF BULGARIA
Ministry of Energy

Innovation Norway

SMART INNOVATION NORWAY

Main Authors:

- Thomas Mikkelsen, Smart Innovation Norway
- Manuela Freté, Smart Innovation Norway
- Iliana Ilieva, Institute for Energy Technology
- Heidi Nygård, Norwegian University of Life Sciences
- Genady Kondarev, Center for the Study of Democracy
- Nadejda Gantcheva, Center for the Study of Democracy
- Pavlin Stoyanoff, Center for the Study of Democracy
- Elenko Bojkov, Chamber of the Energy Communities Bulgaria
- Kristina Tabakova, Chamber of the Energy Communities Bulgaria
- Anton Ivanov, Chamber of the Energy Communities Bulgaria

Summary

This report aims to promote the development of energy communities in Bulgaria by outlining strategies, benefits, and frameworks to support their establishment and growth. It targets regulatory authorities, energy sector stakeholders, local communities, investors, and environmental organizations.

The concept of energy communities is emerging, with initial examples in industrial clusters, agricultural cooperatives, and municipal-led initiatives. However, regulatory gaps and market conditions limit the growth of these communities. The analysis of the regulatory framework and policy gaps in Bulgaria reveals that while the Energy Act and Renewable Energy Sources Act recognize energy communities, they lack detailed operational procedures. Key gaps include the absence of a dedicated registration process, unclear grid access and metering rules, and no established protocols for data exchange. Several institutions play critical roles in shaping the regulatory environment for energy communities in Bulgaria, including the National Assembly, Ministry of Energy, Energy and Water Regulatory Commission (EWRC), Sustainable Energy Development Agency (SEDA), Electricity System Operator (ESO), and Distribution System Operators (DSOs). Energy traders and aggregators also help prosumers and community groups navigate market participation, balancing services, and administrative processes.

Under Bulgarian law, renewable energy communities (RECs) are regulated by the Renewable Energy Sources Act and are limited to renewable energy sources with geographic restrictions. Citizen Energy Communities (CECs), regulated by the Energy Act, can operate across the country, engage in various energy-related activities, and have broader membership eligibility. Energy communities must register under existing corporate or non-profit structures, facing challenges such as strict requirements for condominium associations and lack of specific governance rules. They can produce, consume, store, and sell energy but face regulatory gaps in energy sharing, lack of virtual net metering (VNM), and high grid fees. The establishment of one-stop-shop administrative services and a central registry for energy communities is critical, and SEDA could play a future role in registering and providing support to energy communities.

Within the report specificities of the Norwegian energy systems and the country's regulations in relation to energy communities have been mapped for the purposes of benchmarking and reference to best practices. Norway offers financial support for residential solar installations and exempts prosumers from certain grid fees and taxes. The plus-customer scheme allows sharing of surplus production within properties. DSOs in Norway ensure reliable power supply, integrate renewable energy sources, and manage customer data. The regulatory framework includes economic regulation, quality of supply standards, grid connection codes, and system responsibility regulations. Local flexibility markets enable DSOs to procure flexibility services to manage grid constraints and congestion. Through the NODES market platform flexibility trading is facilitated.

In addition, the report provides examples from a number of EU member states, highlighting different approaches to energy community registration and governance. A roadmap for creating an energy community register in Bulgaria includes legislative steps, administrative preparation, development, and implementation. The register is recommended administered by SEDA and should include information on RECs and CECs.

Within the report, a pilot project being initiated in Vitosha Municipality is described. The establishment of an energy community between buildings with different operating modes by installing a photovoltaic system on the roofs of school buildings is analysed for the purpose. The pilot project refers to energy efficiency audits, preliminary design, simulation models, and assessment of renewable energy opportunities.

When it comes to business models related to energy community establishment, the report focuses on Power Purchase Agreements (PPA), cooperative models, and public-private partnerships. The financial model, on the other hand, considers operational expenses, investment returns, and electricity pricing.

Capacity building and stakeholder engagement has involved the participation and feedback of relevant stakeholders. The accumulation of invaluable input from the wide variety of stakeholder groups – distribution system operators, transmission system operators, regulatory bodies, existing energy communities, traders, platform providers, regulatory bodies and academia (from both Norway and Bulgaria) has made it possible to produce a set of recommendations for facilitating the process of energy community establishments in Bulgaria, given the country-specific conditions. Specifically, the provided in the report comprehensive overview of the strategies, frameworks, and recommendations for advancing energy communities in Bulgaria, highlights the importance of collaboration among various stakeholders to achieve successful implementation.

Importantly, the report outlines the specifications for a software platform designed to support the establishment and operation of energy communities in Bulgaria. The platform is based on open-source software to ensure transparency, flexibility, and cost-effectiveness. It includes one or more centralized databases to store all collected data, such as meter readings, master data, and transaction records, ensuring consistency and easy access for authorized users. The platform supports real-time and historical data analysis, providing valuable insights into energy consumption patterns. It features advanced security measures, including encryption and authentication, to protect sensitive information. The platform also includes modules for managing energy production, consumption, storage, and sharing, as well as tools for financial management, stakeholder engagement, and compliance monitoring. Additionally, it offers user-friendly interfaces for both administrators and end-users, facilitating efficient data management and decision-making processes.

The report provides a thorough and comprehensive analysis of the regulatory framework, technical requirements, roles and responsibilities, and business models necessary for establishing energy communities in Bulgaria as well as valuable recommendations. In this way it is supportive to the process for sustainable and efficient energy transition in Bulgaria.

Contents

Definitions

AMS	Advanced Metering System
BRP	Balancing Responsible Parties
CEC	Citizen Energy Community
CECB	Chamber of the Energy Communities in Bulgaria
CENS	Cost of Energy Not Supplied
CMS	Content Management System
CO	Certificate of Origin
CSC	Collective Self-Consumption
CSD	Centre for the Study of Democracy
DB	Database
DSO	Distribution System Operator
EEA	European Economic Area
EMIF	Elhub Messaging Interface
EMS	Energy Management System
ESM	Energy Saving Measures
ESO	Electricity System Operator
EU	European Union
EV	Electric Vehicle
EWRC	Energy and Water Regulatory Commission (Bulgarian: Комисия за енергийно и водно регулиране (КЕВР))
FSP	Flexibility Service Provider
GHG	Greenhouse gas
GO	Guarantees of Origin
IMED	Internal Market for Electricity Directive
LEC	Local Energy Community
NECP	National Energy and Climate Plan

NEM	The Grid and Energy Market Regulation (Norwegian: Forskrift om nettregulering og energimarkedet)
NPO	Non-profit organisations
NVE	Norwegian Water Resource and Energy Directorate
OS	Operating System
PED	Positive Energy District
PPA	Power Purchase Agreement
PPA	Power Purchase Agreement
PV	Photovoltaic
R&D	Research and Development
REC	Renewable Energy Community
RED	Renewable Energy Directive
RES	Renewable Energy Sources
RME	Regulator for Energy
SEDA	Sustainable Energy Development Agency
SME	Small and medium enterprise
TSO	Transmission System Operator
VNM	Virtual Net Metering
VPS	Virtual Private Server
ЗЕВИ	Закон за енергията от възобновяеми източници (Renewable Energy Sources Act or RES Act)
ЗЕ	Закон за енергетиката (Energy Act)
ЗЮЛНЦ	Закон за юридическите лица с нестопанска цел
ПИКЕЕ	Правила за измерване на количеството електрическа енергия (Rules for Measuring Electricity)
ПТЕЕ	Правила за търговия с електрическа енергия (Electricity Market Rules)

1 General

1.1 Purpose of this document

The document aims to promote the development of energy communities by outlining strategies, benefits, and frameworks to support their establishment and growth. It provides comprehensive recommendations for regulatory changes needed to facilitate the development of energy communities, mapping existing Bulgarian regulations, identifying gaps, and benchmarking against best practices from other countries. Additionally, the document seeks to educate stakeholders about the potential economic, environmental, and social benefits of energy communities, including detailed sections on technical specifications, pilot project designs, and capacity-building initiatives. By fostering collaboration among various stakeholders, including government bodies, private sector entities, and local communities, the document aims to achieve the common goal of sustainable energy development, proposing suitable business models and hands-on training workshops.

1.2 Audience

The primary audience of the document includes regulatory authorities responsible for energy regulation and policymaking in Bulgaria, such as the Ministry of Energy, the Energy and Water Regulatory Commission (EWRC), and the Sustainable Energy Development Agency (SEDA). It also targets energy sector stakeholders involved in the production, distribution, and management of energy, including Distribution System Operators (DSOs), energy traders, and aggregators. Local communities, residents, and organizations interested in participating in or benefiting from energy communities, such as municipalities, cooperatives, and non-profit organizations, are also key audiences. Additionally, the document is intended to inform investors and financial institutions interested in funding or investing in energy community projects, including banks, investment funds, and other financial entities. Environmental organizations focused on promoting sustainable and environmentally friendly energy solutions, such as NGOs, advocacy groups, and research institutions, are also part of the intended audience. The document is designed to be presented to regulatory authorities in Bulgaria to support the development of energy communities and enhance collaboration among related stakeholders.

"The development of energy communities in Bulgaria requires maximum flexibility to enable their emergence in the country's specific context.

2 Introduction

2.1 Background

The partially liberalized market, combined with the absence of clear legal provisions for energy communities and virtual net metering (VNM), creates a hostile environment for the development of energy communities in Bulgaria. Current policy and market conditions favour large industrial self-consumers and utility-scale renewables, while collective citizen-led energy projects struggle to emerge.

The concept of energy communities in Bulgaria is still emerging, with initial examples mainly seen in industrial clusters, agricultural cooperatives, and some municipal-led initiatives. These early projects rely heavily on energy traders and aggregators to handle their market participation, balancing, and administrative processes, as there is no clear regulatory framework tailored to energy communities[1].

Bulgaria's partially liberalized electricity market creates significant challenges for prosumers and energy communities. While industrial consumers must purchase electricity at market prices, households still benefit from regulated tariffs, reducing the financial incentive for self-generation and energy sharing. This distorted price signal, combined with regulatory gaps for VNM and collective self-consumption, limits the growth of energy communities.

The delayed full market liberalization is driven by political concerns over energy poverty, the protection of coal-fired power generation, and institutional resistance to change. As a result, energy communities and prosumers face uncertain revenues, limited access to the market, and high administrative burdens, forcing them to depend on intermediaries like traders and aggregators instead of acting as independent market participants.

The development of energy communities in Bulgaria requires maximum flexibility to enable their emergence in the country's specific context — a sparsely populated country with low entrepreneurial activity, low financial literacy and limited investment culture among the population, scattered enthusiasts, broken traditions of cooperation, and a general lack of familiarity with collective energy initiatives. For energy communities to succeed, simple, user-friendly mechanisms must be introduced, allowing citizens, small businesses, and municipalities to easily form and register communities, share energy across multiple sites, and decouple the physical location of production from the points of consumption. Given the fragmented and informal nature of the current interest in community energy, it is critical to offer streamlined administrative procedures, clear legal recognition, and accessible tools that allow enthusiastic but inexperienced groups to quickly establish and operate energy communities without complex regulatory or financial hurdles.

[1] Center for the Study of Democracy (CSD). (2023). ВЕИ на бързи обороти: Анализ на предизвикателствата и възможностите за ускорено навлизане на възобновяеми енергийни източници в България / Fast Tracking RES: Removing Barriers to Decentralization and Democratization of the Energy Transition in Bulgaria, https://csd.eu/events/event/fast-tracking-res-removing-barriers-to-decentralization-and-democratization-of-the-energy-transitio/

2.2 Definitions of energy communities in the European Union

The term Local Energy Community (LEC) is described in the roadmap from Energy Communities Repository[2] as an innovative legal entity that typically operates at a local level, focusing on the production, consumption, storage, and sharing of renewable energy. It is characterized by open and voluntary participation and is effectively controlled by shareholders or members, which can include individuals, small enterprises, or local authorities such as municipalities. The European Union (EU) has been a strong proponent of LECs, defining two key community types in its directives:

- **Renewable Energy Community (REC)**: As outlined in the recast of the Renewable Energy Directive (REDII, 2018/2001)[3], RECs are primarily concerned with renewable energy production. The shareholders or members of RECs are typically located near the renewable energy projects they own and develop.
- **Citizen Energy Community (CEC)**: According to Article 16 of the Internal Market for Electricity Directive (IMED, 2019/944)[4], CECs have a broader scope than RECs, as they can also engage in aggregation or provide energy services to their members. CECs may facilitate active consumer participation by allowing members to generate, consume, share, or sell energy, offer flexibility services through demand-response and storage, and, if permitted by member states, operate the required electricity grid under the applicable requirements for DSOs. CECs can include different types of energy sources in addition to renewables, such as natural gas installations or even diesel generators, but focus only on electrification.

The term LEC is often used as an umbrella term for REC and CEC. The primary objectives of LECs are to advance the development of distributed energy technologies and to strengthen consumer participation in the energy markets. They aim at prioritizing the local production of electricity from renewable energy sources, emphasizing citizen ownership and participation in the energy system.

Key features that may vary across different LEC models include:

- **Organizational form**: LECs can be organized as associations, cooperatives, partnerships, non-profit organizations, or other legal entities.
- **Technology**: LECs may use various technologies, such as solar panels, wind turbines, biogas plants, and batteries, to generate and store energy.
- **Energy sharing models**: LECs can implement diverse approaches to energy sharing, including direct physical sharing, administrative sharing through the grid, offsetting energy components, and sharing remunerations or tariff adjustments.
- **Activities**: LECs may engage in a range of activities beyond energy generation and consumption, including energy efficiency, supply, aggregation, mobility, and heating and cooling.

[2] A roadmap for a policy and legal framework for energy communities (2024), Directorate-General for Energy, Energy Community Repository.
[3] REDII, Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast)
[4] IMED, Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast)

LECs are gaining traction as a transformative approach to energy production and consumption. They represent a shift towards more decentralized, sustainable, and community-driven energy systems. However, the establishment and operation of LECs are influenced by a range of drivers and barriers that can either facilitate or hinder their development, as identified in recent reports released by Nordic Energy Research[5] and Energy Communities Repository[6].

The drivers include financial incentives, such as the potential for cost savings and stable energy prices, as well as environmental incentives, like the desire to contribute to the energy transition and increase the use of renewable energy. Additionally, the prospect of greater control over energy supply and the ability to reinvest profits into the community are powerful motivators. The democratic nature of LECs, which allows for citizen participation in local energy decisions, also plays a significant role in driving their adoption.

On the other hand, several barriers can impede the advancement of LECs. A lack of public awareness and technical knowledge can make it difficult for communities to initiate projects. Regulatory and legal obstacles, such as unclear legal framework or restrictive regulations, can also pose significant challenges. Financial hurdles, including securing upfront investment and covering infrastructure costs, are common barriers. Additionally, reliance on other actors, like municipalities and grid operators, can lead to authority imbalances and limited support. Technical barriers include difficulties in obtaining grid connections, integrating distributed generation, and navigating in existing grid infrastructure. Limited access to energy markets, challenges in competing with larger actors, and underdeveloped flexibility markets further hinder participation. Lastly, the complexity of setting up and operating LECs, along with scalability issues, can deter communities from pursuing these initiatives.

Understanding these drivers and barriers is crucial for policymakers, community leaders, and stakeholders who are interested in promoting the growth of LECs. By addressing the barriers and leveraging the drivers, it is possible to create an environment that supports the development of sustainable and resilient energy communities.

[5] Energy Communities (2023), Nordic Energy Research

[6] Barriers and action drivers for the development of different activities by renewable and citizen energy communities (2024): Directorate-General for Energy, Energy Community Repository.

3 Analysis of the regulatory framework and policy gaps

3.1 Mapping Bulgarian regulations of relevance for energy communities

Bulgaria's regulatory framework for energy communities has gradually evolved in response to the requirements of the EU Renewable Energy Directive (2018/2001/EC - RED II) and the Internal Electricity Market Directive (2019/944/EC - IMED). These directives establish RECs and CECs as new forms of market participants with rights to generate, store, share, and trade electricity—primarily from renewable sources. Bulgaria has formally transposed these concepts into national legislation, but the practical framework for establishing and operating energy communities remains fragmented and incomplete.

Earlier, the EU has been collecting data from the Member States on their existing policies and regulations for energy communities in the Clean Energy Package context. The information has been published in an openly accessible database called The Energy Communities Repository.[7] Bulgaria had not been providing input to this repository. Below is a mapping of the existing relevant regulations.

3.1.1 Relevant Bulgarian legislation and ordinances

The **Energy Act** (Закон за енергетиката) is the central law governing Bulgaria's electricity market. It defines CECs, giving them the right to participate in energy markets with non-discriminatory access to the grid. However, the Act does not specify the detailed operational procedures for these communities.

The **Renewable Energy Sources Act** (RES Act, Закон за енергията от възобновяеми източници) defines RECs. These are restricted to renewable generation and are subject to geographical proximity requirements, which RED II does not impose. The RES Act allows RECs to produce, store, consume, and sell renewable energy.

The **Power Market Rules** (Правила за търговия с електрическа енергия) regulate participation in the electricity market, covering trading, scheduling, and balancing. However, these rules do not currently recognize energy communities as distinct market participants, nor do they provide specific procedures for how they can trade electricity or offer flexibility services. The latest version of the Power Market Rules can be found on the Energy and Water Regulatory Commission (EWRC) website at dker.bg.

The **Electricity Measurement Rules** (Правила за измерване на количеството електрическа енергия) govern how electricity production and consumption are measured. These rules do not yet address collective self-consumption or the shared metering requirements for energy communities. The rules are available also at dker.bg.

Grid access for renewable installations, including those owned by energy communities, is regulated by the **Ordinance on Grid Connection** (Наредба за присъединяване на

[7] https://wayback.archive-it.org/12090/20240807073925/https://energy-communities-repository.ec.europa.eu/energy-communities-repository-legal-frameworks/energy-communities-repository-policy-database_en

производители и потребители към електропреносната и електроразпределителните мрежи - a.k.a НАРЕДБА № 6 / Ordinance Nr 6 and officially НАРЕДБА № 6 ОТ 24 ФЕВРУАРИ 2014 Г. ЗА ПРИСЪЕДИНЯВАНЕ НА ПРОИЗВОДИТЕЛИ И КЛИЕНТИ НА ЕЛЕКТРИЧЕСКА ЕНЕРГИЯ КЪМ ПРЕНОСНАТА ИЛИ КЪМ РАЗПРЕДЕЛИТЕЛНИТЕ ЕЛЕКТРИЧЕСКИ МРЕЖИ**)**. However, this ordinance does not provide simplified procedures or special provisions for community-owned installations.

The **Spatial Development Act** (Закон за устройство на територията) governs the construction and permitting process for renewable installations, including those by energy communities.

The **Condominium Management Act** (Закон за управление на етажната собственост) provides a limited framework for collective decision-making and management in residential buildings. While it could be relevant for collective self-consumption projects, it does not directly support the creation of energy communities.

The **Cooperatives Act** (Закон за кооперациите) provides a potential legal form for energy communities, but its current scope is largely tied to agricultural cooperatives. Minor amendments would be required to make it suitable for energy projects.

The **Non-Profit Legal Entities Act** (Закон за юридическите лица с нестопанска цел) also offers a potential legal form for energy communities. However, energy activities do not fit neatly into the existing categories for non-profit associations. Amendments would be necessary to accommodate energy communities.

3.1.2 Key gaps and barriers

Despite the formal recognition of energy communities in the Energy Act and Renewable Energy Sources Act, Bulgaria's regulatory framework contains significant gaps:

- There is **no dedicated registration process** for energy communities, leaving them in a legal grey area.
- **Grid access and metering rules** do not account for shared community-owned installations or VNM and virtual billing arrangements.
- Energy communities are **not recognized as distinct market participants** in the Power Market Rules, making it unclear how they should trade electricity or fulfill balancing responsibilities.
- There are **no established protocols for data exchange** between DSOs and energy communities, which is essential for internal energy sharing and access to verified metering data of the dynamic profiles of the consumption and production.
- Bulgaria's **current framework does not include VNM**, **virtual billing** or other energy offsetting mechanisms which are crucial for enabling energy sharing across non-contiguous sites.

3.1.3 Institutional framework and key actors

Several institutions play critical roles in shaping the regulatory environment for energy communities in Bulgaria and will be relevant for closing the recognized gaps:

The **National Assembly of the Republic of Bulgaria (Parliament)**[8] serves as the primary legislator responsible for adopting, amending, and approving all energy-related laws, including the Energy Act and the Renewable Energy Sources Act. Parliament's **Energy Committee** plays a central role in reviewing and proposing legal changes related to renewable energy, energy communities, and the regulatory framework for prosumers. The success of new policies to support energy communities, including the introduction of VNM or improved grid access rules, ultimately depends on parliamentary approval.

The **Ministry of Energy**[9] is responsible for policy development and legislative proposals related to the energy sector. It drafts amendments to the Energy Act, RES Act, and other key laws, and coordinates with Parliament to ensure alignment with Bulgaria's National Energy and Climate Plan (NECP) and EU directives.

The **Energy and Water Regulatory Commission (EWRC)**[10] is the national energy regulator. It is responsible for setting tariffs, approving market rules, issuing licenses, and overseeing the operations of the Transmission System Operator (TSO) and DSOs. While the Energy Act formally recognizes energy communities, EWRC still needs to incorporate specific procedures for them into market rules, metering rules, and grid access regulations.

The **Sustainable Energy Development Agency (SEDA)** (www.seea.government.bg) supports renewable energy development and energy efficiency projects. SEDA could play a future role in

[8] www.parliament.bg
[9] www.me.government.bg
[10] www.dker.bg

registering and providing technical and administrative support to energy communities, acting as a focal point for data collection, monitoring, and promotion of community-led energy projects.

The **Electricity System Operator (ESO)**[11] operates Bulgaria's transmission network and is responsible for balancing the system. ESO will need to adapt its balancing and forecasting processes to accommodate energy communities once they become active market participants, particularly in cases where communities offer aggregated flexibility services.

The **DSOs** are responsible for managing the regional distribution grids, including connecting new generation capacity, such as prosumer installations and community-owned renewable projects. Importantly, DSOs are exclusively responsible for metering energy flows, including the installation, operation, and data management of smart metering infrastructure. This includes recording both energy injected into the grid by prosumers and communities and energy withdrawn for consumption. The effective participation of energy communities, particularly in VNM and collective self-consumption, relies heavily on DSOs ensuring accurate, transparent, and accessible metering data.

The three main DSOs in Bulgaria are:

- **EVN Bulgaria**[12] **- Електроразпределение Юг (**Elektrorazpredelenie Yug)
- **Electrohold (formerly CEZ)**[13] - ЕРМ Запад (ERM Zapad)
- **Energo-Pro**[14] - **Електроразпределение Север (**Elektrorazpredelenie Sever)

> *"The DSOs are responsible for managing the regional distribution grids, including connecting new generation capacity, such as prosumer installations and community-owned renewable projects.*

[11] www.eso.bg
[12] www.evn.bg
[13] www.electrohold.bg
[14] www.energo-pro.bg

3.1.4 The role of energy traders and aggregators

Energy traders and aggregators have the potential to play a key enabling role for energy communities, particularly in the absence of a comprehensive regulatory framework. In practice, the first emerging energy communities in Bulgaria are being formed through bilateral agreements and service packages offered by energy traders who help prosumers and community groups:

- **Bundle and sell excess renewable energy production** into the wholesale market.
- **Arrange balancing services**, a legal obligation for all market participants, including prosumers.
- **Offer administrative and market access support**, including guidance on power purchase agreements (PPAs) and self-supply arrangements.
- **Act as intermediaries**, helping energy communities navigate the complexities of grid connection, data management, and billing processes.

3.1.5 Energy communities under the Bulgarian law

Bulgaria recognizes **two types of energy communities** under national legislation: RECs under the RES Act (Закон за енергията от възобновяеми източници - ЗЕВИ) and CECs under the Energy Act (Закон за енергетиката - ЗЕ). While both share common principles such as open participation, democratic governance, and prioritization of social, economic, and environmental benefits over financial profit, they have distinct legal frameworks and operational limitations.

Renewable Energy Communities (RECs)

RECs in Bulgaria are regulated under the RES Act (ЗЕВИ). They are subject to geographic restrictions, requiring them to be located within a specific urbanized area and in close proximity to the renewable energy installations they operate. RECs are limited to activities involving renewable energy sources only, with the right to produce, consume, store, and sell excess renewable electricity, including through Power Purchase Agreements (PPAs). While they are granted non-discriminatory access to suitable electricity markets, they currently face regulatory gaps concerning rules for energy sharing. Membership in RECs is restricted to natural persons, small and medium-sized enterprises (SMEs), and municipalities that operate within the designated geographical boundaries.

Citizen Energy Communities (CECs)

CECs in Bulgaria are regulated under Article 92(б) of the Energy Act (ЗЕ). Unlike Renewable RECs, CECs are not subject to geographic limitations and can operate across the entire country. They have a broader scope of activities, which includes electricity production (not limited to renewables), distribution, supply, aggregation, storage, energy efficiency services, electric vehicle (EV) charging, and other related energy services. Membership is open to individuals, SMEs, and municipalities, with the condition that large enterprises cannot hold a majority stake, thereby preserving the citizen-driven nature of the community. Additionally, when the RES Act (ЗЕВИ) lacks specific provisions applicable to RECs, the rules outlined for CECs under the Energy Act serve as a fallback legal framework.

3.1.6 Legal-organizational form and governance

EU Directives provide that CECs and RECs shall be “legal entities”. Hence, member-states have the discretion to allow for various legal forms within which energy communities may be organised and exist. It is understood that “legal entity” also includes consortium or joint venture that is not incorporated (i.e., non-personified organisations).

Energy communities in Bulgaria **do not have a dedicated legal form and must register under existing corporate or non-profit structures**:

- Cooperatives (Закон за кооперациите)
- Non-Profit Organizations (NPOs) (Закон за юридическите лица с нестопанска цел - ЗЮЛНЦ)
- Commercial Companies (Търговски закон - ТЗ)
- Condominium Associations (Закон за управление на етажната собственост - ЗУЕС)

The Energy Act (§1, т. 76, ДР) explicitly states that CECs must ensure that their primary goal is to provide environmental, economic, or social community benefits rather than financial profit. However, there is no defined mechanism for monitoring compliance with this requirement, and energy communities could be vulnerable to commercial exploitation by companies seeking financial gain.

For RECs, the Renewable Energy Sources Act (чл. 56, ЗЕВИ) specifies that they must be effectively controlled by their members, own renewable energy installations, and distribute produced energy among members. **Legal challenges** include:

- **Bulgaria has not effectively implemented RED II**. Instead, the Directive's provisions were formally and directly copied into national law without operational mechanisms. As a result, there are no clear definitions for key concepts like *proximity*, *community benefit versus profit-making*, *membership restrictions for commercial entities*, or *rules for internal energy sharing within community installations*.
- **No dedicated registration framework**, requiring energy communities to register under unsuitable legal forms.
- **Strict requirements for condominium associations** (ЗУЕС), such as needing 100% owner consent for solar installations, making collective projects nearly impossible in multi-apartment buildings.
- **Lack of specific rules for governance and decision-making processes** beyond what is outlined in general corporate and cooperative law.

3.1.7 Production, consumption, storage, and energy sharing

Energy communities can produce, consume, store, and sell energy under the Electricity Measurement Rules (Правила за измерване на количеството електрическа енергия) and the Ordinance on Metering and Settlement of Electricity Quantities (Наредба № 6/2014 г.). However, their practical **participation in the market is limited due to regulatory gaps**:

- **No clear framework for energy sharing**: RECs should be able to distribute energy among their members, but grid connection and metering rules do not accommodate intra-community energy exchange.
- **Lack of VNM**: Bulgarian law does not yet allow energy generated at one location to be credited across multiple consumption points within an energy community.
- **Grid access and balancing obligations**: Communities must comply with standard grid access and balancing rules, which can impose high costs and administrative burdens.

The key legal barriers to the involvement of energy communities can be summarized as:

- **Unclear registration and administrative procedures** create uncertainty for potential energy communities.
- **No support mechanisms for energy storage and self-consumption**—regulations treat energy communities like standard market participants.
- **Energy data access restrictions** under the Personal Data Protection Act (Закон за защита на личните данни) prevent communities from accessing real-time metering data or dynamic load profiles at the end of a certain period, which is controlled by DSOs and gathered by regulation once a month (further on we explain the procedure and recommend potential solution).
- **High grid fees and administrative burdens** make energy communities financially unviable in most cases.
- **Risk of corporate takeovers** - large energy companies could exploit loopholes in the law to establish "pseudo-energy communities" that benefit from incentives while operating for profit.

Bulgarian law defines **prosumers** under two different categories: **Active Customers (Активни клиенти)** and **Self-Consumers of Renewable Energy (Потребители на собствена електрическа енергия от ВЕИ)**. While both groups produce and consume electricity, their legal rights and market participation vary based on whether they engage in renewable-only generation, energy storage, or electricity trading.

The Energy Act (Закон за енергетиката - ЗЕ, §1, т. 75) introduces the concept of Active Customers, referring to end consumers or groups of end consumers who generate, store, consume, and sell electricity. These customers are allowed to participate in aggregation, flexibility programs, and demand response schemes, provided that energy production is not their primary commercial activity. The law ensures that active customers cannot be subjected to discriminatory grid access fees or excessive administrative barriers imposed by network operators. Furthermore, they are permitted to aggregate their production and participate in balancing markets, although they remain financially responsible for any imbalances unless they join a balancing group. One of the most significant advantages for active customers is that those with energy storage systems benefit from simplified grid access procedures and are exempt from additional grid fees for stored electricity. However, the regulatory framework remains vague in key areas, particularly concerning balancing cost structures and the definition of a reasonable timeframe for grid connection.

In parallel, the RES Act (Закон за енергията от възобновяеми източници - ЗЕВИ, чл. 18а) defines Self-Consumers of Renewable Energy, specifically covering prosumers generating electricity exclusively from renewable sources. These self-consumers are entitled to produce, consume, store, and sell electricity while retaining their rights as end customers. The law mandates that network operators cannot impose discriminatory conditions on their grid access, ensuring equal treatment in market transactions. Self-consumers can sell excess electricity at market-based prices or through support schemes, but licensing and registration requirements remain unclear, creating uncertainty for small-scale prosumers who want to participate in the market. Unlike in some EU countries, Bulgaria has not yet introduced VNM, meaning that self-consumers cannot virtually allocate their self-generated energy to multiple consumption points.

Despite recent legislative improvements, several challenges remain for prosumers in Bulgaria. The lack of clear licensing exemptions for small-scale self-consumers means they could be subject to complex regulatory requirements, even when selling minimal amounts of electricity. Grid connection delays and costs continue to hinder the expansion of self-consumption, particularly for those without energy storage. Prosumers also lack real-time access to their own metering data or even a retrospective access to verified dynamic consumption profile, as DSOs control energy flow information under the Personal Data Protection Act. Furthermore, while the law acknowledges energy storage as an essential component of decentralized electricity production, it does not yet define technical standards, safety requirements, or market participation rules for stored energy.

3.1.8 Ownership and management of renewable energy installations by third parties

According to Article 18a, Paragraph 6 of the RES Act (ЗЕВИ), **self-consumers of renewable electricity may have their installation owned or managed by a third party**. This third party can be responsible for installation, operation, maintenance, and even metering of electricity production, as long as they act under the written instructions of the self-consumer.

A key legal distinction is that the third party does not acquire the status of a self-consumer, regardless of whether they own or operate the installation. If the third party is the owner of the renewable energy installation, a contractual agreement must exist between them and the self-consumer. This agreement must ensure that the self-consumer retains the right to use the installation and that all electricity produced is legally considered the property of the self-consumer.

This provision enables leasing, service agreements, and third-party ownership models, making it easier for households and businesses to access renewable energy without direct ownership of generation assets. However, the law ensures that the benefits and legal rights associated with self-consumption remain solely with the consumer, preventing third parties from claiming self-consumer status.

> *Self-consumers of renewable electricity may have their installation owned or managed by a third party*

3.1.9 Guarantees of origin

In Bulgaria, Guarantees of origin (GOs) for renewable electricity are **issued and managed by SEDA**, in accordance with Article 43 of the RES Act (ЗЕВИ). This system ensures that electricity produced from renewable sources can be certified and traded, providing transparency and credibility in the market for green energy. The issuance of Guarantees of Origin follows a structured process involving multiple actors, including renewable energy producers, ESO, DSOs, and energy traders.

To obtain a GO, a **renewable energy producer must submit an application** to SEDA. This application can cover one or more calendar months, but it must be filed no later than one month after the end of the production period. The application must include detailed information about the generation facility, including its installed capacity, technology type, geographic location, and grid connection details. Additionally, the producer must provide metering data that verifies the amount of renewable electricity generated. The DSOs and ESO play a key role in this process by supplying official production and grid injection data, ensuring accuracy and preventing fraudulent claims.

Once the application is submitted, SEDA reviews the documentation and verifies the energy production records. If all requirements are met, the agency issues **one GO per megawatt-hour** (MWh) of certified renewable electricity. These certificates are recorded in an electronic registry maintained by SEDA, which ensures transparency and enables producers to transfer, sell, or redeem GOs in line with market demand. Energy traders and corporate consumers often purchase these certificates to demonstrate compliance with renewable energy commitments or sustainability goals. Once a GO is used, it is marked as redeemed in the national register to prevent double counting.

The legal framework governing the GO system establishes the roles and responsibilities of all involved parties. SEDA is responsible for issuing, managing, and overseeing the GO system, ensuring that renewable energy producers comply with national and EU regulations. Renewable energy producers must apply for certification and ensure accurate data reporting, while DSOs and ESO are responsible for verifying production data and providing metering records. Energy traders and corporate consumers participate in the secondary market by buying and selling GOs, either as proof of renewable energy consumption or as part of contractual sustainability obligations.

Despite the existence of this certification system, **several challenges** remain. These include delays in processing applications, a lack of awareness among smaller producers, and the absence of automated integration between DSOs, ESO, and SEDA for real-time data exchange. Addressing these issues could improve the efficiency of GO issuance and facilitate wider participation in the renewable energy market. Yet, we can conclude that there is a streamlined procedure and the data platform required for the virtual metering and consecutive billing of energy communities and prosumers does not require automation and linking to a platform managed by SEDA - it could be considered in the future for convenience and within the one stop shop solution but is not an obstacle for the existence and the operation of energy communities at present.

3.1.10 General regulatory framework for grid connection and construction of small res installations

The RES Act (ЗЕВИ) and the Energy Act (ЗЕ) provide the main legislative framework for connecting small renewable energy installations to the grid in Bulgaria. These regulations have undergone amendments in recent years to simplify procedures, particularly for small-scale photovoltaic (PV) systems designed for self-consumption.

- **Installations up to 20 kW (for self-consumption only):**
  - No construction permit required if installed on single-family residential or villa buildings or in adjacent land.
  - The grid connection process is simplified: the owner submits a notification to the grid operator and signs an amendment to their existing supply contract.
- **Installations between 20 kW and 50 kW (for self-consumption only):**
  - Silent consent rule applies: if the municipal architect does not respond within one month, the construction permit is considered granted (Article 17(5) ЗЕВИ).
  - The total installed power must not exceed the grid connection capacity allocated to the building.
- **Installations above 50 kW or those selling excess energy:**
  - A full administrative process applies, including a construction permit and a grid connection agreement with the DSO.
- **General grid connection process for small RES installations:**
  - Application to the DSO for a connection feasibility study.
  - Technical assessment and issuance of conditions for connection.
  - Conclusion of a preliminary connection contract (valid for two years).
  - Construction of the installation and required grid infrastructure.
  - Signing of a final connection contract and integration into the grid.

3.1.11 Microgrids in Bulgaria: regulatory framework and challenges

As of the latest legislative updates, Bulgaria does not yet have a comprehensive or simplified regulatory framework governing the construction and use of internal electricity infrastructure for energy sharing within energy communities—commonly referred to as microgrids. At present, the general rules for construction and regulations for building electrical transmission infrastructure apply to such networks, meaning no special provisions exist to facilitate their development. Additionally, no specific legal mechanisms have been introduced for balancing electricity production and consumption within energy communities, meaning that general market rules still apply to their operations.

Both the EU Renewable Energy Directive (2018/2001) and the Internal Electricity Market Directive (2019/944) support energy sharing within communities, including the use of microgrids or internal electrical distribution systems. However, Bulgaria has yet to transpose specific rules that enable communities to establish localized smart grids for efficient energy distribution without relying on the public grid. This represents a missed opportunity, especially given the reluctance of national grid operators to invest in distributed infrastructure, which could otherwise encourage the development of localized intelligent networks.

One notable legal advancement, however, has been the introduction of Article 64, Paragraph 11 in the RES Act (ЗЕВИ). This provision facilitates the expansion of existing and the construction of new renewable energy facilities by granting legal servitude rights for linear energy infrastructure (such as power lines) to pass through private properties. This amendment prevents neighbouring landowners from blocking the extension of transmission lines, ensuring that investors in renewable energy projects can establish necessary grid connections without undue delays. Previously, servitude rights were only recognized for expanding or constructing public grid infrastructure, but the updated Article 64 now extends these rights to private renewable energy developments.

Despite this positive regulatory change, the lack of a dedicated microgrid framework remains a significant barrier. Energy communities currently cannot build and operate their own internal grids under simplified procedures, nor do they have clear rules for self-balancing and internal trading. For Bulgaria to align with EU best practices, future legal reforms should explicitly define microgrid ownership, grid-balancing responsibilities, and access to public grid infrastructure, ensuring that energy communities can efficiently share and distribute their locally produced renewable energy.

Neither of the community models (RECs and CECs) considered in Bulgarian laws has a dedicated grid connection framework, which leads to several legal gaps and practical challenges:

- **No special rules for collective self-consumption or energy sharing**
    - Energy communities must register as individual producers, and each member must have a separate contract with the DSO.
    - There are no provisions for direct energy sharing among members via local grids or microgrids.
- **Microgrids and local distribution networks are not legally defined**
    - Current regulations do not provide a clear legal framework for communities to build and operate private electricity networks for internal energy sharing.
    - If an EC wants to share electricity among its members, it must use the public grid and pay distribution tariffs, making local energy sharing economically inefficient.
- **Unclear balancing rules for energy communities**
    - Energy communities have no special status in the balancing market and must either self-balance their production and consumption, which is unrealistic for small energy communities, or join an existing balancing group, which often requires costly agreements with commercial aggregators.
- **No simplified licensing for energy communities selling energy**
    - If an energy community wants to sell excess electricity, it must go through the same licensing process as commercial RES producers. There are no exemptions for small-scale energy communities, which discourages collective investment in renewables.

3.1.12 Administrative services for energy communities: the need for one-stop shops and a central registry

The establishment of one-stop-shop administrative services and a central registry for energy communities is critical to ensuring the effective development of community energy initiatives in Bulgaria. Currently, administrative complexity, fragmented responsibilities, and the absence of a centralized support system present significant obstacles for individuals and organizations seeking to establish energy communities. To overcome these barriers, a legal framework for simplified registration and administrative support must be developed.

The role of one-stop shops

The concept of a one-stop shop has already been incorporated into Bulgarian law through the RES Act (ЗЕВИ), Article 22, which mandates the establishment of municipal administrative service centres to assist with the permitting process for renewable energy installations. However, these centres currently focus on individual projects rather than energy communities, and their effectiveness is limited by a lack of direct decision-making authority.

For energy communities, a well-functioning **one-stop shop system** should:

- **Provide legal, technical, and financial guidance** on the formation and operation of energy communities.
- **Handle all administrative procedures** related to registration, grid connection, permits, and market participation in a streamlined manner.
- **Serve as an intermediary** between energy communities and regulatory bodies, including the EWRC, grid operators, and local authorities.
- **Offer digital services** to facilitate online applications and communication, reducing bureaucratic delays.

A centralized coordination mechanism at the national level, likely under the SEDA, should oversee the harmonization of one-stop shop procedures across municipalities to ensure consistency and efficiency.

The need for a central registry for energy communities

Currently, there is no dedicated registry for energy communities in Bulgaria, creating uncertainty regarding legal status, market participation, and access to support mechanisms. A national registry should be established under SEDA (АУЕР) or another relevant public authority, ensuring transparent and standardized registration of energy communities.

The legal framework should define:

1. **Who should be eligible to register**
   - Energy communities must meet the criteria defined under the Energy Act (CECs) and the RES Act (RECs).
   - Registration should be open to associations of individuals, SMEs, municipalities, and cooperatives meeting the participation and governance criteria.
2. **What information the registry should include**
   - Legal structure and founding documents of the community.
   - Ownership and governance model, ensuring democratic control.
   - Details of energy production, consumption, storage, and grid connection agreements.
3. **Registration rules and procedures**
   - The process should be digitalized and simplified, avoiding excessive bureaucracy.
   - Communities should be able to apply through a standardized online platform managed by SEDA.
   - Approval should be granted within a defined timeframe to prevent unnecessary delays.
4. **Rights and obligations of registered communities**
   - Official registration should grant legal recognition and market access rights.
   - Communities should receive clear guidance on tax treatment, billing procedures, and participation in support schemes.

Legal basis for establishing the registry

The introduction of a central registry for energy communities should be legally mandated within:

- The Energy Act (ЗЕ) – defining the legal status of CECs.
- The RES Act (ЗЕВИ) – incorporating rules for RECs.
- A new regulatory ordinance issued by EWRC (КЕВР), specifying registration and operational rules.

A clear legal mandate is essential to ensure that registration is not left to discretionary municipal processes but is uniform, transparent, and binding nationwide.

“Norway’s power system is distinguished by its significant reliance on renewable energy, leading Europe in the proportion of electricity generated from renewable sources and reporting the lowest emissions from the power sector.

3.2 Mapping Norwegian regulations of relevance for energy communities and expected changes to accommodate those

Norway's power system is distinguished by its significant reliance on renewable energy, leading Europe in the proportion of electricity generated from renewable sources and reporting the lowest emissions from the power sector. Hydropower constitutes approximately 88% of Norway's electricity generation capacity, with wind, solar, and thermal making up the remainder. The total installed production capacity is 39.7 GW as of 2023, and typical annual production is 156 TWh.

Electricity counts for almost half of Norway's total final energy consumption. The residential sector's high per capita electricity consumption (6.5 MWh in 2022) is mainly due to the widespread use of electricity for heating and hot water. Norway has also been a global leader in electrifying transportation, a key component of the green transition. Battery electric and chargeable hybrid vehicles dominate new car sales, achieving a market share above 90% in 2023. Additionally, the country is actively engaged in the electrification of trucks, ships and construction sector, demonstrating its commitment to sustainable practises.

Statnett SF serves as Norway's sole TSO, overseeing the entire transmission grid. The regional and distribution grids, on the other hand, are managed by approximately 120 distinct DSOs, each responsible for a specific region. Given that both the TSO and the DSOs hold natural monopolies in their geographical areas, they are subject to stringent regulations by national authorities, which is shaped by the interplay between the Norwegian Water Resources and Energy Directorate (NVE), the Regulator for Energy (RME), and energy-related legislation. NVE, operating under the Ministry of Petroleum and Energy, oversees the management of the country's water and energy resources, ensuring an energy system that is efficient, reliable, and environmentally sound sustainable. NVE is also responsible for granting licenses for energy production and transmission. RME, a division within NVE also known as NVE-RME, serves as the national regulatory authority for the electricity and downstream gas markets in Norway. Its primary objective is to foster socioeconomic development and an environmentally sound energy system, characterized by efficient and reliable transmission, distribution, trade, and use of energy. RME monitors the TSO and DSOs to ensure consumers receive electricity supplied with adequate quality.

NVE and RME are empowered to enforce laws and regulations within Norway's energy sector, ensuring compliance with the legal framework established by the Norwegian government. It is important to note that the concept of LECs has not yet been implemented in nation law or practice according to the EU definitions. While Norway is not an EU member and not directly obligated to EU directives, it is part of the European Economic Area (EEA). This means that EU directives can be adopted in Norway through the EEA agreement, provided they are deemed relevant by the EEA and EFTA. Given the growing recognition of the potential benefits that LECs can bring, there is a movement towards adapting the existing framework to better accommodate these initiatives. However, as it stands, LEC actors must rely on established energy-related regulations in Norway.

Several key pieces of legislation that govern the Norwegian energy system are particularly relevant for LECs, and understanding these can help in navigating the regulatory landscape:

- **The Energy Act** (Energiloven)[15]: This act, implemented in 1990, ensures that all energy produced in Norway is used in a societally rational manner. It regulates the production, transformation, sale, distribution, and use of energy. Importantly, it establishes the licensing regime for operating grid assets, granting exclusive rights to DSOs within designated areas. This poses a significant challenge for larger LECs aiming to own and operate their own grid infrastructure.
- **The Energy Regulations** (Energilovforskriften)[16]: Implemented in 1990 under the Energy Act, these regulations provide a comprehensive and detailed framework of the conditions to be granted licenses to develop and maintain regional and local distribution grids. They ensure that the production, conversion, transmission, turnover, distribution, and use of energy are rational from a societal perspective and consider private and public interests. They also facilitate an efficient energy market where the sale of energy takes place in a socially rational manner and ensure effective market monitoring.
- **The Grid and Energy Market Regulation** (Forskrift om nettregulering og energimarkedet, NEM[17]): Implemented in 2019, NEM regulates the Norwegian energy market, facilitating an efficient energy market where operations within the market are conducted in a socially rational manner and to ensure effective market surveillance. Furthermore, NEM constitutes a detailed framework of the Norwegian energy market's legislative conditions. RME is responsible for monitoring the energy market to ensure that NEM is enforced.

Additionally, Norway’s commitment to environmental sustainability in energy production is reinforced by several frameworks. The Electricity Certificate Act, introduced in 2011, encourages renewable energy generation through a market-based scheme shared with Sweden. Under this act, producers of renewable electricity earn one certificate per megawatt-hour (MWh) of electricity produced, valid for up to 15 years. Furthermore, The National Climate Plan and the Climate Change Act are the most significant sustainability-related frameworks regulating the energy system. The Climate Plan outlines Norway’s prioritized measures to reduce emissions, while the Climate Change Act aims for a long-term reduction in greenhouse gas (GHG) emissions, targeting a significant decrease by 2050. All actors within the Norwegian energy system must consider these overarching environmental frameworks.

In many ways, the Norwegian legislation portrays a state-controlled framework for energy regulations. The Energy Act and its secondary regulations limit the ability of LECs to independently produce, share and store energy. The requirement for area licenses, primarily granted to DSOs, restricts the development of larger LECs with their own grid infrastructure. However, the regulatory sandbox framework for energy systems, introduced by RME in 2019, offers a mechanism for temporary exceptions. This initiative aims to facilitate pilot and demonstration projects in a controlled environment, providing a pathway for innovation within the regulatory bounds. The sandbox allows innovators to test new technologies, services, business models, and approaches in real-world settings, which is particularly beneficial for LECs. These communities often operate with innovative concepts that may not fully align with

[15] Energiloven (1990), Lov om produksjon, omforming, overføring, omsetning, fordeling og bruk av energi m.m.
[16] Energilovforskriften (1990), Forskrift om produksjon, omforming, overføring, omsetning, fordeling og bruk av energi m.m.
[17] NEM (2019), Forskrift om nettregulering og energimarkedet.

existing regulatory frameworks. A list of all projects that have been approved for the sandbox can be found at the NVE website[18].

The sandbox framework promotes a collaborative process between RME and innovative concepts such as LECs, enhancing the understanding of the evolving energy landscape. RME provides regulatory guidance and advice, clarifying ambiguities regarding the application of existing regulations to innovative LEC projects. The framework includes a transparent process for granting temporary exemptions from licensing requirements, allowing LECs to apply for derogations if their projects demonstrate innovation and potential benefits for the power system.

3.2.1 Incentives for self-consumption and energy sharing

In Norway, there are **national support schemes and tax deductions specifically directed at small-scale distributed energy production**. The country offers a variety of incentives to promote self-consumption of energy, particular from renewable sources like solar power. Enova, the country's clean energy agency, provides financial support for energy efficiency measures, including subsidies for residential solar installations. Homeowners can receive a **base subsidy** of NOK 7500[19] (approx. 1290 BGN) plus an additional NOK 1250 (approx. 215 BGN) per kW of installed capacity. Enova also offers subsidies of up to NOK 10000 (approx. 1728 BGN) for energy management systems that are often installed alongside solar energy systems. Moreover, many municipalities provide specific grants for households and businesses to install solar panels. Innovation Norway also offers grants and loans to businesses for renewable energy projects, including solar energy.

Electricity customers who also produce their own electricity, known as prosumers, benefit from several financial advantages in Norway[20]. They are **exempt from the variable component of the grid rent, as well as electricity tax and VAT**, for the electricity they produce and consume themselves. This exemption is part of a regulation from the Parliament, which generally

[18] NVE, Vedtak – dispensasjonssøknader, https://www.nve.no/reguleringsmyndigheten/bransje/bransjeoppgaver/pilot-og-demonstrasjonsprosjekter/vedtak-dispensasjonssoeknader/

[19] 1 NOK = 0.083 Euro

[20] NVE, Prosumenter og plusskunder, https://www.nve.no/reguleringsmyndigheten/kunde/stroemnettet/prosumenter-og-plusskunder/.

mandates that everyone must pay taxes on all electricity delivered in Norway, including self-produced electricity. The aim of this regulation is to generate state income and reduce energy consumption. However, only electricity produced by solar cells and used directly by the producer is exempt from tax. To qualify for this exemption, the **electricity must be for personal use, produced on-site, and distributed through internal wiring**. This means that the electricity prosumers self-consume is effectively free of charge, providing a strong incentive for self-generation and consumption of renewable energy.

Additionally, prosumers **can sell excess electricity back to the grid trough a plus-customer scheme**, provided they have an agreement with an electricity supplier that offers this option. During periods when their production exceeds their consumption, they can feed the surplus energy back into the grid. The energy flow is measured using a smart meter, which tracks both consumption and production. Plus-customers do not pay a fixed fee for feed-in, and they receive the spot price for their sold electricity. This scheme is **designed for single customers with a production capacity below 100 kW** and encourages small-scale distributed generation. However, prosumers that inject above 100 kW and up to 9 GW are subject to tariffs and transaction costs. While income from the sale of self-produced electricity is basically taxable, the Ministry has stated that they will not tax it for now due to the complexity of different contractual arrangement. As of December 2024, there are around 33,100 registered plus-customers in Norway, of which 26,900 are residential and 6,200 are commercial customers. Updated statistics may be found on the NVE-RME webpage[21].

The Norwegian government has recently expanded the plus-customer scheme to enable the sharing of self-generated solar electricity[22]. As of October 1, 2023, **a new model allows for sharing of surplus production from installations with up to 1 MW installed capacity**, referring to the nominal power of the inverter. The scheme is valid for properties with multiple electricity subscribers provided they are within the same property, as defined by the same municipality, cadastral, and property number. This includes residents in apartment complexes, multi-family houses, and commercial buildings. Subscribers can share surplus energy without paying taxes on it. However, this surplus energy cannot be further distributed to other grid customers, and subscribers receiving shared production cannot have their own production behind their meter. If the installed capacity of the property exceeds 1 MW, the electricity produced from the excess capacity will not be eligible for tax exemption.

In practice, the **energy sharing is managed through a virtual distribution system, with calculations handled by Elhub**. Smart meters, which are crucial components of this system, provide real-time data on energy production and consumption. This enables precise tracking and allocation of energy shared within a property. The energy consumption and production are measured separately, and the amount of production is deducted from each consumption meter's measured usage. The participants can choose between equal distribution (each meter receives an equal share of the surplus) or a custom static distribution (based on factors like investment share or apartment size). However, the regulation currently restricts energy sharing to physical connections within the same property. This means residents of different buildings or communities cannot establish a virtual grid to share surplus production. The model primarily

[21] https://www.nve.no/reguleringsmyndigheten/publikasjoner-og-data/statistikk/statistikk-over-sluttbrukermarkedet/plusskundestatistikk/

[22] NVE. Modell for deling av overskuddsproduksjon, https://www.nve.no/reguleringsmyndigheten/kunde/stroemnettet/prosumenter-og-plusskunder/modell-for-deling-av-overskuddsproduksjon/.

focuses on enabling housing associations to share renewable energy among their residents. It does not yet accommodate broader community-based energy sharing models that involve multiple properties or businesses. As of January 2025, there are 192 connection points that in 2024 shared 5,200 MWh. Updated statistics may be found on the Elhub webpage[23].

The Ministry of Energy has tasked RME with proposing a new sharing scheme specifically tailored for business areas to facilitate the sharing of self-produced electricity between grid customers. In the beginning of December 2024, a proposal was released with the aim of entering into force during summer 2025. This proposal, which follows a report published by RME in early 2024[24], recommends amendments to the existing sharing scheme. The key proposal is to allow producers to share electricity with customers located on neighbouring properties, with an increased limit on the size of the production facility up to 5 MW. This new scheme would complement the existing one and primarily target customers with annual consumption exceeding 100 000 kWh annually who are subject to grid tariffs reflecting marginal loss costs. Under the proposed scheme, prosumers could share power virtually with other customers on the same property and all their neighbouring properties, including non-adjacent neighbouring properties. Notably, the proposal does not impose a limit on the number of neighbours with whom electricity can be shared. If implemented, this would be a significant step towards the implementation of LECs in Norway.

Another innovative initiative that facilitates the sharing of surplus solar electricity within neighbourhoods is the eNabo initiative by Norgesnett, a Norwegian DSO[25]. Although not a formalized LEC, it acts as a precursor to such communities by enabling households to share excess solar energy. This effectively creates an energy community where members can benefit from each other's excess energy production. Participants can benefit from reduced grid fees by charging their EVs with the surplus solar energy, fostering a collaborative approach to energy consumption. The initiative promotes grid-smart charging, aligning with the principles of LECs by optimizing energy usage times for the benefit of the entire community's power grid. By leveraging local renewable energy sources, eNabo enhances the sustainability and resilience of the community's energy supply, reducing reliance on external energy sources. Additionally, participants receive compensation for using local solar energy, which serves as a community dividend, rewarding households for their contribution to the local energy ecosystem. This initiative is a significant step towards more sustainable and community-driven energy solutions, reflecting the potential for LECs to play a role in Norway’s energy transition.

[23] https://elhub.no/data/delt-produksjon/

[24] RME, Deling av overskuddsproduksjon. 2024.

[25] Norgesnett. eNabo - Fremtidens måte å dele strøm? [cited November 2024]. Available from: https://norgesnett.no/kunde/enabo/.

3.2.2 DSO responsibilities and operations in Norway

The electrical grid in Norway is divided into three main levels: the transmission grid, the regional distribution grid, and the local distribution grid[26]. Each level plays a distinct role in the transportation and distribution of electricity from producers to consumers.

Transmission grid: Operated by Statnett, the transmission grid carries high voltage electricity, typically between 132 kV and 420 kV. It connects major power plants with regional grids and includes interconnectors with other countries, facilitating international power exchange. The transmission grid is crucial for balancing supply and demand across large areas and ensuring the stability of the national power system.

Regional distribution grid: This grid links the transmission grid to local distribution networks and can carry voltages between 33 kV and 132 kV. It serves as an intermediary, distributing electricity from the transmission grid to local grids and sometimes directly to large industrial consumers.

Local distribution grid: The local distribution grid operates at voltages below 22 kV and is responsible for delivering electricity directly to residential and small commercial consumers. It is managed by various DSOs, who ensure the reliable delivery of electricity to end-users and maintain the infrastructure.

Statnett is the designated TSO in Norway. Its responsibilities include maintaining the balance between electricity supply and demand, ensuring frequency regulation, and developing market solutions to optimize the power system[27]. Statnett also coordinates grid maintenance and planning, monitors power flows, and facilitates international electricity trade through interconnectors. DSOs manage the regional and local distribution grids. Their key responsibilities include ensuring a reliable power supply, maintaining and upgrading grid infrastructure, and integrating renewable energy sources. DSOs also handle customer data management, comply with regulatory standards, and implement digitization initiatives to improve grid efficiency[28].

Norway is divided into five electricity price areas, where the spot price of electricity can vary based on local supply and demand conditions. These areas are defined by Statnett and reflect the constraints and capacities of the transmission grid. Spot prices can differ significantly between areas, influenced by factors such as regional production levels, consumption patterns, and grid congestion.

Key responsibilities of DSOs in Norway

The DSOs in Norway have a multifaceted role in ensuring the efficient and reliable delivery of electricity to consumers. Their responsibilities are governed by a comprehensive regulatory framework designed to promote stability, sustainability, and innovation within the energy sector. One of the primary responsibilities of DSOs is to ensure a reliable power supply. This involves maintaining and operating the electrical grid infrastructure, including regional and local distribution networks. DSOs must ensure that electricity is consistently delivered to consumers, regardless of external challenges such as adverse weather conditions or technical

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[26] https://energifaktanorge.no/en/norsk-energiforsyning/kraftnett/

[27] https://www.nve.no/norwegian-energy-regulatory-authority/system-operation-in-the-norwegian-power-system/

[28] https://www.nordicenergyregulators.org/wp-content/uploads/2015/06/THEMA-Report-2015-02-Mapping-of-TSO-and-DSO-responsibilities-related-to-information-exchange.pdf

issues. This requires regular maintenance and upgrades to the grid to prevent outages and ensure a stable supply. DSOs also play a crucial role in promoting the green transition. They facilitate the integration of renewable energy sources into the grid, supporting Norway's goals for reducing carbon emissions and increasing the use of sustainable energy. This includes enabling the electrification of various sectors and accommodating new technologies such as solar and wind power.

The Norwegian Energy Regulatory Authority (NVE-RME) oversees the economic aspects of DSO operations[29], including setting revenue caps and monitoring compliance. This regulation ensures that DSOs operate efficiently and maintain the grid infrastructure while keeping costs reasonable for consumers. DSOs must plan and execute the expansion of the power grid in a cost-effective manner, optimizing resources and minimizing costs.

Digitalization and innovation are essential for DSOs to improve efficiency and perform their tasks effectively. This includes the adoption of smart meters and other advanced technologies that provide real-time data on electricity consumption and grid performance. These technologies help DSOs to better manage the grid, reduce operational costs, and enhance service delivery.

DSOs are also responsible for managing and protecting customer data. They must comply with national and EU regulations to ensure secure data exchange and maintain customer privacy[30]. This involves implementing robust data management systems and protocols to safeguard sensitive information.

Digitalization and innovation are essential for DSOs to improve efficiency and perform their tasks effectively.

[29] https://www.nve.no/norwegian-energy-regulatory-authority/economic-regulation/

[30] https://www.nordicenergyregulators.org/wp-content/uploads/2015/06/THEMA-Report-2015-02-Mapping-of-TSO-and-DSO-responsibilities-related-to-information-exchange.pdf

3.2.3 Regulatory framework for DSOs

The regulatory framework for DSOs in Norway is designed to ensure the efficient, reliable, and sustainable operation of the electricity distribution network. This framework is governed by several key regulations and overseen by NVE, specifically through its regulatory arm, the NVE-RME. The primary legislation governing DSOs in Norway is the Energy Act (Energiloven)[31], which outlines the roles and responsibilities of DSOs, including the obligation to provide non-discriminatory access to the grid and ensure a reliable electricity supply. This act serves as the foundation for the regulatory framework, setting the standards for grid operation and maintenance.

Economic regulation is a crucial aspect of the framework, managed by NVE-RME. This involves setting revenue caps for DSOs to ensure they operate efficiently while maintaining and developing the grid infrastructure[32]. The revenue cap model is based on a combination of cost base and cost norm, providing DSOs with a predictable and transparent financial environment. The allowed revenue covers operating costs, depreciation, and a reasonable return on investments, incentivizing DSOs to provide stable and secure services in a socially efficient manner**. Quality of supply regulations** issued by NVE define the standards for voltage quality, frequency, and reliability that DSOs must adhere to[33]. These regulations ensure that the electricity supply meets certain quality criteria, protecting consumers from poor service and ensuring the stability of the grid.

Grid connection codes[34] specify the technical requirements for connecting to the grid, including voltage limits, safety standards, and other criteria that DSOs and grid users must comply with. These codes are essential for maintaining the integrity and safety of the electrical network. Regulations on system responsibility outline the responsibilities of DSOs in maintaining system stability and security. This includes requirements for grid planning, emergency preparedness, and coordination with the TSO Statnett. These regulations ensure that DSOs are prepared to handle emergencies and maintain the continuous operation of the grid.

3.2.4 Revenue cap

The revenue cap for DSOs in Norway is a critical component of the economic regulation framework overseen by NVE-RME. This model is designed to ensure that DSOs operate efficiently while maintaining and developing the grid infrastructure in a socially efficient manner[35].

The revenue cap is set annually and consists of **two main components: the cost base and the cost norm**. The cost base accounts for 40% of the revenue cap and is derived from the DSOs' own costs, including operating expenses, depreciation, and a reasonable return on investments. This component ensures that DSOs can recover their actual costs of providing electricity distribution services[36]. The cost norm, which makes up the remaining 60% of the revenue cap, is based on benchmarking comparable DSOs. This benchmarking process involves comparing the efficiency and performance of different DSOs to establish a standard

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[31] https://lovdata.no/dokument/NL/lov/1990-06-29-50

[32] https://www.nve.no/norwegian-energy-regulatory-authority/economic-regulation/

[33] https://www.nve.no/norwegian-energy-regulatory-authority/network-regulation/quality-of-electricity-supply/

[34]https://www.nve.no/norwegian-energy-regulatory-authority/regulatory-cooperation/grid-connection-codes-rfg-dcc-hvdc/

[35] https://www.nve.no/norwegian-energy-regulatory-authority/economic-regulation/

[36]https://www.nordicenergyregulators.org/wp-content/uploads/2017/05/5.-Network-losses-in-the-regulation-Norway.pdf

cost norm that is decoupled from the individual DSOs' own costs. The cost norm incentivizes DSOs to improve their efficiency and reduce operational costs, as their allowed revenue is partially determined by their performance relative to other DSOs.

The allowed revenue for each DSO includes the sum of the revenue cap, pass-through costs related to property tax, tariffs paid to other regulated networks, and approved research and development (R&D) costs. Additionally, the model includes adjustments for the cost of capital recovery, ensuring that DSOs can recover the actual cost of capital, including depreciation and return on assets, without a time lag.

To further incentivize efficient operation, the revenue cap model incorporates the Costs of Energy Not Supplied (CENS) arrangement. CENS measures the calculated value of lost load for customers and provides an incentive for DSOs to maintain their assets properly and invest in necessary infrastructure to avoid power outages. Any costs associated with energy not supplied are deducted from the allowed revenues, encouraging DSOs to minimize disruptions and maintain a reliable electricity supply.

Excess or deficit revenue for a given year is calculated as the difference between actual collected revenues and allowed revenues. This ensures that DSOs do not overcharge or undercharge customers, maintaining a balance between revenue generation and cost recovery. The regulatory framework also includes mechanisms for handling congestion revenue, which is used to finance investments aimed at eliminating congestion in the grid.

3.2.5 Grid tariffs

Private customers

Grid tariffs for private customers in Norway are structured to cover the costs associated with the operation and maintenance of the electricity grid. These tariffs consist of several components, including a fixed fee, an energy charge, and public taxes.

The fixed fee includes two parts: a fixed part defined by the size of the main power inlet and a capacity part defined by the average of the 3 days with peak consumption each month. For example, if the average of the three highest daily maximums is 4 kWh, the customer falls into Tier 2 (e.g. in the capacity step of 2 to 4.99 KW), which has a **fixed fee** of NOK 215 (approx. 37 BGN) per month[37]. Or if the customer has a higher average of 8.11 kW (Figure 1), then she will fall under Tier 3 (5-9.99 kW) and get a higher fixed fee for capacity.

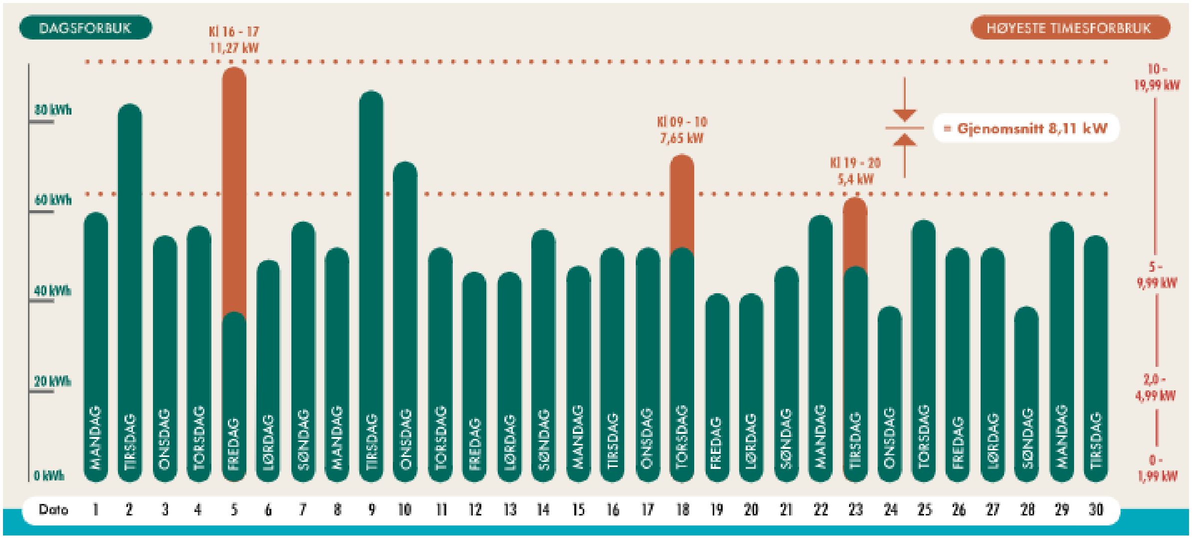

Figure 1 – Example of capacity-based fixed part of the grid tariff, calculated as the average of the 3 highest consumption peaks during the month. (Source: Norgesnett[38])

These specific costs are examples of grid fees from two Norwegian DSOs. The fixed fee covers costs related to operating the power grid, metering, settlement, and invoicing. The **variable component**, known as the energy charge, is related to the amount of electricity consumed. Customers pay a small amount for each kilowatt-hour (kWh) they use. This charge varies depending on the time of day and season, with higher rates during peak demand periods and lower rates during off-peak times[39].

Public taxes include contributions to the Enova energy fund, electricity tax, and value-added tax (VAT). These taxes can make up a significant portion of the grid rent, especially for higher consumption levels. Each DSO can set their own level of tariffs if they stay within the revenue cap established by the NVE-RME. This allows DSOs to adjust tariffs based on their specific

[37] https://www.elvia.no/hva-er-elvia/elvia-transports-the-electricity-to-your-home/grid-rent-prices-for-private-customers/
[38] https://norgesnett.no/kunde/ny-nettleie/
[39] https://www.bkk.no/en/our-grid-tariffs

operational costs and investment needs while ensuring that overall charges remain fair and reasonable for consumers.

Industrial customers

For industrial customers, grid tariffs are structured similarly but with some differences to accommodate the higher and more variable electricity demands of industrial operations. The tariff consists of a fixed part and a variable part. The fixed part of the tariff is generally set for one year at a time and applies to the period from January 1 to December 31. This component includes costs related to the infrastructure and maintenance of the transmission grid. For example, the fixed tariff for large consumption was set to NOK 135 (approx. 37 BGN) per kW in 2025[40]. The variable part of the tariff, known as the energy component, includes marginal loss rates for each exchange point in the transmission grid. These rates are calculated and updated weekly based on the price for the relevant bidding zone. The energy component reflects the cost of transporting electricity and managing losses in the grid.

Statnett, the operator of the transmission grid, also collects congestion revenues, which occur when power is transferred between areas with different power prices. Congestion revenues that arise as a result of power exchange with other countries, i.e. on the interconnectors, are shared 50/50 between Statnett and partners in the neighbouring country. Revenues that arise as a result of power exchange between the price areas in Norway in their entirety accrue to Statnett. And since Statnett's permitted income is regulated, these congestion revenues will be passed on to our customers through reductions in tariffs[41].

3.2.6 Grid connection process in Norway for large consumption or production projects

The process of obtaining a grid connection in Norway for large consumption or production projects involves several steps, ensuring that the connection is both technically feasible and socio-economically rational. This process is overseen by Statnett and involves coordination with DSOs.

Initial contact and application submission: The first step in the grid connection process is to contact the local grid company to express interest in connecting to the grid. For projects with a capacity exceeding 5 MW or an annual consumption of more than 20 GWh, Statnett must be involved from the outset[42]. The applicant must submit a formal application that includes detailed information about the project, such as the type of connection (production or consumption), expected load, and technical specifications[43].

Capacity assessment: Once the application is submitted, the grid owner conducts a technical and economic assessment to determine the available capacity in the grid. This involves several

[40] https://www.statnett.no/en/for-stakeholders-in-the-power-industry/tariffs/this-years-tariff/
[41] https://www.statnett.no/for-aktorer-i-kraftbransjen/tariff/flaskehalsinntekter/
[42] https://www.statnett.no/en/for-stakeholders-in-the-power-industry/the-grid-connection-process/
[43]https://www.statnett.no/en/for-stakeholders-in-the-power-industry/the-grid-connection-process/general-information-about-connecting-to-the-grid/

key activities, including load flow analysis, N-1 analysis (ensuring the grid can operate normally even if one component fails), voltage stability assessment, and thermal rating assessment. The grid owner also evaluates the economic feasibility of the connection, estimating costs associated with infrastructure upgrades, reinforcement costs, and operational expenses.

Connection offer and agreement: If the capacity assessment is positive, the applicant receives a connection offer outlining the terms, conditions, costs, and timeline for the connection1. This offer includes any necessary grid reinforcements or upgrades required to accommodate the new connection. The applicant must review and accept the offer, after which a connection agreement is signed.

Grid reinforcement and construction: In cases where the existing grid infrastructure cannot support the new connection, a study is conducted to identify the necessary reinforcements or upgrades. This could involve upgrading transformers, adding new lines, or enhancing existing infrastructure. The grid owner is responsible for planning and executing these upgrades, ensuring they are completed in a cost-effective and timely manner.

Special conditions and capacity queue: If there is no available capacity in the grid under regular terms, Statnett can assess the possibility of providing a connection with special conditions, such as disconnection or limitation in consumption or production during peak periods. Additionally, if there are more customers meeting the maturity requirements than there is available capacity, a capacity queue is established. The time of the customer's submission of a mature order determines their place in the queue.

Final connection and commissioning: Once all necessary upgrades and reinforcements are completed, the final connection is made, and the project is commissioned. The grid owner ensures that all technical and regulatory requirements are met, and the new connection is integrated into the grid.

3.2.7 Capacity queue

The capacity queue in Norway is a mechanism used to manage the allocation of grid capacity when the demand for connections exceeds the available capacity. This process ensures that grid connections are granted in an orderly and fair manner, prioritizing projects that are most likely to be realized. The capacity queue is governed by regulations set forth by the Norwegian Ministry of Energy and overseen by Statnett and the local DSOs. Stanett aims to give transparency and provides statistics on the capacity queue cases[44][45].

The primary rule for managing the capacity queue is the first-come, first-served principle. This means that applications for grid connections are processed in the order they are received[46]. However, this principle is supplemented by additional criteria to ensure that the most viable projects are prioritized.

[44] https://www.statnett.no/om-statnett/nyheter-og-pressemeldinger/nyhetsarkiv-2025/storre-apenhet-om-reservert-nettkapasitet-og-hvem-som-star-i-ko/
[45] https://www.statnett.no/for-aktorer-i-kraftbransjen/nettkapasitet-til-produksjon-og-forbruk/foresporsler-og-reservasjon-i-nettet/
[46]https://www.statnett.no/en/for-stakeholders-in-the-power-industry/the-grid-connection-process/how-to-get-increased-capacity/

Effective from January 1, 2025, new regulations require that only mature projects can reserve capacity or secure a position in the capacity queue[47]. The maturity of a project is assessed based on objective and standardized criteria, known as maturity criteria. These criteria evaluate the likelihood of a project's successful realization, including factors such as financial readiness, technical feasibility, and regulatory compliance.

Once a project secures a position in the capacity queue, its progress is continuously monitored to ensure it remains on track. Projects that do not fulfil an agreed progress plan risk losing their capacity reservation or queue position. This ongoing assessment helps to prevent unrealizable projects from occupying valuable grid capacity and ensures that available capacity is used efficiently. In cases where there is no available capacity in the grid under regular terms, Statnett and the local DSOs can assess the possibility of providing a connection with special conditions. These conditions may include disconnection or limitation in consumption or production during peak periods. This approach allows for the accommodation of additional projects without compromising the stability and reliability of the grid.

Grid operators have an obligation to ensure market access on objective and non-discriminatory terms. This means that all applicants are treated equally, and the allocation of grid capacity is based on transparent and fair criteria. The capacity queue system is designed to uphold these principles, ensuring that all projects have a fair chance of securing a grid connection.

3.2.8 Local flexibility markets

Local flexibility markets are emerging as a vital tool for DSOs to manage grid stability and efficiency in the face of increasing renewable energy integration and decentralized energy resources. These markets enable DSOs to procure flexibility services from various providers to address local grid constraints, manage congestion, and avoid costly grid expansions.

Local flexibility markets operate by allowing participants with flexibility resources, known as Flexibility Service Providers (FSPs), to offer their services to DSOs and other grid operators. These resources can include demand-side flexibility, energy storage, and distributed generation[48]. The primary participants in these markets are DSOs, who seek to manage local grid issues, and FSPs, who provide the necessary flexibility.

The market-based approach to local flexibility involves creating a platform where flexibility can be traded as a service. DSOs identify areas within their grid where flexibility is needed, such as regions experiencing congestion or high demand. They then issue requests for flexibility services, specifying the required amount, duration, and location2. FSPs respond to these requests by submitting bids, offering their flexibility resources at competitive prices.

In Norway, the NODES platform[49] is a key player in facilitating local flexibility markets. Euroflex, a market on the NODES platform, involves eight of the largest DSOs in Norway who buy flexibility using various products such as hourly activation in the ShortFlex™ market, availability products in the LongFlex™ market, and capped power products in the MaxUsage™ market. This

[47] https://www.wr.no/en/news/wr-energy-update-new-requirements-for-allocation-of-grid-capacity
[48] https://powercircle.org/local_flexibility_markets.pdf
[49] https://nodesmarket.com/euroflex/

platform matches supply and demand for flexibility, ensuring that the most cost-effective solutions are utilized.

The market platform matches supply and demand for flexibility, ensuring that the most cost-effective solutions are utilized. This approach leverages modern technology, digitization, and forecasting models to optimize the use of flexible resources. By using a market-based system, DSOs can efficiently allocate flexibility resources where they are most needed, enhancing grid stability and reducing operational costs.

Local flexibility markets offer several benefits for DSOs. They provide a cost-effective alternative to traditional grid reinforcement, allowing DSOs to manage grid constraints without extensive infrastructure investments. These markets also enhance the integration of renewable energy sources by providing the necessary flexibility to accommodate variable generation from wind and solar power[50].

However, there are challenges associated with the operation of local flexibility markets. Ensuring sufficient participation from FSPs is crucial for the market's success. Additionally, the regulatory framework must support the development and operation of these markets, providing clear guidelines and incentives for both DSOs and FSPs. Effective communication and coordination between market participants are also essential to ensure the efficient functioning of the market. The development of local flexibility markets is expected to continue as the energy transition progresses and with the future advances in smart grid technology, energy storage, and digital platforms.

3.3 Benchmarking against Bulgaria, recommendations and implementation roadmap

The benchmarking analysis between Bulgaria and Norway reveals significant differences in their regulatory frameworks and the operation of DSOs, which impact the establishment and functioning of energy communities. Norway's regulatory environment is characterized by a well-defined and supportive framework for residential and industrial prosumers, including incentives for self-consumption and energy sharing, robust DSO responsibilities, and advanced technological infrastructure such as the Elhub data platform. Norwegian DSOs operate under a clear set of regulations that ensure efficient, reliable, and sustainable grid management, supported by economic incentives like revenue caps and grid tariffs designed to promote renewable energy integration, research and development initiatives, and local flexibility markets. Despite that, Norway lacks a clear framework for energy communities as such and has not accommodated for VNM in its current regulations, with energy sharing (of certain production size) across neighbouring entities being the closest one gets to energy community implementation. Still, piloting activities and the authorities commitments to EU regulations, indicate that Norway is on the right path regarding energy community development.

Bulgaria's regulatory framework for energy communities, on the other hand, is still evolving and faces several challenges. The current legislation, while recognizing energy communities, lacks detailed operational procedures and support mechanisms. Bulgarian DSOs are primarily focused on traditional grid management, with limited provisions for integrating decentralized

[50] https://www.sintef.no/projectweb/cineldi/cineldi-knowledge-base/niva-3/flexibility-markets-for-distribution-grids/

energy resources and facilitating energy sharing. The absence of a comprehensive smart metering rollout and real-time data exchange further hampers to a certain extent the development of energy communities.

To accommodate energy community establishments, Bulgaria needs to undertake several future steps: in the short, medium and long term. Firstly, it should develop a dedicated regulatory framework that includes clear definitions and operational guidelines for energy communities, similar to Norway's approach. This framework should address grid access, metering, and data exchange protocols to enable efficient energy sharing and self-consumption. In the middle term, there should be facilitated collaboration between DSOs, energy traders, and community members through streamlined administrative procedures and one-stop-shop services will enhance the overall efficiency and sustainability of energy community projects. Implementing incentives for renewable energy production and self-consumption, along with supportive grid tariffs and revenue cap models, will encourage the growth of energy communities. Lastly, Bulgaria could invest in technological infrastructure, such as a centralized data platform akin to Elhub, to facilitate real-time data collection and exchange.

To ensure realistic approach to the benchmarking and recommendation steps, we have made a number of interview with a variety of stakeholders. During the rounds of interviews with DSOs we recognized that the interest in virtual billing is higher than the introduction of VNM. The **virtual billing mechanism** allows consumers to receive financial credits on their electricity bills corresponding to the amount of renewable energy produced elsewhere, without directly offsetting their consumption. This system is often more straightforward to implement within existing billing infrastructures, as it primarily involves financial transactions rather than physical energy flow adjustments.

Countries like Greece have already progressed from VNM to virtual billing. Greece's legal framework for energy communities facilitates collective self-consumption through virtual net metering, enabling consumers to benefit from renewable energy production without on-site installations.

Thus, the project partners recognize net metering and virtual net metering as easier and more appealing concepts from a prosumer perspective rather than virtual billing. However, virtual billing is a good start for customers (including prosumers and energy communities) who have the financial culture, who aim for environmental responsibility or both.

The long-term impact of self-consumption on grid stability and tariff structures is an aspect that remains insufficiently explored. The SEDA report warns that large-scale prosumer participation could lead to cost shifts between self-consumers and other electricity users, particularly if prosumers are exempted from certain grid fees while still relying on network services for surplus energy exports. Addressing this issue requires a careful reassessment of tariff structures to ensure that prosumers contribute fairly to network maintenance costs while being incentivized to maximize local energy consumption and storage.

Technology status in Bulgaria

4 Technical specifications

4.1 Technology status in Bulgaria

4.1.1 Energy metering and accounting of production and consumption

Electricity in Bulgaria is metered through commercial metering devices installed at grid connection points, managed exclusively by DSOs. Prosumers and energy producers must have bidirectional meters capable of recording both imported (consumed) and exported (produced) electricity. These meters are installed and maintained by DSOs under the Electricity Measurement Rules (Правила за измерване на количеството електрическа енергия, issued by EWRC) and the Ordinance on Metering and Settlement of Electricity Quantities (Наредба № 6/2014 г. за измерване на количествата електрическа енергия).

Billing for electricity consists of several components:

- **Electricity price** (determined by contract for free-market consumers or set by the regulator for regulated consumers).
- **Network charges** for transmission (Такса пренос) and distribution (Такса разпределение), set by the **EWRC**.
- **Obligation to Society Fee** (Такса "Задължение към обществото") to support renewables and cogeneration.
- **Excise duty** on electricity (Акциз върху електрическата енергия).
- **Value-added tax (VAT)** applied to the total bill.

Prosumers receive compensation for excess electricity exported to the grid based on **market prices** or specific **feed-in tariff agreements**, depending on their contract and regulatory status. Billing responsibility depends on whether the consumer is on the regulated market or the free market. The roles of DSOs, energy traders, and suppliers are distinct, but all interact in the billing process.

4.1.2 Smart metering penetration in Bulgaria

The penetration of smart meters in Bulgaria is a subject to clarification. While various sources put the smart meter penetration rate in Bulgaria as low as 1%, we found out that quite a large portion of old meters in Bulgaria have been replaced and many of the models used are capable of recording dynamic profiles. Eurelectric clarified that only 34% of the meters in Bulgaria have remote functionalities, but they do not fully comply with the EU smart metering requirements as there are no local requirements and no rollout defined. The rollout of smart meters is not mandatory for households, despite EU recommendations, and is hindered by regulatory delays and cost concerns.

DSOs are responsible for installing, maintaining, and managing smart meters in accordance with the Electricity Measurement Rules and Grid Connection Ordinance (Наредба за присъединяване на производители и потребители към електропреносната и електроразпределителните мрежи). However, the absence of a clear regulatory mandate for nationwide smart metering deployment limits the ability of consumers and energy communities to access real-time consumption and production data.

4.1.3 Energy data exchange and access regulations

Energy data exchange between market participants is governed by the Energy Act (ЗЕ) and secondary legislation issued by EWRC. The key actors involved in data exchange include:

- Producers and prosumers – required to submit generation data to DSOs for settlement purposes.
- DSOs – responsible for collecting and verifying metering data before transmitting it to TSOs, suppliers, and traders.
- Electricity System Operator (ESO - TSO) – manages balancing responsibilities and requires aggregated production and consumption data from DSOs.
- Traders and suppliers – require access to consumer metering data for billing and market trading.
- Consumers – currently have limited access to real-time data, as smart meters are not widespread, and data exchange is restricted.

Currently, there are no legal provisions allowing energy communities or third parties to directly access metering data from DSOs in real-time. Data access is controlled under the Personal Data Protection Act (Закон за защита на личните данни), restricting sharing without explicit consumer consent. This limits the ability of energy communities to optimize self-consumption, implement collective billing, or develop VNM arrangements.

To enable efficient energy sharing and market participation for energy communities, Bulgaria needs:

- A nationwide smart metering rollout plan, ensuring all prosumers have granular dynamic profile reading at the end of each period (now set at one month) and in the future ideally aiming for real-time production and consumption visibility.
- Regulatory changes to allow energy communities to access metering data, with standardized digital interfaces for data exchange and regulated granted access to the data to third parties (such as energy traders and aggregators).
- Clear rules for VNM and Virtual Billing, allowing production to be accounted for across multiple consumption points.

4.1.4 Proposal for smart meter utilization and dynamic pricing in Bulgaria

The DSOs in Bulgaria have already installed smart meters for many consumers, but their full functionality remains underutilized. Currently, metering data is collected only once a month, while the existing smart meters can technically record energy consumption at hourly or even 15-minute intervals. However, these meters do not transmit data in real-time, limiting their use for dynamic pricing and demand-side flexibility.

One way to work around this limitation is to introduce a market-based mechanism where energy traders provide price signals to consumers either day-ahead or in real-time. This would allow households and businesses to adjust their consumption patterns in response to electricity prices, optimizing self-consumption and grid efficiency.

Instead of requiring real-time data transmission, the consumption patterns would be logged by the smart meters and reconciled at the end of the month. The final billing would still reflect the consumer's actual consumption curve, but would be structured around price signals received earlier, ensuring an efficient and transparent process.

Data Collection Requirements

To implement this system, the following types of data would need to be collected and processed:

1. Consumption data from smart meters:
    - Hourly or 15-minute consumption records (stored by the smart meter).
    - Total monthly consumption + dynamic profile - collected by the DSO and used for final billing by the trader. This made available through an online platform accessible for the customer and a third party whose right is granted by the customer.
    - Requirement to **make metering data available to customers for at least the past 13 months** comes from the **European Commission Recommendation 2012/148/EU** on preparations for the roll-out of smart metering systems.
2. Price signals from energy traders (via a platform with user interface - e.g. an app):
    - Day-ahead or real-time electricity price updates.
    - Tariff structure applied to individual consumers or consumer groups.
    - The data platform of the energy traders should be compatible with other smart grid application that may be used by the customers.
3. Consumer behaviour data (Optional, for Optimization Purposes):
    - Self-determined or automated appliance usage patterns (e.g., setting washing machines or heating systems to run when electricity is cheapest).
    - Energy storage or EV charging behaviour if applicable.

At the end of the month, the recorded smart meter data would be compared against the price signals received to calculate the final bill based on actual consumption patterns rather than just total monthly usage.

Legal and data protection framework

For this system to be legally implemented in Bulgaria while ensuring data protection and security compliance, several key legal amendments and regulatory approvals are required.

1. Alignment with the Personal Data Protection Act (Закон за защита на личните данни) and GDPR:
    - Electricity consumption data is considered personal data when linked to individuals.
    - Consumers must provide explicit consent for their data to be used for dynamic billing and demand response purposes and disclosed with third parties.
    - Data minimization principles must apply, ensuring that only necessary consumption data is collected and processed.
2. Approval from the EWRC (KEBP):
    - Smart meter data disclosure rules must be defined, ensuring that only aggregated or anonymized data is shared with the relevant authorities for planning and statistical purposes
    - Energy traders must be authorized to send pricing signals and access hourly or 15-minute smart meter data, but only for billing and forecasting purposes.
    - EWRC has to develop rules that allow the design of certain flexibility services and capabilities - e.g. conditions and consent under which aggregators can orchestrate

the consumptions of small consumers such as households; as well as conditions under which traders/DSOs can apply penalty fees in cases of high consumption during peak demand periods.

3. Coordination with DSOs and TSOs:
    - DSOs must enable smart meter programming to record hourly or 15-minute intervals, even if data is collected only monthly.
    - TSOs must ensure grid stability and monitor how dynamic consumption patterns affect balancing and network congestion and must plan for potential need to evacuate energy from certain regions in the cases when energy production is decoupled from the location of the energy consumption.
4. Consumer Transparency and Opt-In Mechanism:
    - Consumers should be able to opt-in voluntarily to this pricing scheme, with full transparency on how their data will be used.
    - The contract between the consumer and the energy trader should clearly define:
        i. How frequently data will be used for billing.
        ii. What level of detail the trader will access.
        iii. How consumers can withdraw consent.

Legal Enforcement Mechanisms

To introduce this system into Bulgarian law, the following legal amendments and regulatory changes would be needed:

1. Amendment to the Energy Act (ЗЕ)
    - Include a provision allowing energy traders to send dynamic price signals and consumers to adjust their usage accordingly.
    - Ensure verified smart meter data can be used for billing based on historical price signals, even if it is only collected monthly.
2. New regulation under the Electricity Measurement Rules (Правила за измерване на количеството електрическа енергия)
    - Define the responsibility of DSOs to enable hourly or 15-minute metering functionality without real-time transmission.
    - Specify that energy traders may access this data exclusively for settlement purposes.
3. Introduction of a Data-Sharing Framework
    - Establish clear guidelines for secure data exchange between DSOs, traders, and consumers, in line with GDPR.
    - Ensure consumers have full control over their data access permission

This approach would allow Bulgaria to maximize the potential of already installed smart meters without requiring costly real-time data transmission infrastructure. It would enable dynamic, time-based pricing, improving grid efficiency, demand-side flexibility, and cost savings for consumers.

Technology status in Norway

4.2 Technology status in Norway

4.2.1 Overview of Elhub's operation

Elhub functions as a central data hub for the Norwegian electricity market, facilitating the exchange of information among various market participants, including grid operators, power suppliers, and balance suppliers[51]. It plays a crucial role in supporting several key business processes essential for the efficient operation of the electricity market.

The key actors involved in Elhub's operations include grid operators, who are responsible for maintaining the physical infrastructure and providing meter readings; power suppliers, who sell electricity to consumers; balance suppliers, who are responsible for balancing supply and demand in the electricity market; and end customers, who have contractual relationships with market participants regarding network connection, supply of electricity, or other related services.

Elhub ensures that all data exchanged is accurate, timely, and protected against unauthorized access. This includes compliance with personal data laws and the use of advanced security measures such as encryption and authentication. Elhub provides guidelines and technical specifications for integrating with its systems, ensuring that all market participants can efficiently and accurately exchange data with Elhub[52].

4.2.2 Business processes supported by Elhub

Elhub supports several critical business processes that are essential for the efficient operation of the Norwegian electricity market. These processes include:

Metering: Elhub facilitates the collection and validation of meter readings from grid operators. This process ensures that accurate data is gathered from smart meters installed at consumers' premises and submitted to Elhub using standardized messages. The validation process includes initial checks for basic errors and more advanced consistency checks to ensure the accuracy of the data.

Supplier Switching: Elhub manages the process of switching electricity suppliers for consumers. This involves updating records to reflect the new supplier and ensuring a seamless transition for the consumer. The process is designed to be efficient and accurate, minimizing disruptions for consumers.

Billing and Settlement: Elhub ensures that financial transactions between market participants are accurately processed and settled. This includes the calculation of charges based on meter readings and the reconciliation of payments between suppliers and grid operators. The process is designed to ensure transparency and accuracy in financial transactions.

Master Data Management: Elhub is responsible for updating and maintaining master data related to metering points, customers, and contracts. This includes ensuring that all data is accurate and up-to-date, and that any changes are reflected in the system promptly. Master

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51 https://www.nve.no/norwegian-energy-regulatory-authority/retail-market/elhub/

52 https://elhub.no/app/uploads/2018/04/47f6755f6e127fa6d93d94ed2b2a1215.pdf

data management is essential for the efficient operation of the electricity market, as it ensures that all participants have access to accurate information.

End of Supply: Elhub manages the process when a customer ends their electricity supply contract. This involves updating records to reflect the termination of the contract and ensuring that all necessary steps are taken to finalize the termination. The process is designed to be efficient and accurate, minimizing disruptions for consumers.

Reconciliation: Elhub ensures that data related to energy consumption and production is accurate and reconciled between different market participants. This includes comparing meter readings with data from other sources and resolving any discrepancies. The reconciliation process is essential for maintaining the integrity of the data and ensuring that all participants have access to accurate information.

The system ensures that data is accurate, timely, and protected against unauthorized access, and provides guidelines and technical specifications for integrating with its systems.

4.2.3 Collection of meter readings

Meter readings are collected periodically by Metered Data Collectors (MDCs), which can be grid operators or other authorized entities. These readings are gathered from smart meters installed at consumers' premises and submitted to Elhub using standardized messages. The responsibility for collecting meter readings from end customers primarily lies with the grid operators, who use various communication technologies such as GSM, GPRS, LTE, and RF mesh networks to collect data from end customers.

The process of collecting meter readings involves several steps. Smart meters installed at consumers' premises record electricity consumption data at regular intervals. These meters are equipped with communication modules that enable remote data transmission. The collected data is then transmitted to the grid operators' systems using secure communication protocols. Grid operators aggregate the meter readings and prepare them for submission to Elhub. The data is formatted according to the standardized message specifications defined by Elhub, ensuring consistency and accuracy.

Once the meter readings are collected and validated by the grid operators, they are transferred to Elhub using the Elhub Messaging Interface (EMIF)[53]. The EMIF ensures that data is transmitted securely and efficiently between the grid operators' systems and Elhub. The data transfer process involves several key steps.

Initially, grid operators prepare the collected meter readings for transfer by formatting the data according to Elhub's message specifications. This preparation includes ensuring that all required fields are populated and that the data adheres to the specified format.

Following preparation, the data is transmitted to Elhub using secure communication protocols such as Transport Layer Security (TLS). This protocol ensures that the data is encrypted during transmission, thereby preventing unauthorized access.

53 https://dok.elhub.no/e27/elhub-messaging-interface-emif

4.2.4 Validation of meter readings

Upon receiving the data, Elhub performs an initial validation to check for basic errors such as missing data, incorrect formats, or out-of-range values. More advanced validation checks are then conducted, including consistency checks to ensure that the meter readings are consistent with historical data and expected consumption patterns. Additionally, cross-validation is performed by comparing the submitted readings with data from other sources, such as previous readings or estimates provided by balance suppliers. If any discrepancies or errors are detected during validation, Elhub generates nonconformity reports and communicates these issues back to the relevant market participants for correction.

Data Storage Process

Elhub uses a centralized database to store all collected data, including meter readings, master data, and transaction records. This centralized approach ensures consistency and easy access for authorized users. To protect sensitive information, all data stored in Elhub is encrypted, preventing unauthorized access and maintaining data integrity. Elhub follows regulatory requirements for data retention, storing data for a specified period before securely archiving or deleting it. Regular backups are performed to ensure data is not lost in case of system failures, and robust disaster recovery plans are in place to restore data quickly and efficiently.

Data Access

Elhub implements strict access control measures, allowing only authorized market participants to access specific data relevant to their operations. Different actors can access Elhub data through various means. Market participants, such as grid operators, power suppliers, and balance suppliers, can access detailed data through dedicated APIs and the Elhub Actor Portal. End customers can access their own data through Elhub's My Pages, via their electricity supplier's customer portal, or other authorized platforms. Authorized third parties can access data from customer metering points with customer consent. Public access to aggregated datasets is available through open APIs and downloadable files on the Elhub website.

For end customers, the data includes information about their metering points, historical and current meter readings, customer information registered by the grid operator and power supplier, information about the current electricity supplier, and the ability to manage third-party requests for access to their metering point data. End customers can log in to "My Pages" using secure authentication methods such as BankID or other supported login services, ensuring that only authorized users can access their personal data.

Public Access Datasets

Elhub provides several public access datasets designed to promote transparency, support innovation, and provide valuable insights into the Norwegian electricity market. These datasets include aggregated consumption data, which provides information on electricity consumption across different regions and time periods, and aggregated production data, which contains information on electricity production from various sources such as renewable energy and traditional power plants. Market process data includes information on various market processes such as supplier switching, contract changes, and end-of-supply events. Data quality reports provide information on the quality of data, including measurements and calculations, and are used for monitoring and improving data quality, ensuring compliance with regulatory standards, and supporting data-driven decision-making.

Data Security

Elhub places a strong emphasis on data security to protect the integrity and confidentiality of the information it handles. The system employs multiple layers of security measures, including encryption, authentication, and access control. All data transmitted between market participants and Elhub is encrypted using Transport Layer Security (TLS) to prevent unauthorized access during transmission. Additionally, Elhub uses WS-Security standards to ensure that messages are securely signed and encrypted.

Access to Elhub's systems is strictly controlled through the use of secure authentication methods, such as BankID, which ensures that only authorized users can access sensitive data. Elhub also implements role-based access control (RBAC) to restrict access to data based on the user's role and responsibilities. This ensures that users can only access the data necessary for their specific tasks, minimizing the risk of unauthorized access.

To further enhance security, Elhub conducts regular security audits and assessments to identify and address potential vulnerabilities. The system is designed to comply with relevant data protection regulations, including the General Data Protection Regulation (GDPR), ensuring that personal data is handled in accordance with legal requirements.

Elhub's disaster recovery plans include regular data backups and the implementation of robust recovery procedures to ensure data availability and integrity in the event of a system failure. These measures help to maintain the reliability and resilience of Elhub's operations, providing confidence to market participants that their data is secure and protected.

Public access datasets

Elhub provides several public access datasets designed to promote transparency, support innovation, and provide valuable insights into the Norwegian electricity market. These datasets include aggregated consumption data, which provides information on electricity consumption across different regions and time periods, and aggregated production data, which contains information on electricity production from various sources such as renewable energy and traditional power plants. Market process data includes information on various market processes such as supplier switching, contract changes, and end-of-supply events. Data quality reports provide information on the quality of data, including measurements and calculations, and are used for monitoring and improving data quality, ensuring compliance with regulatory standards, and supporting data-driven decision-making.

1. **Aggregated consumption data** provides aggregated data on electricity consumption across different regions and time periods. It includes hourly, daily, and monthly consumption data. The dataset can be used for market analysis, research, and public information. It helps in understanding consumption patterns and trends in different areas.

2. **Aggregated production data** contains aggregated data on electricity production from various sources, such as renewable energy (wind, solar, hydro) and traditional power plants. The dataset is valuable for analyzing production trends, supporting energy policy decisions, and promoting renewable energy initiatives.

3. **Market process data** includes data on various market processes, such as supplier switching, contract changes, and end-of-supply events. This dataset provides insights into the dynamics of the electricity market and can be used for understanding market activities, improving market efficiency, and supporting regulatory oversight.

4. **Data quality reports** provides information on the quality of data, including measurements and calculations. It includes reports on data completeness, accuracy, and timeliness and can be used for monitoring and improving data quality, ensuring compliance with regulatory standards, and supporting data-driven decision-making.

Public datasets are accessible through the Elhub API Portal. The portal provides detailed documentation on how to access and use the APIs. Some datasets are available as downloadable files directly from the Elhub website. These files can be used for offline analysis and research.

The public access datasets include consumption divided in different regions and consumption groups. The regions are, per price area, per grid settlement area and per municipality, and the consumption groups are primary, secondary and tertiary industry, households and leisure. The latter includes holiday homes and recreational facilities. To allow for proper anonymization of the datasets there is a minimum of 5000 metering points in the grid settlement dataset. For the same reason the municipality dataset is divided into three consumption groups, private (households and leisure), business (tertiary industry) and industry (primary and secondary industry).

4.3 Benchmarking against Bulgaria and recommendations

After series of consultation with key Bulgarian actors and testing the limitations with DSOs of what is feasible short-term and long term our team has reached the following proposal for data exchange that will, in our view, enable both prosumer and energy community models in Bulgaria while avoiding excess upfront burden for the DSOs or the public budgets. Thus, ultimately to the consumers and taxpayer.

Elhub is well-developed platform, and its architecture is free to inspire and copy for everyone. Of course, the adaptation to local conditions and the maintenance of such a platform is a constantly endeavour which is why we recommend a gradual approach that will allow for a quick take off of enabling practices while keeping the long-term goal of a common-nationwide platform at sight and within reach. We illustrate the desired limits through the description below where we have RES energy production under one DSO and consumption of this energy under a different DSO. Simpler arrangements where point of production and consumption are close or coincide fall within this scope.

Actors in the Model:

1. Consumer – residential or SME participant with a smart meter (under DSO A)
2. RES Producer / Energy Community – owns or co-owns the RES plant (connected to DSO B)
3. Trader / Aggregator – licensed market participant managing balancing, billing, data exchange, and energy sharing logistics.
4. DSO A & DSO B – responsible for validated meter readings and data disclosure.
5. ESO / IBEX / Market Operator – oversees balancing, nominations, and financial settlement.
6. EWRC - the national regulator responsible for setting tariffs, approving market rules, issuing licenses, and overseeing the operations of the TSO and DSOs

4.3.1 Cross-DSO prosumption via energy trader/aggregator in Bulgaria

Scenario overview

- A prosumer (Person A) is connected to DSO A's network.
- Person A owns shares in a RES plant (e.g., a PV park) connected to DSO B's network.
- An energy trader/aggregator acts as an intermediary to match Person A's share of generation with their consumption and handle market participation and settlement. The trader/aggregator manages the energy flows and administrative processes within both DSOs.

Step 1: Prosumption relationship established

- Person A joins an energy community or enters into a PPA or virtual net metering agreement with the RES plant. The model could be as simple as one individual owning a PV installation on the rooftop or the plot of his/her weekend home while the same person may consume this energy at the same place or while in his/her urban base.
- Ownership or contractual entitlement to a portion of RES generation is documented and validated (e.g., 10% of a 500 kW solar plant output).
-

Step 2: Energy trader/aggregator matches and balances

- The aggregator/trader pools the RES production and the consumption profiles of its clients.
- They match Person A's virtual share of production against their consumption.

Step 3: Metering and data exchange with DSOs
Smart meters- bidirectional or in the case of decoupled production and consumption at both ends (RES plant and prosumer) record production and consumption data; recording of hourly consumption profile should be a sufficient first step but, in the future, this will ideally happen at 15-min intervals.

The DSOs collect and validate this data and make it available to the consumer and a third party - an energy trader, based on explicit consumer consent (ideally the procedure should be simple, quick and streamlines).

This allows the trader to:

- Settle net consumption for Person A.
- Report imbalances and forecast better.
- Provide flexibility services if needed.

As per current practice this data is collected once a month and not in real time. This provides a dynamic consumer profile which is retrospective which can still be compared with the dynamic pricing of the market in the past month. This leaves one major gap - how to provide real-time price signals to the consumers so they can adjust their consumption. Until real-time or near real-time data transmission is introduced in Bulgaria, we propose the following solution for the development of which one or more energy traders can invest:

- For balancing purposes, the energy trader provides (e.g. through an app) information about the power prices day-ahead and spot market so that the consumer is exposed to the price signals through dynamic pricing and can plan their consumption when prices are low (excess power generation) and avoid consumption when prices are high (peak demand of power). Ideally the platform that provides the pricing information is compatible with all sorts of smart applications such as smart devices, smart charging, storage, etc.
- The consumer profile is then matched at the end of a given period with the consumption profile for the same period provided by the DSO platform.

4.3.2 Changing the energy trader: How data access should work?

Step 1: Customer consent for data sharing
Person A authorizes a new energy trader/aggregator (Trader B) to access their smart meter data from DSO A. This consent is registered via a standardized consent form and reflected in the DSO's data hub where metering data is collected and available.

Step 2: DSO Notified of switch
Upon switching, DSO A is automatically notified through the platform. The DSO revokes access from Trader A and grants access to Trader B to:

- Historical validated data (up to 13 months as per EU guidelines).

- Future collected consumption data and ongoing consumption/load profile data until another provider switch is required by the customer.

We recommend the introduction of a defined transition period (e.g., 10 business days) which allows for proper data handover and billing finalization. After that, Trader B becomes the active partner responsible for balancing, billing, and managing Person A's energy flows.

4.3.3 Specification of the platform needed

It could start as separate platforms managed by each DSO. It will be more cost efficient if DSO co-develop their data platform around the same architecture and consider the possibility that the platforms will unite under a common platform in the future - managed by a government agency or co-owned by the DSOs. EU regulations require the data platform to keep data for 13 months.

Minimum two platforms are needed - one by the DSOs (or jointly developed by the DSOs even though managed as 3 different platforms) which collects and provides the verified dynamic profiles of the producers/consumers. The other platform could also be jointly developed by energy traders but operated by each trader as energy prices obtained by each trader could differ - this platform requires a customer interface (e.g., an app) which would allow the trader to provide pricing forecast to the customer day-ahead and real time market price so that the customer can adjust consumption according to the moments of excess or deficit energy production. Some examples of traders' platforms in Norway that provide apps for the end-users, with ability to incorporate smart energy management are Tibber[54], Fjordkraft[55], Smart Energi[56]. In addition, there are platforms that provide comparison and facilitate the customers' choice and change of trader – for example Strøm.no and Bytt.no[57] (Norway) and Elca.bg[58] (in Bulgaria). Change of the third-party disclosure should be feasible (e.g., customer changes the energy trader).

[54] https://tibber.com/en
[55] https://www.fjordkraft.no/
[56] https://www.smartenergi.com/
[57] https://www.bytt.no/
[58] https://www.elca.bg/

Energy Community Register

5 Energy community register

Bulgaria as a Member State of the European Union, was required to implement two European Directives:

- Directive (EU) 2019/944 on common rules for the internal market for electricity and amending Directive 2012/27/EU and
- Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources (RED II)

These Directives include a range of new regulations to provide greater legal and policy certainty for the development of new players on the energy market – e.g., CECs and RECs, with possibility to be producer, consumer, trader sharer of energy (mainly electricity from renewable energy). Table 1 shows the texts of the Directives (EU) 2019/944 and (EU) 2018/2001 and Energy Act and RES Act related to the two types of energy communities, allowing us to compare the degree of transposition of the two directives into Bulgarian laws as well as to compare the provisions of Energy Act and ERSA regarding CECs and RECs.

Table 1 - Comparison between the provisions of Energy Act and RES A regarding CECs and RECs

CECs	RECs
European regulatory framework: **Directive (EU) 2019/944 on common rules for the internal market for electricity and amending Directive 2012/27/EU** Consideration (46) in the Directive: Citizen energy communities constitute a new type of entity due to their membership structure, governance requirements and purpose. They should be allowed to operate on the market on a level playing field without distorting competition, and the rights and obligations applicable to the other electricity undertakings on the market should be applied to citizen energy communities in a non-discriminatory and proportionate manner. Those rights and obligations should apply in accordance with the roles that they undertake, such as the roles of final customers, producers, suppliers or distribution system operators. Citizen energy communities should not face regulatory restrictions when they apply existing or future information and communications technologies to share electricity produced using generation assets within the citizen energy community among their members or shareholders based on market principles, for example by offsetting the energy component of members or shareholders using the generation available within the community, even over the public network, provided that both metering points belong to the community. Electricity sharing enables members or shareholders to be supplied with electricity from generating installations within the community without being in direct physical proximity to the generating installation and without being behind a single metering point. Where electricity is shared, the sharing should not affect the collection of network charges, tariffs and levies related to electricity flows. The sharing should be facilitated in accordance with the obligations and correct timeframes for balancing, metering and settlement. The provisions of this Directive on citizen energy communities do not interfere with the competence of Member States to	European regulatory framework: **Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources (RED II)** Consideration (26) in the Directive: Member States should ensure that renewable energy communities can participate in available support schemes on an equal footing with large participants. To that end, Member States should be allowed to take measures, such as providing information, providing technical and financial support, reducing administrative requirements, including community-focused bidding criteria, creating tailored bidding windows for renewable energy communities, or allowing renewable energy communities to be remunerated through direct support where they comply with requirements of small installations. Consideration (71) in the Directive: The specific characteristics of local renewable energy communities in terms of size, ownership structure and the number of projects can hamper their competition on an equal footing with large-scale players, namely competitors with larger projects or portfolios. Therefore, it should be possible for Member States to choose any form of entity for renewable energy communities, provided that such an entity may, acting in its own name, exercise rights and be subject to obligations. To avoid abuse and to ensure broad participation, renewable energy communities should be capable of remaining autonomous from individual members and other traditional market actors that participate in the community as members or shareholders, or who cooperate through other means such as investment. Participation in renewable energy projects should be open to all potential local members based on objective, transparent and non-discriminatory criteria.

design and implement policies relating to the energy sector in relation to network charges and tariffs, or to design and implement energy policy financing systems and cost sharing, provided that those policies are non-discriminatory and lawful. <u>Consideration (47) in the Directive:</u> This Directive empowers Member States to allow citizen energy communities to become distribution system operators either under the general regime or as 'closed distribution system operators. Once a citizen energy community is granted the status of a distribution system operator, it should be treated as, and be subject to the same obligations as, a distribution system operator. The provisions of this Directive on citizen energy communities only clarify aspects of distribution system operation that are likely to be relevant for citizen energy communities, while other aspects of distribution system operation apply in accordance with the rules relating to distribution system operators. **Article 2, (11) in the Directive (definitions):** "Citizen energy community" means a legal entity that: (a) is based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises. (b) has for its primary purpose to provide environmental, economic or social community benefits to its members or shareholders or to the local areas where it operates rather than to generate financial profits; and (c) may engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders. **Article 16, in the Directive:** Citizen energy communities 1. Member States shall provide an enabling regulatory framework for citizen energy communities ensuring that: (a) participation in a citizen energy community is open and voluntary; (b) members or shareholders of a citizen energy community are entitled to leave the community, in which case Article 12 applies; (c) members or shareholders of a citizen energy community do not lose their rights and obligations as household customers or active customers; (d) subject to fair compensation as assessed by the regulatory authority, relevant distribution system operators	Measures to offset the disadvantages relating to the specific characteristics of local renewable energy communities in terms of size, ownership structure and the number of projects include enabling renewable energy communities to operate in the energy system and easing their market integration. Renewable energy communities should be able to share between themselves energy that is produced by their community-owned installations. However, community members should not be exempt from relevant costs, charges, levies and taxes that would be borne by final consumers who are not community members, producers in a similar situation, or where public grid infrastructure is used for those transfers. **Article 2, (16) in the Directive (definitions):** "Renewable energy community'" means a legal entity: (a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity. (b) the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities. (c) the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits. **Article 22, in the Directive:** Renewable energy communities 1. Member States shall ensure that final customers, in particular household customers, are entitled to participate in a renewable energy community while maintaining their rights or obligations as final customers, and without being subject to unjustified or discriminatory conditions or procedures that would prevent their participation in a renewable energy community, provided that for private undertakings, their participation does not constitute their primary commercial or professional activity. 2. Member States shall ensure that renewable energy communities are entitled to: (a) produce, consume, store and sell renewable energy, including through renewables power purchase agreements; (b) share, within the renewable energy community, renewable energy that is produced by the production units owned by that renewable energy community, subject to the other requirements laid down in this Article and to maintaining the rights and obligations of the renewable energy community members as customers; (c) access all suitable energy markets both directly or through aggregation in a non-discriminatory manner.

cooperate with citizen energy communities to facilitate electricity transfers within citizen energy communities; (e) citizen energy communities are subject to non-discriminatory, fair, proportionate and transparent procedures and charges, including with respect to registration and licensing, and to transparent, non-discriminatory and cost-reflective network charges in accordance with Article 18 of Regulation (EU) 2019/943, ensuring that they contribute in an adequate and balanced way to the overall cost sharing of the system. 2. Member States may provide in the enabling regulatory framework that citizen energy communities: (a) are open to cross-border participation; (b) are entitled to own, establish, purchase or lease distribution networks and to autonomously manage them subject to conditions set out in paragraph 4 of this Article; (c) are subject to the exemptions provided for in Article 38(2). 3. Member States shall ensure that citizen energy communities: (a) are able to access all electricity markets, either directly or through aggregation, in a non-discriminatory manner; (b) are treated in a non-discriminatory and proportionate manner with regard to their activities, rights and obligations as final customers, producers, suppliers, distribution system operators or market participants engaged in aggregation; (c) are financially responsible for the imbalances they cause in the electricity system; to that extent they shall be balance responsible parties or shall delegate their balancing responsibility in accordance with Article 5 of Regulation (EU) 2019/943; (d) with regard to consumption of self-generated electricity, citizen energy communities are treated like active customers in accordance with point (e) of Article 15(2); (e) are entitled to arrange within the citizen energy community the sharing of electricity that is produced by the production units owned by the community, subject to other requirements laid down in this Article and subject to the community members retaining their rights and obligations as final customers. For the purposes of point (e) of the first subparagraph, where electricity is shared, this shall be without prejudice to applicable network charges, tariffs and levies, in accordance with a transparent cost-benefit analysis of distributed energy resources developed by the competent national authority. 4. Member States may decide to grant citizen energy communities the right to manage distribution networks in	3. Member States shall carry out an assessment of the existing barriers and potential of development of renewable energy communities in their territories. 4. Member States shall provide an enabling framework to promote and facilitate the development of renewable energy communities. That framework shall ensure, inter alia, that: (a) unjustified regulatory and administrative barriers to renewable energy communities are removed; (b) renewable energy communities that supply energy or provide aggregation or other commercial energy services are subject to the provisions relevant for such activities; (c) the relevant distribution system operator cooperates with renewable energy communities to facilitate energy transfers within renewable energy communities; (d) renewable energy communities are subject to fair, proportionate and transparent procedures, including registration and licensing procedures, and cost-reflective network charges, as well as relevant charges, levies and taxes, ensuring that they contribute, in an adequate, fair and balanced way, to the overall cost sharing of the system in line with a transparent cost-benefit analysis of distributed energy sources developed by the national competent authorities; (e) renewable energy communities are not subject to discriminatory treatment with regard to their activities, rights and obligations as final customers, producers, suppliers, distribution system operators, or as other market participants; (f) the participation in the renewable energy communities is accessible to all consumers, including those in low-income or vulnerable households; (g) tools to facilitate access to finance and information are available; (h) regulatory and capacity-building support is provided to public authorities in enabling and setting up renewable energy communities, and in helping authorities to participate directly; (i) rules to secure the equal and non-discriminatory treatment of consumers that participate in the renewable energy community are in place. 5. The main elements of the enabling framework referred to in paragraph 4, and of its implementation, shall be part of the updates of the Member States' integrated national energy and climate plans and progress reports pursuant to Regulation (EU) 2018/1999. 6. Member States may provide for renewable energy communities to be open to cross-border participation.

their area of operation and establish the relevant procedures, without prejudice to Chapter IV or to other rules and regulations applying to distribution system operators. If such a right is granted, Member States shall ensure that citizen energy communities: (a) are entitled to conclude an agreement on the operation of their network with the relevant distribution system operator or transmission system operator to which their network is connected; (b) are subject to appropriate network charges at the connection points between their network and the distribution network outside the citizen energy community and that such network charges account separately for the electricity fed into the distribution network and the electricity consumed from the distribution network outside the citizen energy community in accordance with Article 59(7); (c) do not discriminate or harm customers who remain connected to the distribution system. **Bulgarian regulatory framework – Art 92b in EA** Art. 92b. (New - SG 86/23, in force from 13.10.2023) (1) End customers, including household ones, may participate in a civil energy community without losing their rights or obligations as end customers and without fulfilling unreasonable or discriminatory conditions or procedures that would hinder their participation in the civil energy community. When undertakings participate in civil energy communities, their participation must not be related to their main commercial or professional activity. (2) Civil energy communities may be organized in the form of a trade company, a cooperative, a non-profit association under the Management of Condominiums Act or a civil association under the Obligations and Contracts Act, subject to compliance with the requirements of this law. (3) Relations between the members of the civil energy community shall be determined by a statute or contract according to the chosen organizational form, which necessarily contains the following: 1. the main goals related to environmental, economic and/or social benefits of members and/or the region; 2. the conditions regarding the development of projects for the production, consumption, storage, sale and/or sharing of energy within the community in accordance with the subject of the community's activity and the rights and obligations of the members of the community in connection therewith; 3. the conditions for raising and spending the funds regarding the environmental, economic and/or social activities and goals of the community; 4. the terms and conditions for protecting the rights of community members as energy users;	7. Without prejudice to Articles 107 and 108 TFEU, Member States shall take into account specificities of renewable energy communities when designing support schemes in order to allow them to compete for support on an equal footing with other market participants. **Bulgarian regulatory framework – Art 18b in ERSA:** Art. 18b. (New – SG, 86/23, in force from 13.10.2023) (1) End customers, including residential customers, may participate in a renewable energy community without losing their rights or obligations as end customers and without having to fulfill unreasonable or discriminatory conditions or procedures, that would prevent their participation in a renewable energy community. In case of participation of enterprises, their participation must not be related to their main commercial or professional activity. (2) Renewable Energy Communities: 1. may produce, consume, store and sell surplus amounts of energy from renewable sources as an equal participant in the energy markets under the conditions defined in the Energy Act, including through agreements for purchase of electric energy; 2. may share within the renewable energy community the energy, produced by installations, owned by the renewable energy community, respecting the rights and obligations of the members of the renewable energy community as consumers; 3. shall have access in a non-discriminatory manner to all relevant energy markets. (3) The development of renewable energy communities shall be promoted through: 1. removal of unreasonable regulatory and administrative obstacles; 2. application of the requirements of the Energy Act when selling energy and other energy services; 3. ensuring cooperation with the relevant distribution network operator and heat transfer company for transfer of energy in the community; 4. the competent authorities, applying fair, proportionate and transparent administrative procedures, including registration and licensing, and ensuring, that regulated prices for network services are applied to all network users, which should contribute in an adequate, fair and balanced way to the distribution of total costs for the system in accordance with a transparent analysis of the costs and benefits of distributed energy resources; 5. application of non-discriminatory treatment to communities in relation to their activities, rights and obligations as end-users, producers, suppliers, distribution system operators or as other market participants;

5. the types of funds, the conditions for distribution of dividends and the method of determining their amount. (4) Civil energy communities: 1. may produce, consume, store and sell excess amounts of energy as an equal participant in the energy markets under the conditions defined in this law and in the secondary legislation on its implementation, including through agreements for the purchase of electrical energy; 2. may share within the community the energy produced by installations owned by the community, while respecting the rights and obligations of the members as users; 3. shall have access in a non-discriminatory manner to all relevant energy markets. (5) The development of civil energy communities shall be promoted through: 1. removal of unreasonable regulatory and administrative obstacles; 2. application of the requirements of this law when selling energy and other energy services; 3. ensuring cooperation with the relevant distribution network operator and/or heat transfer company for the transfer of energy in the community; 4. implementation by competent authorities of fair, proportionate and transparent administrative procedures, including registration and licensing, which ensure that regulated prices for network services are applied to all network users, which should contribute in an adequate, fair and balanced way for the distribution of total costs for the system in accordance with a transparent costs and benefits analysis of the distributed energy resources; 5. applying non-discriminatory treatment towards communities in relation to their activities, rights and obligations as end users, producers, suppliers or as other market participants; 6. accessibility of all users to participate in communities, including households in a situation of energy poverty or vulnerable customers; 7. facilitating access to financing and information; 8. provision of regulatory support and assistance for building the capacity of public authorities in facilitating and creating energy communities and in facilitating their direct participation; 9. introduction of rules to guarantee the equal and non-discriminatory treatment of users participating in the civil energy community.	6. accessibility for all users to participate in communities, including low-income households or vulnerable clients; 7. facilitating access to finance and information; 8. providing regulatory support and assistance to build the capacity of public authorities in facilitating and creating renewable energy communities and in facilitating their direct participation; 9. introduction of rules to guarantee the equal and non-discriminatory treatment of users, participating in the renewable energy community. (4) To promote the development of renewable energy communities, the Executive Director of ASED shall prepare an assessment of the existing obstacles and the potential for development of renewable energy communities. (5) Information on the incentives under Para. 3 shall be presented with reports on the progress and updating of the Integrated Plan in the field of energy and climate of the Republic of Bulgaria in accordance with Regulation (EU) 2018/1999. (6) For renewable energy communities, the requirements of Art. 92b of the Energy Act shall apply. **Additional provisions** 56. (new – SG, 86/23, in force from 13.10.2023) "Community for renewable energy" is an entity without limitation of legal organizational form, which: a) is based on open and voluntary participation, is independent and is effectively controlled by its shareholders, partners or members; b) owns and manages installation/installations for the production of energy from renewable sources located within an urbanized area and facilities where its shareholders, partners or members consume the produced energy; c) consists of shareholders, partners or members who are natural persons, small and medium-sized enterprises or municipalities; d) has the primary objective of providing to its shareholders, associates or members or to the areas in which it operates, not so much financial as environmental, economic or social benefits

Additional provisions 76. (new - SG 86/23, in force from 13.10.2023) "Civil Energy Community" is a legal entity: a) based on voluntary and open participation, effectively controlled by members, partners or shareholders who are natural persons, municipalities or small undertakings; b) which has for its primary purpose the provision of environmental, economic or social community benefits to its members or shareholders or to the local areas in which it operates, rather than financial gain, and c) which may carry out production, including of energy from renewable sources, distribution, supply, consumption, aggregation, storage of electric energy, energy efficiency improvement services or electric vehicle charging services, or provide other energy services to its members or shareholders.	

5.1 Roadmap for the creation of an energy community register in Bulgaria, including key considerations and action steps.

According to the roadmap from Energy Communities Repository[59], "Registering as an energy community with a public authority to validate an initiative's status as an REC or CEC includes a procedure to submit required identifying information, as well as founding documents (statutes, articles of association, etc.) as required by national law. If designed with a long-term view, a registration system also provides a basis for logging and tracking information from registrants communities over time".

5.1.1 Key considerations to create register of energy communities

The main reasons for the creation of a Common Register of Energy Communities are as follows:

1. **Support for the sustainable development of energy communities:**

The register serves as official recognition and support for energy communities, which play an important role in the transition to sustainable energy sources.

2. **Legal framework:**

The introduced changes in EU legislation, especially the RED II, create the need for a clear legal framework to regulate the existence and functioning of energy communities.

3. **Facilitation of access to funding:**

The register can facilitate access to various financial instruments including grants, subsidies, and financing from different programs aimed at promoting sustainable energy policies.

4. **Transparency, trust, and accountability:**

The establishment of the register ensures transparency regarding the activities of energy communities, thereby increasing the trust of participants and investors.

5. **Exchange of information and experience:**

The register can serve as a platform for exchanging information and best practices among different energy communities, contributing to their development and resilience. It raises public awareness about the benefits of energy communities and their social, environmental, and economic roles.

6. **Encouragement of cooperation:**

The register can act as a platform for exchanging information, experience, and best practices among various energy communities, supporting their development.

These factors highlight the importance of registering energy communities as part of the efforts to promote sustainable development and the transition to renewable energy sources.

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[59] A roadmap for a policy and legal framework for energy communities (2024), Directorate-General for Energy, Energy Community Repository.

5.1.2 Roadmap for creation of energy community register in Bulgaria

This Roadmap proposes legislative and administrative steps for the establishment of a Register for CEC, REC and optionally of Active Customers (AC) and Consumers of their own electricity from Renewable energy sources (CERES). As further elaborated in Section 5.3.3, the Register shall be administered by the SEDA and in this way transparency, control and facilitated participation of these entities in the energy market will be ensured.

Legislative steps: Amendment of the RES Act and the Energy Act

A/ Creation of a new Article 18c and 18d in the RES Act

Art. 18c

(1) There shall be established a Register of Renewable Energy Communities and Citizen Energy Communities, (hereinafter referred to as "the Register").

(2) The Register shall be administered by the Sustainable Energy Development Agency (SEDA) and shall contain information on:

- Renewable Energy Communities (RECs) - type, structure, members, installed capacity, type of energy source used, location and place of connection of the relevant energy community, participants in the energy community, participation in the energy community of energy poor households or vulnerable consumers, mode of organisation, energy consumption and storage.
- Civil Energy Communities (CECs) - type, structure, members, installed capacity, type of energy source used, location and connection point of the respective energy community, participants in the energy community, participation in the energy community of energy poor households or vulnerable consumers, mode of organisation, energy consumption and storage.

(3) Entry in the Register shall be mandatory for all entities participating in the energy market in the specified categories to ensure transparency and control.

(4) SEDA shall monitor compliance with the obligations of the registration and shall provide publicly available information on the registered entities.

(5) The Minister of Energy shall adopt Ordinance for the management, maintenance and registration or relevant facts in the Register.

B/ Supplement to Art. 92b and 92c of the Energy Act in relation to the entry of circumstances in the Register concerning citizen energy communities.

C/ Discussion of an addendum to the Administrative Provisions in relation to the introduction of an obligation (and penalty) in case of non-compliance with the obligation to enter obliged entities in the Register.

Administrative and technical preparation, as well as project implementation

Stage 1: Analysis and preparation

- Review of European best practices.
- Definition of technical requirements for the Register.
- Preparation of a draft amendment to the RES Act, the Energy Act and accompanying regulations.

Stage 2: Legislative changes and approval

- Submission of the legislative proposal to the National Assembly.
- Discussion and adoption of a new Article 18c and 18d in the RES Act, in line with the proposal of the CECB.
- Development of the subordinate legislation - participants Ministry of Energy and SEDA.

Stage 3: Development of the register

- Development of the electronic registry system within the SEDA.
- Testing and implementation of basic functionalities.
- Integration with EWRC, ESO and other regulators' systems.

Stage 4: Implementation and monitoring

- Training of the SEDA team to manage the Register.
- Start of initial entry of entities.
- Monitoring of effectiveness and process improvements.

5.1.3 Legal and technical framework for the register, ensuring compliance with Bulgarian and EU laws.

Table 2 – Legal and technical framework for the register specified in the Energy Act and RES Act.

Energy Act – CECs	ERS Act – RECs
Additional provisions (76): c) which may carry out production, including of energy from renewable sources	**Art. 18b. (2)** 1. may produce, consume, store and sell surplus amounts of energy from renewable sources as an equal participant in the energy markets under the conditions defined in the Energy Act, including through agreements for purchase of electric energy;
Additional provisions (76): a) based on voluntary and open participation, effectively controlled by members, partners or shareholders who are natural persons, municipalities or small undertakings;	**Additional provisions (56):** a) is based on open and voluntary participation, is independent and is effectively controlled by its shareholders, partners or members;
Additional provisions (76): c) which may carry out production, including of energy from renewable sources, distribution, supply, consumption, aggregation, storage of electric energy, energy efficiency improvement services or electric vehicle charging services, or provide other energy services to its members or shareholders.	**Additional provisions (56):** b) owns and manages installation/installations for the production of energy from renewable sources located within an urbanized area and facilities where its shareholders, partners or members consume the produced energy;
Additional provisions (76): a) based on voluntary and open participation, effectively controlled by members, partners or shareholders who are natural persons, municipalities or small undertakings;	**Additional provisions (56):** c) consists of shareholders, partners or members who are natural persons, small and medium-sized enterprises or municipalities;

Additional provisions (76): b) which has for its primary purpose the provision of environmental, economic or social community benefits to its members or shareholders or to the local areas in which it operates, rather than financial gain, and	**Additional provisions (56):** c) consists of shareholders, partners or members who are natural persons, small and medium-sized enterprises or municipalities. d) has the primary objective of providing to its shareholders, associates or members or to the areas in which it operates, not so much financial as environmental, economic or social benefits
Art. 92b. (5): 5. applying non-discriminatory treatment towards communities in relation to their activities, rights and obligations as end users, producers, suppliers or as other market participants;	**Art. 18b. (3)** 9. introduction of rules to guarantee the equal and non-discriminatory treatment of users, participating in the renewable energy community.

In the Bulgarian Energy Act and ERS Act, the minor differences between CECs and RECs that exist according to the definitions in the Directives (EU) 2019/944 and (EU) 2018/200 have also been avoided. In Table 2, a comparison is made of the main requisites in the definitions for CEC and REC as recorded in the additional provisions of the EA and the ERSA. These requisites completely match. This consistency allows for the proposal that CEC and REC be registered in a unified national state register called "Register of Citizens' Energy Communities and Renewable Energy Communities in Bulgaria."

5.2 Benchmark of the legal framework regarding the registers of energy communities in 6 EU member states

As part of the project work, a brief study was conducted on the legal framework related to energy communities and the registers of energy communities in Greece, Germany, Italy, France, Romania, and Austria. Below are the results of the study and the sources from which the information was obtained.

5.2.1 Greece

In Greece, energy communities are primarily registered through the General Commercial Registry (GEMI). The GEMI oversees the National Register for RECs and CECs, where these entities must submit their statutes and relevant details to gain legal recognition[60].

As of November 2022, there were 1,406 active energy communities in Greece established under Law 4513/2018. However, legislative changes in March 2023, specifically Law 5037/2023, introduced new definitions for RECs and CECs, effectively phasing out the establishment of new energy communities under the previous law. Consequently, since April 1, 2023, new energy communities must be formed under the updated legal framework.

For those interested in forming an energy community in Greece, it's essential to follow the legal and administrative procedures outlined in the current legislation. A practical guide detailing

60 https://thegreentank.gr/wp-content/uploads/2024/11/202411_%CE%A4heGreenTank_EnComBrief_6_final_ENG-1.pdf

these steps, including the preparation of legal statutes, document submission to GEMI, and other foundational actions, is available to assist prospective energy communities[61].

Additionally, the European Commission's Energy Communities Repository offers a map showcasing various energy communities across Europe, including Greece. This resource provides insights into existing projects and can serve as inspiration for new initiatives. For the most current information and guidance, consulting the official GEMI website or contacting local authorities is recommended, as they can provide up-to-date details on registration processes and legislative requirements[62].

5.2.2 Germany

In Germany, energy communities—collective initiatives where citizens collaboratively generate and consume energy—are primarily organized as cooperatives ("Genossenschaften"). To formalize such an entity, it's essential to register as a member of a statutory auditing association ("Genossenschaftsverband") in accordance with § 54 of the Genossenschaftsgesetz (GenG) 2020. This registration ensures compliance with legal standards and provides a framework for cooperative operations[63].

Beyond cooperative registration, all participants in the German electricity and gas markets are mandated to register with the Core Energy Market Data Register ("Marktstammdatenregister"). This comprehensive, official register, managed by the Bundesnetzagentur (Federal Network Agency), serves as a centralized database for energy market participants and their installations. The registration process is facilitated through an online portal, accessible at Marktstammdatenregister[64]. This platform consolidates data to enhance transparency and streamline energy-related processes across the nation[65].

It's important to note that energy communities in Germany are subject to both national and European Union regulations. The Renewable Energy Sources Act ("Erneuerbare-Energien-Gesetz" or EEG) plays a pivotal role in shaping the national legal landscape for these communities. Additionally, EU directives, such as the Renewable Energy Directive II (RED II), influence the operational and legal frameworks of energy communities, promoting renewable energy adoption and citizen participation across member states[66]. For those interested in establishing or participating in an energy community in Germany, it's advisable to consult with legal experts familiar with cooperative law and energy regulations. Engaging with existing energy cooperatives can also provide practical insights and guidance on best practices within this sector[67].

[61] rescoop.eu
[62] energycommunityplatform.eu
[63] https://pub.norden.org/nordicenergyresearch2023-03/germany.html
[64] www.marktstammdatenregister.de
[65] clean-energy-islands.ec.europa.eu
[66] bundesnetzagentur.de
[67] pub.norden.org

5.2.3 France

In France, energy communities are collaborative legal entities aimed at producing, consuming, and managing energy locally and sustainably. The legal framework for these communities was clarified by a decree published at the end of 2023, which specifically defines the possible legal forms and criteria for proximity and autonomy[68][69].

To facilitate the development of renewable energy and the identification of suitable areas for their implementation, the Ministry of Energy Transition has established several tools:

1. Renewable Energy Mapping Portal: This tool helps municipalities identify acceleration zones for renewable energy projects in their territory. It provides objective and compilable data on energy-related themes in France[70].

2. National Register of Electricity Production and Storage Installations: This register presents installations connected to public electricity networks, offering a comprehensive view of energy production in the territory[71].

These tools are designed to support local authorities and project developers in planning and developing local energy solutions, in line with national energy transition objectives[72].

5.2.4 Italy

In Italy, the development of RECs has been actively promoted through legislative measures and financial incentives. These communities enable individuals, businesses, and local authorities to collaboratively produce, consume, and manage energy from renewable sources, fostering sustainability and local energy autonomy[73].

The legislative foundation for RECs in Italy began with the transposition of the European Union's Renewable Energy Directive (RED II) through the "Milleproroghe" Decree (Decree-Law 162/2019) in February 2020. This was further solidified by the Implementing Decree in December 2023, which allocated €5.7 billion to support the establishment and operation of RECs across the country. These funds aim to encourage the production and sharing of renewable energy, with specific provisions such as a non-repayable grant covering up to 40% of incurred costs for municipalities with fewer than 5,000 inhabitants.

To facilitate the registration and management of RECs, the Gestore Servizi Energetici (GSE), Italy's Energy Services Manager, has established a dedicated web portal. This platform provides technical guidelines and oversees the application process for RECs seeking to access incentive tariffs. However, it's important to note that the registration process can be complex, requiring substantial data input, which may pose challenges for community representatives[74].

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68 https://www.rescoop.eu/policy/transposition-tracker/enabling-frameworks-support-schemes/france
69 https://www.data.gouv.fr/fr/datasets/registre-national-des-installations-de-production-et-de-stockage-delectricite-au-31-08-2024/?utm_source=chatgpt.com
70 cler.org
71 planification.climat-energie.gouv.fr
72 data.gouv.fr
73 https://www.ambienteitalia.it/en/servizi/comunita-energetiche-rinnovabili-cer/
74 magaldigreenenergy.com

For a broader perspective, the European Commission's Energy Communities Repository offers a comprehensive map showcasing various energy communities across Europe, including those in Italy. This resource provides valuable insights into the distribution and activities of RECs, serving as a useful tool for stakeholders interested in the development of community energy projects[75].

In summary, Italy's commitment to advancing Renewable Energy Communities is evident through its robust legislative framework and substantial financial support. While the registration process entails detailed administrative procedures, resources like the GSE portal and the European Commission's repository are instrumental in guiding and supporting the establishment and growth of RECs throughout the country.

5.2.5 Romania

Romania has been actively developing the legal framework to support energy communities, aiming to empower citizens, local authorities, and businesses to participate in renewable energy initiatives. In December 2022, the government introduced legislation defining RECs through Emergency Ordinance 163/2022. This ordinance outlines the conditions and rights for RECs, emphasizing open participation and local control[76].

To facilitate the formal registration and governance of these energy communities, the National Energy Regulatory Authority (ANRE) has established a dedicated Energy Communities Register. This register ensures that energy communities operate transparently and in compliance with national regulations[77].

Starting from October 1, 2024, under ANRE Order no. 60/2024, changes will be implemented regarding the method of calculating the price of electricity sold during the trial period, as well as the maximum duration allowed for this period, depending on the installed capacity[78].

The Order, adopted at the end of August 2024 by the National Energy Regulatory Authority (ANRE), establishes the duration of the trial period for different categories of installations, depending on the power of the connection point and installed power of the plant. Thus, the trial period from the first energization is set as follows[79]:

- Category A installations: maximum 6 months;
- Category B and C installations: maximum 12 months;
- Category D installations: maximum 24 months.

Previously, these durations were not clearly specified, nor were there such detailed distinctions between categories. According to the new amendments, the price of energy delivered during the trial period will change as follows:

- In the case of a positive PZU price, for electricity produced and delivered to the National Energy System (SEN), the producer will receive from the TSO the lower value between

[75] rescoop.eu
[76] dbu.de
[77] https://www.rescoop.eu/policy/transposition-tracker/enabling-frameworks-support-schemes/romania
[78] https://www.linkedin.com/pulse/unlocking-renewable-energy-potential-romanias-updated-stamate-mypff/
[79] https://interreg-danube.eu/projects/nrgcom/news/creating-a-favorable-legal-framework-for-energy-communities-in-romania

the closing price of the next day price (PZU) in each imbalance settlement interval and 400 lei/MWh.

- In the case of a negative PZU price, the producer will pay the TSO the amount corresponding to the negative price for the energy delivered to the National Energy System.

Additionally, the users in the trial period will no longer be able to submit offers on the balancing market, a prohibition that was not clearly regulated before. Furthermore, the new regulation has introduced a fixed price of 400 RON/MWh as the upper limit for the price of electricity produced during the trial period.

Another significant change introduced by the adoption of ANRE Order no. 60/2024 is the obligation for users to register as a balancing responsible party (BRP) upon completion of the trials to participate in the electricity market. In the case that this registration does not occur, the production/consumption sites must be disconnected from the grid and remain so until the registration process is completed. Moreover, it is important to note that users will not be able to conduct functional tests on public holidays and legal days off, and they will be required to inform the relevant network operator and TSO upon completion of these tests.

5.2.6 Austria

Austria has been proactive in promoting energy communities, allowing citizens, businesses, and local authorities to collaboratively produce, consume, store, and sell renewable energy. The legal foundation for these initiatives was established with the Renewable Energy Expansion Act (EAG) enacted on July 7, 2021, which facilitates energy sharing using public electricity grids beyond individual property boundaries[80]. To support and regulate these energy communities, Austria has established a comprehensive framework:

E-Control Austria: The national regulatory authority responsible for overseeing energy markets, including energy communities. They provide guidelines and resources for establishing and operating energy communities[81].

Coordination Office for Energy Communities: This office serves as a central point of contact, offering information and support to existing and prospective energy communities. Their official website provides detailed guidance on legal requirements, registration processes, and operational best practices.

For those interested in registering an energy community in Austria, the Coordination Office's website offers a step-by-step guide and necessary forms. It's advisable to consult with legal and energy experts to ensure compliance with all regulatory requirements. By fostering the development of energy communities, Austria aims to enhance local energy production, increase public participation in the energy sector, and promote the use of renewable energy sources.

In Table 3, the laws of 6 EU member states are shown, in which the registration of energy communities (CECs, RECs) is defined, along with the institutions that administer and maintain the registers and the main requisites of these registers.

[80] de.wikipedia.org

[81] https://www.e-control.at/international/energy-community

Table 3 – Comparison of regulations and content of different countries' energy community registers

Comparative table of CECs and RECs in 6 countries of the European Union						
	Greece	**Romania**	**Austria**	**Germany**	**France**	**Italy**
Law or Regulation	Law 4513/2018. Energy Communities and other provisions Law 5037/2023,	LEGE nr. 220 din 27 octombrie 2008 pentru stabilirea sistemului de promovare a producerii energiei din surse regenerabile de energie*)	Energieeffizienzgesetz Energiecommunitygesetz	Erneuerbare-Energien-Gesetz	Loi relative à la transition énergétique pour la croissance verte	DECRETO LEGISLATIVO 8 novembre 2021, n. 199
Name of Register	Registry of Energy Communities	Registrul comunităților energetice".	Register der Energiegemeinschaften	Marktstammdatenregister (MaStR)	Registre National des Communautés Énergétiques (RNCE),	"Registro Nazionale delle Comunità Energetiche".
Administrated by	General Commercial Registry (GEMI).	Autoritatea Națională de Reglementare în Domeniul Energiei – ANRE	Bundesnetzagentur	Bundesnetzagentur (BNetzA)	Agency for Ecological Transition (ADEME)	Ministero dell'Economia e delle Finanze, Agenzia Nazionale per le Risorse Energetiche
Structure and content of Registry						
	The name and purpose of the Energy Community.	**Identification of the Energy Community:** - Name of the energy community. - Unique identification number.	**Name of the Energy Community.**	**Name of the Community.** Date of Commisioning	**Identification Data:** - Name of the energy community. - Date of establishment.	**Identification Data:** - Name of the energy community. - Date of establishment
	The category of the Energy Community in relation to the responsibility of its members.	**Legal Form:** - Type of legal entity (e.g., cooperative, association, etc	**Legal Status:** - Type of organization (cooperative, association, company, etc.).	**Energy Cooperatives and Communities:** They are registered as operators provided they own or manage energy facilities.	**Type of Organization:** (e.g., cooperative, association, etc.)	**Type of Organization:**

		Goal and Activities: - Main goals of the energy community. - Description of planned activities (e.g., energy production from renewable sources).	**Community Type:** Renewable Energy Community (REC) promoting local renewable sources. Citizen Energy Community (CEC) which can include both renewable and non-renewable sources. Production facilities: Type (solar panels, wind turbines, biogas plants, etc.). Installed power (in kW or MW). Commissioning date	**Energy Production Facilities:** - Photovoltaics (solar panels). - Wind turbines. - Hydroelectric power plants. - Biogas and biomass plants.	**Description of Projects:** - Information on current and planned projects related to renewable energy sources. - Types of technologies used (e.g., solar, wind, hydroelectric).	**Description of Projects:** - Information on current and planned projects related to renewable energy sources. - Types of technologies used (e.g., solar, wind, hydroelectric).
	The names of the legal representatives of the Energy Community	**Members of the Community:** - List of members, including individuals and legal entities. - Information about their contributions and obligations.	**Number of Participants:** - Number of households, businesses, or other entities that are part of the community. **Categories of Participants:** - Individuals. - Small and medium enterprises (SMEs). - Public institutions (e.g., schools, municipalities).		**Membership:** - Number of members and information about the participants in the community.	**Membership:** - Number of members and information about the participants in the community.
		Technical Approvals: - Records of obtained technical approvals and licenses.	**Legal and Regulatory Information:** - Community Statutes: Basic rules and objectives of the energy community. - Licenses and Permits: Information on regulatory requirements and compliance with legislation. - Agreements: Contracts between community members and TSO and DSOs		**Documents and Regulations:** - Stutes, operating rules, and other legal documents related to the functioning of the community.	**Documents and Regulations:** - Stutes, operating rules, and other legal documents related to the functioning of the community.
		Financial Information: - Information about the community's capital and financial mechanisms.	**Financial Information:** - Sources of Funding: Membership fees, grants, loans, and others. - Investments: Data on investments made in the community.	**Power Purchase Agreements.** Connections between Producers and Suppliers. Participation of Operators in Networks and Contracts with Network Companies.	**Financial Data**: - Main financial sources and funding models. - Information on membership fees and investments.	**Financial Data**: - Main financial sources and funding models. - Information on membership fees and investments

		Contact Information: - Address and contact details of the energy community.	**Contact Information:** - Address of the headquarters. - Contact person: Name, phone number, and email. - Managing board: Information about the members of the management team.		**Contact Information:** - Address of the headquarters. - Names and contacts of key representatives and the management team.	**Contact Information:** - Address and contact information of the community. - Names of key representatives.
			Geographical Location: - Location of the community: Area or municipality where the energy community operates. - Areas of activity: Territory covered by the community's network, including the location of energy production and consumption facilities.	**Location** (address, geographical coordinates)	**Geographical Location:** - Localization of projects and scope of activities (e.g., regional, local levels).	**Geographical Location:** - Localization of projects and scope of activities
			Energy Flow Data: **-** Production: Amount of energy produced by the community. - Self-consumption: Energy used internally within the community. - Shared Energy: Energy provided to community members. - Sale of Excess Energy: Data on energy sold to third parties or fed back into the grid.	**Data on Energy Flows. Information on:** - Energy produced (including renewable energy). - Energy consumption. - Shared and self-consumed energy (e.g., within energy communities).	**Production and Consumption Data:** - Data on energy produced and its usage.	**Production and Consumption Data:** - Data on energy produced and its usage.

From the analysis of various registers and the comparative Table 3, it is evident that the structures and content of the examined registers are relatively similar. The Austrian, French, and Italian registers most closely align with the definitions, structure and function of CECs and RECs described in EA and ERSA.

In analysing the content of the different registers, the following distinctive features stood out as positive:

- The Austrian, German, French, and Italian registers include a description of the geographical localization of CECs and RECs facilities, allowing for their connection to interactive geographical maps and geographic information systems.
- The Austrian, German, French, and Italian registers include data on energy produced and its usage, specifically:
    - "Amount of Produced Energy": The amount of energy generated by the community is recorded, usually expressed in megawatt-hours (MWh).
    - "Energy Sources": Information on the various technologies and renewable sources used for energy production (e.g., solar, wind, hydroelectric).
    - "Energy Consumption": The amount of produced energy utilized in CECs and RECs– for the community's own needs, sold to the electrical grid, or provided as services to third parties.
    - "Monitoring and Accountability": Requirements for regular reporting of produced and used energy, ensuring transparency and sustainable resource management.
- The German Register also includes "active customer" and "renewable self-consumer" who must register in the "Marktstammdatenregister". Registration is mandatory for anyone producing energy, regardless of whether it is used for personal needs or sold. This is part of Germany's efforts for transparency and effective management of the energy sector.

5.3 Governance model for the register, detailing roles and responsibilities of key stakeholders.

5.3.1 Information related to CECs and RECs, managed by the energy community register

After analysing the content of the registers described in Table 3, and after reviewing the activities, registration conditions, and functioning of CECs and RECs as described in Article 92b of the EA and Article 18a of the ERSA, as well as analysing the requisites of the definitions of CECs and RECs outlined in the additional provisions of the EA and ERSA, the following information for CECs and RECs is proposed for the unified national register of CECs and RECs:

1. Identification data:

- Name of the energy community.
- Date of establishment.

2. Legal status:

- Type of organization (cooperative, association, company, etc.).

3. Community type:

- Renewable Energy Community (REC) promoting local renewable sources.
- Citizen Energy Community (CEC) which can include both renewable and non-renewable sources.
- Production facilities:
    - Type (solar panels, wind turbines, biogas plants, etc.).
    - Installed power (in kW or MW).
    - Commissioning date

4. Number of participants:

- Number of households, businesses, or other entities that are part of the community.

5. Categories of participants:

- Individuals.
- Small and medium enterprises (SMEs).
- Public institutions (e.g., schools, municipalities).

6. Legal and regulatory information:

- Community Statutes: Basic rules and objectives of the energy community.
- Licenses and Permits: Information on regulatory requirements and compliance with legislation.
- Agreements: Contracts between community members and TSOs and DSOs.

7. Financial information:

- Sources of Funding: Membership fees, grants, loans, and others.

- Investments: Data on investments made in the community.

8. Contact information:

- Address of the headquarters.
- Contact person: Name, phone number, and email.
- Managing board: Information about the members of the management team.

9. Geographical location:

- Location of the community: Area or municipality where the energy community operates.
- Areas of activity: Territory covered by the community's network, including the location of energy production and consumption facilities.

10. Energy flow data:

- Production: Amount of energy produced by the community.
- Self-consumption: Energy used internally within the community.
- Shared Energy: Energy provided to community members.
- Sale of Excess Energy: Data on energy sold to third parties or fed back into the grid.

5.3.2 Governance model for the register

As is described in the roadmap from Energy Communities Repository[82], three general approaches can be observed in Member States of EU that have designed a system to register energy communities:

- Some Member States appoint an authority (NRA or Agency) to set up a register of energy communities. From a holistic perspective, such a system is ideal because it allows for clear identification of an energy community that can be used regardless of the activity being pursued. It also connects more easily to long-term monitoring over time.
- Some Member States have set up prequalification criteria market that actors must meet to access specific support schemes for RECs. Integrating prequalification criteria for energy communities under different support mechanisms or procedures can be complementary to setting up a general registration process. In the absence of a registration framework, using prequalification criteria can be helpful first step in jumpstarting energy communities while a more holistic national framework is being put in place.
- A few Member States combine registration of an energy community with a more formal licensing procedure to engage in particular activities within the energy sector (e.g. energy sharing). This could help streamline the registration process, because many energy communities are also trying to establish an energy sharing project. However, when using this approach, there are potential drawbacks that may need to be avoided. In Member States where such an approach has been utilised, it has coincided with a

[82] A roadmap for a policy and legal framework for energy communities (2024), Directorate-General for Energy, Energy Community Repository.

conflation between regulation of specific activities, such as energy sharing, and energy communities, which are an organisational concept. This can result in a misperception of the socio-economic added value of energy communities. It can also result in overly technical requirements being imposed on new energy communities, for instance capital requirements, demonstrable technical capacity, or an existing project. Such requirements overlook the fact that most new energy communities form before a concrete project has been realised, they usually start out with little capacity, and they may have broader goals spanning beyond one activity.

> *The establishment of a unified national register of CECs and RECs in Bulgaria is a crucial step toward integrating decentralized energy production, fostering sustainable energy development, and ensuring transparency in the sector.*

Regardless of the approach, demonstration of evidentiary requirements for registration or prequalification needs to be easy and simple for energy communities. Without conflating concepts, procedures to register as an energy community can be streamlined with other applicable procedures. In many Member States, setting up a legal entity already requires becoming registered, for instance in a commercial companies' registry. This is important to keep in mind, as this may imply coordination between different national authorities. Registration and prequalification requirements need be as light-touch as possible in order not to over-burden an energy community. Where energy communities have already established a legal entity that could comply with the national definitions, procedures can allow them to easily show proof that their set-up complies with the criteria.

The establishment of a unified national register of CECs and RECs in Bulgaria is a crucial step toward integrating decentralized energy production, fostering sustainable energy development, and ensuring transparency in the sector.

5.3.3 The Role of SEDA in administering the CEC and REC register

Table 3 described the authorities with role to set up and administrate registries of CECs and RECs in 6 different states members of EU. In all these states authorities are governmental entities and in 4 the obligations to administrate and maintain the Registry of CECs and RECs are imposed to states regulatory agencies for ecological transition.

The above-mentioned examples and the experience in creation and maintenance of:

- Unified electronic register of guarantees of origin, which is created and maintained by SEDA
- Public register of persons who can carry survey of the energy efficiency, building certification, compliance assessment of investment projects and preparation of energy savings assessment
- Public register of persons who can carry survey of industrial systems and systems for outdoor artificial lighting and energy savings assessments

from the SEDA are the reason to suggest the SEDA as well-positioned to create, maintain and administrate the CEC and REC Registry due to its expertise in monitoring sustainable energy initiatives.

Key responsibilities of SEDA relating to the Registry of CEC and REC will include:

- Registry creance maintenance and administration – Managing and updating the database, ensuring compliance with regulations, and processing registrations.
- Certification of Green Energy – Issuing certificates of origin and ensuring compliance with sustainability standards.
- Monitoring and Compliance – Conducting regular audits and assessments to ensure energy communities operate within the regulatory framework.

5.3.4 Registration process

- The information described in subchapter 5.3.1 shall be submitted in SEDA on the form explained in subchapter 5.5.
- Review and verification of compliance with legal requirements.
- Approval and issuance of a registration certificate.
- Periodic updates and compliance monitoring by SEDA.

5.3.5 Compliance and Monitoring

Registries can also be set up so that they can contribute to effective monitoring over time. There are several aspects around energy communities that need to be monitored at the national level. First, it is useful to monitor the development of energy communities over time, in numerical terms.

Monitoring can help identify whether commercial objectives or actors are becoming more prevalent in the sector. Having such information can help support decisions to refine criteria or incentives and ensure that support is received by actors that really need it.

Energy communities must comply with national energy regulations and EU directives:

- Annual reporting requirements to ensure transparency and accountability.
- Potential sanctions for non-compliance, including deregistration.

5.3.6 Public access to selected information

To ensure transparency and encourage investments all data related to an EC can be made accessible to the unregistered users, except those, who concern private information for internal contact with the members and those, who do not want to reveal to the public or is used for the classification of the EC. The availability of public accessible data shall aid the process of finding an EC in the register, as well as contacting its representative. Besides this information there could be added:

- **Searchable database** – Users can filter results by region, type of energy sources, and capacity.
- **Funding and support information** – Energy communities will have access to information about available subsidies, financing mechanisms, and government or EU programs promoting renewable energy.

5.3.7 Financial sustainability of the register

To maintain and update the registry, a fee-based model will be implemented. The following charges will apply:

- Initial Registration Fee – A one-time fee for new energy community registrations.
- Modification Fees – Fees for updating registered information.
- Annual Maintenance Fees – A periodic fee to ensure database maintenance and continuous improvement.

These fees will support the operational costs of the registry and ensure long-term sustainability.

5.4 Key stakeholders and responsibilities

5.4.1 Sustainable Energy Development Agency (SEDA)

- Administers, controls and maintains the information in Register described in subchapter . 5.3.1.
- Ensures and controls the compliance with Article 18b and §56 Additional Provisions of the RES Act and Article 92b and §76 Additional Provisions of the Energy Act .
- Provides guidance on the legal framework and registration process.
- Verifies the eligibility of applicants and approves their registration.
- Publishes and updates information on registered energy communities. Monitors the functioning of energy communities and reports to relevant authorities.
- Plays a crucial role in the issuance of Certificates of Origin (COs) (also known as GOs) for renewable energy communities.

- Prepare an assessment of the existing obstacles and the potential for development of renewable energy communities.

5.4.2 Energy and Water Regulatory Commission (EWRC)

- Determines the pricing of network services related to the use of energy infrastructure by energy communities.
- Regulates access to distribution networks and ensures fair competition.
- Oversees compliance with grid connection regulations and network tariffs.
- Issues regulatory guidelines and decisions on the integration of energy communities into the energy market.
- Issues of COs to CECs for high efficiency combined production of thermal and electricity
- Play an important role in creation and implementation of regulations and rules related smart metering and VNM

5.4.3 Ministry of Energy

- Oversees the implementation of the functions of the Energy Communities Register and monitors the activities of SEDA within the Minister's legal powers.
- Exercises control over the administration of the Register to ensure its compliance with national energy policy.
- Under Article 4 of the Energy Act, should develop and monitor the implementation of a national strategy for the development of energy communities in Bulgaria.
- Ensures alignment between national and EU policies in promoting decentralized energy production.
- Coordinates interinstitutional efforts to facilitate the integration of energy communities into the national energy system.
- Information on the incentives shall be presented with reports on the progress and updating of the Integrated Plan in the field of energy and climate of the Republic of Bulgaria in accordance with Regulation (EU) 2018/1999
- Shall monitor the performance of the Register and the usage of the information integrated in the registry system thereto.

5.4.4 TSO and DSOs

- Promote the development of renewable energy communities through cooperation with CECs and RECs for transmission and distribution of energy in and out of the community.

5.4.5 Energy communities

The register will include the following types of stakeholders in energy communities (CECs and RECs):

Depending on type of legal entities:

- Commercial companies
- Cooperatives
- Non-profit organizations
- Civil partnerships

Depending on type of membership in CECs and RECs:

- Non-profit legal entities that promote the use of renewable energy.
- Natural persons, small and medium enterprises, and local authorities.

Roles and responsibilities of CECs and RECs:

- Facilitate active citizen participation in energy markets.
- Operate in electricity generation, distribution, supply, and aggregation.
- Enhance energy democracy and decentralization of the energy system.
- Contribute to energy self-sufficiency and local economic benefits.
- Engage in production, consumption, storage, and sale of renewable energy.
- Owns and operates renewable energy installations (within an urbanized area only) and sites where its shareholders, partners or members consume the energy produced.

5.5 Operational guidelines and technical specifications for data management, security, and interoperability

There are two ways to submit the initial information described in 5.3.1:

1. **By electronical application form submitted by e-mail and/or physically:**

Completion of all necessary data (fields) is a necessary condition in order apply for registration of an CEC or REC. The data sent via the registration form shall be received on the E-mail of the responsible administrator/editor of the Registry, with a copy to the sender. In the very form adding an E-mail and contact phone of the representative of the CEC or REC shall be required.

In the Register, a copy of each application for registration must be kept to make references and download the registrations in a convenient file format (XLS/CSV). Archive of the sent registrations can be kept for a certain period. In the CEC or REC application form there must be required fields which shall facilitate the registration process and give possibility to make connection to the registrant.

2. **By sending an online registration of an CEC or REC request:**

To facilitate the process, it is recommended the request for an CEC or REC registration to be filled and send online. This shall shorten the process and reduce the costs, as well as lighten the users who want to register their energy community in the platform, saving them time and removing the necessity to go personally to offices and municipalities.

Of course, SEDA must define the necessary to be filled fields, and the required documents, in the registration form. Logic can be applied into the registration fields and to be shown and make required those, based on the user's choice. This shall make the process interactive, fast, and in case of missing or improper information representative of the legal entity shall contact the user who has made the request to clarify the issue.

The availability of an online registration form is not something unique. It is seen on the Websites of other registers in Europe, such as the ones in Austria and Spain. The French energy community network gives also possibility to create a user profile. In this case the legal and responsive for the register entity must decide to give the user access in order that he can update certain information in his public EC profile. Examples of online CEC and REC registration forms can be found at the Austrian information platform on energy communities[83][84], the Cler network in France[85], Energía Común[86] (the National Observatory on Energy Communities)

5.5.1 Accessibility of information in the registry

All data related to an energy community can be made accessible to the unregistered users, except those, who concern private information for internal contact with the members and those, who do not want to reveal to the public or is used for the classification of the EC. The

[83] https://energiegemeinschaften.gv.at/kontakt-beratung/

[84] https://energiegemeinschaften.gv.at/kontaktdaten-einreichen/

[85] https://cler.org/adherer-2/

[86] https://www.energiacomun.org/adhesion/

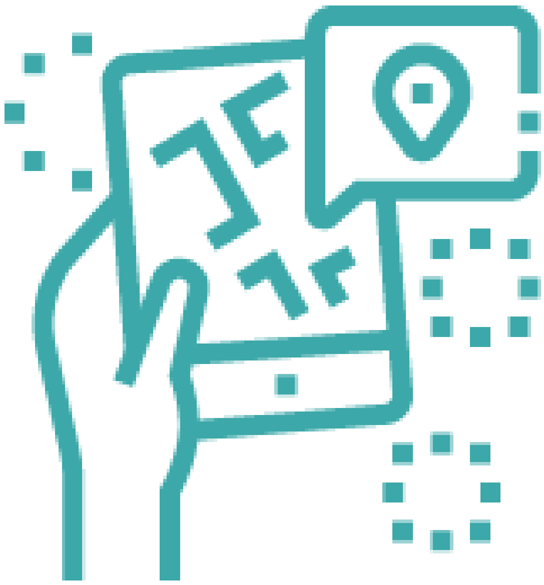
availability of public accessible data shall aid the process of finding an EC in the register, as well as contacting its representative. An example for information available to the public in an inline register in Spain can be found at Energía Común[87].

Information for internal usage should be accessed only from editor and administrator of the register and considered as one, related only to distinguish intern ally the member, documents for references, for primary EC registration, monthly electricity usage and member application.

5.5.2 Possibilities for geological information for CECs and RECs

The availability of an interactive map, showing the overall CEC or REC member, and giving the possibility for choosing one, and scaling the area, shall aid the members and the users in order to orientate in the CEC or REC density in one hand and the proximity in the other, thus helping the user finding a CEC or REC in the near area.

When viewing an energy community, the map shall be displayed as well as additional information related to the latter. It is possible to show more CECs and RECs from this area/country. The EC will be classified as accurate address (City, Country in order to be placed in the map), as well as region according to the administrative division of Bulgaria. As a geolocation utility we suggest using Google maps, which information is updated on a regularly bases and seems to be accurate.



[87] https://www.energiacomun.org/comunidades/comunidad-energetica-renovable-valdeajos/

Registration of Domain and use of open-source software

It is suggested to register the domain ec-hub.bg (ec-hub.org) or to create a subdomain to the entity which shall administer the REC, like ec-hub.nameofentity.bg on the portal register/information system), shall be visible all the registered so far energy communities and there will be implemented a search option(s) according to those criteria:

- Location (region)
- Name of the ECT
- Type of the EC
- Installation(s) type
- Power or any other preliminary defined option
- List and interactive map view.

An example can be found at the Austrian information platform on energy communities[88]. Also, it is recommended to base the Registry of CECs and RECs on an Open-Source application (Core and modules), which shall make the process in which the application operates transparent, as well as all the separate programs involved in data processing, part of the platform.

The usage of Open-Source software shall lower the costs of the project, increase its level of security, and the reason for that is that such a software is developed from communities, which contribute constantly in testing, developing and improving the modules and programs who work beside the core of the main application.

Initiative in the EU which encourage the usage of Open-Source software can be found in the documentation provided by the EU's Intellectual Property Office[89], and publications by the European Commission[90],[91]. These documents concern government initiatives in Norway related to the usage of Open-Source software.

The register must be based on Multiplatform solution, which can be installed to work on different operating systems, having in mind the good practices related to Web servers and solutions in the public sector. A reliable model is LAMP (or Linux, Apache, MySQL, PHP stack), which working on a virtual (VPS) or dedicated and well configured server, shall provide the necessary environment of the Web application

The register itself can be based on a content management system[92] (CMS) like: Energy Community Platform[93], Austrian information platform on energy communities[94] or the Cler network[95]. All these three registers use an Open-Source application. Internationally there are

[88] https://energiegemeinschaften.gv.at/landkarte/
[89] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://euipo.europa.eu/tunnel-web/secure/webdav/guest/document_library/observatory/documents/reports/2020_Open_Source_software/2020_OSS_Full_EN.pdf
[90] https://interoperable-europe.ec.europa.eu/sites/default/files/inline-files/OSS%20Country%20Intelligence%20Report_NO_0.pdf
[91] https://interoperable-europe.ec.europa.eu/sites/default/files/inline-files/OSS%20Country%20Intelligence%20Factsheet_NO_0.pdf
[92] CMS refers to computer software used to manage the creation and modification of digital content.
[93] https://energycommunityplatform.eu,
[94] https://energiegemeinschaften.gv.at/
[95] https://cler.org/

used platforms such as Wordpress[96], Drupal[97], Typo3[98]. All available as an Open-Source software, which obliges the developer to maintain the transparency of the code when using and creating the **Web application**.

It is important to choose an **Open-Source CMS** which works on a modular base, which gives a possibility to add future functionalities. Those could be multi-language, flexibility in the user management. Thus, the project must not be limited in its preliminary scope, but to give an option to be upgraded, maintained and developed further.

The administrator of the register, who takes care of creating a scope, development and maintaining of the Registry must choose one of the following options to host the register and to provide its technical maintenance:

a) dedicated server operating on the territory of Bulgaria;
b) virtual server, working again on this very territory;
c) shared hosting, on the same territory.

The usage of **local infrastructure and IP address** from the Bulgarian Internet space shall accelerate the access to the register for Bulgarian users and will serve results in the search engines, according to its location. The **dedicated server** gives broad spectre of settings, choosing the information centre, in which it shall be located, and the possibilities for physical security. On the other hand, it is related to more investments, technical maintenance on a monthly basis and increased electricity consumption. However, it is the best solution for a separate, or working along with others on it, Web application.

The dedicated server can be located in an information centre, property of the entity who administrates the Registry, or in a one, from a provider of such a service (so called collocation centres). The hardware can be delivered by the provider of the service in the centre, or be property of the entity, who administrates the REC. In case there are other Web applications working on the very server, consuming shared resources, they have to be well secured and maintained/updated concerning the core and modules which they use. The operating system and all the programs working in its stack (LAMP) if used, must be regularly updated.

The same requirements apply for the **virtual private server (VPS)**, and it can be created in the infrastructure of the entity, responsible for the administration of the register, or to be used as a service from a third party and work in its infrastructure. The shared hosting provides the minimum possibilities for technical solutions concerning the program stack, necessary for the work of the Web application. There are limits of the inodes number, as well as of the uncompressed database size. It is a low budget solution, which from one hand is provided from a company outside the responsible entity infrastructure, and from the other, is related to limitation of the resources and the programs. It is obligatory to avoid such a solution, in case is expected that the register shall contain huge amount of information.

In order to keep the already uploaded/added in the Registry information, in the file structure and the database, there must be provided a **regular backup solution** for the both, and the administrator of the register must access and download the data on a monthly bases. Archives

[96] https://wordpress.org/download/
[97] https://www.drupal.org/project/drupal
[98] https://get.typo3.org/

can be made automatically on an external media, which is available in the information centre, in case of emerged physical problem with the server, the VPS, or the shared hosting.

Administrator shall connect himself to the platform and the server using secure protocols SSH (for using the terminal) and SSL to access the Web application and shall copy the database of the register (DB) in a **local encrypted volume or disk**. If possible, an overall encryption of the database can be made on the server/vps or shared hosting. This shall guarantee that the information will not be readable in case of security breach and the unauthorised DB download. The encryption of the DB on the very host can be a challenge and not every Web platform provides it. Credential data, such as passwords are in principle encrypted in the time of their creation, thus making them unreadable on a later stage. The recommendation is if the technical environment allows it to use encryption, only if this measure does not slow down the work of the Registry or it does not lead to information loss.

Security, and interoperability

5.5.3 Security, and interoperability

Basic and other requirements

There are some basic requirements towards the applications operations to provide security and future compatibility. The main requirement is to have feedback and transparency from all the involved in the work with the register persons. All patches must be documented, information about unstable and in development modules must be available and the latter should be used occasionally and during the development. To provide project's security, it must have an inheritance from the editor(s) and the administrator of the register, as well as from all involved with the information security persons. After an employee was released from his post, the administrator must decide either to erase his profile (risk of data loss emerges), or just to change his password or username, if the latter uses a common E-mail for site administration.

The compatibility of the data is separated in a few levels - program stack, server stack, the chosen DB software and the file formats, used for data interchange. The best compatibility will be achieved in cases, in which we use easy to read and open formats preferably based on Open Source. The easy-to-read file formats are PDF (read by the Web browser and mobile devices), ods and odt files, which can be opened with Open source and free software like Open Office and in Google Docs, as well as broadly used for data interchange structured formats like CSV, Json and XML. Thus we export information in platform independent files/formats, without obliging the user to use a particular OS or commercial software.

The compatibility shall be guaranteed from the data perseverance possibilities in future update of the server's stack or the Web based platform of the register. One must search for a solution which guarantees flawless work in near future, without data loss when updating the applications. In case of future core and modules update of the Web based register, or when the old system reaches end of maintenance and updates, one must follow this protocol:

- An archive of the old system has to be created
- Development installation has to be set on the same or distant server
- Data output from the old system has to be set
- Data input in the news system has to be set
- The structure, meeting the register needs, has to be expanded in the new system
- User accounts (if possible) have to be kept and transferred to the new system
- All ec public profiles have to be imported (and to be associated with their users)
- Url user friendly addresses of pages have to be kept in order to maintain the search engines indexing
- If possible, the address of public accessible files has to be kept (or redirected to the new location)
- Usage of mass data import and export utilities (modules) is highly advisable

After the administrator proves that everything in the new system works as expected, the old one can be left to work as a reference, best in development mode, for a certain period.

Important: When updating the stack, one must schedule the update of the Web application. In principle the software application development is parallel, thus it is not advisable to use old applications on a new server stack, because they can pose a security risk. Besides a different software versions (PHP for instance) must be installed to achieve compatibility. Our suggestion is to schedule and apply a global, step by step update regarding the Operating System, the working on its applications and the Web one itself.

Information security policy

The security policy should be based on predefined and adequate user access. The user access is classified on a few levels:

- Registry administrator with full access
- Editor (s), who shall have the possibility to add, edit and associate users to their public EC profiles
- An audit entity, who may export reports form the register considering the EC, along with their data in an appropriate format (XLS/CSV)
- Member of CEC or REC, who shall be able to access his profile and change some details in it (contact details etc), except those data, which may change his legal status
- Anonymous user (site visitor), who shall access the public section of the register

The platform must provide flexibility towards the user roles and their rights in the system, as well as control, who can access the information in it, which fields one can read/write and manage. The administrator, editor, and all users, who have access to personal data in the site, must be familiar with the information security policy of the entity, who shall maintain the register. The latter must have a developed in details policy, which has to be published online in order to inform its users.

The legal entity maintaining the site has to be an administrator of personal data, and has to determine a person, who shall process the data. It is important to have contracts between all the parties, who have access to personal user data in the system, which can be extracted and provided to third party. The contracts are based on the policy of the entity maintaining the register, regarding the processing of personal user data, as well as the policy of the Information security and processing of personal data of each party, having access to it. Sample policy for of a legal entity is provided by novsait.eu[99].

Documentation and proper usage of credentials

It is extremely important that the developer provides a manual for usage of the register in which the interaction with the platform is clearly explained, concerning the work of the editor and the auditing entity(s). The manual shall support the work of all parties engaged in the process of adding and extracting data from the register, as well as in case of substitution of an employee. Part of the manual, related to the interaction of registered in the platform EC, can be uploaded and make public accessible in order to facilitate the work with the application.

All personalities, having an editor or an audit entity role, must access the register form secure devices, checked for malicious software, trough personal and administrative networks, where the Wi-fi traffic is encrypted. It is advisable to avoid the usage of public, unencrypted Wi-fi networks. The credentials needed to access the register form the editor or the audit entity, must not be provided to third parties and it is recommended to be saved in an application encrypted

[99] http://novsait.eu/sites/default/files/Politika_za_lichni_Danni_Nov_sait_EOOD.pdf

form, which one can access using password and a key. KeePass is an example of possible Open-Source password manager[100].

Security, monitoring and proper usage of the server

The web server, where the register shall reside, is the environment where the application will work. In case we choose that the register shall operate on a dedicated or virtual server it is important to choose an Operating System (OS) which give us a possibility to easy upgrade, inform us for new packages, and which can automatically apply partial upgrade of the latter. An example of a GNU Open Source based OS, which can be maintained easy after the primary installation, is Debian Linux[101].

Best practices to follow:

- On the web server there have to work only the programs (applications), needed for its flawless work, which are used for permanent or temporary web application support or development.
- The core of the OS must be updated on a regular basis in order to guarantee its security and the latter has to be restated in some cases thus the updates could be applied.
- To disable all the unused communication ports, and leave open only those, needed for server administration, access to the register and other working on the server Web application.
- All other programs running on the server, which do not need public access, has to listen only to internal to the server or to the internal network address(es).

The ports in a Internet based OS can be easily maintained with the help of the iptables program[102].

Example of good settings of a network server

In Table 4 below are exemplified public available open ports, such as 22, 80 and 443, but 3306, 11211 and 25 are used for internal communication, which secures them from a possible attack. The server access for its management must be done not via password, but with a pair of public and private, password protected key. This applies for all users, who shall connect to the server via terminal. The server's administrator must use a user profile with non administrative privileges, for administrative tasks, using the sudo program in order to attain the root privileges, and according to certain circumstances.

Table 4 - Active Internet connections (only servers)

[100] https://keepass.info/

[101] https://www.debian.org/

[102] https://www.linode.com/docs/guides/control-network-traffic-with-iptables/

Proto Recv-Q	Send-Q	Local Address	Foreign Address	State	PID/Program name
tcp	0	127.0.0.1:3306	0.0.0.0:*	LISTEN	618/mariadbd
tcp	0	127.0.0.1:11211	0.0.0.0:*	LISTEN	2058613/ memcached
tcp	0	0.0.0.0:22	0.0.0.0:*	LISTEN	533/sshd: /usr/sbin
tcp	0	127.0.0.1:25	0.0.0.0:*	LISTEN	846963/exim4
tcp6	0	:::80	:::*	LISTEN	336519/apache2
tcp6	0	::1:25	:::*	LISTEN	846963/exim4
tcp6	0	:::443	:::*	LISTEN	336519/apache2

The shell (terminal) access can be provided to other trusted persons, if necessary, who shall use secure protocols, again with a pair of public and private key. The access to the Web applications must be done via the HTTPS protocol, which gives the opportunity to use HTTP2 and provides increased speed and security. Akamai Cloud provides more detailed information[103] in this regard. An example of an application which enables the periodical issuing of SSL certificates, which shall encrypt the connection when using the Web server and the Internet based application is available through Let's Encrypt[104].

Automatization regarding the OS update and notifications

Application for automatically update the server programs is available, such as through Debian[105]. Notification for available OS updates - core and packages – can be provided by applications such as Debian GNU Linux[106].

Periodical update of the core and modules of the CMS on which the register is based

The CMS based on open source (as well as all others), are constantly developed and tested from the communities working on the project. A constant flow of notification for problems, solutions and patches is also available. The periodical update shall guarantee security and future of the project. Before updating the platform, the CMS must be backed up, concerning the file system and the database in order to avoid emerged in the update process problem and a possible recovery of the system. A good practice is to have a copy of the platform, working behind another domain name on the same or another host (server), on which we can test the updated prior applying them to the main site (register), version. It is recommended to update the system during the less loaded time, and the platform can be set into development mode. Thus we shall avoid information loss. The best scenario is to not rend the work of the register difficult, so it would be better to update the system in a shortest period. The web platform must have a possibility to notify the administrator for all available updates and if possible, some of them to be either applied automatically, or better manually, under his control.

[103] https://www.linode.com/docs/guides/how-to-configure-http-2-on-apache/
[104] https://letsencrypt.org/
[105] https://wiki.debian.org/UnattendedUpgrades
[106] https://manpages.debian.org/unstable/apticron/apticron.1.en.html

Passive and active defensive techniques (IDS etc.)

The Web based platform must provide functions such as:

- Blocking a user in case of unauthorised access
- Checking if the filled form is sent by human or a program (using Captcha for instance) applying other methods in order to check the correctly field data
- Notification of the administrator in case of unauthorised access
- Active blocking of users (or bots), who make unauthorised requests or search for possible application vulnerabilities.

Some of these solutions can be applied on server level like the installation of Fail2ban[107] and OSSEC[108]. OSSEC[109].

Checking the server for presence of malicious software

On the server an antivirus application can be installed to check the uploaded files for malicious software. An open-source example can be considered ClamAV[110]. The antivirus application must be configured to update its database and malware definitions automatically, if possible. The server's administrator can check periodically the folder with public uploaded files for presence of malicious software and executable ones. The running of scripts in the public folders to which users have access must be prohibited.

Prevention for inappropriate users file upload

The platform users must have rights to upload files in certain file formats (like pdf, doc, docx, ods, odt, jpeg, jpg, png). They must not be able to upload executable files and archives (concerning the latter if not preliminary scanned for viruses), as well as system files.

Prevention regarding the text (control vial input format)

When creating text in the site's text fields, filters must be applied which shall limit the text format to simple text, text using a predefined HTML tags (like emphasis, hyperlinks etc). Java Script, PHP and the usage of any script language in the text fields, which can reflect in security breach and lack of functionality, shall be prohibited. The placement of iframe serving content from a third party, from unauthorised users shall be prohibited, only if the iframe is not serving data from trusted partner and is placed by the site's administrator.

System user log and monitoring the users activity

Besides the log working on server there must be implemented a log which shall provide reports for the users activities such as:

- IP address from which the register is accessed
- Time and date of access

[107] https://github.com/fail2ban/fail2ban

[109] https://www.ossec.net/

[110] https://www.clamav.net/

- User which has opened the session
- Editing and saving of data
- Software errors during the process
- Access denied
- Page not found etc.

The goal of using a log is to give a possibility to the system administrator to check the systems condition, and to obtain reports for a certain period, concerning the activities mentioned above.

Blocking of user

In case certain Internet users, who are not part of the REC, try to login, the system has to block them automatically for a certain period. The auto-banning of users can be triggered after a certain number of unsuccessful attempts. To inform the user, as well as the administrator, and to block the users IP address for a period of time (or permanent). Depending on the administrator's views and according to log's reports, certain IP addresses can be blocked when it is confirmed, that from them there are multiple attempts for unauthorised access. This can be treated like a brute force attack. Platform users can be blocked in case they make multiple attempts to access the REC using a wrong password or have changed their E-mail address for its recovery/reset. It this case they must turn themselves to the site administrator (legal entity) in order to update their credentials/data and to be provided with access. A blocked user cannot user the system in order to change his details. No matted that the REC shall serve the EC public profile, to which he is related.

Time to keep the information in the register

The keeping of the data in the register, without its update, is a matter of approach of the entity, which shall administer it. A possible solution is that the register is updated on a yearly basis and/or by every change of its user. The members of the register must have access to change their public information, in order to guarantee that the information is up to date. In case of legal issue, leading either the transformation of the energy community or its closure, the site administrator shall decide how long to preserve information of the energy community in the system, according to the policy of the entity which maintains it. The presence of non useful information shall overload the database.

Avoiding server overload and speed improvement

The data serving speed and the optimal usage of server resources are critical for the security of each Web based application. Thus, it remains accessible, serves the information quicker and caches already made requests. In order to increase the speed of the server used for hosting the REC, we recommend the usage of some programs which cache the content related to the Web application and which communicate with it. Possible solutions are Varnish[111], which can be configured to receive incoming requests on the secure HTTPS protocol, process them and send them back to the Web server. The Varnish configuration together with SSL might be a challenge, but there are tutorials in explaining the topic[112]. In order to cache the database one may use Memcached[113], available for most of the OS like a package, which can be easily installed and

[111] https://varnish-cache.org/
[112] https://www.varnish-software.com/developers/tutorials/terminate-tls-varnish-hitch/
[113] https://memcached.org/

configured. Another caching application is Redis[114][115], again available as OS package. The Redis configuration is again a little bit sophisticated and needs attention, while in case of memory insufficiency and particular settings, the Web application might stop working. All caching application, except Varnish, which shall be publicly listening to HTTP port, must listen and process requests from the internal for the server or the entity's Intranet address, in order to provide security.

Informing the users for the usage of monitoring technologies like cookies and the processing of personal data

Users should be at least informed about the following:

- That technologies like cookies are used, in order to follow one's session
- The usage of additional applications related to statistics collection, which might work on the REC
- The way in which their personal data shall be processed and saved
- That they are to comply with the terms and conditions and the personal data policy when using the register or when applying for membership
- Inappropriate site access (forgotten password, resting attempts to login, blocking of the users IP etc)
- That the user's profile is personal and related with the EC which he represents and that his credentials must not be shared with third party

Giving the user a possibility to recover his password

The system must provide mechanism for password recovery via link send on the users E-mail. The field for the password recovery must be captcha and with other technical means protected. Certain data, already available in the register, can be exported in a data flow, which can be read in any time, in XML, Json or XLS/CSV format. The data shall be updated in real time. This information might consist selected details concerning the members of the register, which can be exported on a specific URL, from which outer system may read the content. In case that it concerns only public, available on the register data, the information access might not be secured in a particular way. In case, that the details contain sensible or private information, which must not be shared with the public, the URL (or the page containing the data) must be password protected. It is possible to integrate other applications, which data can be placed in the member's profile. Their import is related to the way in which they are fed to the register and its possibility to process and integrate them in its structure.

A possible solution is to update the register's data for a particular EC(s) periodically importing data from an outer source in json, or XML format, or via updating a XLS like table in CSV format. Having in mind, that each EC has a unique id (not just the VAT number), the latter can be easily distinguished and his data updated via distant feed read, or operator's file upload. During the update process it is possible to rewrite an already available data. Thus, it is important to define which information must be updated, who collects it, and how it is imported into the system.

[114] https://github.com/redis/redis?tab=readme-ov-file
[115] https://redis.io/

Usability of the register

The register's usability is of key importance for the Internet users. It is related from one hand with security questions, in order that the user feels him safe using the platform, and on the other hand, providing intuitive access and retrieving of information. The usability depends on**:**

- Easy to navigate and intuitive user interface
- Accessible navigation (menus), which must not change their place;
- Additional navigation elements situated in the sidebar or the footer;
- Access to contact page and details to make quick connection with an operator, in case of difficulties or a problem;
- Availability of useful information concerning the registration process (as well as any other, which can be helpful for grounding of an EC).

It is also important to provide accessibility for different devices including:

- Desktop computers with different screen sizes;
- Portable computers/laptops with a fixed screen size;
- Tablets and E-book readers;
- Mobile devices (smartphones).

There are two major approaches to achieve this:

1. To create and base the design on responsive theme, in which all the page elements shall reposition themselves according to the screen size;
2. To have two themes - one for desktop and portable computers, and one for mobile devices and smartphones.

The creation of two themes might have sense in case that there are some difficulties to show all the information in the responsive theme. Using two themes gives the possibility to control which information we display, according to the user's display. It is mandatory to have in mind that the administrative theme must have responsive or mobile characteristics, because it shall be used form the site administrator/editor, and its logged in users. An overall positive user experience is targeted, towards the site users. The information must be found easy, and a search functionality might be implemented, like searching by keyword or phrase. The users must easily distinguish the register. The application might change its outlook during the time or after a technical improvement. However, there must be some sort of succession on order that the user recognises the register. Handbooks can be used to assist the process on the Website creation – e.g., like in the Elements of User Experience[116]. It has to be an user centred design and overall outlook of the application.

Usability for disabled persons

For this case the register must meet the following demands:

- Choose and use easy to read Sans Serif font face, with Bulgarian characters for some letters like "б", "в", "д". An example of free distributed font face is Sofia[117], which is also used in Web sites of the Bulgarian government.

[116] Garrett, J. (2010). The Elements of User Experience: User-Centered Design for the Web and Beyond (Voices That Matter). New Riders (publisher).

[117] https://fonts.google.com/specimen/Sofia+Sans/about

- The text must be easily distinguished from the page's background.
- The minimum letter size must be 1-1.1em, except when used in decorative elements.
- A colour scheme must be set and used to clearly distinguish the main text form titles, hyperlinks and menu items.
- To use alternate descriptions (ALT) and titles for images, in order that the latter could be read from screen readers.
- To have possibility to add title to the hyperlinks in the menu items.
- All fields that must be filled with user information, must have label or a title.
- Recordings and videos with subtitles related to the founding of an EC shall be of use for all people with disabilities.

Other accessibility tool is the availability of HTML sitemap of the REC, describing its structure and containing all the pages accessed from the public. A tool for testing the screen contrast related to accessibility is provided by for example Firefoc Browse ADD-ONS[118]:

‘

Other solutions concerning the usability

The register developers can take advantage of other approaches concerning it's usability like:

- Possibility to change the font size of the content
- Possibility to invert the colours of the background and the main text
- Text to speech
- Change of the type face for people with reading difficulties (Dyslexia)

All the mentioned above approaches must be implemented carefully. They must not have a negative impact over the user experience but provide tools for users with certain (sight) disabilities to access information.

[118] https://addons.mozilla.org/en-US/firefox/addon/wcag-contrast-checker/

HTML5 semantic structure and hyperlinks

It is a common practice to use the HTML5 semantic's in the page structure, in which the different elements could be easily distinguished such as <header>, <nav> main navigation, <main> for the main information <aside> for sidebars containing the secondary data, <sections> for certain blocks, and finally <footer>, placing the page closure and credits. The semantic structure enables the search machines to localise the main page content and to differ the elements on it. With <div> we can wrap all the elements, which are not of importance and reside into the semantic containers. Another good practice is to structure the headlines <h1> to <h6> in hierarchy according to the page one. Ex. h1 for page title, h2, block one and h3 for the block content title. It is also possible to integrate a module for structured data, which can wrap certain fields of the content[119]. This shall enable the description of content types like person, organisation etc end certain fields. It is recommended to open all the external links in a new browser window or a tab. The attached files can be downloaded directly, and a download counter might also be implemented.

SEO optimization

It is also extremely important that all pages and categories in the REC have adequate meta-title and meta-description, if possible, which shall help finding the register and information in it, from Internet users according to their search, based on keywords and phrases.

An XML sitemap must be created, which contains all the pages available to the public, and which contains important to the user information. All the EC public profiles must be placed in it. The URL addresses of the nodes (pages), must be transliterated and made human readable, corresponding to the title of the page or the section of the register. A transliteration module must be implemented in the system to transliterate the URL addresses and the uploaded from the users' files, removing spaces and special symbols. Tools for monitoring the site visitors and the server's performance and emerged problems can be implemented, using third parties. Two of the most important outer applications are Google Search Console and Google Analytics. The monitoring of the site visitors is related to collecting of user's statistical data such as age, sex, location etc. Thus, the users must be informed for the presence of such instruments in the register.

> *"The compatibility shall be guaranteed from the data perseverance possibilities in future update of the server's stack or the Web based platform of the register.*

[119] https://schema.org/docs/schemas.html

5.6 Decision making software which could be used in favour of the future energy community members on their way to found and register an energy community

We suggest using a multiplatform decision-making software, based on Open Source. This shall make it platform independent regarding hardware and Operating System, and all the source code of the program will be provided. In this way the application shall provide transparency of its workflow and user's security, without additional costs for license agreements. An example for such a software is Loomio[120], but should be a subject of later tests.

The Web based decision making software can be installed on a server to which all the EC members must have access. In the application users can be organized in groups, share information internally, ask questions, which can be structured as polls / surveys, and a statistic can be gathered upon the users answers to help them later taking their decisions. The application must be secure and accessible only from the energy community members. It must be maintained and administrated easy and has the possibility to notify each member, after any change has been made, regarding a poll/survey, voting, sharing of documents etc. Thus, the platform users will be real time informed. The notify channels can be E-mail, or other online based protocols and applications (such as Viber, SMS, WhatsAPP, Jabber, iChat etc), according to the possibility to integrate such a messaging system with the application and the user's desire to be notified in such a way. It is important to have the possibility to exchange documents, photos and eventually videos. A multilingual support in favour of energy community members, who do not use other language besides their mother one, will be an advantage.

5.6.1 Main functionalities

The application can be used in such a way helping the establishment of an energy community. Questions regarding the registration of an energy community can be asked:

- Choosing the legal type of the energy community
- Determination of its members
- Preparation of the necessary documents
- Defining the energy community structure (Auditing board, Managing board, secretary, treasurer, responsible persons etc.)
- Necessary agreements with the local electricity provider/operator
- Distribution the tasks among the members

Also, questions related to technical issues can be discussed:

- What kind of installation(s) for transformation of energy and storage of electricity shall be used (solar panel, wind generators, batteries, smart meters etc.)?
- How to define the location and the way of assembly of the installation(s)?
- Who shall provide the installations?

[120] https://www.loomio.com/

- Delivery and assembly of the latter
- Long term installation(s) maintenance
- Storage of the transformed in surplus electricity
- Reports concerning the transformed and consumed electricity
- How to connect to the local/regional grid?

Economical questions in favor of the energy community can be discussed, such as:

- Must the transformed as electricity energy be used only internally?
- Shall the electricity be shared and with whom (outside the energy community)?
- Does the energy community want to sell the surplus electricity, and to whom?
- What kind of agreements between the energy community and its member/customers are needed?
- Local and regional benefits from the grounding of the energy community?

5.6.2 Free trial and application options

The software tested so far provides a 14-day free trial period. In this case it will not be necessary to install it on an own VPS or dedicated server, which is related to costs and the hiring of qualified people. The application itself can be freely downloaded and installed in preliminary prepared environment through github – Loomio[121].

Concerning the technical requirements regarding the latter (if we install the application on our own server), the options are via docker[122] or manually to install all the packages needed for its operation on the OS[123].

Sample packages when installing under Debian/Ubuntu are presented below:

```
sudo apt-get update
sudo apt-get install postgresql postgresql-contrib build-essential \
        libssl-dev libreadline-dev zlib1g-dev \
        libpq-dev libffi-dev libmagickwand-dev \
        imagemagick python3 redis
```

More information concerning the Debian package of Loomio can be found[124], as well as installation manual[125]. It is very important to estimate if we can invest in long-term resources such as installation and maintaining the software during the time when the energy community members take their decisions. The usage of an online tool will provide collaborative options, real time messaging when there is activity on a thread or a deadline for taking decision is reached.

In this respect, Loomio provides:

- Discussions on a topic

[121] https://github.com/loomio/loomio
[122] https://github.com/loomio/loomio-deploy
[123] https://github.com/loomio/loomio/blob/master/DEVSETUP.md
[124] https://wiki.debian.org/SummerOfCode2019/ApprovedProjects/PackageLoomioForDebian
[125] https://ipv6.rs/tutorial/Debian_Latest/Loomio/

- Categorising of a discussion (tags)
- Real time audio and video recording
- Working with tables and links via WYSIWYG
- File upload which shares the save storage
- Text formatting, etc.

One can also invite other people to take part in the group, becoming its members, in order to get involved in the discussion and to be assigned tasks. In the trial version of Loomio the group consists of ten people. In the starting plan the number rises to thirty, without the possibility to create subgroups.

Using the same model one turns to the community members for advice, to make them familiar with the application, and notify them of being in the role of team leader or a moderator.

Concerning the decisions, it is possible to:

- Ask for feedback in a certain period
- Ask for advice
- Ask for consent
- Ask for group consent
- Ask for graded consent

The application gives a possibility to use predefined answers such as “Yes”, “No”, “Abstain”, “Disagree” and “Block” (pose a veto) for certain proposal. There are unlimited options, and it is up to the thread creator to set them up.

Polls can be added as:

- Sample, with one or more possible options
- Score based answer
- Wuantity based answer
- Ranking one

All these options give tools to create polls meeting the community needs. One can create threads and polls for future meetings like:

- Day of the meeting
- Starting hour
- Duration

Also, one can send invitations to future members to participate in which the predefined choice is limited to confirm or decline. It has to also be mentioned that the software provides export of all the data of a thread in a CSV file, which can be further analyzed and processed.

Unfortunately, despite all the mentioned above advantages the software lacks a translation into Bulgarian so far. In this regard the members of the future EC have the following options:

a) Use it in English
b) Hire a specialist who can translate the strings in the user interface

c) Use the application in a close to Bulgarian language (Russian for instance).

Some already available translations are offered[126].

Despite the language drawback, the application should be considered as modern, flexible and meeting the needs of any community which must take decisions. Thus, efforts in the direction of its translation can be invested to facilitate its usage for members having language difficulties. Another option can be the usage of a built-in browser translator. This way the elements of the application's interface will be translated, with a possible deviation or omission. One must bear in mind that if not preliminary created on the user's mother language translation is always necessary, which is based on strings residing in files or in the database.

Of course, the community has the choice between installing the application on its own server, hiring a specialist or relying on an experienced member, or buying an annual subscription for using the application, including its hosting on the developer's server.
The annual subscription starts from $399, and the package provides:

- Up to 30 members
- No subgroups
- Server location in USA, Europe or Australia
- Technical support

In case that the organization, which wants to buy a subscription plan is of non-commercial type, then the price for the starting package is reduced to 299$ per 12 months.
An intuitive conclusion is that the installation and the configuration of a Web server, as well as the annual expenses for a virtual or dedicated one, shall exceed this investment.
The intermediate investment for a VPS is around 25 BGN monthly. The server's initial installation and the application set up can exceed 300 BGN. The monthly technical support of a server is 50 or more BGN. Thus, we have a yearly investment of around, or exceeding 1000 BGN. In case we use the server for user interface translations, for information hub for files, shared and used by the community, as well as for hosting of its website, the investment is justified. It can be therefore recommended to the future application users to make research concerning the investments and to take decision related to one of the proposed variants.

One could claim that 12 months period shall be enough to take decisions concerning the first steps in direction of founding an EC. On the other hand, throughout the timeline new questions may emerge, concerning future installations, etc. If the users are already familiar with the application it will be reasonable that the latter is available for longer period, if the main process of founding an EC is taking part.

[126] https://explore.transifex.com/rdbartlett/loomio-1/

5.6.3 Documentation

There is plenty of documentation for the decision-making software, concerning its usage and examples[127]. Each question can be categorized using taxonomy (tags). The latter can be created from the thread's creator and work only in the scope of the group. The comments are thread based, which gives an option to follow them in a treelike structure, as well as pinning a particular discussion below the main theme. Comments in threads can be edited or deleted from the moderator. One can address someone directly in the system, again in thread-based message, in which one can add decision making options. Thus, the tools are always available. After setting up a deadline for a thread, a notification is received on the E-mail of each group member. It is possible to set notification on each thread activity. The notifications are received in real time in the system, and each group member can create a poll, or a thread concerning a certain topic and publish it. For the E-mail notification to work it has to have: 1) set up an E-mail server, and 2) SPF and DMARC records for the domain. An option is to use an external E-mail server.

5.6.4 Energy management software

The recommendations regarding software, which can be used in favor of an EC won't be complete, if we do not consider the one discovered by the authors recently. The application is based again on Open source, and it is free to use, giving the possibility for monitoring and management of electricity.

Table 5 - main links concerning the openems project

Project download:	https://github.com/OpenEMS/openems
Project's Website	https://openems.io/association/
Documentation:	https://openems.github.io/openems.io/openems/latest/introduction.html
Community driven forum	https://community.openems.io/
Live-Demo	https://gitpod.io/#https://github.com/OpenEMS/openems
Introduction on OpenEMS	https://openems.github.io/openems.io/openems/latest/introduction.html

5.6.5 Open Energy Management System

Open energy management system (EMS) — the Open Source Energy Management System — is a modular platform for energy management applications. It was developed around the requirements of monitoring, controlling, and integrating energy storage together with renewable energy sources and complementary devices and services like electric vehicle charging stations, heat-pumps, electrolysers, time-of-use electricity tariffs and more.

If one plans to use OpenEMS for own projects, one should consider joining the OpenEMS Association e.V.[128], a network of universities, hardware manufacturers, software companies as

[127] https://help.loomio.com/en/
[128] https://openems.io/association/

well as commercial and private owners, and get in touch in the OpenEMS Community forum[129] .

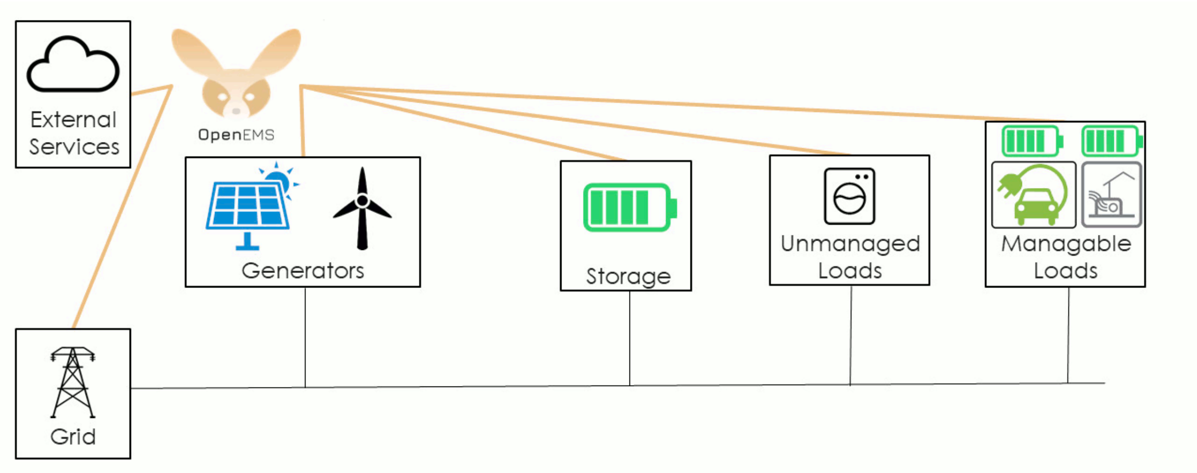


Figure 3- OpenEMS in Local Energy Management.

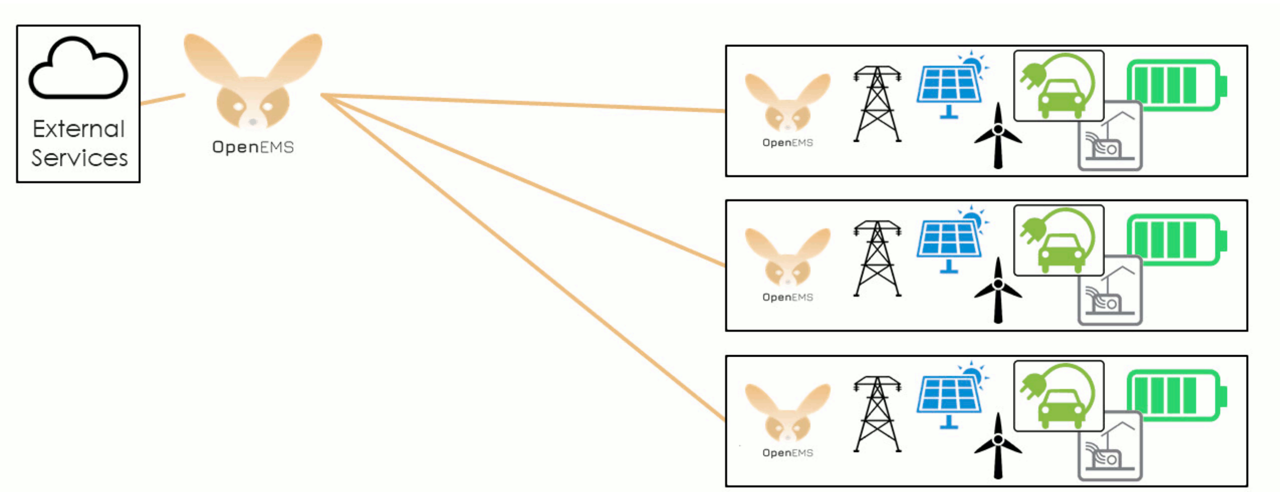


Figure 2 - OpenEMS in Areal Energy Management.

Examples of OpenEMS usage are presented in Figure 2 and Figure 3.

[129] https://community.openems.io/

5.6.6 OpenEMS IoT stack

The OpenEMS Internet of Things stack contains three main components:

- OpenEMS Edge: runs on site, communicates with devices and services, collects data and executes control algorithms
- OpenEMS UI: the real-time user interface for web browsers and smartphones (Figure 4 and Figure 5)
- OpenEMS Backend: runs on a (cloud) server, connects the decentralized Edge systems and provides aggregation, monitoring and control via internet

Features: The OpenEMS software architecture was designed to leverage some features that are required by a modern and flexible Energy Management System:

- Fast, PLC-like control of devices
- Easily extendable due to the use of modern programming languages and modular architecture
- Reusable, device independent control algorithms due to clear device abstraction
- Wide range of supported devices and protocols

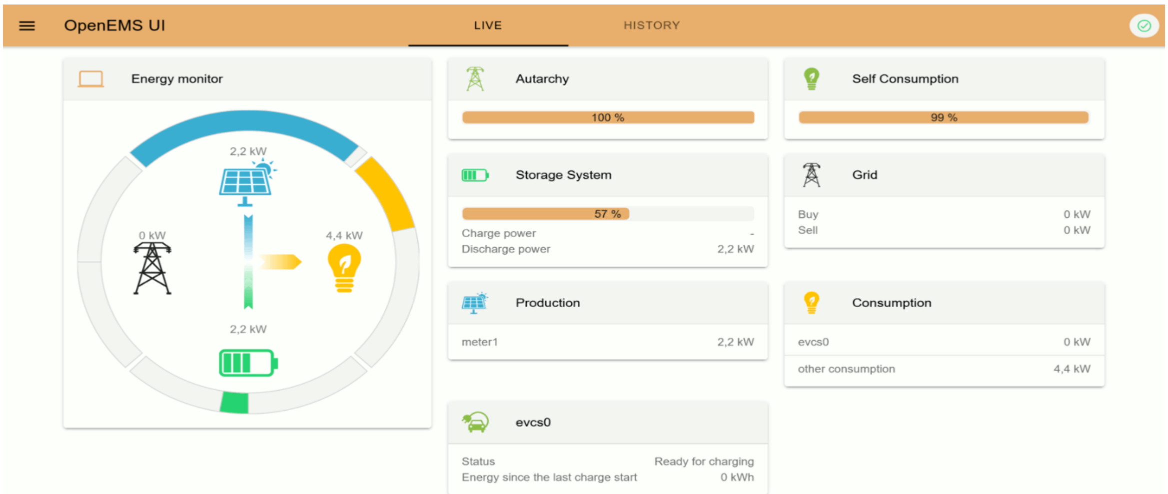


Figure 5 – Example of OpenEMS UI

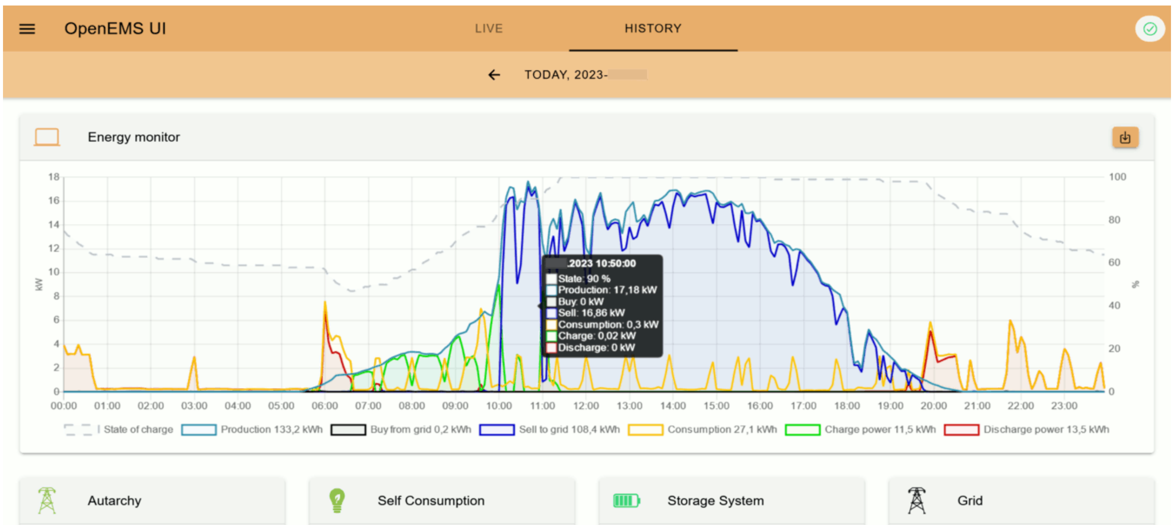


Figure 4 - Example of OpenEMS UI: Overview outlook

5.6.7 System architecture

OpenEMS is generally used in combination with external hardware and software components (the exception is a simulated development environment - see Getting Started). As a brief overview,

Figure 6 presents how OpenEMS is used in production setups:

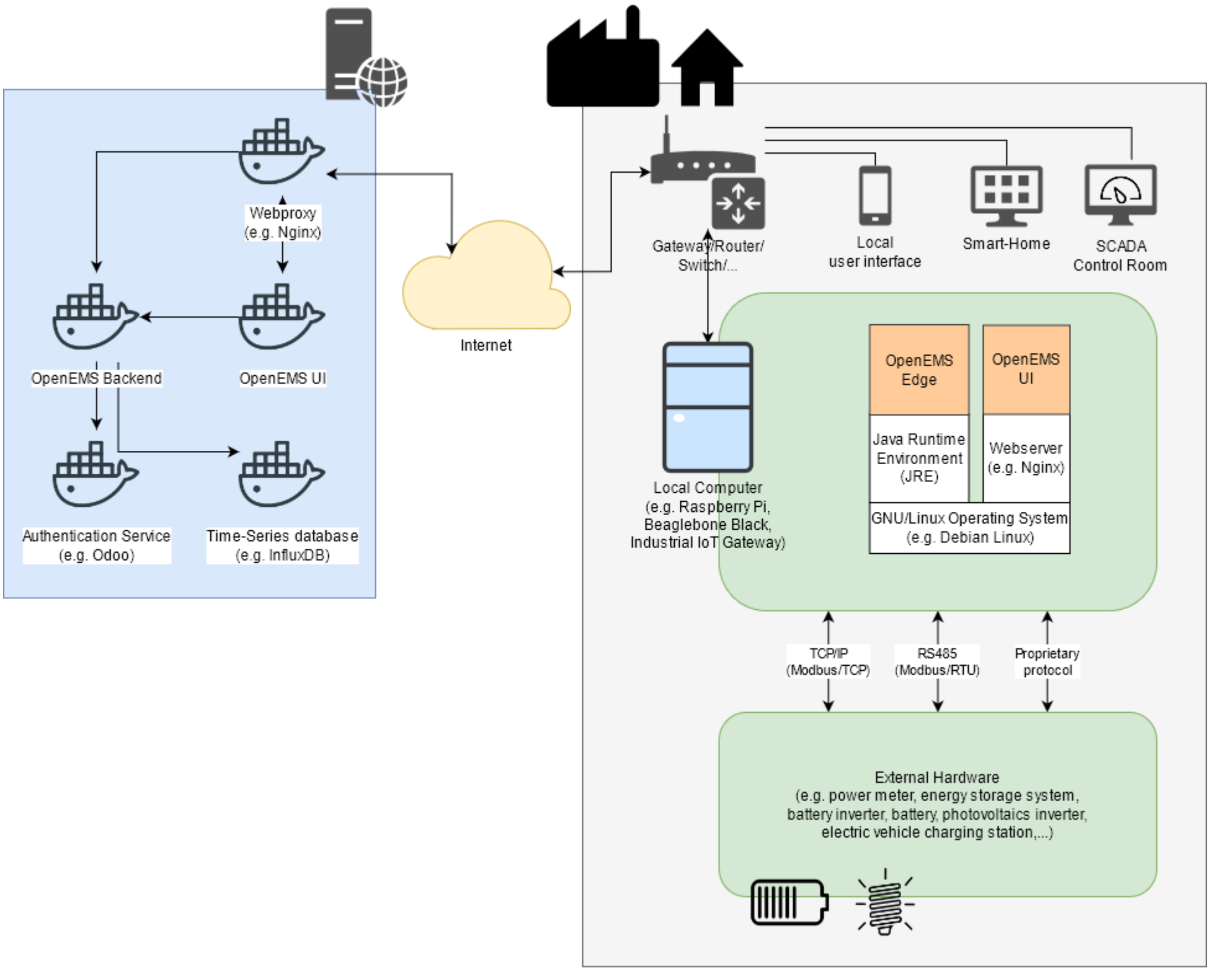


Figure 6 - OpenEMS system architecture

5.6.8 Development guidelines

The source code is available online at openems.io[130] and on GitHub[131] . New versions are released every month and tagged accordingly[132]. Version numbers are built using the pattern year.month.0, e.g. version 2022.1.0 is the release of January 2022. The patch version is always 0 and reserved for private distributions. Git development follows the Gitflow Workflow[133], so the main branch[134] always holds the stable release, while active development is happening on the develop branch[135] or in separate feature branches. For Edge and Backend Java development it is recommended to use the Eclipse IDE[136] . For the UI (TypeScript + Angular.io) we recommend Visual Studio Code[137] . The documentation is generated using AsciiDoc[138] . For handling git we recommend Sourcetree by Atlassian[139] .

5.6.9 Open Source philosophy

The OpenEMS project is driven by the OpenEMS Association e.V.[140], a network of users, vendors and scientific institutions from all kinds of areas like hardware manufacturers, software companies, grid operators and more. They share the common target of developing a free and open-source platform for energy management, that supports the 100 % energy transition: "We are inviting third parties to use OpenEMS for their own projects and are glad to support them with their first steps. In any case if you are interested in OpenEMS we would be glad to hear from you in the OpenEMS Community forum[141]".

OpenEMS development was started by FENECON GmbH[142], a German company specialized in manufacturing and project development of energy storage systems. It is the software stack behind FEMS - FENECON Energy Management System[143] and widely used in private, commercial and industrial applications. OpenEMS is funded by several federal and EU funding projects.

130 https://openems.io/
131 https://github.com/OpenEMS/openems
132 https://github.com/OpenEMS/openems/releases
133 https://www.atlassian.com/git/tutorials/comparing-workflows/gitflow-workflow
134 https://github.com/OpenEMS/openems/tree/main/
135 https://github.com/OpenEMS/openems/tree/develop
136 https://www.eclipse.org/topics/ide/
137 https://code.visualstudio.com/
138 https://asciidoc.org/
139 https://www.sourcetreeapp.com/
140 https://openems.io/association/
141 https://community.openems.io/
142 https://fenecon.de/
143 https://fenecon.de/fenecon-fems/fems-app-eigenverbrauchsoptimierung/

References to best practices from other countries that are advanced on the energy community's topic and utilize data platforms of the type

6 References to best practices from other countries that are advanced on the energy community's topic and utilize data platforms of the type

6.1 France

6.1.1 Legal framework France[144]

France has incorporated a legislative framework for both RECs and CECs in its Energy Code[145]. This framework encompasses definitions, rights and obligations, enabling frameworks, and support schemes. The framework combines the former approach of participative projects and energy communities, resulting in a somewhat complex structure.

REC: A legal entity based on open and voluntary participation that is autonomous. It is controlled by shareholders or members close to the renewable energy projects to which it has subscribed and developed. The REC's primary objective is to provide environmental, economic, or social benefits to its shareholders, members, or the local areas where it operates, rather than generating financial profits.

CEC: A legal entity based on open and voluntary participation of any type of members or shareholders. Similar to a REC, a CEC must be autonomous and aims to provide environmental, economic, or social benefits to its members, shareholders, or local areas of operation, instead of financial profits. Effective control in a CEC can only be exercised by natural persons; local authorities and their groupings; joint stock companies with public and private capital; or small enterprises to the extent they are autonomous.

Both RECs and CECs can take the form of a limited company; a simplified joint-stock company; a cooperative of collective interest; or an association.

Rights and Obligations:

- Both RECs and CECs are grouped under the concept of energy communities. Some provisions apply to both RECs and CECs.
- **Renewable Energy Community**: Can produce, consume, store, and sell renewable energy, including through renewable PPAs. RECs can access all relevant energy markets, either directly or by aggregation, in a non-discriminatory manner.
- **Citizen Energy Community**: Can engage in production (including from renewable energy sources), supply, aggregation, storage, and sale of electricity. CECs can also provide different energy services to their members, such as energy efficiency and charging of electric vehicles. CECs can access all relevant electricity markets, either directly or by aggregation, in a non-discriminatory manner.

[144] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-communities/energy-communities-repository-policy-database_en#france
[145] https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000023983208/2023-07-14/

A common enabling framework for both RECs and CECs has been outlined in the law and will be applicable to both types of initiatives defined as energy communities. The DSOs for electricity, gas, and district heating must cooperate with energy communities for energy sharing. Energy communities benefit from proportionate and non-discriminatory treatment for their rights, activities, and obligations as final consumers, producers, suppliers, and market operators. Energy communities must declare their installations to the electricity, gas, heating, and cooling DSOs prior to their commissioning and use of the grid.

To the extent that energy sharing is considered as collective self-consumption (CSC), the regulator establishes specific network tariffs for consumers participating in self-consumption operations so that those consumers do not pay for access fees that do not reflect the costs of the DSOs.

The pluriannual energy programme[146] will include a chapter on the balanced development of the grid, storage, energy transformation, and demand-response to support local energy production, smart grids, and self-consumption. France has also set up a specific framework on public offerings for the financing of renewable energy production projects by citizens and local authorities.

6.1.2 Smart meters and data platforms

As of 2023, France has achieved approximately 94% coverage of smart meters. The rollout began in December 2015, with the goal of installing 35 million meters by the end of 2021. The deployment has been largely successful, with Enedis, the main DSO, continuing to manage and optimize the network.

Linky meters[147] are the primary smart meters deployed in France. The meters are equipped with advanced communication capabilities, allowing for real-time data transmission between the meter and Enedis. This is facilitated through powerline carrier technology, which uses existing electrical wiring to send data to data concentrators, and subsequently to a central information system via telecommunications networks. The meters provide detailed consumption data, enabling consumers to monitor and manage their energy use more effectively.

The Enedis DataHub[148] is the central platform for managing electricity data from Linky smart meters in France. This system is designed to collect, store, and process vast amounts of data generated by the millions of Linky meters deployed across the country. The DataHub ensures secure and efficient data handling, facilitating various applications such as billing, energy management, and grid optimization. The data is transmitted using power line carrier (PLC) technology, which utilizes existing electrical wiring to send information to data concentrators. From there, the data is transferred to the Enedis DataHub via telecommunications networks such as GPRS.

Once the data reaches the Enedis DataHub, it is securely stored and processed. The DataHub uses advanced data management systems to handle the large volumes of data, ensuring that it

[146] https://www.ecologie.gouv.fr/politiques-publiques/energies-renouvelables-citoyennes

[147] https://en.selectra.info/energy-france/guides/electricity/linky

[148] https://www.enedis.fr/acceder-aux-donnees-fournies-par-enedis

is accessible for various purposes. The platform supports both real-time and historical data analysis, providing valuable insights into energy consumption patterns.

Enedis offers several services through the DataHub to facilitate data access for different stakeholders:

- **Data Connect**: This API platform allows third-party service providers to access consumption data from Linky meters with the consent of the consumers. It enables the development of innovative energy management solutions and services.
- **SGE (Système de Gestion des Échanges)**: This platform provides access to technical data and consumption measurements for residential, commercial, and industrial customers. It requires prior authorization and the installation of specific software provided by Enedis.
- **Open Data**: Enedis also offers open data services, providing access to aggregated and anonymized electricity statistics for public use. This data can be visualized, downloaded, and queried via APIs.

Enedis adheres to strict regulations to protect consumer data. The data is anonymized and encrypted to prevent unauthorized access. Consumers have control over their data, and third-party access is only granted with explicit consent from the network users. The DataHub ensures compliance with data protection laws, including the General Data Protection Regulation (GDPR).

Eliq[149], a company specializing in energy insights and customer engagement, has integrated its platform with Enedis to directly collect data from Linky meters. This integration allows utilities to provide consumers with tools such as mobile apps for real-time energy monitoring and management.

These platforms collectively enhance the efficiency and reliability of energy management in France, supporting the country's goals for sustainability and smart infrastructure.

6.1.3 Collective self-consumption

Collective self-consumption in France is a system that allows locally produced electricity to be shared between producers and consumers connected to the public distribution network within the same geographical area. This model promotes renewable energy production and consumption, aiming to enhance energy efficiency and sustainability. The concept has gained traction due to rising social expectations for greener energy solutions and the proactive policies supporting the green transition[150].

The legal framework for collective self-consumption in France has evolved significantly since its inception. The first mentions of collective self-consumption appeared in the Green Transition Law of August 17, 2015, which laid the groundwork for subsequent regulations. Key legislative milestones include the decree of April 28, 2017, which modified the Energy Code to

[149] https://eliq.com/blog/meet-linky-frances-smart-meter-which-talks-to-consumers-through-our-utility-apps/

[150] https://www.encyclopedie-energie.org/en/collective-self-consumption-principles-and-state-of-the-art-in-france/

accommodate collective self-consumption, and the ordinance of July 27, 2016, which provided a detailed definition of collective self-consumption in the French Energy Code. The geographical proximity criteria were expanded in October 2020, allowing participants in rural areas to be up to 20 km apart. In March 2023, the French government enacted the Law No. 2023-175 on accelerating the production of renewable energies (APER Law), which brought more clarity to the legal provisions governing electricity grid connection and allowed for better planning and greater flexibility in their construction[151]. These regulations aim to stimulate the development of collective self-consumption by providing a clear legal structure and support mechanisms.

Participants in a collective self-consumption project must form a legal entity (LE), which can be a co-ownership, association, cooperative, or other organizational forms[152]. This entity is responsible for managing the operation and establishing agreements with the public distribution network operator, typically Enedis. The LE must sign a collective self-consumption contract with Enedis, outlining the allocation of electricity production between consumers, which can be static or dynamic. Additionally, energy communities up to 1 MW are exempt from certain taxes, providing financial incentives for smaller projects[153].

The LE manages the operation and ensures that information on electricity consumption sharing is transmitted to the distribution system operator. Participants define the rules for sharing the electricity produced, allowing each consumer to benefit from the share of local production allocated to them. Only the supply of additional energy to cover their needs is invoiced by their electricity supplier. This system does not require any specific equipment for consumers, who remain connected to the public distribution grid.

Collective self-consumption promotes local renewable energy production and consumption, reducing reliance on centralized energy sources. This model supports the integration of renewable energy into the grid, enhancing energy efficiency and sustainability. By encouraging local energy production, collective self-consumption helps stabilize long-term energy prices and improves energy independence.

Participants in collective self-consumption projects benefit from lower energy costs and exemptions from certain taxes. They gain insights into their energy usage patterns, promoting energy-saving behaviour and reducing overall consumption. Additionally, this model supports France's goals for sustainable energy and reduces the carbon footprint.

[151] https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/france

[152] https://flux50.com/media/5757/05%20Enedis.pdf

[153] https://www.rescoop.eu/policy/transposition-tracker/enabling-frameworks-support-schemes/france

6.2 Germany

6.2.1 Legal framework Germany[154]

Germany has a comprehensive legal framework for energy communities, primarily defined by the Renewable Energy Sources Act (EEG) and the Energy Industry Act (EnWG). The EEG provides the foundation for promoting renewable energy in Germany. It includes specific provisions for energy communities, known as Bürgerenergiegesellschaften (citizen energy companies)[155]:

- **Simplified Tender Procedures**: Energy communities benefit from simplified tender procedures for onshore wind projects. They can participate in tenders with up to six wind turbines, with a total capacity not exceeding 18 MW.
- **Market Premiums**: Energy communities can receive higher market premiums for their projects. The premium is determined by the highest bid still accepted in the tender.
- **Local Participation**: At least 51% of the voting rights in an energy community must be held by local residents. No single member can hold more than 10% of the shares.

The EnWG provides the regulatory framework for the electricity market in Germany. It includes provisions for the integration of energy communities into the energy market[156]:

- **Grid Access**: Energy communities have the right to non-discriminatory access to the electricity grid. This ensures they can connect their renewable energy projects to the grid and participate in the energy market.
- **Energy Sharing**: The EnWG allows energy communities to share the electricity they produce among their members. This promotes local consumption of renewable energy.

Germany also has specific regulations for cooperatives, which are a common legal form for energy communities:

- **Cooperative Law (GenG)**: This law outlines the requirements for forming and operating cooperatives. Energy communities organized as cooperatives must register with a statutory auditing association and comply with specific governance and financial reporting requirements.

These laws and regulations create a supportive environment for energy communities in Germany, promoting local renewable energy production and citizen participation in the energy market.

6.2.2 Smart meters and data platforms

Germany has been working towards the widespread deployment of smart meters as part of its energy transition strategy. However, the rollout has faced several challenges, resulting in slower

[154] https://energy.ec.europa.eu/topics/markets-and-consumers/energy-consumers-and-prosumers/energy-communities/energy-communities-repository-policy-database_en#germany
[155] https://clean-energy-islands.ec.europa.eu/countries/germany/legal/community-energy-policies/energy-communities-energy-cooperatives-energy
[156] https://www.boell-sh.de/sites/default/files/2024-07/policy-factsheet-germany_updated-version.pdf

progress compared to other European countries. By 2021, only around 160,000 of the over 50 million metering locations were equipped with smart metering systems[157]. This places Germany among the laggards in Europe, with countries like Denmark and Sweden achieving nearly 100% coverage in the same period. To address this, the German government adopted a draft law in 2023 to restart the digitalization of the energy transition and accelerate the rollout of smart metering. The law, which came into force in the spring of 2023, sets binding deadlines to achieve an essentially full rollout by 2030. The targets include a 20% rollout by the end of 2025, 50% by the end of 2028, and 95% by the end of 2030 for residential and small business consumers.

The slow rollout of smart meters in Germany poses significant challenges for Energy Communities. One major issue is the limited availability of real-time data. The slow deployment means that many ECs lack access to the necessary data to optimize energy usage and integrate renewable energy sources effectively. This limitation hampers their ability to fully realize the potential benefits of smart meters, such as cost savings and improved energy efficiency. The delayed rollout also affects consumer engagement. Without widespread access to smart meters, consumers are less likely to participate actively in energy-saving initiatives and demand response. Regulatory and technical challenges have contributed to the slow rollout. These include the need for certification of smart meter gateways and compliance with stringent data protection regulations, which have slowed down the deployment process and increased costs. Additionally, the slow rollout has delayed the implementation of dynamic tariffs, which are essential for encouraging consumers to shift their energy usage to off-peak times and reduce overall demand on the grid.

Germany does not have a single, centralized datahub for smart meter data akin to the Enedis DataHub in France. Instead, the country employs a decentralized approach with multiple systems and platforms to manage smart meter data.

The core of Germany's smart meter infrastructure is the Smart Meter Gateway (SMGW)[158]. These gateways facilitate secure and efficient data transmission between smart meters and energy providers. They enable two-way communication, allowing for real-time data exchange and remote management of energy consumption.

The Metering Point Operation Act (MsbG)[159] governs the operation of metering points and data communication in intelligent energy grids. This act stipulates technical and organizational specifications to ensure data protection and security. The Federal Office for Information Security (BSI) has defined standards and protection profiles within the framework of the MsbG to safeguard consumer data.

The BSI Gateway Administration system[160] oversees the secure operation of smart meter gateways. This includes managing encryption keys, ensuring compliance with data protection regulations, and monitoring the integrity of data transmission

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157 https://www.ffe.de/en/publications/the-smart-meter-rollout-in-germany-and-europe/

158 https://www.openvolt.com/blog/post/the-state-of-smart-meter-data-access-across-europe

159https://www.bsi.bund.de/EN/Das-BSI/Auftrag/Gesetze-und-Verordungen/Smart-Metering-GDEW-MsbG/smart-metering-gdew-msbg.html

160 https://www.bsi.bund.de/EN/Service-Navi/FAQ/SmartMeter/faq_smartmeter_node.html

Several companies provide competitive solutions for smart meter data handling in Germany. For example, EMH Metering offers a portfolio of meters and communication solutions essential for the smart meter rollout. BRUNATA-METRONA operates as a measurement point operator for various energy sectors, including electricity and gas, offering innovative digital services and solutions for streamlined energy management

6.3 Denmark

6.3.1 Legal framework

Denmark has established a robust legal framework to support the development and integration of energy communities, aligning with both national policies and EU directives. The primary legislation governing energy communities includes the Energy Supply Act (Elforsyningsloven) and the Promotion of Renewable Energy Act (Lov om Fremme af Vedvarende Energi). These laws provide the foundation for the establishment and operation of CECs and RECs in Denmark[161].

The transposition of EU directives, particularly the Electricity Market Directive (2019/944) and the Renewable Energy Directive (2018/2001), has significantly influenced Denmark's regulatory landscape. These directives promote the integration of renewable energy sources and the establishment of ECs, ensuring that Denmark's legal framework is in harmony with broader European energy policies[162].

In addition to primary legislation, Denmark has issued several Executive Orders to detail the implementation of the Energy Supply Act and the Promotion of Renewable Energy Act. These orders cover aspects such as electricity sharing, grid access, and cooperation between DSOs and energy communities. The Danish Energy Agency also runs grant schemes to support community projects and information initiatives around energy.

Despite the comprehensive legal framework, there are still challenges to the full development of energy communities in Denmark. Regulatory and administrative barriers remain, and the government continues to work on further revisions to improve the enabling framework for energy communities.

6.3.2 Smart meters and data platforms

Denmark has been a frontrunner in the deployment of smart meters, achieving nearly complete coverage across the country. This extensive rollout has been instrumental in supporting the development and operation of energy communities, facilitating the integration of renewable energy sources, and enhancing energy efficiency.

The rollout of smart meters in Denmark began in earnest in 2014, driven by a national decision to install these meters for all residents. By the end of 2020, Denmark had achieved 99% smart

[161] https://pub.norden.org/nordicenergyresearch2023-03/denmark

[162] https://www.rescoop.eu/policy/transposition-tracker/enabling-frameworks-support-schemes/denmark

meter coverage[163]. The Radius-Kamstrup cooperation played a significant role in this achievement, installing 1 million remotely read electricity meters and meeting all safety standards within budget[164].

The Danish government mandated the installation of smart meters to enhance the digitalization of the energy sector and support the development of a smart electrical network. The comprehensive deployment of smart meters ensures that almost all households and businesses in Denmark have access to real-time energy consumption data.

Smart meters are a critical component in the operation of energy communities in Denmark. They provide the necessary data infrastructure to monitor, analyse, and optimize energy usage within the community. Smart meters provide real-time access to energy consumption data, enabling energy communities members to monitor their energy usage and make informed decisions. This data is accessible through platforms like Energinet's ElOverblik[165], which allows consumers to track their energy consumption patterns. This transparency encourages active participation in the energy market and promotes energy-saving behaviour among energy communities members.

Smart meters facilitate the integration of distributed energy resources (DERs) such as solar panels and wind turbines. By providing accurate and timely data on energy production and consumption, smart meters help energy communities optimize the use of renewable energy sources and reduce reliance on fossil fuels. The data collected by smart meters supports advanced analytics and energy management practices. Energy communities can use this data to identify energy-saving opportunities, implement demand response programs, and improve overall energy efficiency.

The digitalization of the energy sector, supported by smart meters, enables the development of innovative energy solutions and business models which energy communities can leverage to enhance their operational efficiency and sustainability.

Energinet, the Danish TSO, operates two data platforms: **DataHub[166]** and **Energi Data Service[167]**. These platforms are essential for managing and sharing energy data, thereby supporting the development and operation of energy communities in Denmark.

DataHub is a central and independent IT system owned and operated by Energinet. It serves as the backbone of the Danish electricity market by handling all data communication between market participants. DataHub collects billions of data points related to customers, consumption, and prices, ensuring seamless and secure data exchange. This platform supports various market processes, including customer switching, billing, and settlement, thereby enhancing the efficiency and reliability of the electricity market.

One of the key features of DataHub is its ability to provide consumers with access to their energy consumption data through the ElOverblik portal. This empowers consumers to monitor their

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163 https://www.openvolt.com/blog/post/the-state-of-smart-meter-data-access-across-europe

164 https://www.annualreports.com/HostedData/AnnualReportArchive/o/OTC_DOGEF_2019.pdf

165 https://eloverblik.dk/

166 https://energinet.dk/data-om-energi/datahub/

167 https://www.energidataservice.dk/

energy usage in real-time and make informed decisions about their energy consumption. Additionally, DataHub ensures compliance with regulatory requirements by providing accurate and timely data to market participants and regulatory bodies.

For Energy Communities, DataHub plays a crucial role in DERs by enabling efficient data management and communication. This ensures that ECs can operate smoothly within the broader electricity market, optimizing energy production and consumption at the community level. By providing real-time access to consumption data through the ElOverblik portal, DataHub empowers energy communities' members to monitor their energy usage, make informed decisions, and participate actively in the energy market.

Energi Data Service is another vital platform operated by Energinet, designed to provide open access to energy data for various stakeholders. This platform offers a comprehensive data catalogue that includes datasets on electricity consumption, production, grid operations, and market prices. By making this data publicly available, Energi Data Service fosters innovation and supports the development of new energy solutions and technologies.

The platform features advanced analytics and visualization tools, enabling users to analyze energy data and gain insights into energy trends and patterns. Energi Data Service also supports the green transition by facilitating the integration of renewable energy sources and promoting energy efficiency. The platform is regularly updated to ensure the availability of the latest data, making it a valuable resource for researchers, industry stakeholders, and the public.

For energy communities, Energi Data Service provides the necessary data infrastructure to monitor and optimize energy usage. The platform features advanced analytics and visualization tools, enabling energy communities to analyse energy data and gain insights into energy trends and patterns. This data-driven approach helps energy communities enhance their operational efficiency, reduce costs, and contribute to Denmark's sustainability goals. By leveraging the open data available on Energi Data Service, energy communities can improve their energy management practices and support the integration of renewable energy sources.

Together, DataHub and Energi Data Service provide the essential data infrastructure needed to support Denmark's energy transition, enhance grid management, and empower consumers. These platforms exemplify Energinet's commitment to transparency, innovation, and sustainability in the energy sector.

6.3.3 Other data services for energy communities in Denmark

In addition to Energinet's DataHub and Energi Data Service, several other data platforms and services are utilized to support the development and operation of energy communities in Denmark. These platforms provide essential data for managing energy consumption, production, and distribution, thereby facilitating the integration of renewable energy sources and enhancing energy efficiency.

EnergyDataDK[168] is a comprehensive platform that collects, stores, analyses, and shares energy data from various sources across Denmark. Operated by the Technical University of

[168] https://energydata.dk/en/

Denmark (DTU), this platform provides real-time access to a wide range of energy data, including CO2 emissions, power and voltage measurements, and operational data from district heating systems. EnergyDataDK supports the development of data-driven solutions and innovations in the energy sector by offering insights into energy consumption patterns and behavior. This platform is particularly valuable for energy communities as it enables them to monitor and optimize their energy usage, contributing to the overall efficiency and sustainability of the community.

Center Denmark[169] operates a data platform that collects and manages energy data from over 200,000 Danish households. The platform is designed to drive digitalization and innovation in the energy sector by providing efficient and secure data management. It supports advanced analytics, real-time monitoring, and the use of AI technologies. The data collected includes information from the electricity system, water supply, district heating, and gas systems. For energy communities, this platform offers the necessary data infrastructure to enhance operational efficiency, reduce costs, and support the integration of renewable energy sources.

6.4 Smart Meters in Norway

The deployment of smart metering in Norway, also known as Advanced Metering Systems (AMS), started with pilot projects in the early 2000s and became a legal requirement for all grid companies in 2019. The DSOs are responsible for the installation and operation of the AMS system. Today, nearly 100% of Norwegian households have smart meters installed.

6.4.1 Technical specification of smart meters

Smart meters for private households in Norway have several technical specifications designed to enhance the efficiency and accuracy of electricity consumption monitoring.

1. **Automatic Meter Reading:** Smart meters automatically record electricity consumption at regular intervals, typically on an hourly basis. They can also be configured to record data every 15 minutes if needed. The recorded data is transmitted to the grid operator daily, ensuring timely and accurate meter readings.
2. **Communication Technologies:** Many smart meters use GSM (Global System for Mobile Communications) or GPRS (General Packet Radio Service) for data transmission. Some meters use Radio Frequency (RF) mesh networks, which allow meters to communicate with each other and relay data to a central hub. PLC (Power Line Communication) uses existing power lines to transmit data, reducing the need for additional communication infrastructure
3. **Data Storage and Security:** Data transmitted from smart meters is encrypted to ensure security and privacy. Smart meters have local storage capabilities to retain data in case of communication failures. This ensures no data is lost.
4. **Event and Fault Detection:** Smart meters can detect and report power outages, helping grid operators respond quickly to issues. They monitor voltage levels and can detect anomalies, contributing to better grid management.

[169] https://www.centerdenmark.com/en/the-data-platform/

5. **Regulatory Compliance:** Smart meters in Norway comply with the regulations set by the Norwegian Water Resources and Energy Directorate (NVE), ensuring they meet national standards for accuracy and reliability.

In relation to LECs, smart metering is essential for effective interaction with the grid. Real-time data from smart meters allows DSOs to monitor local energy flows and manage grid congestion more effectively. This is particularly important as LECs often involve distributed renewable energy generation, which can introduce intermittency and fluctuations into the grid. Moreover, smart metering enhances transparency and trust within the communities. Members can access their own consumption data and verify the accuracy of energy bills, fostering confidence in the community's operations. This is especially important in decentralized energy systems, where multiple actors are involved and maintaining trust among participants is crucial.

Smart metering also opens possibilities for innovative business models relevant for LECs. For example, dynamic pricing schemes, where electricity prices vary based on real-time supply and demand, can be implemented more effectively with smart meters. This allows communities to incentivize energy consumption during periods of low demand or high renewable energy generation, further optimizing energy use and reducing costs.

Pilot project design

7 Pilot project design

7.1 Reference to best practices from existing pilots in Norway and abroad

This sub-chapter refers to EC initiatives in Norway and abroad, where, in addition to the United Kingdom, Switzerland and Greece, Estonia is taken as a contextually relevant case with specific activities in the EC field and challenges faced.

7.1.1 +CityxChange

An example of an urban energy community in Norway is the positive energy district (PED) pilot in the +CityxChange (Positive City ExChange)[170] in the city of Trondheim. Funded by the European Union's Horizon 2020 program, this smart city project ran from 2018 to 2023. It focused on developing and piloting positive energy blocks and districts, which are urban areas that generate more energy than they consume. The long-term goal is to create zero-emission urban ecosystems and achieve 100% renewable energy in city-regions by 2050. The project involved two Lighthouse Cities: Trondheim (Norway) and Limerick (Ireland), and five Follower Cities: Alba Iulia (Romania), Písek (Czech Republic), Sestao Berri (Spain), Smolyan (Bulgaria), Võru (Estonia).

One of the key outcomes was the demonstration of a Local Flexibility Market (LFM) in Trondheim, specifically in the Brattøra and Sluppen areas. This LFM enables neighbourhoods to exchange energy capacity and system services. It supports trading of local energy production, user flexibility, and DSO services through automated trades at a 60-minute time resolution. The market solution incorporates advanced AI trading algorithms, demand-response systems, and detailed weather forecasts to optimize energy trading. Furthermore, the project integrated e-mobility into PEDs by using Vehicle to Grid (V2G) and Vehicle to Building (V2B) technologies to charge and discharge electric car batteries. These technologies allow EVs to provide additional battery storage and support during grid stress or demand spikes.

The project highlighted the importance of storytelling and emotional connection in engaging people with PED initiatives. By creating relatable narratives, the project helped local stakeholders understand the benefits and long-term impacts of investing in such initiatives, paving the way for future projects and funding opportunities. has shown that PED projects rely on the right stories and emotion to connect with people. Creating a story around PED creation can help people to identify with and understand what's going on.

7.1.2 Smart Senja[171]

LECs are particularly beneficial in remote areas, such as islands. In Norway, these remote islands often face harsh weather conditions, leading to power failures. LECs can provide a

[170] https://cityxchange.eu/

[171] https://smartsenja.no/

secure energy supply, sometimes operating entirely off-grid, especially when connections to the main grid are limited or frequently disrupted.

A notable example of a Norwegian energy community project in a rural area is Smart Senja, an innovative project launched in 2019 with the aim of meeting the growing electricity demands of the island's fishing industry while maintaining low energy costs. This project is a collaborative effort involving residents, as well as national and international partners. It is owned by the DSO Arva AS and receives financial support from Enova, a Norwegian government agency promoting environmentally friendly energy production and consumption. The project is expected to continue until 2025.

As an island community at the end of the electric grid, Senja faces energy supply issues and variability in renewable energy sources. One of the main challenges is the variability of renewable energy sources compared to conventional ones. Hydropower is affected by seasonal variations in precipitation, while solar and wind power are influences by instantaneous weather changes. Additionally, energy consumption fluctuates throughout the day, with significant peaks and troughs.

Key solutions implemented by Smart Senja include the installation of smart power management systems in homes and businesses to distribute electricity consumption more evenly between day and night. The project also involves large lithium batteries at two locations to help balance out fluctuations in electricity consumption. These solutions will potentially reduce the need for infrastructure development, leading to savings on grid tariffs and electricity bills for both businesses and households.

The Smart Senja project demonstrates the potential of energy communities to address energy challenges in remote locations. However, it also highlights the need for a more supportive regulatory framework in Norway to enable the broader adoption of these innovative energy models that combine smart power management systems, energy storage, and local renewable energy production.

7.1.3 Energy community examples from UK, Switzerland and Greece

Relevant examples are described, considering the regulatory environment, technology and business models accommodated.

Oxfordshire's Low Carbon Hub (United Kingdom)[172]

- **Regulatory environment**: Established in 2011, the Low Carbon Hub operates within the UK's regulatory framework, which has evolved to support community energy projects, despite challenges like reduced government incentives in recent years.
- **Technological specifications**: The Hub boasts 55 renewable energy installations, including two hydroelectric dams on the River Thames and the UK's largest community-owned solar park, Ray Valley Solar, which generates 19.5 GWh annually—enough to power over 6,000 homes.

[172] https://www.lowcarbonhub.org/

- **User acceptance and business models**: With 1,773 members, the Hub reinvests profits from electricity sales into community projects, such as improving insulation in schools. This model not only reduces energy consumption but also fosters community involvement and acceptance.

Quartierstrom project in Walenstadt (Switzerland)[173]

- **Regulatory environment**: This pilot operates under Switzerland's regulatory framework, exploring peer-to-peer energy trading within a local community.
- **Technological specifications**: Involving 37 households, the project utilizes a blockchain-based system to manage energy transactions between consumers and prosumers. Participants can set prices for buying and selling locally produced solar energy, promoting local balancing.
- **User acceptance and business models**: By enabling direct energy transactions without intermediaries, the project empowers participants to influence their energy costs, enhancing user acceptance and fostering a community-centric business model.

Student Housing Renewable Energy Community (Greece)[174]

- **Regulatory environment**: Greece's Law 4513/2018 established a framework for energy communities, promoting social and solidarity-based economy principles. This legislation allows natural persons, legal entities, and local authorities to participate in energy initiatives.
- **Technological specifications**: A pilot project was initiated in a student housing complex, aiming to implement a renewable energy community. The project proposed the installation of photovoltaic (PV) panels with a capacity tailored to meet the energy demands of the housing units. Additionally, energy storage systems were considered to optimize self-consumption and manage peak demand.
- **User acceptance and business models**: The project emphasized active involvement from student residents, fostering a sense of ownership and responsibility towards energy consumption. Educational workshops and participatory decision-making processes were employed to enhance user engagement. The business model focused on collective investment and shared benefits, reducing energy costs for participants and promoting sustainability.

[173] https://quartier-strom.ch/index.php/en/homepage/

[174] https://www.mdpi.com/2071-1050/13/7/3792?utm_source=chatgpt.com

7.1.4 Reference to the EC development in Estonia

A study resembling the ambition of this project has been carried for Estonia[175], analysing Estonia's energy communities in terms of regulatory environment, technological specifications, and user acceptance/business models. The key takeaways can be summarized as:

- Legal frameworks exist but require clarification, particularly on energy sharing rules and municipal involvement.
- Technological implementation is limited by grid constraints, small system sizes, and low adoption of battery storage.
- Financial and regulatory hurdles discourage user participation, despite strong municipal interest.
- Future success depends on better-defined business models and stronger government support for local energy projects.

Some more details of the Estonian study, found to be of relevance for the current project, are presented below:

Regulatory Environment: Estonia transposed the EU Clean Energy Package directives (RED II and IEMD) into national law through the Energy Sector Organization Act and the Electricity Market Act (2022). These laws recognize RECs and Citizen Energy Communities CECs, allowing them to produce, store, and share energy. However, some legal definitions remain unclear, such as "proximity" requirements and the role of municipalities.

State-owned energy market dominance: Eesti Energia (state-owned) controls 90% of Estonia's electricity market, making it difficult for independent energy communities to gain a foothold. The largest Distribution System Operator (DSO), Elektrilevi, has set restrictions that limit small energy producers from feeding more than 15 kW into the grid, creating a barrier for larger EC projects.

Municipal barriers: Public procurement laws prevent direct purchasing of electricity from ECs by municipalities, making it difficult for municipal buildings to participate in local energy generation projects.

Limited financial incentives: KredEx provided subsidies for installing 15 kW solar systems on apartment buildings, but 72% of applications failed due to grid limitations and long connection times. Energy cooperatives lack structured financial support mechanisms, leading to financial risks for early adopters.

Technological specifications of EC installations:

Solar PV installations: Most pilot projects in Estonia focus on small-scale rooftop PV systems, typically ranging from 13 kW to 50 kW, due to grid limitations. Example: The Tartu Annelinn apartment project planned a 22 kW solar installation, with 17 kW sold back to the grid.
Energy storage and smart metering: Energy storage adoption is low due to high costs and regulatory uncertainty. Smart meters are required for energy sharing, but legal uncertainties about joint contracts hinder adoption.

[175] https://www.sciencedirect.com/science/article/pii/S0301421525000217

District heating and community-scale energy solutions: Kääpa EC (rural project) aims to integrate solar power with local heating systems, demonstrating a more integrated community approach.
Grid limitations: The 15 kW feed-in limit forces many ECs to consume all generated power onsite rather than selling to the grid. Some areas, particularly Estonia's islands and near the Russian border, face restrictions on solar installations exceeding 50 kW due to security concerns.

User acceptance and business models

User engagement challenges: Post-Soviet distrust in cooperatives makes it difficult to convince citizens to join ECs. Many Estonians are unfamiliar with electricity markets and renewable energy options, requiring extensive public engagement. In rural areas, low-income levels and aging populations discourage investment in ECs.
Business models: Crowdfunding and citizen investment have been used in projects like the Tartu Municipal Solar Roof initiative. The Seto Aiad EC (agricultural cooperative) is attempting to integrate renewable energy with farming operations to create a self-sufficient business model.
Profitability concerns: Financial returns are often too low to justify the administrative burden of setting up an EC. Example: In Tartu Annelinn, projected savings of €50 per apartment per year were deemed too low to justify the effort of establishing an energy-sharing cooperative.
Municipal support but limited direct involvement: Cities like Tartu have supported ECs by providing technical guidance but cannot directly invest due to procurement laws.

Capacity building, stakeholder engagement and business models

8 Capacity building, stakeholder engagement and business models

8.1 Involvement and feedback from relevant stakeholders

As part of the project a wide range of strategic stakeholders were consulted to gather insights, identify barriers, and co-create solutions. These included regulators, DSOs, energy traders, academics, and emerging energy community representatives. The consultations confirmed both the urgency and the complexity of unlocking the potential of energy communities in Bulgaria's evolving power market.

Key highlights from the stakeholder meetings:

EWRC (Regulator): The Commission emphasized the importance of fulfilling pending reforms tied to EU funding and especially the Recovery And Resilience Facility, including one specifically on enabling energy communities. However, political resistance continues to delay market liberalization, a precondition for flexible participation by a wider variety of market actors, including prosumers and energy communities.

Academia (experts from leading Bulgarian universities): Experts called for flexible models, improved modelling tools, and pilot projects beyond PVs (e.g., heating, cooling, storage). Concerns were raised about delayed transposition of EU rules and insufficient adaptation to local context.

DSOs: While DSOs recognize the role of energy communities, they emphasize the need for well defined smart metering rules, legal clarity, and the inclusion of capacity-based tariffs on top of the tariffs based on transported energy volumes which is the only foundation of the current tariff system. The presence of many connections where the consumption is zero or near zero makes this tariff model a one that undermines the long-term investment in the grids. EVN supports virtual billing as the best future proof mechanism for Bulgaria, whereas Elektrohold stresses the need for national data platforms and pilot support via EU funds.

TSO: The interviewed experts from ESO advocate for building a smart grid ecosystem with DSOs empowered to manage flexibility similar to the TSO. Highlights the need for legal updates to market rules and grid codes, and supports that a centralized datahub should be developed and placed under the management of the TSO.

Energy traders/traders' platform operator: Traders seem to support energy communities in general but note current structural and pricing distortions. They are planning to offer products for energy communities but not proactively yet. They stress the need for data transparency and see value in platforms for education, aggregation, and market participation. Elca.bg as operator for a trading platform is ready to facilitate digital access for communities.

Energy communities: The initiatives carried Gabrovo and Burgas demonstrate the feasibility and benefits of local, community-driven energy sharing. However, legislative gaps, lack of smart meters, and limited financial incentives remain barriers.

8.2 Hands-on training workshops focusing on roles and responsibilities, economic viability and technology

During the last month of the project period a workshop with Bulgarian Energy community stakeholders was held in Sofia. The participants were divided in 3 groups and addressed questions related to roles and responsibilities, economic viability and incentives, technical integration and innovation. A summary of the received feedbacks is presented in Table 21.

Table 21 – Summary of workshop feedbacks from Bulgarian energy community stakeholders

Group	Roles and responsibilities	Economic viability and incentives	Technological integration and innovation
DSOs	DSOs are neutral party and should treat all customers alike. Municipalities are seen as the key stakeholder – have trust among citizens and can inform. Energy communities should be represented by a legal party – e.g., energy community operator, aggregator, retailer, or another third party. Secondary legislation addressing energy communities is needed so that DSOs can adequately support their establishment in the grid. To develop demand-oriented market products.	There should not be reduction in grid tariffs in relation to introduction of energy communities. In addition, all metering points should pay a fixed tariff for being measured. Currently there is not sufficient knowledge among households about the possibilities and consequences associated with market liberalization and the outcome of transferring households to a liberalized market is per now not guaranteed as favourable.	"Net metering" is not feasible for the DSOs, as by regulations electric power flows should be measured in both directions (production/consumption). There is need for detailed description of the technical specifications of smart meters. Per now a number of the metering points can be read remotely. To be able to innovate and accommodate for energy communities DSOs require introduction of regulatory sandboxes so that they can start with small-scale pilots and gradually increase the adoption. Software for real time data sharing, hardware for measuring and sharing of electricity in close local distance.
Municipalities, citizens	To increase their attention on their demand profiles and to explore options for generation for own consumption. To support energy communities by raising awareness and providing resources. To actively promote best practices and encourage development of pilot projects.	There will not be any engagement from citizens unless it is proved that EC will provide lower electricity bills. The business models need to be profit based, not only that citizens can save money, but actually make profit through selling electricity.	The infrastructure should be very simple for regular citizens. It should be "call and sign" procedures, and a third party handles all the technicalities. If it becomes too complicated and bureaucratic, it is not viable.
National authorities	Reduction of grid taxes, targeted financial support for vulnerable consumers, development of specific administrative regulation for easy participation of citizens in EC. Liberalisation of electricity prices in short terms.	The national authorities need to come with clear definitions of network tariffs and other regulations.	To encourage the short-term replacement of all the household meters with smart ones. Differentiate between CEC and REC in regulation.

Academia	To intensify the development of SW and HW solutions that enable the sharing of electricity.		To enlarge the home automation applications and devices.

8.3 Final closing conference to present project outcomes, recommendations, and scaling strategies

8.4 Business models that trigger stakeholder participation

Suitable business models are by no doubt crucial for motivating stakeholders' engagement. In this relation, the current work refers to relevant business models and their applicability in a Bulgarian context.

Various business models have been utilized to support the financial sustainability and operational efficiency of energy communities across European countries. This sub-chapter outlines some key business models, elements of which could be relevant in a Bulgarian setting.

Cooperative model: One of the most established business models for energy communities is the cooperative model. This structure allows members—typically local citizens and businesses—to collectively invest in renewable energy projects and share the benefits. Characterized by:

- Democratic governance: One member, one vote.
- Revenue generation through electricity sales and savings on energy bills.
- Reinvestment of profits into community projects or energy infrastructure.
- Examples: Ecopower in Belgium[179] and Som Energia in Spain[180].

Public-private partnership (PPP) model: Involves collaboration between local governments, private investors, and community groups. The municipality often plays a key role in securing funding, streamlining regulatory approvals, and facilitating grid access. Key advantages include:

- Access to public subsidies and incentives
- Increased investment security and scalability
- Ability to integrate broader sustainability goals, such as district heating and energy efficiency programs
- Example: Practiced, among others, within the LEC projects carried by Energiequelle in Germany[181]

Prosumer-based model: In this model, energy community members act as both producers and consumers of electricity. Through peer-to-peer (P2P) trading platforms, excess energy

[179] https://energycommunityplatform.eu/communities/ecopower/

[180] https://www.somenergia.coop/es/welcome-to-som-energia/

[181] https://www.energiequelle.de/en/services/project-development/citizen-participation

generated by rooftop solar or wind installations is shared within the community. Key characteristics:

- Use of blockchain or digital platforms to enable transparent transactions
- Reduced dependency on traditional utilities
- Enhanced energy autonomy and grid resilience
- Example: Powerpeers in the Netherlands

Energy-as-a-Service (EaaS) model: The EaaS model provides communities with renewable energy solutions without requiring upfront capital investment. Third-party providers install and maintain solar panels, wind turbines, or storage systems while communities pay for the electricity generated. Key benefits:

- No need for high initial investment.
- Predictable energy costs through subscription-based pricing.
- Potential bundling with demand-side management and smart grid services.
- Example: Hyllie district in Malmö, Sweden where the investment was carried out by E.ON[182]

Aggregation and demand response model: This is a rather ambitious and currently mostly research verified business model. Here**,** energy communities can act as aggregators, pooling energy resources from multiple members to participate in flexibility markets. Demand response strategies allow communities to adjust consumption patterns based on grid needs and market prices. Features include:

- Revenue generation through participation in balancing and ancillary services
- Use of smart meters and automation to optimize energy usage
- Increased stability and efficiency of the local energy system
- Example: FLEXCoop project in the EU[183]

Local energy supply and retail model: This business model refers to the energy communities' ambition to establish their own local energy supply companies, allowing them to buy and sell electricity directly. This model is still seldom to see as it requires a licensing process and grid access agreements but offers:

- Local price control and tariff customization
- Improved energy retention within the community
- Economic benefits through job creation and local investment
- Example: Bürgerwerke in Germany[184]
-

8.4.1 Suitability of the business models in Bulgarian context

Energy communities in Bulgaria are still in their early stages of development and face several regulatory, financial, and technical barriers. Considering the feedbacks received from the few existing ECs in the country and the experiences collected in a broader "European best

[182] https://www.eon.com/en/business-customers/success-stories/hyllie-project.html

[183] https://www.flexcoop.net/

[184] https://buergerwerke.de/oekostrom/buergeroekostrom

practices" perspective, it is possible to refer to several of the above-described models as suitable ones.

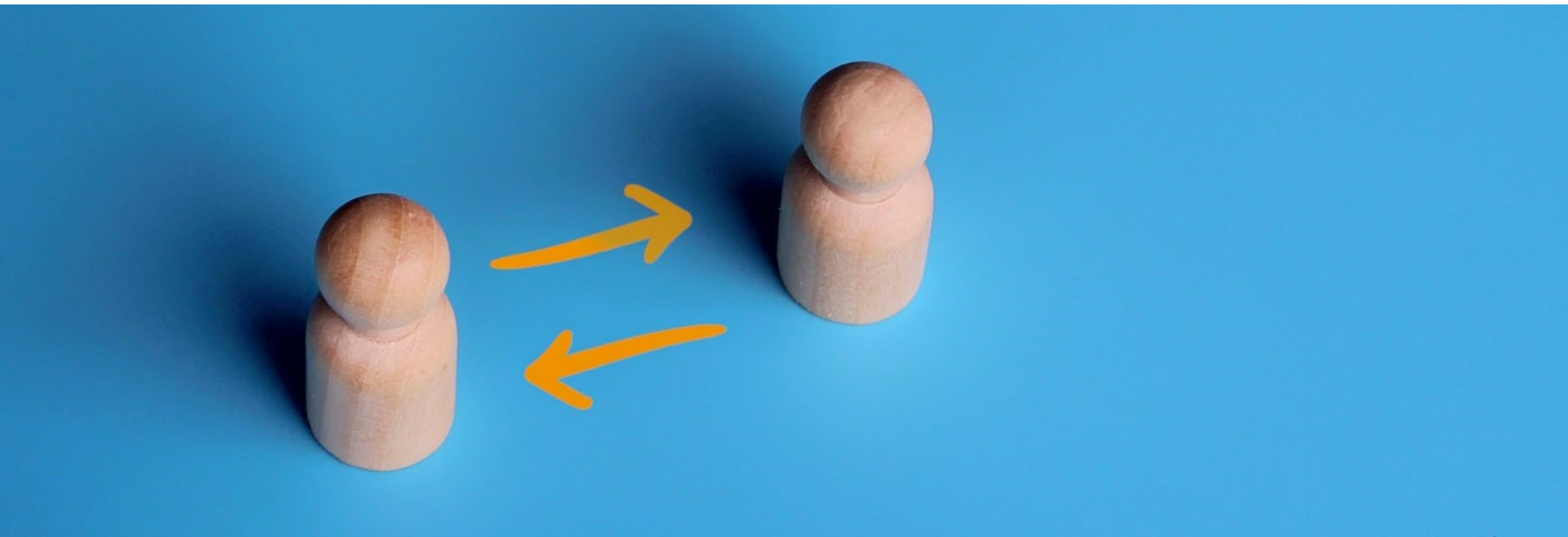
Given the need for collective citizen engagement and shared investments, the **cooperative model** can be considered appropriate. It allows for democratic governance (one member, one vote), financial sustainability through energy sales, and reinvestment into local projects. Cooperatives can help overcome financial barriers by pooling resources, particularly in rural and small urban areas where local ownership is key to trust and participation.

Next, taking in account Bulgaria's limited access to financing for new renewable projects, an **EaaS model** could allow third-party providers to install and manage renewable energy systems while communities pay for the energy consumed through fixed fees or performance-based contracts. This model reduces the upfront investment required by citizens and municipalities, making it easier for communities to adopt renewable energy without financial barriers.

Also, emphasizing the need for state and municipal support in fostering energy communities, a **PPP model**, where local governments provide regulatory and infrastructural support while private investors and local businesses offer funding and expertise, would be highly beneficial. Municipalities could allocate public spaces for solar or wind installations and facilitate grid access. This model aligns with best practices in the Netherlands and Austria, where public institutions prioritize purchasing energy from local communities.

Finally, despite the obstacles related to grid access, smart metering, and energy sharing regulations a **peer-to-peer (P2P) energy sharing model** could work if technical and regulatory improvements are made, such as smart meter installation and local energy exchange platforms. For realizing these models, the Bulgarian government should also provide clearer policies for energy sharing, as seen in Spain and Greece, where prosumers can trade excess electricity at fair prices.

The realization and adoption of the various business models will be dependent on the legal and regulatory constraints, existing financial barriers, technical challenges and the public awareness and trust. Current Bulgarian regulations limit renewable energy projects to urban areas, restricting options for larger-scale wind and solar farms built through an energy community approach. Access to bank loans and investment capital is limited and the insufficient spread out of smart metering and grid integration is a key issue. Given Bulgaria's limited experience with energy communities, a cooperative model could be most successful in building trust and encouraging citizen participation, as proved by the established in Gabrovo energy community.



Recommendations

9 Recommendations

The benchmarking carried between Bulgaria, Norway and other European countries uncovered areas for regulatory, technical, strategic and economic improvements. To successfully integrate more energy communities in Bulgaria, leveraging Norway's success in empowering end-users through clear regulations, smart metering, a liberalized market, and comprehensive data access via the Elhub platform can serve as a guiding framework. The following recommendations outline key areas of action for the SEDA and the Bulgarian Ministry of Energy.

9.1 Key legal recommendations stemming from the legal gap assessment

9.1.1 Legal form and recognition

Bulgaria should introduce a dedicated legal definition and recognition of energy communities under the **Energy Act** and the **RES Act**. This should establish RECs and CECs as distinct market participants with clearly defined rights and obligations. While current laws mirror basic EU definitions, they lack specificity. To address this, primary legislation must define key terms such as "voluntary and open participation", "autonomy", and "effective control" (e.g., one member–one vote), and introduce safeguards against covert commercial control or misuse. Proximity requirements for RECs should also be clarified in the primary legislation, leaving technical implementation to secondary acts. Furthermore, these laws must mandate a national registration system for energy communities, empower EWRC with oversight responsibilities, and introduce sanctions for violations of community principles (e.g., ineligible members or deviation from non-profit objectives).

9.1.2 Secondary legislative amendments

To enable full market participation, the **Rules for Measuring Electricity (ПИКЕЕ)** and the **Electricity Market Rules (ПТЕЕ)** should be updated. These amendments must specify the roles of energy communities in metering, data exchange, and collective self-consumption, and allow for models such as VNM. Transparency, data access, and interoperability standards should also be introduced.

9.1.3 Legal entity options

Energy communities should be allowed to register under existing legal forms—cooperatives, non-profits, or commercial entities—**only if** they meet the criteria for energy communities. The **Cooperatives Act** requires clarification to allow activities beyond agriculture. For example, Article 2 limits cooperatives to seven individuals and ties them to land use for farming or forestry, which restricts flexibility for energy projects. The **Non-Profit Legal Entities Act** may also need minor changes to ensure that energy-related activities do not conflict with non-profit status.

9.1.4 National registry of energy communities

A central registry should be established under **EWRC** or **SEDA**. This would grant legal visibility and allow energy communities to access the energy market, apply for public support, and qualify for financing. It should also ensure consistent monitoring and enforce compliance with community-based principles.

9.1.5 Need for reforms

The necessity for carrying the reforms is grounded in the following:

- Current legal forms (e.g., commercial companies, cooperatives, non-profits, condominiums) do not support energy market functions like grid access, trading, data rights, or balancing.
- Without a legal definition, energy communities remain invisible to regulators, DSOs, and funding bodies.
- EU directives (RED II and Directive 2019/944) require national legislation to define and enable energy communities as active energy market participants.
- A robust legal framework, supported by a registration system and one-stop-shop services, would unlock access to EU and national funding, ESCO partnerships, and administrative simplification.
-

9.2 Enabling energy communities to share and distribute energy locally and efficiently

To support the practical implementation of energy communities in Bulgaria and align with the rights established under EU law, further targeted reforms in primary and secondary legislation are required. These reforms must clarify the legal status of internal energy distribution and sharing systems operated by energy communities, simplify participation in the market, and establish proportionate regulatory obligations. To avoid political or conceptual sensitivities around the term "microgrid", we propose the more neutral and context-specific terms: **"internal energy networks"**, **"community-level distribution infrastructure"**, or **"internal distribution systems"**. Specifically, the following steps are proposed:

9.2.1 Legally define and enable internal distribution systems for energy communities

Amend the **Energy Act** and **Ordinance №6** to introduce a legal definition and framework for **internal distribution systems** operated by energy communities. These systems should enable registered RECs and CECs to share energy between members either locally (e.g., on a shared internal network) or virtually, with simplified connection and regulatory procedures.

In the case of geographically clustered members, such systems should qualify as **closed distribution systems** under **Article 119 of the Energy Act**, treated as a single connection point to the public grid. This framework should enable energy communities to build and operate private internal networks—especially in residential, commercial, or industrial zones—without requiring full distribution operator licenses. Technical parameters, including **voltage level**, **connection point**, and **maximum capacity thresholds**, can be set in secondary legislation.

Importantly, such practices already exist informally in Bulgaria in industrial and mixed-use zones. Legal recognition of these practices for energy communities would improve transparency, safety, and market participation, while maintaining consumer rights and network reliability.

9.2.2 Enable collective self-consumption and virtual energy sharing

Amend the **Electricity Market Rules (ПТЕЕ)** and **Electricity Measurement Rules (ПИКЕЕ)** to explicitly allow for:

- **Collective self-consumption** within a single metering point (e.g., residential buildings)
- **Virtual energy sharing** (via VNM or Virtual Billing), where the production and consumption occur at different locations but within the same grid zone.

Sharing should be enabled through metering data platforms and facilitated by a single point of contact (e.g., a retailer, aggregator, or coordinating entity). These models can operate under **standardized digital platforms** or mobile applications, giving consumers transparent access to their usage and participation profiles.

9.2.3 Introduce balancing market provisions for energy communities

Create a special participation framework for energy communities in balancing and flexibility markets. This includes:

- The right to join **simplified balancing groups**
- Representation by **aggregators**, subject to tailored conditions (e.g., reduced minimum capacity thresholds, simplified reporting)
- Clear rules on how behind-the-meter production and consumption is scheduled, reported, and settled.

This will ensure that energy communities can contribute to system balancing and demand-response services, in line with the evolving flexibility needs of the electricity system.

9.2.4 Establish simplified licensing and exemptions for small-scale energy communities

Amend the **licensing regime** under the Energy Act to:

- Exempt **small energy communities** (e.g., under 100 kW aggregated capacity) from full permitting requirements for energy generation and sale.
- Allow registered energy communities to act as **self-balancing entities** or be recognized as **balancing group coordinators**, without the obligations imposed on commercial traders.

Such exemptions will reduce entry barriers for local initiatives while maintaining accountability and system integrity.

9.2.5 Reform tariff models to avoid penalizing local energy sharing

Adjust the **tariff structure** so that internal energy sharing—either via internal networks or through the public grid at low-voltage levels—is not subject to the full extent of standard transmission and distribution fees. For example:

- When both production and consumption occur **within the same transformer station zone**, grid fees should be reduced proportionally to the infrastructure use.
- In internal networks recognized under Article 119, **capacity-based tariffs** rather than volume-based ones could apply, reflecting the actual system costs more accurately.

These reforms would reflect the lower impact of localized energy flows on the overall grid and incentivize efficient local balancing.

9.2.6 Establishing a national one-stop shop framework for energy communities

To effectively support the development of energy communities and fulfil Bulgaria's obligations under the EU Renewable Energy Directive (2018/2001/EC), it is necessary to upgrade the current framework of municipal one-stop shops under Article 22 of the RES Act (ЗЕВИ). This should be done by introducing a **dedicated national one-stop shop system** tailored to the needs of energy communities, prosumers, and decentralized energy initiatives. We recommend amending the RES Act (ЗЕВИ) to mandate the creation of **nationally coordinated one-stop shop services**, with clearly defined functions and responsibilities, supported by a dedicated regulatory ordinance issued by EWRC. These services should:

- **Provide legal, technical, and financial support** for the formation and operation of Renewable Energy Communities (RECs) and Citizen Energy Communities (CECs).
- **Centralize and streamline administrative procedures** related to registration, licensing, permitting, grid connection, and market access.
- **Enable digital access** through a national online platform, integrated with e-government systems, allowing communities to submit documents, track progress, and communicate with relevant institutions.
- **Be coordinated by SEDA** to ensure consistency across municipalities, introduce national service standards, and provide training for local authorities.

9.3 Establish a regulatory sandbox for energy innovation in Bulgaria

To support the integration of innovative technologies, business models, and new market actors such as energy communities, **Bulgaria should introduce a regulatory sandbox framework** under the Energy Act, following the example of Norway's energy sandbox administered by NVE. The sandbox should allow **temporary regulatory exemptions** and **supervised testing environments** for pilot projects that aim to demonstrate technical or market innovations. This would enable energy communities, aggregators, prosumers, DSOs, and other actors to test real-life solutions—such as energy sharing, peer-to-peer trading, local balancing, and dynamic pricing models—without being constrained by the current rigid regulatory rules.

Key features of the Bulgarian energy regulatory sandbox

The **legal basis** for establishing a regulatory sandbox should be introduced through a new provision in the **Energy Act**. This provision must explicitly empower the **EWRC** to create and manage sandboxes for testing energy innovations. To operationalize this framework, a dedicated **secondary ordinance** should be adopted by EWRC, clearly outlining the scope of the sandbox, eligibility criteria for applicants, the application and approval process, the duration of each sandbox period, and the reporting requirements that apply to participating projects.

In terms of **institutional setup**, EWRC would act as the lead authority responsible for managing sandbox applications, monitoring the progress of approved projects, and evaluating outcomes. The **SEDA** could be assigned a supporting role, particularly to offer technical assistance related to clean energy innovation and stakeholder engagement. All participating projects should be required to demonstrate that they are innovative, technically feasible, time-limited, and likely to produce benefits for the energy system, such as flexibility, consumer empowerment, or improved system efficiency.

Eligible projects for the sandbox may include a broad range of initiatives. For example, energy communities may test new models of **collective self-consumption**, **virtual net metering**, or **peer-to-peer energy sharing**. Distribution system operators (DSOs) may pilot advanced **grid management technologies**, **digital platforms for data exchange**, or **dynamic pricing models**. Aggregators and energy retailers could explore **demand response services** or other innovative **flexibility offerings** for households and businesses. The sandbox could also support projects focused on **energy storage integration** or **hybrid renewable systems**, particularly where such configurations are not yet accommodated under current regulation.

The **benefits of the sandbox approach** are significant. It enables **evidence-based policy learning** and regulatory evolution in alignment with EU energy legislation. It lowers the risk for innovators and early adopters by providing a safe space for experimentation. It also helps Bulgaria **build institutional capacity**, preparing regulatory bodies and market participants for the next stages of energy market modernization. Ultimately, it supports national goals of increasing decentralization, system flexibility, and consumer involvement in the energy transition.

Finally, the sandbox should operate with a strong emphasis on **transparency and evaluation**. A public **registry of approved sandbox projects** should be maintained by EWRC, including information on project aims, partners, timelines, and performance outcomes. Upon completion, each project should undergo a regulatory review, and **EWRC should publish a**

summary of the findings, which could inform future **regulatory adjustments** or the development of permanent frameworks for energy communities and new market actors.

9.4 Further reforming grid tariffs and cost recovery to enable smart grids and fair access

9.4.1 Transition to capacity-based tariff model

Current Issue: DSOs in Bulgaria are financially dependent on energy volumes (kWh) transmitted. This creates disincentives for energy efficiency, self-consumption, and local energy sharing—especially in low-consumption areas and all DSOs have to deal with the issue of nigh number of zero or near-zero consumption points.

Recommendation: Amend the Ordinance on Pricing of Electricity (Наредба за регулиране на цените на електрическата енергия) and Energy Act (ЗЕ) to**:**

- Introduce capacity-based grid fees (€/kW) reflecting the fixed costs of maintaining the grid, regardless of energy volume used. Thus, zero and near zero-consumption customers will have to contribute to the maintenance of the grid with fixed amount.
- Ensure tariffs are cost-reflective, non-discriminatory, and technology-neutral, in line with Article 18 of EU Regulation 2019/943.
- Remove higher voltage distribution and transmission fees when energy communities' production and consumption units are within the boundaries of a substation/ transformer station at the same voltage level
-

9.4.2 Cost recovery for smart metering and data platforms

Current Issue: Upfront smart meter installation and platform development costs are high and often passed directly to consumers.

Recommendation: Amend the Energy Act (ЗЕ) and/or Electricity Measurement Rules to:

- Allow DSOs to recover costs of smart metering systems, data platforms, and AMI infrastructure through regulated grid tariffs over time, not as upfront fees.
- Classify smart metering and data infrastructure as regulated assets, eligible for return on investment under EWRC/KEBP oversight.
- Establish a standardized annual surcharge (e.g. €1–€3/year per consumer) for data platform maintenance, subject to affordability review.
-

9.4.3 Ensuring fair grid tariffs for prosumers and energy communities

Current issue: Currently, prosumers and energy communities in Bulgaria pay full grid tariffs even when electricity does not transit through the public grid, such as in cases of local production and consumption. This undermines the efficiency and fairness of the tariff system and disincentivizes participation in decentralized energy generation.

Recommendation: The **Energy Act**, the **Electricity Market Rules (ПТЕЕ)**, and the **Tariff Ordinance** should be amended to introduce **a fair and modernized grid fee structure** that reflects actual grid use and system benefits. This includes:

- **Introducing VNM** and **virtual billing mechanisms** that allow for the fair allocation of costs between prosumers, traders, and the grid without requiring complex administrative obligations for households (e.g., invoicing, excise duties, or accountancy).
- **Recognizing avoided grid use** and **local balancing benefits** by applying reduced tariffs or energy credits in areas with high renewable potential, rural and mountainous regions with under-maintained infrastructure, or zones reliant on polluting fuels.
- **Enabling data platforms operated by DSOs and the TSO** to support VNM and energy sharing among community members, active consumers, and suppliers based on transparent, verified data. This functionality should also allow smart pricing signals and flexible billing models.
- Ensuring that tariff reform supports **location-based signals, avoided cost principles, and dynamic tariffs**, so that grid users contribute fairly while being incentivized for sustainable behaviour.

Regulatory Sandbox Approach: These new tariff models and virtual mechanisms could first be piloted through **a regulatory sandbox**, offering temporary regulatory flexibility to test their impact under controlled conditions. This allows EWRC and stakeholders to evaluate cost, fairness, and system readiness before scaling.

Ongoing Monitoring and Transparency: EWRC should establish a **transparent review mechanism**, including an **annual public report** on the cost and fairness of smart metering and tariffs across user groups. A **multi-stakeholder Tariff Council**, including DSOs, traders, consumer advocates, and energy community representatives, can help ensure inclusive governance and timely course correction.

9.5 Introduction of new legal definitions

We propose a **3-stage Step-By-Step Implementation Plan** to the introduction of data platform in Bulgaria. For the purpose of the platform the introduction of new legal definitions is necessary as well as setting the minimum technical requirements for smart meters. The proposed new legal definitions are:

9.5.1 Net Metering

Proposed definition:

***Net Metering** is a billing mechanism that allows electricity consumers (prosumers) to offset their electricity consumption by feeding surplus renewable energy into the grid. The exported electricity is credited against the consumer's electricity bill, typically on a one-to-one basis (kWh exported vs. kWh consumed) over a specified settlement period.*

Explanation: This mechanism is primarily used for on-site renewable energy generation, such as rooftop solar PV, where a consumer produces electricity during sunny hours and consumes grid electricity when their production is insufficient.

9.5.2 Virtual Net Metering

Proposed definition:

***Virtual Net Metering (VNM)** is a billing mechanism that allows electricity consumers to benefit from renewable energy generation located at a different site than their actual consumption point, within the same grid zone. Instead of directly using the generated electricity on-site, the energy is fed into the grid, and the consumer receives credits or financial compensation based on the amount of energy produced.*

Explanation: This mechanism is particularly useful for energy communities, businesses with multiple locations, and municipalities that want to utilize renewable energy sources without having to install generation on every individual site.

9.5.3 Virtual Billing

Proposed definition:

***Virtual Billing** is a mechanism that allows multiple electricity consumers to share the financial benefits of a single renewable energy installation by allocating production credits or cost reductions across different electricity accounts without requiring a direct physical connection between the generation site and the consumption points.*

Explanation: This system enables energy communities, businesses, municipalities, and multi-site consumers to benefit from renewable energy generation, similar to VNM, but with a stronger focus on the financial settlement rather than the energy flow. Virtual billing exposes the producers, consumers and prosumers to the price signals thus stimulating them to consume more in times of peak generation and to avoid consumption in times of peak demand.

9.5.4 Smart meter

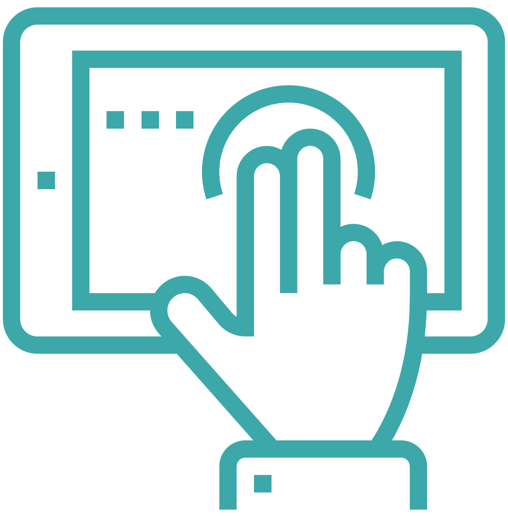
Proposed definition:

*A **smart meter** is an electronic device that accurately measures electricity consumption and/or production and enables secure, remote, two-way communication with the grid operator or energy supplier. It allows real-time or near-real-time data processing, supports dynamic pricing, and facilitates participation in energy markets, energy sharing schemes, and demand-response programs.*

Explanation: The proposed definition of a smart meter emphasizes that it "allows real-time or near-real-time data processing", which should not be misinterpreted as requiring the device itself to include built-in real-time communication functionality. Rather, **"allows"** in this context implies that the smart meter must be **technically capable of supporting such functionalities**, either directly or through **the integration of external or add-on components** (e.g., communication modules, gateways, or LAN ports). This interpretation is consistent with the flexibility allowed under EU directives, which do not mandate a specific hardware configuration but instead focus on **the capabilities and outcomes** that the metering system should support. Therefore, a smart meter can meet the regulatory definition even if real-time communication is achieved via complementary devices or system architecture, provided that the setup enables secure, two-way communication and supports key functionalities like dynamic pricing, demand-response, and data access. This approach enables cost-effective deployment and future scalability without compromising interoperability or compliance.)

9.5.5 Core requirements for smart metering and data platform

All newly installed electricity meters in Bulgaria must support **remote reading**, **two-way communication**, and **data recording at intervals of at least every 15 minutes**. Meters must measure both imported and exported energy, allow remote configuration, and provide secure, user-friendly access to validated consumption and production data for customers and authorized third parties. Full compliance with **EU cybersecurity and interoperability standards (e.g., DLMS/COSEM)** is mandatory. These functionalities are essential to support **prosumers**, **energy communities**, **collective self-consumption**, **aggregation**, and **virtual net metering**.



9.6 Step-by-step implementation plan for the introduction of data platform in Bulgaria

9.6.1 Stage 1 – Pilot/test phase

This stage embraces the period until full market liberalisation, using the currently existing technology and regulatory environment (i.e., what is already available).

The stage is to be based on **voluntary rollout:**

- Customers may request installation or reprogramming of smart meters with 15-minute resolution.
- DSOs must respond within **30 working days**.
- DSOs provide access to:
  - **Near real-time data** (unverified),
  - **Verified dynamic profiles** (available within 10 days after month-end, accessible for at least 13 months).
- Energy traders use market data to offer **day-ahead and real-time price signals** while the verified consumption data is the basis for dynamic billing.

This phase allows testing of business models, encourages early market entry, and builds trust. Regulators (KEVR) should combine **incentives** (e.g., fast-track approvals) and **obligations and concrete targets** to ensure DSOs and market actors support the pilot. An **information campaign** should raise public awareness.

9.6.2 Stage 2 – Full rollout at market liberalisation

The process in this stage will be **mandatory for all users**:

- All customers move to **dynamic pricing and smart billing**.
- DSOs scale up platforms and infrastructure.
- Market actors integrate offerings.
- Oversight by EWRC ensures **data protection**, **consumer rights**, and **market fairness**.
- Priority given to larger users and early adopters; limited-time **derogation possible for zero/low-consumption users**.
-

9.6.3 Stage 3 – Optional centralized data hub

The establishment of a centralized data hub could be considered if justified by volume and complexity:

- A **national platform** (e.g., hosted by ESO) may centralize data exchange.
- Inspired by **Norway's Elhub**, this would enhance coordination among DSOs, traders, aggregators, and prosumers.
- Only introduced after stakeholder consultation and evidence that it improves efficiency and trust beyond decentralized DSO systems.

Declaration of the possible use of generative AI and AI-assisted technologies in the writing process.

During the preparation of this work, the authors may have used ChatGPT, an AI language model developed by OpenAI, or other AI tools to improve grammar and readability. After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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