Future Energy
Lab

REPORT

Energy sharing in Germany

From concept to realisation

A project by

dena

Legal information

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Contents

Preface

A successful energy transition in Germany requires the participation of various stakeholder groups, including citizens. Energy sharing is an opportunity for direct participation not only in the expansion, but also in the efficient local utilisation of renewable energies. Whether solar power from a neighbour's house or wind energy from your own nearby wind farm, energy sharing can offer a solution for the purchase of electricity and also creates an additional incentive for the further expansion of renewable energies. In the best case scenario, an Energy Sharing Community (ESC) will also contribute to reducing grid congestion due to consumption occurring close to where the energy is generated or due to the additional offer of flexibility.

However, the discussion about energy sharing is multi-layered and complex: It starts with the objective and the target groups and continues through regulatory issues of admissibility and promotion to specific practical challenges, such as participation in market communication, adequate data measurement or contract design. Against the background of the EU-initiated empowerment of citizens as active participants in the energy market (keyword: active customer), Germany is called upon to create new opportunities in the energy market and shape them in regulatory terms.

It is therefore worth taking a closer look at the specific ways in which energy sharing can be organised. These show both the necessity and the potential of digitalisation very clearly: The granular synchronisation of generation and consumption is a core element of energy sharing and is inconceivable without Intelligent Metering Systems (iMSys) and efficient data integration. Integration into the energy system also requires the optimised control of energy assets. Without digital technologies, a far-reaching switch to renewable energies is hardly possible. The requirements for the database, the digital infrastructure and data governance should therefore also be given greater attention in the discussion about energy sharing models.

Resolving these issues and drawing a path for the implementation of energy sharing in Germany requires a comprehensive approach that takes various perspectives into account. We have developed and bundled together these at the German Energy Agency (dena) in the business units *Digital Technologies & Startup Ecosystem* and *The Future of Energy Supply*. With the project *ESCdigital – Digital Technologies in Energy Sharing Communities* project, we promote regular exchange with and among stakeholders from areas such as grid operation, energy supply, community energy, municipal companies and digitalisation. We help address open legal, organisational, economic, digital and social issues, meet challenges and provide new impetus for the development of projects and framework conditions.

Our aim is to develop a guide that makes the implementation of energy sharing communities as scalable as possible. To this end, the implementation of Energy Sharing is being closely monitored by scientists in a real-life environment in the WUNergy pilot community in Wunsiedel. This report sets out the range of conceivable models – within and outside the current legal framework – and is also intended to support the ongoing debate on possible regulation of energy sharing through this categorisation.

We would like to thank everyone involved for their participation and support in the project!

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1. Executive Summary

There are currently no specific regulations for energy sharing in German law. Nevertheless, the practical realisation of Energy Sharing Communities (ESCs) is already possible – albeit complex – taking into account all energy industry tasks and obligations and through the use of intelligent systems. A look at practice shows that projects for community electricity supply on site today mainly take place behind the grid connection point. At least some of the real, virtual and balance sheet supply relationships between the participants in energy sharing take place using the public electricity grid, in contrast to such neighbourhood, building or tenant electricity models.

In particular, the market roles of the electricity supplier, grid operator and metering point operator and the associated responsibilities are of central importance in this context for the implementation of ESCs in the energy industry. The amendment of the European Commission's Electricity Market Directive (EMD) creates new opportunities here.[1] A first step in this direction is the community building supply already introduced with Solar Package I, which for the first time in Germany made it possible to supply end customers without having to fulfil full supplier obligations.

Depending on the legal framework, various models can be realised, some of which already describe existing approaches. They differ primarily in the way the ESC as a whole, its members or its service providers fulfil energy industry tasks. Three prototype models (based on FfE 2023) are described as a basis for discussion for the practice and for a possible further development of the framework conditions:

- **The ESC uses a central supplier in model 1.**
  The members of the ESC (if they are prosumers or producers) offer the electricity they do not use themselves to the central supplier, who in turn supplies it to all consumers of the ESC. A precise allocation of the consumption within the ESC to the individual consumers is carried out in cooperation with the supplier and, if necessary using further data from the metering point operator. This model is already possible under the current framework conditions (see WUNergy pilot community).

- **In model 2, the ESC organisation itself or intermediaries become suppliers.**
  In this case, the producers of the ESC choose their own suppliers who purchase their electricity and supply selected consumers (in the ESC) who want electricity from precisely this producer. The supplier(s) shall procure the residual electricity that cannot be supplied by the relevant producers from the market or from other suppliers within or outside the ESC. This model is only available in certain versions today.

- **In model 3, energy and commercial supply relationships exist within the ESC between decentralised producers, prosumers and consumers without the involvement of brokers or energy suppliers Intermediary of brokers or energy suppliers.**
  The main difference to models 1 and 2 is a digital platform operated by the ESC for the complete mapping of the supply and trading relationships between the ESC members. Such peer-to-peer trading without the involvement of an energy supplier is currently not possible in Germany.

1 The BMWK is currently conducting a stakeholder dialogue for the implementation of the EMD into national law. The realisation is to take place in a Solar Package II.

For new and small players in particular, the implementation of ESCs in Germany is still associated with major hurdles. The necessary fulfilment of energy industry obligations, such as supplier obligations, means that implementation in practice is dependent on the direct involvement of established market players. The **WUNergy pilot community** in Wunsiedel demonstrates in practice and in a real environment how an energy sharing community can be set up in which a municipal utility acts as a central supplier (model 1) and becomes part of a cooperative that implements energy sharing among its members. However, irrespective of current legal regulations, other models are conceivable in the future in which energy industry tasks could increasingly be taken over by digital platforms.

Regardless of the legal and regulatory structure, the successful implementation of energy sharing in any model requires the use of appropriate **digital technologies**. The expansion of the digital infrastructure (e.g., installation of smart metering systems) and the development of data-driven applications (e.g., visualisation of collectively and individually consumed electricity on site) as well as the design of overarching governance for the exchange and handling of data (e.g., access rights for consumption values) are required in order to efficiently connect many decentralised producers and consumers within the ESC and in cooperation with external players in the energy system. The synchronisation of generation and consumption, which is central to energy sharing, is implemented efficiently and quickly using digital technologies. Based on this, billing can be based on variable rates if necessary and the use of the energy assets can be optimised, planned and even controlled automatically. An essential element for the realisation of ESC is a **sharing platform** that is used to coordinate energy management and energy technology processes and records, aggregates and visualises generation and consumption. A **trading platform** handles transactions with external suppliers or customers and also realises an internal market, provided direct trading relationships exist within the ESC. The **community management** that takes over the organisation and coordination (e.g., member administration) can also be implemented or supported by a platform.

It is also worth taking a look at other EU countries for the implementation of ESCs. In **Austria**, there are renewable energy communities that are localised and must be located within a specific grid area. In addition to electricity, these communities may also trade renewable heat and gas. There are also citizen energy communities that are allowed to exchange electricity, which does not have to be renewable, across regions. Austria is easing the full supplier obligations for the exchange of electricity within these communities in general. Conversely, established suppliers may not be members of an ESC, or only under certain conditions. An electricity supply licence is required for electricity supplies to third parties outside of the community.

In **Denmark** energy sharing using the public grid is also possible and takes place via an electricity supply contract together with an electricity trading company, which takes over the billing and distribution of the shared electricity and procures additional electricity. The energy community can also take over these activities itself and must then bear all obligations in electricity trading.

Italy has legally permitted collective self-consumption from renewable energy plants with a capacity of less than 200 kW on an experimental basis since 2019. Two models are defined in more detail. Firstly, the shared use of renewable energy in buildings, such as residential buildings and buildings in the tertiary sector, industry or public administration. Secondly, renewable energy communities, which are connected to the same medium- or low-voltage substation. A recent amendment to also gives established generation communities of municipal facilities the opportunity to set up energy sharing and receive funding.

There are already various proposals for setting the framework in Germany, which differ in terms of the criteria applied for the origin of electricity, the balancing periods, the geographical scope, the participants, the full supply of participants and the monetary incentive or privileges. The practical implementation of different models of ESCs should be considered in the legal design and tested in parallel so that operating models can be developed for different stakeholder constellations and local conditions.

2. Energy sharing – understanding the term

2.1 Background

The restructuring of the energy supply system requires a paradigm shift from large, fossil-fuelled power plants to a large number of decentralised renewable energy generation plants. The involvement of different stakeholders is also crucial to the success of this system transformation: The active participation of citizens and other diverse stakeholder groups (such as citizens' initiatives, small and medium-sized enterprises and municipal companies) is essential for the success of this comprehensive change in the energy sector. Energy sharing is one of the models that can both advance the decentralised energy transition and enable various stakeholders to participate in the expansion of renewables.

The term 'energy sharing' refers to the coordinated consumption of electricity generated jointly in close proximity using the public grid. The EU stipulates that energy sharing must be made possible without discrimination for members of a Renewable Energy Community (REC) in accordance with Article 2(2)16 of the Renewable Energy Directive (RED II) or a Citizen Energy Community (CEC) in accordance with Article 2(11) of the Electricity Market Directive (EMD). The national states have incorporated the legal concepts described in RED II and the EMD into their national law in different ways. As a result, numerous models for such communities have developed, some of which implement energy sharing.

The REC was legally implemented in Germany in accordance with RED II with Renewable Energy Communities (in German, Bürgerenergiegesellschaften, pursuant to Sect. 3 of the EEG). The practical implementation of energy sharing is possible for BEGs in compliance with all energy industry tasks and obligations, although there is no explicit regulation in Germany. An analysis by the Federal Environment Agency (Ritter et al. 2023) concludes that although the implementation of energy sharing is quite complex, no further adjustments to national law are required under current EU law.

New impetus for energy sharing is provided by an amendment to the EMD, which the EU agreed as part of the trilogue last year. The legislative text has now been formally confirmed by Parliament and the Council and published in the Official Journal of the EU. The agreement contains simplifications for energy sharing in terms of content. The amendment also has implications for the German legislator.

The opportunities to efficiently connect producers with consumers, optimise the control of flexibility, automate billing and manage the complex integration into the overall energy system are increasingly being used to develop organisational and business models that also address small players. Regardless of the legal and regulatory structure, the successful implementation of energy sharing requires the use of appropriate digital technologies. Efficiently connecting many decentralised players is a major challenge and requires not only the expansion of infrastructure (e.g., installation of smart metering systems) and the development of data-driven applications, but also the design of overarching governance for the exchange and handling of data.

In Germany, various proposals for the implementation of energy sharing are currently being discussed. The political debate already begins at with the **Objective** and the question of what motivates various players to spread energy sharing models. These include an increase in the expansion of renewable energies, participation in the energy transition, a reduction in electricity costs for participants, the resilience of the electricity supply through local electricity procurement, reduction of grid congestion through generation and timely consumption and the development of flexibility and ultimately a reduction in the costs of grid expansion. Many of these objectives are linked via various effects. For example, active participation in the expansion of renewable energies can strengthen acceptance, attract private investment for the energy transition and thus also contribute to an increase in the expansion of renewable energies. Increasing self-consumption and optimising the use of renewable energy plants by energy sharing participants can reduce their electricity costs. On the other hand, this could increase the costs of the overall system (Ritter et al. 2023). In this respect, it is important to keep the overall system in mind when designing an ESC.

At present, there are only a few estimates of the potential or cost-benefit analyses for energy sharing on a broad scale in Germany (Wiesenthal et al. 2022, dena 2023), meaning that it is still difficult to quantify the impact with regard to the various objectives under discussion . It should also be noted that although it is possible for higher grid levels to reduce grid congestion by aiming for local synchronisation of generation and consumption (e.g., within an ESC), not every ESC can make a significant contribution to a reduction of grid congestion (e.g., if there are no or few load shifting options). In this respect, the evaluation of energy sharing communities requires a more detailed consideration of the effects in the context of the specific form of implementation, as will be done in this project.

2.2 Energy Sharing Community

The term ‘Energy Sharing Community’ (ESC) was introduced in the project to describe the many variants that are conceivable in the energy system even outside the framework of the EU directives, in order to create a terminological distinction.

Energy Sharing Community (ESC) refers to a locally cohesive group whose members (individuals, small and medium-sized enterprises, public institutions) generate, use and, if necessary, store electricity using their own systems and the public grid collectively and according to certain optimisation rules. This requires that the ESC has (renewable) energy plants in close proximity, i.e., that individual members of the group or several members together or the ESC itself can own, operate or control them (group-affiliated energy assets). The timely synchronisation (e.g., every quarter of an hour) of generation, storage and consumption can be ensured by advanced information and communication technology.

Taking into account the following requirements, various design options are conceivable depending on the model:

- Electricity from the group-affiliated energy assets can be consumed by the owners themselves or supplied to members of the community. The ESC may utilise an established market participant for this purpose if the ESC or its members do not wish or are unable to assume the role of a supplier within the meaning of the Energy Industry Act.
- A full supply from our own plants is neither a goal nor a prerequisite. The remaining electricity is procured individually or jointly for the ESC.
- Surplus electricity from the company’s own renewable energy plants can be fed in by individual members or the ESC or sold on the market.
- A specific legal form or contractual structure for the ESC is not prescribed.

3. Current legal situation and outlook for regulatory developments in energy sharing

3.1 Energy sharing in EU law

Current EU law provides for energy sharing to be made possible for the following constructions:

- **Joint self-consumption:** Article 2(2)15 of the RED II
- **Renewable Energy Communities (REC):** Article 2(2)16 of the RED II
- **Citizen Energy Communities (CEC):** Article 2(11) of the EMD

'Joint self-consumption' refers to a group of at least two jointly acting actors who generate and consume renewable electricity themselves. These 'prosumers' must be located in the same building; however, Member States can also define other geographical boundaries.

A REC is a legal entity whose energy generation assets are jointly owned. In addition to natural persons, small and medium-sized enterprises and public organisations can also be part of an REC. If companies participate in an REC, this must not be their primary business or professional activity. RECs must be located in close proximity to the plant locations.

A CEC is defined as a legal entity based on voluntary participation. Natural persons, local authorities including municipalities and small companies are eligible to participate. In contrast to the REC, the CEC's field of activity is broader: In addition to energy generation, includingrenewable sources, it can also engage in energy efficiency services for its members, such as charging services for electric vehicles. The CEC is not intended to be located in close proximity to the generation plants. In accordance with the requirements of the EU directives, in addition to the participation of the above-mentioned legal entities in the energy market, national law must also allow the electricity generated to be consumed collectively. However, this does not constitute a mandatory requirement for financial support or an exemption from energy industry obligations (see Supplier obligations – section 4.1).

The EU has also agreed on an amendment to the EMD, which contains further requirements and simplifications for energy sharing. The 'Proposal for a Regulation amending Regulations (EU) 2019/943 and (EU) 2019/942 and Directives (EU) 2018/2001 and (EU) 2019/944 on improving the Union's electricity market design' was published under the name COM/2023/148 as 2023/0077 (often referred to as EMD III). The European Parliament has already adopted this amendment and on 15 January 2024 the responsible parliamentary committee also approved the text. The European Council has now also adopted the proposal. When it comes into force, this regulation will enable new solutions in the areas of energy communities, self-consumption, energy sharing and peer-to-peer trading. It is therefore foreseeable that there will also be implications for German legislation.

EMD III introduces the following definition for energy sharing: '"energy sharing" means the self-consumption by active customers of renewable energy [...]' (Art. 2(10)a)[2]. In this respect, there is no need to become a member of one of the above-mentioned energy communities (REC, CEC). The right to energy sharing is expressly extended to so-called 'active customers' and groups of such customers. This refers to 'active producers and consumers', which are redefined: '"active customer" means a final customer, or a group of jointly acting final customers, who consumes or stores electricity generated within its premises located within confined boundaries or self-generated or shared electricity within other premises, or who sells self-generated electricity or participates in flexibility or energy efficiency schemes, provided that those activities do not constitute its primary commercial or professional activity' (Article 2(8)). It also states under No. (24): 'Energy sharing operationalises the collective consumption of self-generated or stored electricity injected into the public grid by more than one jointly acting active customer. Member States should put in place the appropriate IT infrastructure to allow for the administrative matching within a certain timeframe of customer's total metered consumption with self-generated or stored renewable energy which is deducted from the total consumption for the purpose of calculating the energy component of the energy bill issued by the customer's supplier and thereby reducing the customer's bill' (EuropeanCommission 2023).

The details of the organisation can be found in Article 15a of the EMD III. The right to participate in energy sharing is to apply to small and medium-sized enterprises (SMEs) and households within a bidding zone. If larger companies participate, the maximum generation capacity may not exceed 6 MW. The Member States are also free to further restrict the geographical area for energy sharing. Active Customers should be able to sell surplus production from their own plants or those that they own, rent or lease jointly with others, either directly or via a third-party provider at a price they specify, or to share it free of charge. Active customers involved in energy sharing bear the financial responsibility for the imbalances caused by them. However, there is the possibility for active customers to transfer theirbalancing responsibilities (balancing group responsibility) to other market participants. Article 15(a) also provides for an exemption from supplier obligations. Households with an installed capacity of up to 10.8 kW for individual households and up to 50 kW for apartment buildings are exempt from supply obligations. The Member States are given additional leeway here, as these thresholds can be adjusted: up to 30 kW for individual households and between 40 kW and 100 kW for multi-family houses. This amendment does not provide for statefinancial support for energy sharing.

2 In the same article, in contrast to 'energy sharing', 'peer-to-peer trading' is also defined under No. (10b) as 'the sale of renewable energy between market participants by means of a contract with predetermined conditions for the automated execution and settlement of the transaction, either directly between market participants or indirectly via a certified third-party market participant, such as an aggregator'.

3.2 Legal situation in Germany

Germany has at least partially implemented the RECs and CECs outlined in section 3.1 with regard to the currently valid EU legislation. Although energy sharing is possible in Germany in variants, there are neither specific regulations nor legal definitions of energy sharing and ESCs. Currently, individuals and organisations that want to generate and use electricity collectively in Germany using the public grid or supply it to group members must be treated like all other participants in the electricity market and fulfil the so-called full supplier obligations. These include transparency and reporting obligations as well as grid utilisation contracts and fees on the one hand and the procurement and provision of residual electricity on the other (EnWG, EEG, StromStG, StromStV and MaStRV). They involve considerable organisational effort and a high financial risk, which is particularly difficult for small players to bear and is therefore not implemented in practice.

However, with the support of established companies in the energy industry (e.g., municipal utilities), a whole range of energy sharing models have already been trialled and at least partially implemented (see Appendix). In Germany, other options are also used to sell, market or purchase decentrally generated renewable electricity, which are briefly described below:

- **Own consumption:** So-called 'prosumers' can generate their own electricity in their own plant and consume it themselves without using the public grid, as well as purchasing residual electricity via the public grid. A legal definition of self-consumption no longer exists at the present time. It was removed from section 3 of the EEG as part of the abolition of the Germany Renewable Energy Sources Act surcharge (Gaßner et al. 2022).

- **Tenant electricity (section 21 of the EEG):** In Germany, tenant electricity refers to the provision of electricity (typically from solar systems) that is generated in, on or at a residential building and supplied directly to the tenants or homeowners and owners without using the public grid. The provider of the tenant-electricity fulfils all supplier obligations and also supplies the participants with the corresponding residual electricity volumes that it has to procure on the market. A similar model is the joint building supply introduced in the federal government's Solar Package I (section 42(b) of the EnWG; Federal Government 2024). In this model, tenants or owners can be supplied without using the public grid and without supplier obligations. The participants use the electricity generated in, on or around the building as far as possible, but must procure the remaining electricity themselves. Although these two concepts are similar to the proposal for energy sharing according to EMD III, there is a key difference with regard to the use of the public grid.

- **Regional electricity rates:** Here, a supplier supplies its customers in a region with renewable electricity with regional certificates (UBA regional certificate register), which was generated in third-party plants within the same region. Proof is provided via regional verification certificates. This model differs from energy sharing in that generation and consumption are not synchronised. An equalisation of the amount of electricity generated and consumed regionally takes place over a period of theoretically up to 24 months. Regional certificates can only be acquired after the end of production, so this is a balanced electricity product. However, the time of energy generation corresponds to the time of consumption with an energy sharing product.

- **Power Purchasing Agreement (PPA):** System operators conclude a bilateral contract for the supply of electricity with a consuming company (corporate PPA) or with an energy supplier (utility PPA). In the case of a utility PPA, the energy supplier can either market the electricity on the electricity exchange or supply it to an electricity consumer (possibly defined in the contract). With a corporate PPA, either a direct line (for physical delivery to the customer) or the public grid (referred to as on-balance-sheet purchase with payment of grid charges) can be used. The producing company only has to fulfil the obligations set out in the PPA contract. In the case of a corporate PPA, the purchasing company generally procures the residual electricity that cannot be supplied via PPA from a supplier of its choice. The utility PPA model can play a role in energy sharing communities if an energy supplier acts as a member or service provider of the energy supplier.

- **Virtual Powerplant (VPP):** This is a portfolio of distributed energy generation plants and, where applicable, storage facilities whose output is aggregated and traded on the market. In contrast to energy sharing, the focus here is not on joint and simultaneous generation and use in a region, but rather on optimised marketing of the aggregated output on energy markets such as the electricity exchange. However, there may be links to an energy sharing model if, for example, marketing is carried out via a local energy supplier to customers who are in the catchment area of the VPP or even have a stake in the VPP.

The following constructions could also play a greater role in the development of future energy sharing models, most of which are currently not realisable under German law:

- **Peer-to-peer trading (P2P trading):** Individual electricity producers in peer-to-peer trading sell electricity either directly to other consumers without a conventional energy supplier acting as an intermediary or indirectly via another certified market participant (such as an aggregator). This is usually done via a digital platform or network that enables transactions between producers and consumers. Under current law, the producer becomes a supplier by supplying end customers and must therefore also fulfil the corresponding obligations. The forthcoming changes to EU law outlined in section 3.1 attach growing importance to P2P trading and, if the legal foundations are created, it could play a role in the supply of members of an ESC to each other. Innovative information and communication technologies could then also be used (e.g., distributed ledger technologies, digital identities), as have already been tested in several EU projects and the German energy research programme.

- **Net billing:** Electricity fed into the grid in this billing procedure is sold to the energy supplier that also supplies the electricity that is not generated in-house. The energy supplier customer receives only one invoice, in which the purchase and sale (with possibly different prices) are netted. With net billing, it is possible to demonstrate a balance between generation and consumption over a certain period, but generation and consumption are not synchronised and not recorded. This is where differs from energy sharing.

- **Net metering:** Here, a special meter is used to calculate the net energy exchanged between the electricity producer and the electricity grid. This means that the energy generated by the electricity producer is offset against the energy procured from it. The electricity producer then only pays for the difference between the energy fed into the grid and the energy procured within a certain period of time. There is no simultaneity of generation and consumption. While net metering is generally not permitted in Germany, there is currently an exception for balcony power plants, for which meters running backwards are temporarily tolerated and thus net metering is implemented.

Larger battery storage systems shared by several prosumers and operated via the public grid could become particularly important in the context of energy sharing. They would be more economical to operate than small storage units in the building of each individual prosumer. They would also offer more flexibility in the utilisation of the electricity generated by the members of the ESC and could also be used to provide system services for grid operation. The following legal frameworks are important here (see Federal Network Agency 2021):

According to section 118(6) of the EnWG (see also section 19 of the StromNEV), electricity storage systems connected to the electricity grid are exempt from grid charges for a period of 20 years after commissioning. The exemption does not apply to storage, but to the procurement of the electricity to be stored. In November 2023, the German Bundestag decided to extend the exemption from (double) grid fees for storage facilities from 2026 to 2029. Distribution system operators make payments to the plants connected to their grid, including electricity storage systems, in accordance with section 18 of the StromNEV (‘Remuneration for decentralised feed-in’). This can be a part of the business model of a ‘market storage facility’ operated in this way.

3.3 Energy sharing concepts in Germany: Status and discussion

Concepts for energy sharing in Germany that go beyond what the current legal framework allows are currently being discussed. The following concept proposals for energy sharing are listed in Table 1:

1. German Renewable Energy Federation (BEE), Bündnis Bürgerenergie e.V. (BBEn) and the German Cooperative and Raiffeisen Confederation (DGRV)
2. Energy Brainpool, on-site supply variant (Cluster 1)
3. Energy Brainpool, on-site supply variant (Cluster 2)
4. German Association of the New Energy Economy (bne)

The REC according to RED II and the contents of EMD III are also listed for comparison. The concept proposals are elaborated on the basis of the following characteristics: Origin of electricity, electricity quality, balancing, geographical reference, participants, full supply to participants and monetary incentive.

	(1) Energy sharing according to BEE/ BBEn/DGRV	(2) On-site supply – Cluster 1 according to Energy Brainpool	(3) On-site supply – Cluster 2 according to Energy Brainpool	(4) On-site supply according to bne	Energy sharing in REC according to EU RED II	Energy sharing for active customers according to EMD III
Origin of electricity	Pro rata from a joint plant	Pro rata from 'private' plants	Origin of electricity irrelevant	Pro rata from participants/private plants	Pro rata from a joint plant	Pro rata from 'private' plants
Power quality (green vs. grey)	Green	Green	Grey	Green	Green	Green
Accounting	Every 15 minutes	Every 15 minutes	Every 15 minutes	Static model with fixed percentage distribution or dynamic model with a 15-minute distribution of the quantities of electricity generated and consumed	Not specified	Within a certain time frame [3]
Procurement in close proximity	Yes, postcode area within a 50 km radius of the municipality in which the plant is located[4]	Yes, the same grid level 7 (possibly supplemented by geographical definition if data-based verification is difficult)	Same grid area[5]	On grid levels 6 and 7 behind the busbar of a regional transformer station in a concession area, feed-in to grid level 5 or higher is possible as long as the generation plant produces a maximum of 1 MW and is no further than 5 km away from the transformer station used	Yes, 'close to the projects'	Within a bidding zone, can be further restricted by Member States
Participants	Members of the renewable energy community	Contractual partner	All distribution grid customers	Contractual partner	Members of the RE community	Contractual partner
Full provision for participants	Not mandatory, participants are entitled to full provision, community if necessary	No	No	No	No	
Monetary incentive	Yes, energy sharing premium	Yes, reduction of levies and charges	Yes, variable distribution grid charges	Yes, reduction in electricity tax and, until further notice, a flat-rate reduction of 25 per cent in grid charges for electricity generated and consumed simultaneously in the energy community	Not specified	

Table 1: Energy sharing models discussed in Germany; BBEn et al. (2023) and BBH (2023); Energy Brainpool (2023); bne (2023)

3 Balancing intervals vary depending on the Member State
4 A regional connection in accordance with section 50(c)1 lit. 2 of the EEG is given if the points of delivery of the supplied end consumer are located in postcode areas that are wholly or partially within a radius of 50 kilometres of the municipality in which the installation is located (see section 50(c)3 of the EEG (BBH 2023)).
5 Below grid level 4 (110 kV/20 kV) or grid level 6 (20 kV/0.4 kV)

The concept of BBEn, BEE and DGRV essentially provides for financial support for energy sharing for the BEGs implemented in Germany in accordance with RED II. Specifically, an energy sharing premium, which is paid on electricity generated and consumed within the BEG, is proposed here. The amount of the premium corresponds to 1.6 to 4.9 ct/kWh, depending on the generation technology. The entitlement to the market premium for surplus electricity should remain unaffected. Proof of electricity quantities consumed within the BEG is to be provided by transmitting the corresponding generation and consumption data, based on 15-minute measurements, to the grid operator.

The proposals of the bne and Cluster 1 of Energy Brainpool ('onsite supply') are aimed at energy sharing in the lower grid levels. Prosumers in particular should have the opportunity to share their surplus electricity at a low threshold. This is precisely what the EMD III provides for with the introduction of energy sharing for active customers and with the exception of supplier obligations for individual households up to 10.8 kW and multi-party houses up to 50 kW (the amendment also provides leeway for setting the limits for the Member States (see section 3.1)). These concepts are also intended as a special advantage in the form of a reduction in levies and surcharges or grid fees, whereby both the bne's proposal and Cluster 2 from Energy Brainpool aim to reform the grid fee system in the long term. All end consumers in the same grid area are incentivised to adopt grid-friendly behaviour through dynamic grid charges, irrespective of the origin of the electricity, according to the proposal for local supply in Cluster 2.

The bne's proposal also contains details for energy economic processing: The metering point operator (MPO) should record actual values and make them available to the grid operator (GO), the energy balancing responsible party (BRP) and the supplier for projects within a grid area and static distribution of the electricity quantities. The GO should be responsible for the correct balancing of actual consumption and actual feed-in and prepare the data for the BRP and the supplier. If projects cover several grid areas and the electricity volumes are distributed dynamically, an energy sharing coordinator should take over the energy balancing using a virtual balancing model.

A virtual electricity grid could also be used in the future to implement energy sharing. For example, the startup decarbon1ze developed such an approach, according to which grid operators in the physical electricity grid continue to receive all the data they need for system control when operating the virtual electricity grid. The individual participants in the ESC could be allocated to different balancing groups and the allocation to the corresponding balancing group can be made on a quarter-hourly basis.[6]

Currently it is unclear whether and in what form one of these concepts for energy sharing will be realised in Germany. However, the formal confirmation of the regulation by Parliament and the Council has implications for German legislation. For example, an exemption from supplier obligations must be provided for buildings with small systems. EMD III expressly allows the Member States leeway both in defining these boundaries and in the geographical context. The concepts presented here provide a good basis for further discussion regarding the exemption from supplier obligations, the geographical connection and the grid levels, as well as balancing and financial incentives.

It is undisputed that a legislative response must be provided to the following aspects (Ritter et al. 2023).

- Locality requirement
- Simultaneity of generation and consumption
- Power quality (grey vs. green)
- Treatment of new and old plants
- Plant size and maximum RE output
- Special advantage

6 decarbon1ze.com

4. Implementation of energy sharing in the energy sector

Taking into account the energy industry regulations, the implementation of Energy Sharing Communities (ESCs) in Germany is possible, as explained in section 3. Many different models are conceivable for the specific design. This always involves a suitable contractual formulation of the energy exchange and the simultaneity of generation and consumption. Two features are of particular importance here:

(A) Contractual situation

If individual contracts with an energy supplier exist for each member of the energy supplier, electricity volumes are procured, balanced and offset between the parties involved for each individual member ('collective action' as defined by the EU directives). Alternatively, the entire group as a whole has a contract for the utilisation of the jointly generated and consumed quantities of electricity ('Energy Community' as defined by the EU directives). This does not necessarily mean that members are fully supplied. This means that each member could have an individual electricity supply contract for the residual electricity volumes that are not supplied via the ESC group contract. Conversely, parts of the electricity generated could also be marketed outside of this group contract.

(B) Simultaneity of generation and consumption (synchronisation)

For the type and scope of energy sharing, a time interval must be selected in which generation and consumption should be synchronised. In some concepts, the balance is analysed over longer periods (e.g., month, year, etc.). The electricity quantities are then billed using pro rata consumption quotas, for example. The synchronisation of generation and consumption of the group can and should be recorded for shorter intervals (15 minutes or less) and used for billing and, if necessary, optimisation and control processes in the ESC, as it is understood here (see section 2.2).

With a view to a possible broad implementation of ESC, the ability to optimise in short time intervals is sought. However, optimising consumption within a group of producers and consumers is not desirable at all times (EERA 2022): An Energy Sharing Community in the sense of an integrated energy transition should be oriented towards generation and consumption load peaks in the grid area and be able to control or have its energy assets controlled in a targeted manner using intelligent information technology, if necessary also at the expense of the group's own consumption rate or another optimisation approach. Such an integrative ESC could develop potential through externally orientated operation of its systems with regard to grid or system usefulness[7]. With regard to the BDEW traffic light model, it is important to ensure that an ESC optimises its self-supply in the green area, but provides (or even has to provide) suitable ancillary services in the amber and red areas and is remunerated for these (BDEW 2017).[8] The study of existing initiatives in Germany (see Appendix: List of initiatives surveyed) as well as theoretically possible implementations of energy communities and other collective approaches to energy supply (also detached from the applicable legal framework), there are striking differences in the characteristics of these two key features for ESCs and their integration into the energy system, which are analysed below.

4.1 Market roles and activities

Various types of energy sharing communities can be realised, taking into account the preliminary investigations of existing energy communities (not exclusively those within the meaning of the EU directives; see Appendix) and possible designs of energy sharing. For all forms of ESC, the following market roles that exchange data via market communication are particularly relevant, given the current legal framework (see Figure 1):

- Electricity supplier
- Grid operator
- Metering point operator

The ESC must be assigned to a balancing group for which balancing group responsibility exists since they as a whole or all its members individually belong to the overall energy system and use the public grid. The energy balancing responsible party, who needs to ensure an evenly stabilised balancing group, is also of central importance in this context. It should not be assumed that an ESC will take on one of these market roles itself, nor can it be assumed with certainty that the existing market roles will continue to exist in this form in the long term. In all likelihood, the delivery obligation of electricity suppliers will be waived under certain conditions in the future: Both the recently adopted EMD III of the EU (see section 3) and current efforts to renew the Harmonised Electricity Market Role Model (HEMRM)[9] suggest that the relationship between ESCs and other market participants could change overall in the future. However, as the feasibility of an ESC under current framework conditions is to be considered first in this project, the existing system of market roles will be taken as a basis in the following sections or specifically pointed out if this is not the case.

7 Grid efficiency is understood to mean the economically optimised planning and operation of the grids, including, for example, optimising the use of existing operating resources or the connection of new producers and consumers. System efficiency is understood to mean economic optimisation with a view to the entire energy system, taking into account optimised market and grid aspects.

8 BDEW traffic light phases: (i) Green – There are no critical grid conditions. The distribution system operator (DSO) monitors the grid status without intervening in the market. (ii) Yellow – A bottleneck is emerging in a grid segment. To remedy this, the DSO calls on the flexibility offered and contractually agreed from market participants. (iii) Red – Immediate threat to stability in the distribution grid. The DSO ensures grid stability through direct control/regulation of operating resources and market intervention.

9 See https://energy.ec.europa.eu/system/files/2021-06/bridge_wg_regulation_eu_bridge_hemrm_report_2020-2021_0.pdf and https://www.onenet-project.eu//wp-content/uploads/2022/10/D25-Recommendations-for-the-Harmonised-Electricity-Role-Model.pdf

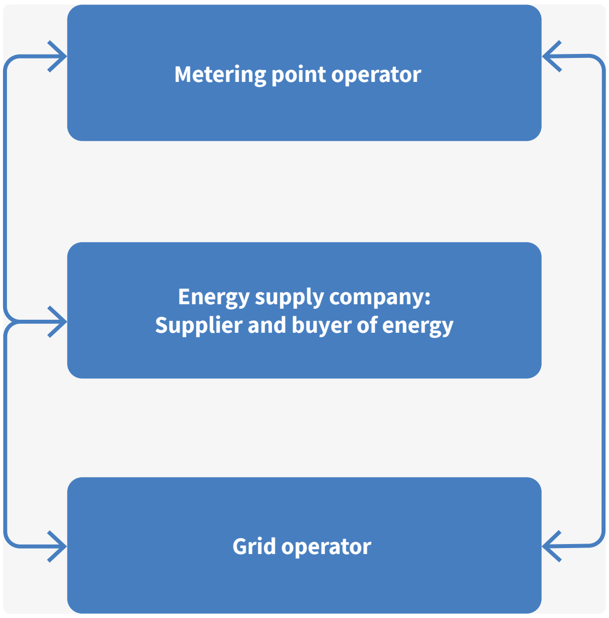

Figure 1: Interaction of the primarily relevant market roles (selection)

Grid operator

A grid operator regulates utilisation of its grid in grid usage contracts. As a rule, electricity suppliers have concluded grid usage contracts with the grid operator. Household customers do not have their own grid usage contract, but are integrated into grid usage via the contract with their electricity supplier. To use the grid, the user must pay grid fees and fulfil requirements such as allocation to a balancing group and prescribed business processes and data exchange (FfE 2023). An ESC or its members use the public electricity grid[10], so that the associated requirements mentioned above apply[11]. As a rule, the ESC will have to reach agreements with grid operators regarding the supply of data, compliance with rules for generation and consumption (in the sense of schedules or supply and purchase commitments) and, if applicable, the remuneration of grid-supporting behaviour (FfE 2023). The latter is of great importance with regard to the integration of prosumers, storage facilities and end consumers into the overall system, as the simultaneous feed-in and feed-out in a grid area is relevant for the utilisation of existing grids and the optimisation of the group's own consumption can have the opposite effect. Energy sharing can be used to adapt consumption and generation locally through load shifting and energy storage, provided digital technologies are used. It can be assumed that the actual effects of energy sharing in a grid area depend on the reliability of the group's behavioural adjustment (EERA 2022), in addition to the specific conditions in the respective grid area, and the remuneration of these contributions within the framework of corresponding agreements may also depend on this. Changes with regard to the necessary agreements between an ESC and the grid operator could result from the introduction of active customers (see section 3.1).

Electricity supplier

Today, producers and prosumers have the opportunity to sell the electricity they generate and do not consume themselves on the market. However, producers and prosumers must fulfil the role of electricity supplier if direct supply to end consumers is to take place (FfE 2023). In Germany, the supply of electricity is currently associated with compliance with market processes, rules and obligations. EnWG, EEG, StromStG, StromStV and MaStRV require regulations on the duration of contracts (e.g., cancellation dates, notice periods, customers' right of withdrawal) and on price adjustments. The services to be provided, payment methods, liability and compensation conditions in the event of non-compliance with contractually agreed services and free, rapid supplier changes are also regulated (FfE 2023, Ritter et al. 2023). A supplier must be able to procure residual electricity on the market in order to cover the ESC's demand or substitute electricity if a producer is unable to deliver as planned.

Energy balancing responsible party

In Germany, the balancing and equalisation energy system must be used when supplying electricity using the public electricity grid, i.e., also for energy sharing. This means that all feed-in and exit points are assigned to a balancing group that is managed by a BRP. The BRP prepares a forecast on the previous day and must ensure that the balancing group is evenly stabilised on the following day. Short-term surpluses or shortfalls can be sold or purchased by BRP on the electricity exchange. Quantities that cannot be balanced (but still have to be provided by the grid operator) are invoiced to the BRP as balancing energy by the grid operator. A BRP thus bears the economic risk of balancing generation and consumption (SAENA 2023).

An ESC or a contracted service provider can manage its own balancing group for the ESC and procure, sell or balance surpluses or shortfalls using established markets and market participants. However, other models in which the members of an ESC each remain assigned to a balancing group individually or the ESC as a whole reaches an agreement with the relevant BRP regarding the provision of flexibility are also possible. It is undisputed that an ESC records its synchronisation of generation and consumption in real time in its own interest using suitable information technology and possibly with the support of a supplier or grid operator and controls it in line with its optimisation model.

10 See definition of terms in section 2
11 See Ritter et al. 2023

Metering point operator

Metering point operators (MPOs) are responsible for the installation, operation, reading and maintenance of electricity meters and for the actual metering of end consumers' electricity quantities. The local grid operator often takes on this role (basic metering point operator), but a third party can also be appointed as the metering point operator (competitive metering point operator). The obligations of an MPO include the transmission of data to electricity suppliers, grid operators and energy service providers. It will be important for the ESC to make a clear arrangement with the MPO or the administrator of the measured data in order to obtain its own data, i.e., data relating to group-affiliated energy assets or members, in sufficient resolution and not too high an aggregation.

If the Harmonised Electricity Market Role Model (HEMRM), which is currently under discussion, is adopted in the foreseeable future, new roles will be created in the domain of energy information technology. New roles that are currently being discussed with regard to decentralised energy supply models are, for example, 'Data Exchange Platform Operator', 'Flexibility Services Provider', 'Local Flexibility Calculator' and 'Authentication Service Provider' (Oliveira et al. 2021).

4.2 Possible implementation models

In the current energy law framework, the distribution of roles outlined in section 4.1 applies. Various options are currently conceivable for the implementation of an ESC. The basic models described below are intended to outline a scope for the implementation of an ESC. Not all elements of the models are necessary for the implementation of an ESC and not every (interim) model is currently legally possible. The models considered as examples are:

- **Model 1: Central supplier**
  The ESC selects a supplier that purchases the electricity from the members and supplies it to all consumers in the ESC (see section 4.2.1).

- **Model 2: Supply relationships with intermediaries**
  The supplier is the ESC itself or (in each case) an energy supplier that implements a virtual supply of the ESC members among themselves (see section 4.2.2).

- **Model 3: Supply relationships without an intermediary**
  The producers themselves become suppliers and may outsource parts of the supplier obligations (see section 4.2.3).

In Germany, model 1 is already possible today and model 2 is at least partially possible according to the current legal framework. Supply relationships according to model 3 are currently not realisable in Germany. In all forms of implementation, the term 'community' refers to a group of energy producers and consumers acting jointly or in a coordinated manner.

The concept of an ESC leaves open whether energy sharing is operated as a loose association or as a legal entity, for example, in the sense of the REC and how this is legally or economically organised. Unlike BEGs, the organisation as an independent legal entity is not bound by strict guidelines. ESC agreements in the form of a civil law partnership (in Germany, abbreviated as 'GbR') or as an association and legal forms such as a cooperative, GmbH or GmbH & Co. KG are also conceivable. An ESC does not need to be profit-oriented, community-based or socially oriented, but it should be economically viable in the interests of its members. The schematic diagram in Figure 2 shows an overview of the organisational and structural elements of an ESC and the communication between them. The green and blue colours indicate the energy technology and energy industry partners (and the typical interactions with them). Essential elements of an ESC are thus:

- The **community management** is responsible for the organisation and coordination, the admission and administration of community members, and marketing and financing. Community management may enter into agreements with the grid operators regarding the exchange of data, compliance with rules for generation and consumption or the rewarding of grid-friendly behaviour. The supply of flexibility is depicted as a flexibility market in the following figures. Community management can also enter into contractual agreements with one or more central suppliers and other market and technology partners on behalf of the members. If the group as a whole enters into such agreements, it will typically be organised as a legal entity and the management of such a legal entity will then also be one of the fields of activity of community management. To support all of these processes, community management can operate an IT-based **community platform**.

- Community management will also include a **sharing platform**, which is typically realised using advanced information technology (see section 5). The sharing platform describes and coordinates the group's energy technology and energy management processes. Generation and consumption are recorded – usually on the basis of data recorded by the grid operator or a metering point operator – in suitably defined time intervals and aggregated if necessary. The exchange of energy between members of the group or their energy assets is also recorded here, even if it is not carried out under commercial law, and balanced within the community depending on the model. A front end (user interface) can also be used to provide the ESC or members with an insight into various aggregations and analyses of the data. The provision of information can already motivate optimised behaviour, but the IT of this platform can as such receive signals (e.g., from the grid operator) and use them directly to control the community's systems and appliances.

- The energy supply and trading of energy is not realised via the sharing platform. Trading relationships between partners within and outside the Energy Sharing Community either take place via the trading platforms of the participating suppliers or the community itself operates an **ESC trading platform** (possibly with the involvement of contracted service providers). Such a platform maps transactions with external suppliers and customers and can also realise an internal ESC market if supply situations arise between the members of the ESC. A special case would be ESC-internal trading using a blockchain (see dena 2022).

- Relevant **grid operator** and therefore the cooperation or contractual partner is the party whose grid infrastructure the ESC uses, i.e., in whose grid areas the members' connection points are located.

Surpluses from ESC plants are sold using established markets and market participants, and energy is procured to cover the demand not covered by the company's own plants. To this end, the ESC as a whole or individual members will conclude purchase and/or supply agreements or other cooperation and support agreements with market participants in the **energy trading** sector. If there are (energy) trading processes between the members of the community, these trading partners can also realise the energy exchange or energy trading within the community in accordance with the legal framework conditions. The platforms are shown separately here, but it is also conceivable that it is a joint platform for trading, sharing and community.

The models illustrated and explained in the following sections show the range of conceivable options for organising energy sharing communities. The selection is also based on a comprehensive presentation of energy communities and the associated role of prosumers by the Forschungsstelle für Energiewirtschaft e.V. (FfE 2023).

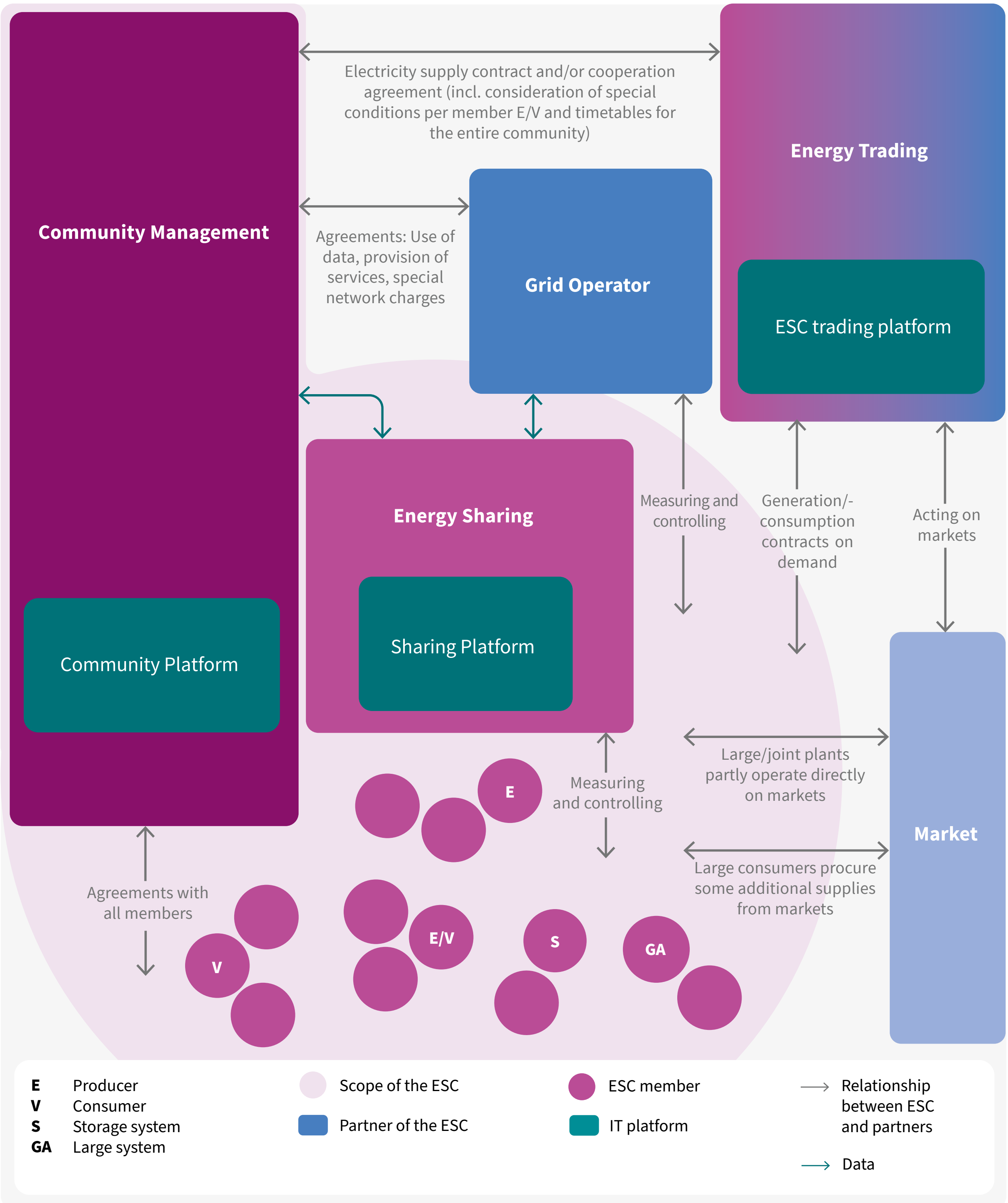

Figure 2: Structural elements of an energy sharing community

4.2.1 Model 1: Central supplier

One way to implement an ESC is to fill the role of a central supplier that ensures full supply to members. Figure 3 illustrates this basic model. The supplier role can be assumed by the ESC itself (assuming all legally prescribed supplier obligations within and outside the community; see also model 2b in section 4.2.2) or by an established energy supplier. The energy supplier itself is not part of the ESC in Figure 3. However, in general, it is also possible for the energy supplier to be a member of the ESC or a shareholder of the legal entity. For example, the central supplier wants also to become an organisational member of the ESC in the current pilot project (see section 4.3). A separate energy balancing responsible party (BRP) is used in this model, in addition to the three central market roles of supplier, grid operator and metering point operator. In this respect, Figure 3 shows an extreme case, as the central supplier is not the party responsible for the balancing group in which the producers and consumers involved in the ESC are located.

However, it will exchange data with the BRP in the usual procedure and supplement this exchange with data on the ESC. As can be seen in Figure 3, there is no direct energy trading between the individual members of the ESC, because under the current legal framework, producers would then become suppliers with full obligations if they supplied consumers directly. Instead, the members of the ESC therefore offer their electricity to the central supplier, who supplies all ESC consumers with this electricity and also procures residual electricity from the energy market or from other producers. Consumption within the ESC is allocated to the individual consumers on the sharing platform, using data from the supplier and the metering point operator, among other things. Member billing is handled by the central supplier using information from the community platform and the sharing platform. The supplier can use a rate model that rewards the simultaneity of generation and consumption or grid-friendly behaviour, for example.

The supplier is responsible for paying the grid fees to the grid operator. In cooperation with the community management, the supplier could ensure flexibility in the ESC, steer the group accordingly and reach an agreement with the grid operator. The legal framework currently only allows grid operators to reward or incentivise grid-friendly behaviour to a very limited extent by setting grid charges. The low financial added value in particular has hardly been an incentive to participate so far from the consumers' point of view (see Fietze et al. 2020). The sharing platform (SP) makes it possible to incentivise, measure and document the agreed (and possibly rewardable) behaviour of the ESC. Figure 4 provides an overview of the tasks and functions to be provided by ICT (see section 5 for more details). Although, in the illustration of model 1 (Figure 3), the energy supplier uses a service provider for trading on the energy market, it is also conceivable that the energy supplier takes over this trading itself.

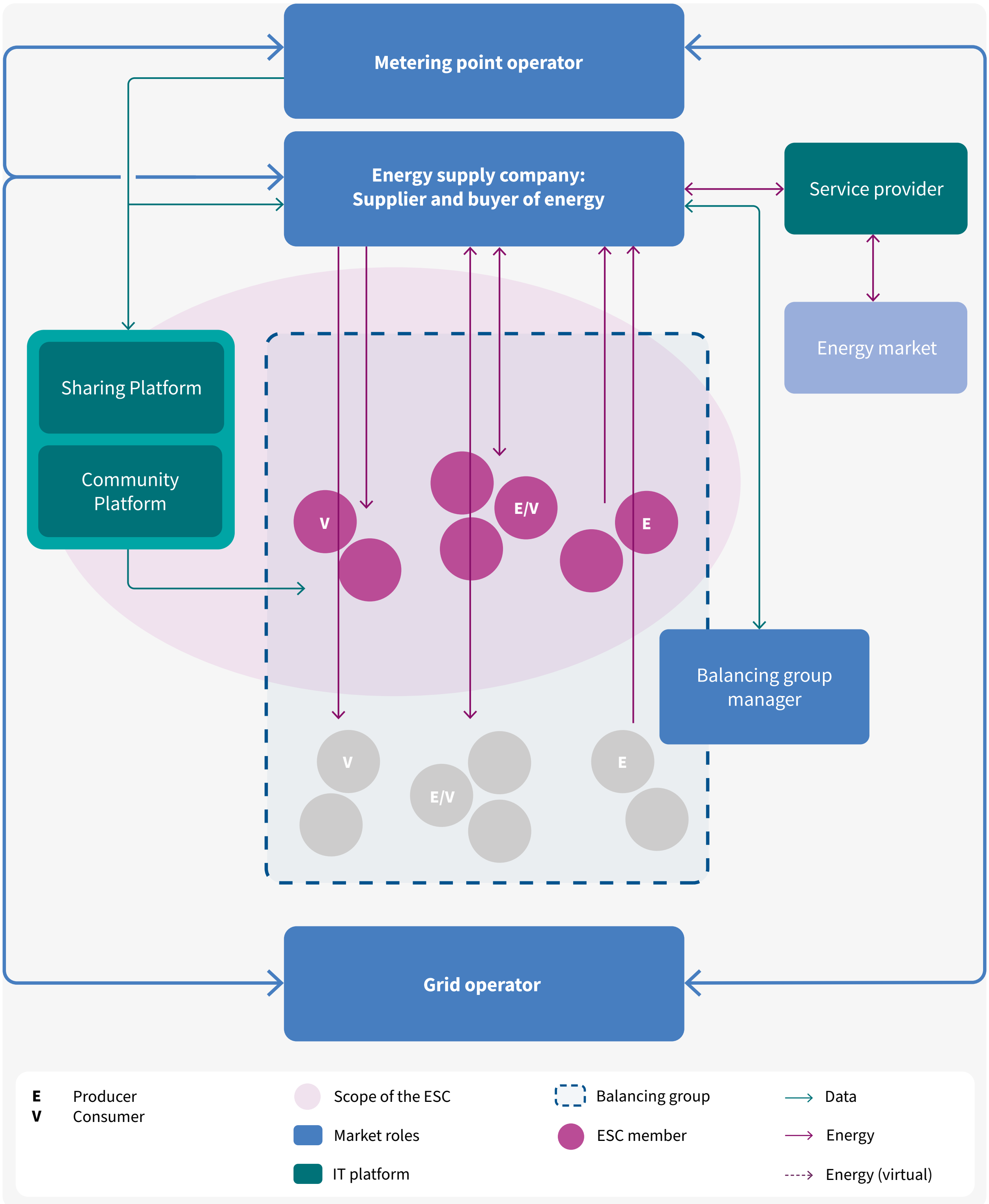

Figure 3: Realisation of an energy sharing community with a central supplier (model 1)

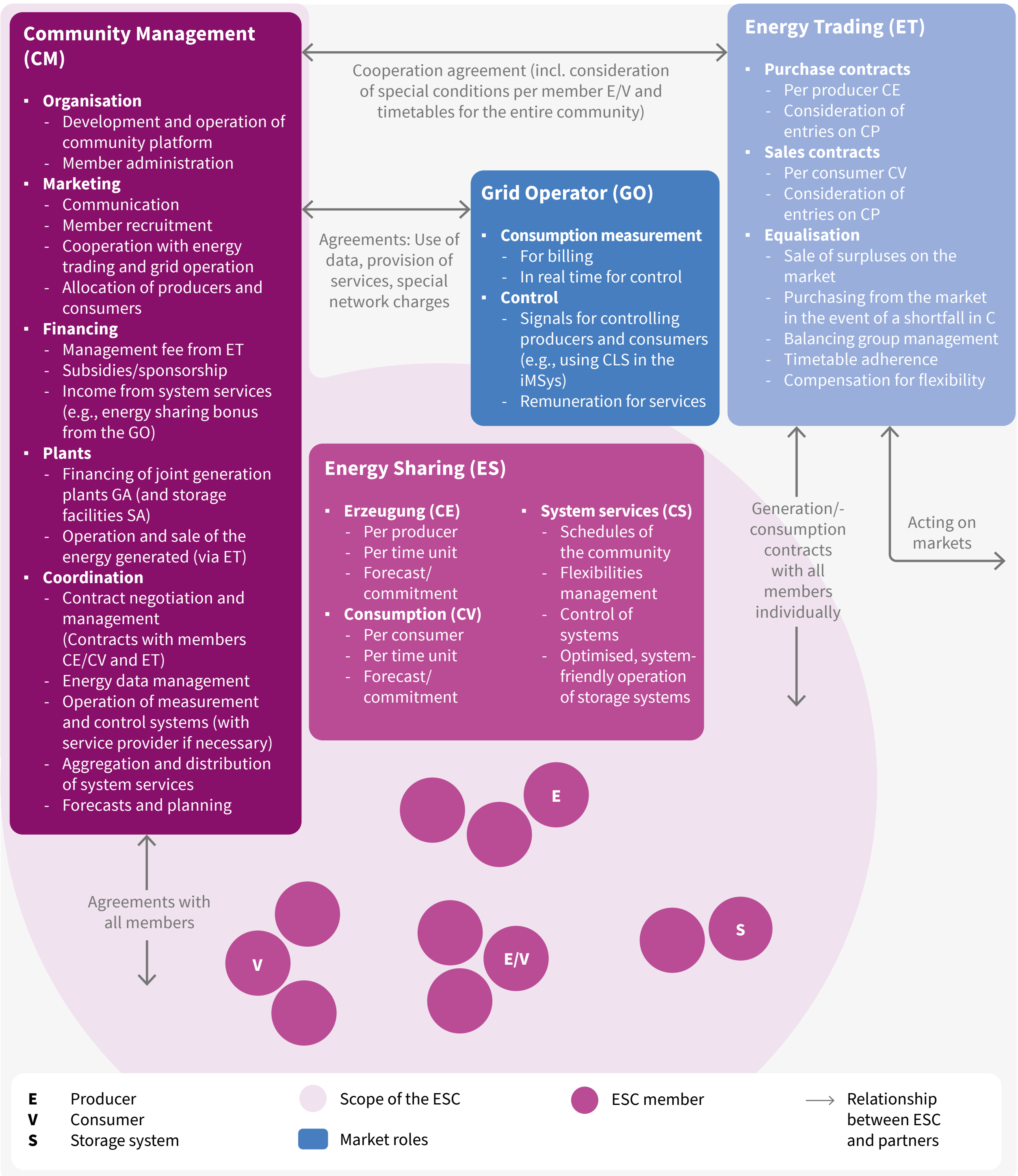

Figure 4: Tasks and processes for implementing an ESC with a central supplier (model 1)

4.2.2 Model 2: Supply relationships with intermediaries

'Virtual' supply relationships between prosumers, producers and consumers are to be realised in model 2. This increases the complexity, in contrast to model 1. It should be noted that even in this model there is no direct supply relationship between the members of the ESC within the meaning of the Energy Industry Act. The implementation of the model is carried out via one or more intermediaries authorised for energy trading or additional suppliers, but all transactions are registered on the common sharing platform and processed (as outlined in Figure 6 and Figure 7) for the presentation of virtual supply relationships. ESC management can in addition provide mechanisms for initiating and mapping virtual supply relationships. Irrespective of the energy industry and commercial law relationship, de facto supply relationships (virtual deliveries) and the synchronisation of generation and consumption of the ESC can be recorded, incentivised and, if applicable, rewarded.

There are three variants for model 2:

Model 2a:
The producers choose a partner in the energy market who buys their electricity and supplies it to selected consumers (in the ESC) who want to purchase electricity from precisely this producer. Figure 5 shows a single intermediary supplier, which in turn manages a balancing group with all ESC participants. However, different partners per producer are also conceivable. The suppliers then procure the remaining electricity that cannot be supplied by the affiliated producers from the market or from other suppliers within or outside the ESC. Figure 5 is similar to model 1 (Figure 3) in many respects.

The main difference is that although all ESC members also have a supply contract with the intermediary energy supplier, virtual deliveries between the ESC members are modelled here by using data from the sharing platform. Consequently, there is no common electricity pool, but rather a more specific allocation and mapping of the supply relationships between the participants. The intermediary supplier assures its customers, for example, that they will receive the highest possible percentage of the electricity supplied from selected producers in the ESC.

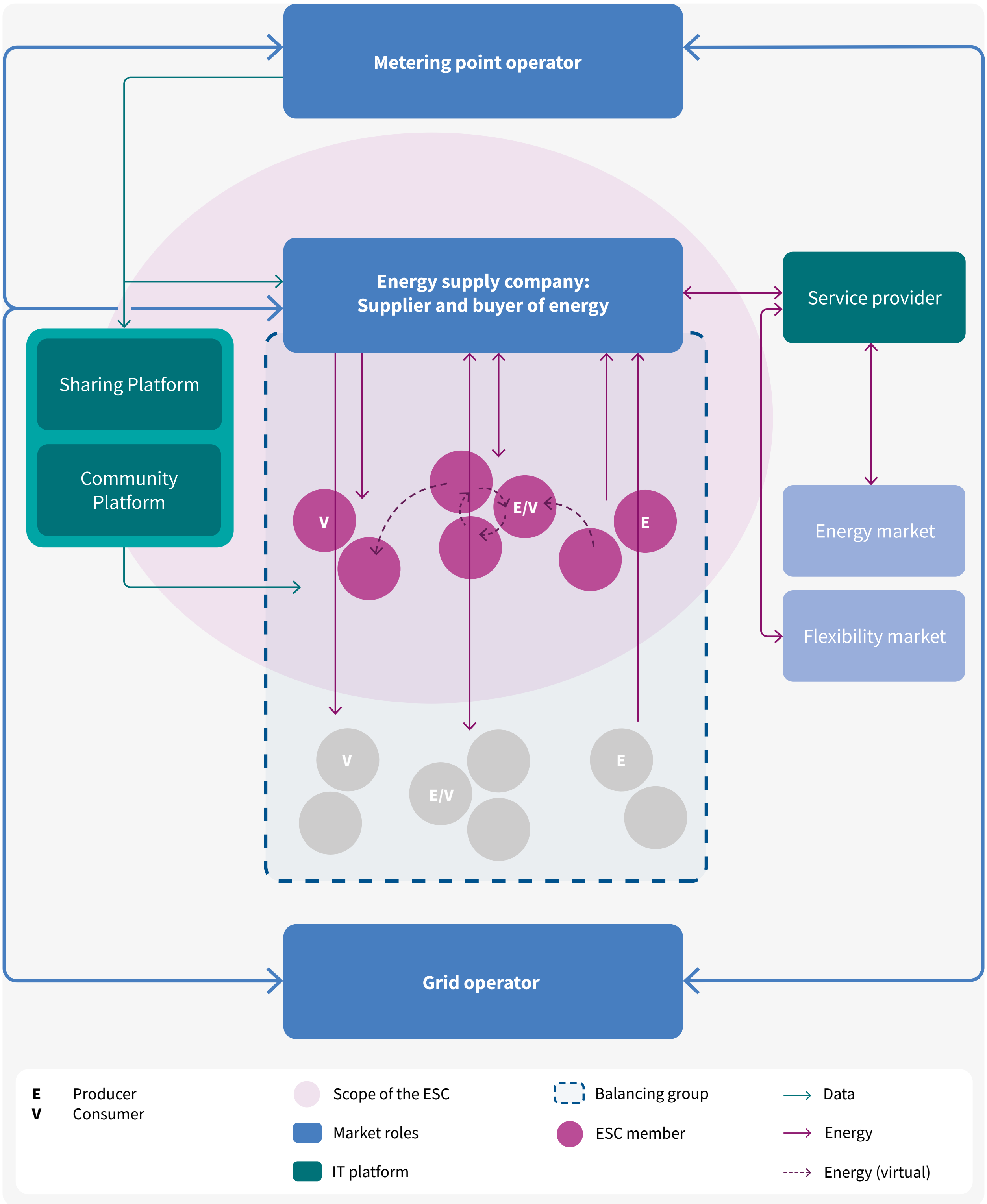

Figure 5: Realisation of virtual deliveries via intermediaries (model 2a)

Model 2b:
In model 2b, shown in Figure 6, prosumers and consumers work with several suppliers, for example, to procure the remaining electricity that does not come from producers in the ESC. This is not possible under the current legal framework in Germany, as a metering point can only be served by one supplier. This model would probably also be realisable in Germany with the planned right to simplified supplier obligations under certain conditions according to EMD III and the discussed possibility of a 'two-contract model' (as in the case of communal building supply; see section 3.2). This is because this regulation means that residual electricity could be supplied by another supplier. Therefore, in this model, the individual participants are not fully supplied by a central supplier or individual suppliers. Instead, the remaining electricity that cannot be supplied by the connected producers can be procured from the market or from other suppliers within or outside the ESC. In this model, prosumers and consumers have a contract with a supplier connected to the ESC, which supplies them with electricity from selected producers within the ESC, but can obtain the necessary residual electricity via a second contract with another supplier outside the ESC if required. In addition, the question of balancing group allocation arises once different suppliers supply the members of the ESC. In Figure 6, consumers that receive electricity from the ESC and whose residual electricity is supplied by a separate energy supplier are in the balancing group of the separate energy supplier. At the same time, the necessary data exchange takes place between the suppliers involved. Although the complexity is higher than in model 2a, de facto deliveries or a virtual delivery can be mapped at least between individual members of the ESC using suitable information technology. Instead of the suppliers, an Energy Sharing Organiser in accordance with EMD III could be used to allocate the energy quantities.

It would also be conceivable for individual ESC producers to (continue to) feed their electricity into the grid in accordance with the EEG. This is illustrated in Figure 6 by an energy arrow from producer to grid operator. In this model, it is also not necessary for all suppliers involved to participate in the optimisation and remuneration models of the ESC. In this respect, not all suppliers need to have access to the data on the ESC's sharing platform.

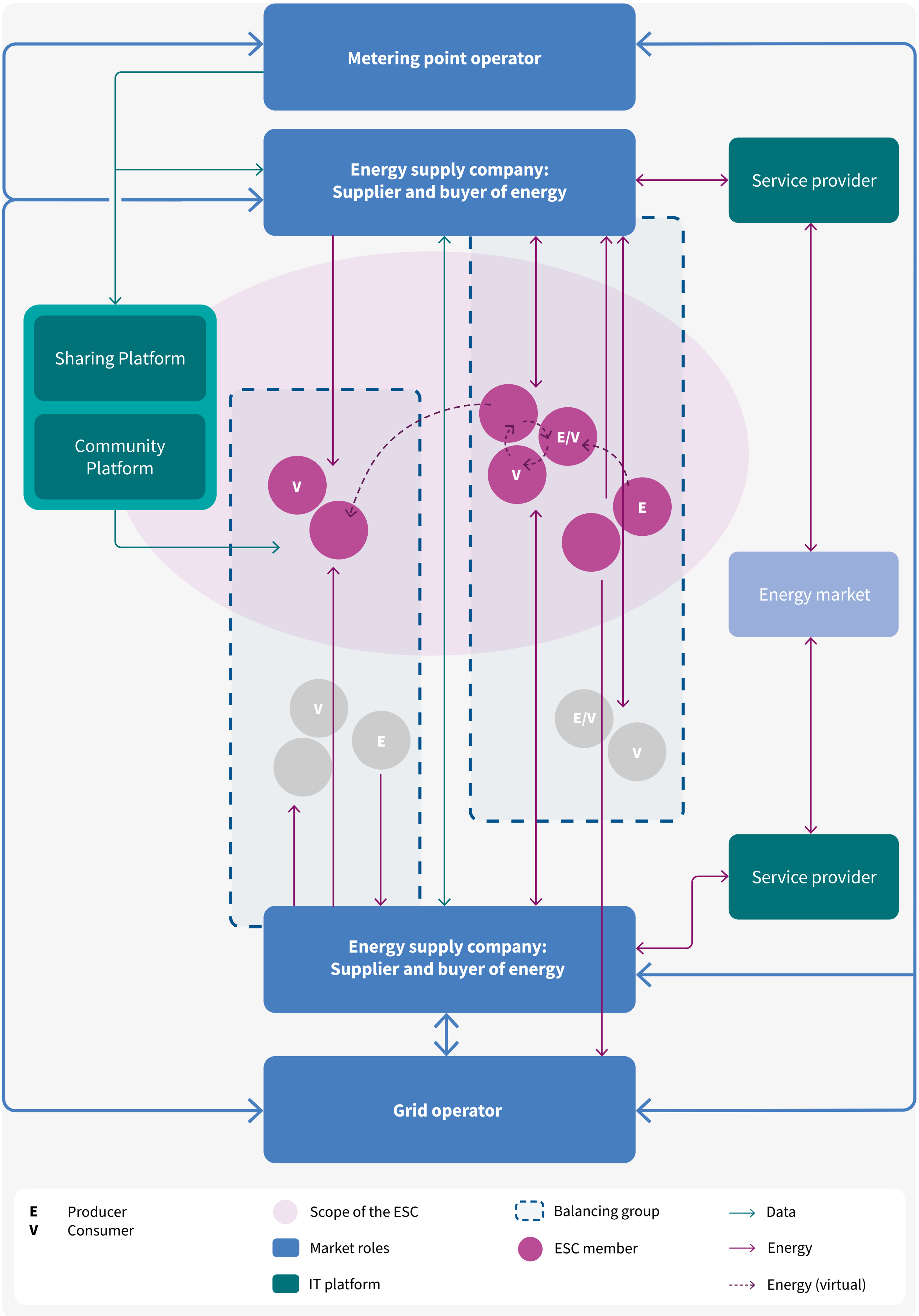

Figure 6: Realisation of virtual deliveries using intermediaries and additional suppliers (model 2b)

Model 2c:
A sharing and trading platform plays a major role in this model. A schematic representation of such a model is shown in Figure 7. In this model, transactions are initiated and processed via a combination of ESC's own sharing and trading platform, whereby, as shown in Figure 7, the operator of the trading platform itself or a third party as a service provider (energy service provider) assumes supplier obligations. This includes, for example, the procurement of residual electricity for all members of the ESC and the correct allocation of all deliveries within the ESC into a separate balancing group. The consumption of residual power can be controlled individually or centrally. The community can sell surplus electricity on the market via trading partners. To this end, contracts can be concluded with one or more selected partners established in energy trading and specific agreements can be made for the ESC regarding prices for members. This is illustrated in Figure 7 by the relationship between the trading platform and the external supplier.

Irrespective of the contractual and supply relationships under energy law, the community management or the operator of the sharing and trading platform can control the behaviour of producers and consumers in line with the objectives of the ESC. This figure shows that a storage system can be used for optimisation within the ESC or to optimise the procurement of residual electricity. This is also conceivable in the other models.

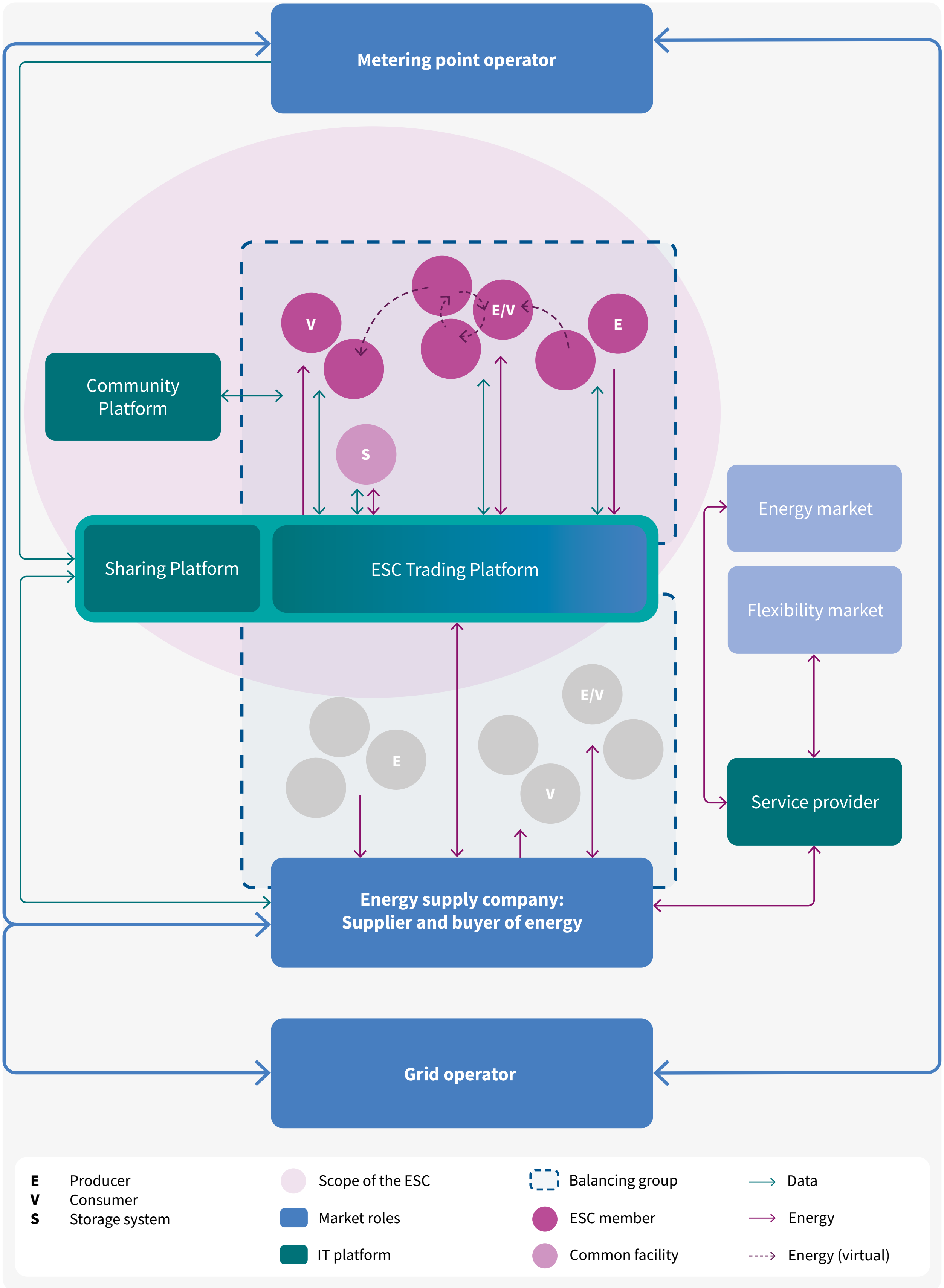

Figure 7: Realisation of an energy sharing community with its own supplier (model 2c)

Software-as-a-service solutions in the form of platforms are being offered today for complex tasks relating to the integration of decentralised energy into the energy system. This advanced information technology can also be used for an ESC. It allows the energy behaviour of the individual members to be recorded at least every 15 minutes and aggregated into load profiles. A well-equipped sharing platform can also receive signals from the grid operator in order to incentivise flexibility among the members of the ESC. As shown in Figure 8 (specifically for models 2a and 2b), all members of the energy sharing community in model 2c also have agreements with the community with regard to the joint optimisation of generation, storage and consumption behaviour.

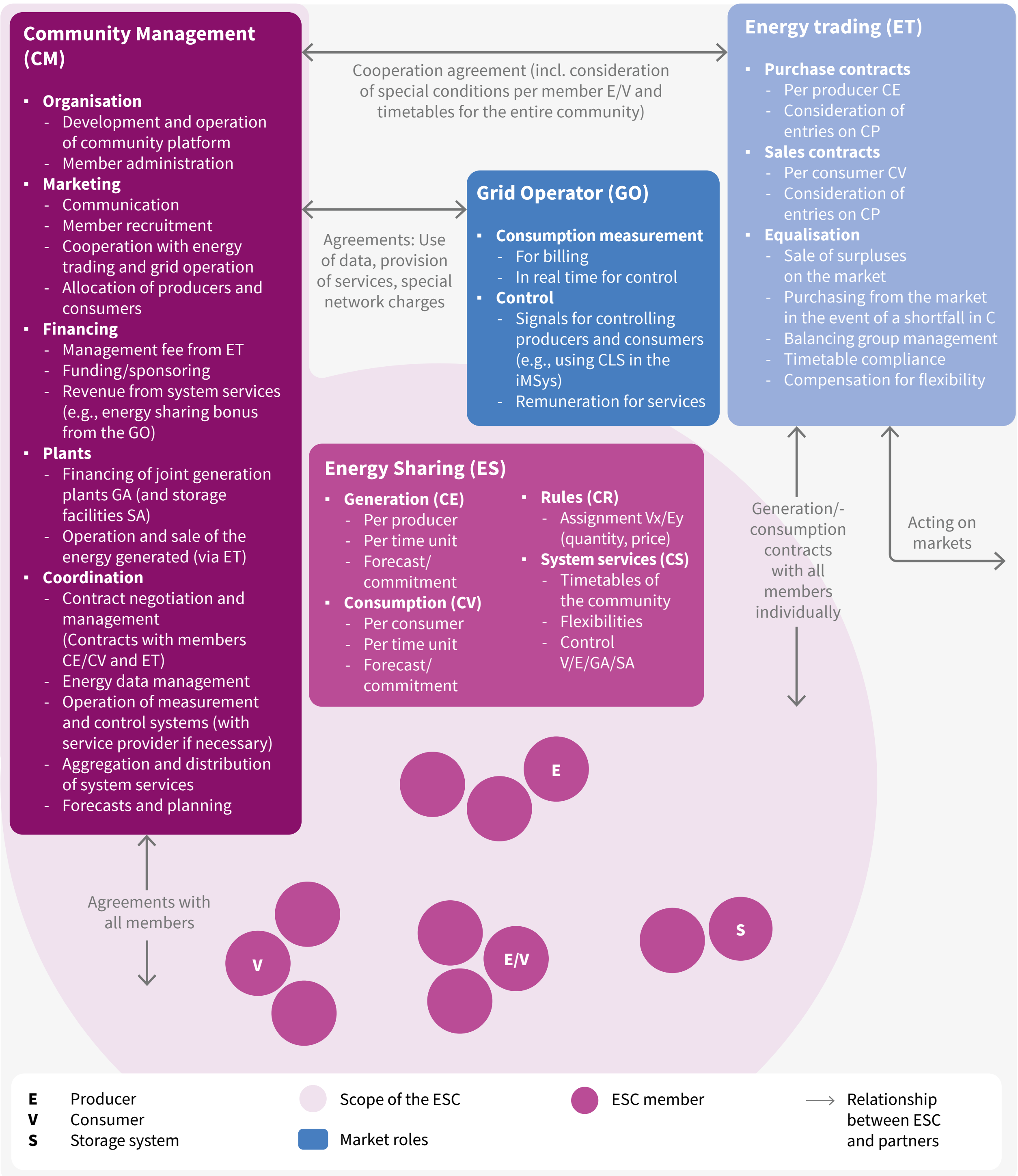

Figure 8: Tasks and processes for implementing an ESC with one or more intermediaries (here models 2a and 2b)

4.2.3 Model 3: Supply relationships without intermediaries

Direct supply relationships between decentralised producers, prosumers and consumers (peer-to-peer transactions) without central intermediaries such as exchanges, brokers or energy suppliers could form a new trading world in the electricity sector in the future, which is characterised by the active participation of small players in the processes of the energy market. The participants can appear individually or as a group. This potential future model is shown schematically in Figure 9 and Figure 10. The main difference to models 1 and 2 is the digital platform operated by the ESC for the complete mapping of the supply relationships between the ESC members (peer-to-peer trading) and the digital connection to the energy markets for the joint, optimised handling of surpluses and residual electricity requirements of the ESC's generation and consumption. This means that a separate balancing group, for which the ESC itself is responsible, can be formed for the ESC.

The balancing group must then be evenly stabilised by the digital platform, which works together with a suitable service provider. The service provider in this model is not only an electricity trader, but also provides the ESC with additional information on the market (price) via the sharing and trading platform. This additional information flow is shown in Figure 9 by the corresponding data arrows. Residual electricity could also be supplied to individual consumers by individually selected suppliers. Simplified supplier obligations could enable this type of supply relationship if EMD III is implemented. With the introduction of smart metering systems and the use of platforms such as those developed in various German and EU innovation projects, such solutions also appear to be within reach.

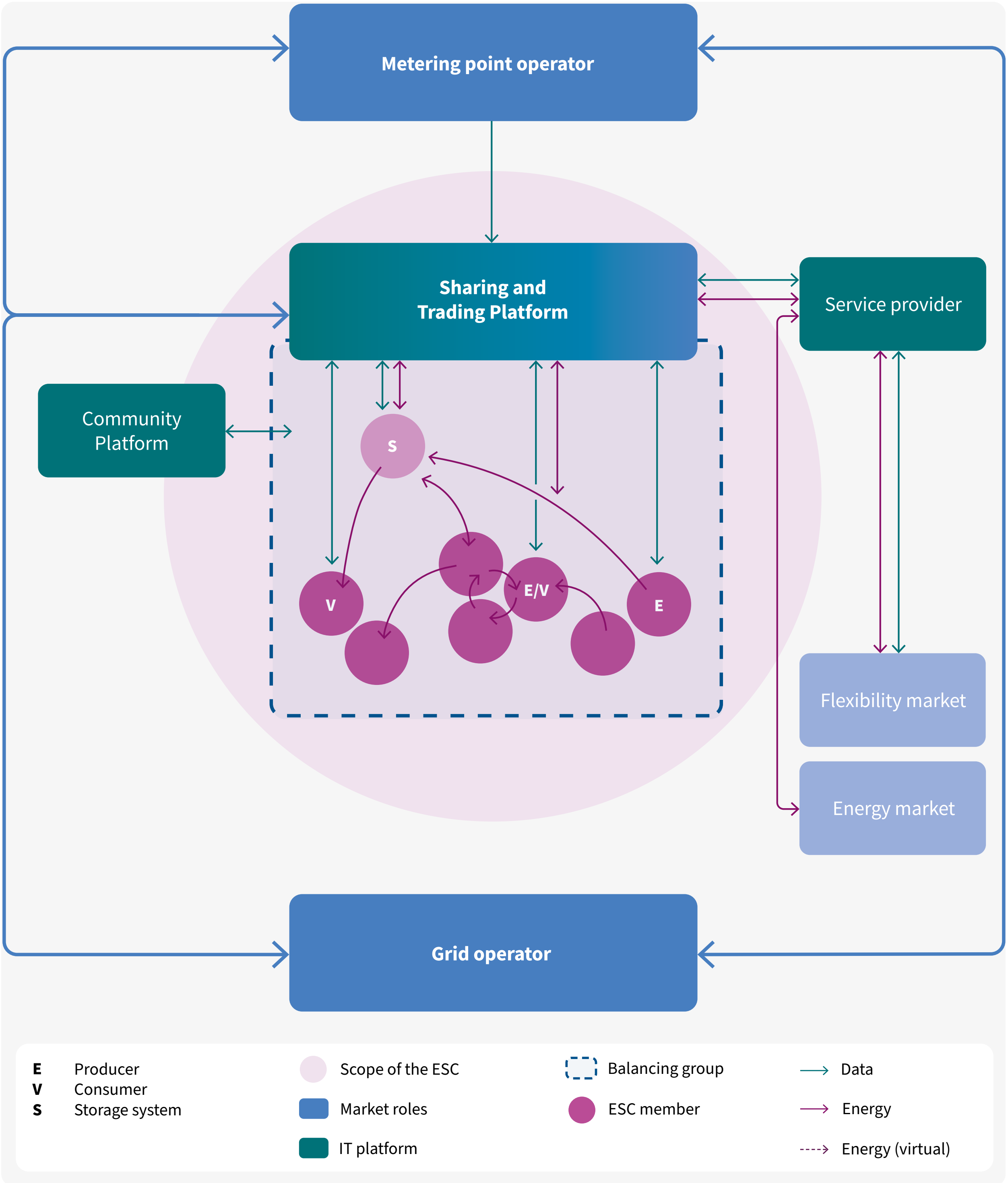

Figure 9: Implementation of an energy sharing community with members as suppliers (model 3)

Although many joint energy projects are already striving for direct trading between private energy producers and consumers, private individuals generally lack the energy industry, regulatory and IT expertise and resources (e.g., assumption of full supplier obligations in accordance with section 41 of the EnWG, complexity of distributed databases). It should also be noted that such peer-to-peer trading is currently not possible in the German legal framework (without the involvement of an established energy supplier). However, a 'quasi peer-to-peer' solution can be realised within the framework of model 2 using an intermediary acting as a supplier.

A storage system is foreseen in Figure 9. This can also be useful in models 1 and 2, but it probably corresponds most closely to the intentions of an ESC in model 3 to be as self-sufficient as possible and to provide as much flexibility as possible, for example, by means of the storage system. On the one hand, it can be seen as a buffer between the ESC's balancing group and external energy supply partners and energy markets. For example, electricity can be purchased externally if it is cheap and it is foreseeable that self-supply by the producers within the ESC balancing group cannot be guaranteed. On the other hand, the storage system can also be used as an 'electricity bank' for the optimised exchange of energy between members of the ESC. It has not been conclusively clarified whether a formal supply relationship between the members of an ESC arises from the joint feed-in and feed-out into or from a storage system, respectively. There was an MVV pilot project from 2015 in which a GbR made up of prosumers jointly operated a battery storage system. The partners could feed their surplus electricity into it and take it back from the general supply grid as required. However, the project was not pursued further as it was not economically viable under the conditions prevailing at the time.

In contrast to model 2, no central market platform or central supplier will be used here, but decentralised architectures such as distributed ledger or blockchain technologies will be used, supplemented by mechanisms for automated contract execution (see dena 2022). They establish supply relationships, record specific deliveries and bring about a settlement. The aggregation and trading of flexibilities within the community or on future flexibility markets can also be considered. Such a solution has not yet been fully implemented, although EU projects and, for example, the 'pebbles' project[12] funded by the German energy research programme have identified and explored this path. However, the market-oriented integration of decentralised consumption and generation units into the German energy system is seen as having the potential to generate direct economic, social and ecological benefits for citizens while also reducing electricity grid costs (dena 2023).

12 https://pebbles-projekt.de/

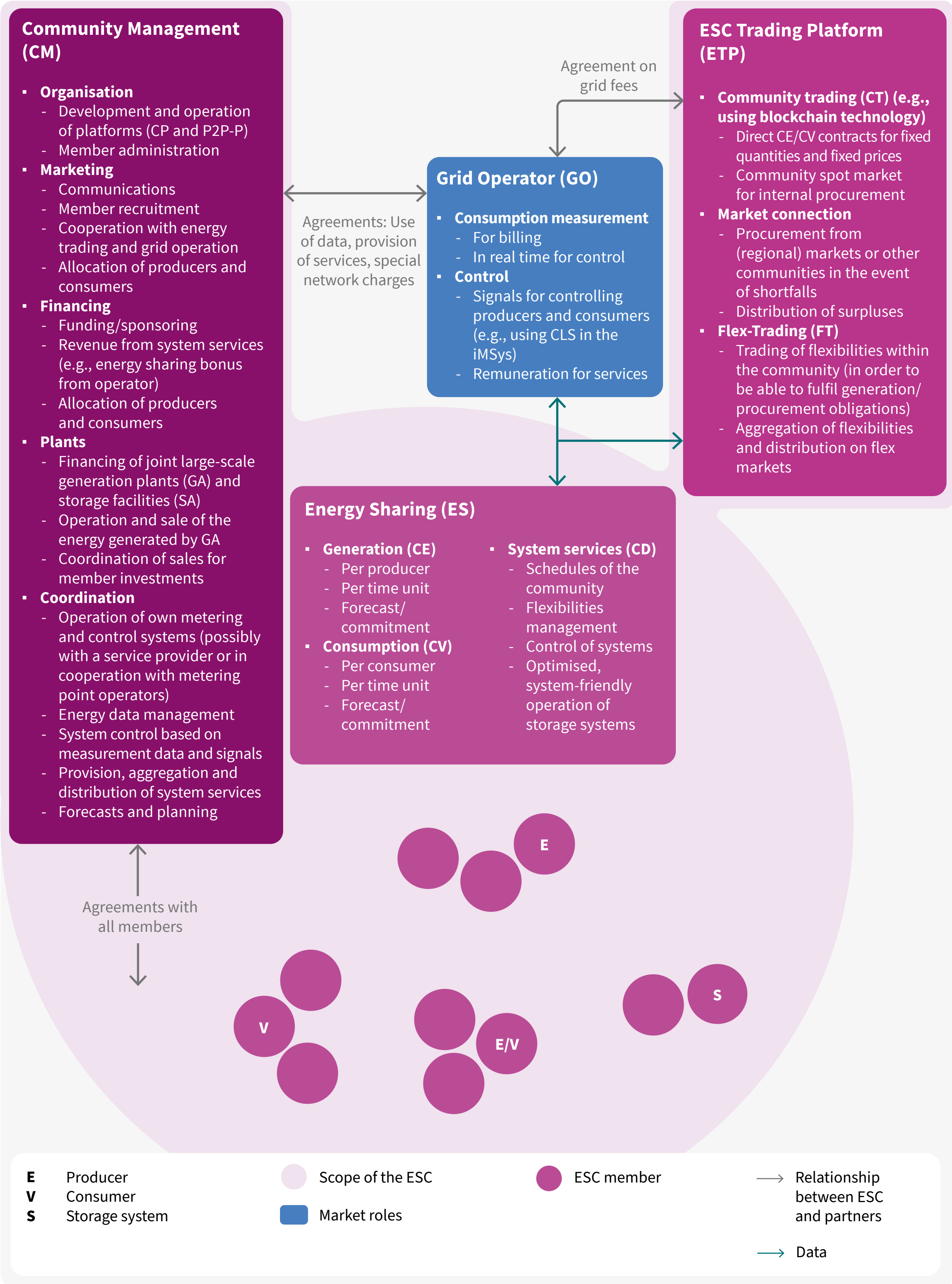

Figure 10: Tasks and processes in an energy sharing community with peer-to-peer trading (model 3)

4.3 Model of the WUNergy pilot community

The findings from this analysis, together with the results of a pilot project, will be incorporated into a guideline that identifies technical and economic criteria for energy sharing models and provides recommendations for practical implementation as well as for the development of the political and regulatory framework. A consortium led by SWW Wunsiedel GmbH was selected for the pilot project. Other consortium partners are Es-geht!-Energiesysteme GmbH, SEtrade GmbH and Exnaton AG, with the allocation of electricity volumes via *PowerQuartier* by Exnaton and the optimisation of the ESC via the *Offset Energy* platform. Together, these partners are developing a pilot ESC called WUNergy. A cooperative was chosen as the organisational form by means of which the model shown in Figure 11 is to be implemented.

The WUNergy ESC largely corresponds to model 1 shown in Figure 3. It is characterised by the following features:

1. SWW GmbH shall become a member of the cooperative, but does notorganise the exchange of energy between the members, nor does SWW represent the cooperative (e.g., as a supplier or as a representative of the cooperative as a legal entity on the market). However, SWW itself operates generation plants and contributes them to the ESC as a member.

2. All members of the cooperative (insofar as they consume, i.e., including those members who only consume and do not produce) have an individual electricity supply contract based on a dynamic rate with SWW as the supplier. This is independent of the fact that SWW is also a member of the cooperative. Members receive special rates from the supplying member SWW, which are being developed in the pilot project. These rates take into account both the electricity prices of intraday exchange trading and the member's contributions to the success of the ESC.

3. Whether and what contributions a member makes to the success of WUNergy is recorded by the Exnaton software PowerQuartier and made available in the form of billing items as the basis for SWW to issue the electricity bill of each individual member.

4. Prosumers consume part of the electricity they generate themselves and deliver the rest to SWW under a PPA (power purchase agreement). This is a separate contractual relationship that is independent of the above-mentioned electricity supply contract. No member feeds the electricity into the grid in accordance with the EEG or sells it in any other way.

5. SWW uses the electricity purchased by the members of the cooperative via PPA to (a) place it in a pool from which the members of the cooperative are supplied at optimised 15-minute intervals and (b) aggregate the surpluses and place them on the intraday exchange via the service provider SEtrade.

6. If there is not enough electricity in the pool, SWW procures the remaining electricity on the market with the help of the service provider SEtrade and thus fulfils its supplier obligations to the individual customers, i.e., the members of the ESC.

7. The aforementioned transactions are mapped in a balancing group specifically created for this purpose at SWW. The cooperative is not obliged to balance this balancing group or to procure replacement electricity or balancing electricity. Balancing of the balancing group is the responsibility of the energy balancing responsible party SWW GmbH, which may balance the balancing group by utilising its own energy assets and other balancing groups in its supply area.

8. The cooperative itself as a legal entity has no role in the energy industry (at least initially). However, it has a cooperation agreement with SWW that regulates how the 'behaviour of members in terms of optimising energy sharing' is rewarded by SWW (e.g., as part of the dynamic rate or in the form of a payment to the cooperative).

9. There is an idea is for the cooperative to procure and operate a storage facility as part of its business model. It is to be examined which energy management structure the members can use to store and procure energy there (e.g., to realise an exchange within the cooperative without establishing a supply relationship between the members) and how the cooperative, as the owner of the storage system, can possibly operate on the market with electricity from this storage system.

10. There are no other contractual relationships relevant to the energy industry, in particular none between members of the ESC (i.e., no peer-to-peer).

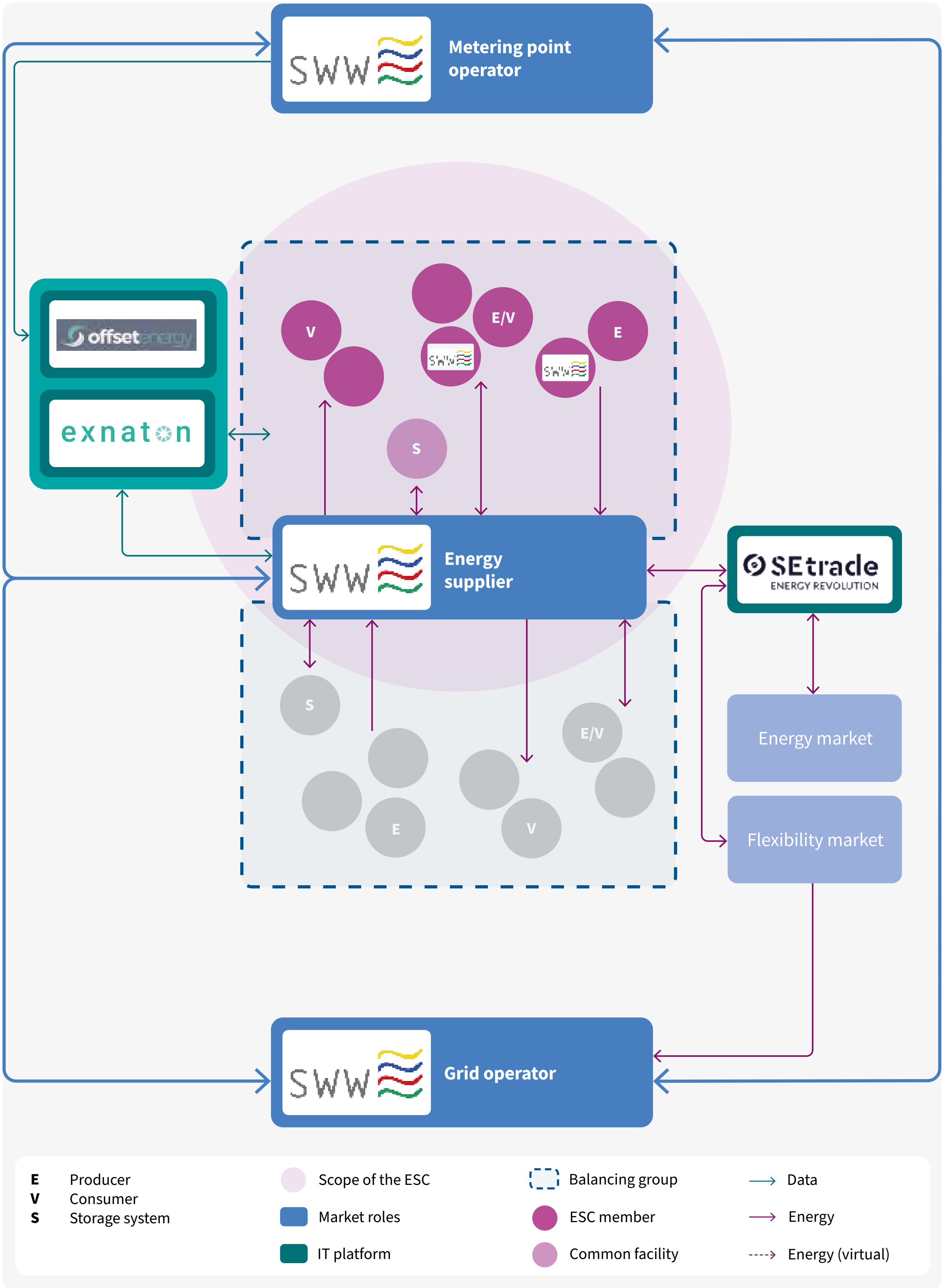

Figure 11: Model and players in the WUNergy pilot project

5. Digital technologies for energy sharing communities

The mandatory and optional features of an ESC described in section 4.2 can only be realised effectively and, above all, cost-efficiently through the use of innovative information technologies. The possibilities offered by an Intelligent Metering System (iMSys) as a central communication unit with a Smart Meter Gateway (SMGW) and interface to a Controllable Local System (CLS) should definitely be utilised for the energy management of an ESC. In addition, the operation of an ESC will require various other IT functions, depending on its characteristics.
Some of them are already being used by the established players (e.g., for energy service offerings, the realisation of redispatch requirements or the management of local flexibilities), while others will have to be used more widely in the future anyway with the increasing decentralisation of supply systems. The development of the various functions is part of the necessary digitalisation of the energy system and therefore not only enables energy sharing, but also a wider variety of added values and products, so that the resources required for this must also be evaluated accordingly.

The essential requirements are listed in Table 2. For the realisation of an ESC that can achieve the envisaged goals (use of energy on site, simultaneity of generation and consumption, participation and transparency for members, resilience of the energy system, grid or system serviceability), the respective IT solutions are indispensable – indicated by ‘x’ – or at least of great advantage – indicated by ‘(x)’ – depending on the model.

Functionality	Requirements	Relevant for models		
		M1	M2	M3
Member administration	Organisational and contractual management of the ESC: personal data, joining, leaving, agreements, billing of remuneration, marketing, financing, coordination, communication, etc.; secure and data protection-compliant access for members	**X**	**X**	**X**
Websites	Contact point for interested parties, also with the aim of recruiting members; possibly access to an internal area for registered members	**(X)**	**(X)**	**(X)**
Contract management	Management of the contractual relationships of all members with an intermediary partner or an affiliated supplier (e.g., local municipal utility); if necessary, debt collection on behalf of the central supplier, offsetting bonuses for system-friendly behaviour	**X**	**X**	**(X)**
Community dashboard	Internal area where registered members can find out about their own and the entire ESC's generation and consumption behaviour at any time; access via internet browser, if possible also via smartphone app	**X**	**X**	**X**
Notification system	Possibility of promptly informing consumers in particular in order to initiate ESC or overall system-friendly behaviour	**(X)**	**(X)**	**(X)**
Energy data management	Own recording or receipt of measurement data from partners for the ESC's generation, storage and consumption systems (preferably recorded by iMSys at intervals of 15 minutes)	**X**	**X**	**X**
Monitoring the success of the ESC	Recording and evaluation of aggregated data on generation and consumption at relevant intervals (preferably 15 minutes or less) as a basis for evaluation with regard to the ESC's objectives (e.g., maximising self-sufficiency)	**X**	**X**	**X**
Monitoring of generation and consumption by individual members	Data protection-compliant recording and evaluation of data on the production and consumption of individual members (preferably 15 minute intervals), for example, for the billing of dynamic rates or the remuneration of individual members	**(X)**	**(X)**	**(X)**
Forecasting system	Calculation of optimal system behaviour of the ESC from internal (learned behaviour patterns of members, flexibility offers) and external data (e.g., weather data)		**(X)**	**X**
Energy schedule management	Using the technical plant data, information on the flexibility of the members and (if available) the forecasts to calculate a behaviour that serves the objectives of the ESC; preparation and transmission of schedules to partners in the energy system and, if applicable, to the members of the ESC	**(X)**[13]	**X**	**X**
Price and control signals	Receiving signals from ESC-external connected partners in the energy system for use in calculating schedules or for controlling systems	**(X)**	**(X)**	**(X)**
Control of energy assets	Possibility of direct control of at least some of the generation, storage and consumption systems depending on the system situation and the schedules and in line with the selected optimisation approach; control via protected interfaces (iMSys with CLS)	**(X)**	**(X)**	**(X)**

13 If the ESC itself acts as a supplier, then the ESC must also assume responsibility for schedule management. This task is not required if an external supplier is connected to the ESC as a service provider.

Functionality	Requirements	Relevant for models		
		M1	M2	M3
Connection to energy markets	Software for the procurement or marketing of energy for members or the entire ESC on established marketplaces	**(X)**[14]	**X**	**X**
Quasi peer-to-peer trading	Mapping of balance supply relationships between members of the ESC via one or more intermediaries without the ESC member becoming a supplier in the sense of the EnWG		**X**	
Peer-to-peer trading	Centralised or decentralised (e.g., blockchain-based) marketplace for peer-to-peer trading to map actual supplier relationships between members of the ESC			**X**
Balancing group management	Ensuring that generation and consumption are balanced at all times by utilising ESC's internal resources (including flexibilities) or interacting with external suppliers or customers	**(X)**	**(X)**	**X**
Flexibility management (internal)	Platform for receiving flexibility offers from ESC members as a basis for optimised control of the ESC's generation, storage and consumption systems	**X**	**X**	**X**
Flexibility management (external)	Platform for accepting offers and aggregating and placing flexibilities on regional or supra-regional flexibility markets	**(X)**	**(X)**	**(X)**
Remuneration system	System for calculating monetary (or other) rewards, depending on the degree of contribution to the ESC's optimisation targets; system for 'distributing' the reward (e.g., monthly or annual transfer to the member's account, transmission to suppliers for offsetting against the electricity bill)	**(X)**	**(X)**	**(X)**

Table 2: ICT requirements for an energy sharing community

14 See footnote 13.

6. Status of energy sharing in selected EU countries

Austria, Italy and Denmark have largely implemented renewable energy communities (REC) and CE communities (CEC) in law. There are clear differences in the implementation with regard to the facilitation and promotion of energy sharing. For the comparison with the status quo in Germany, we looked at Italy and Austria, two countries that are well advanced in the field of energy sharing, and Denmark, a country that can look back on one of the longest histories of community energy supply and thus offers good indications for further regulations on energy sharing (see dena 2022).

6.1 Summary of the framework

CECs enable balanced energy sharing without geographical boundaries. In EU legislation, RECs (in EU law) require geographical proximity. Renewable energy communities are therefore suitable for synchronised energy sharing, which can also relieve grid congestion locally or regionally due to the simultaneous generation and consumption of the members.

All three EU countries analysed enable and support the establishment and operation of CE communities. Austria is also subsidising some of the investments here. In Denmark, small plants with a capacity of up to 10 MW are subject to less stringent approval requirements. The supply of electricity and heat in Denmark has been a non-profit public good since the 1990s. For photovoltaic plants (PV) up to 50 kW and wind turbines up to 25 kW, the grid expansion fees that Denmark charges for expanding the public electricity grid are reduced. PV prosumer plants with hourly measurement are completely exempt.

Italy and Austria are specifically promoting RECs and the associated reduction of grid congestion through energy sharing. Italy also subsidises the self-consumed electricity of a renewable energy community directly with a premium. Both Austria and Italy utilise indirect support mechanisms such as reduced grid charges and levies. In addition, Italy and Austria subsidise investments by renewable energy communities. Physical proximity is a prerequisite for the reduction of grid congestion through energy sharing. This is guaranteed in Italy and Austria because RE communities must ensure that all connection points are connected to the same transformer station. In addition, Italy explicitly encourages grid-friendly behaviour with the subsidy premium. In Austria, simultaneity is addressed indirectly in that the usual supplier rights and obligations do not apply to electricity supplies within energy communities.

Subsidy and incentive models for energy sharing are currently being discussed in Denmark. The first result is the possibility for distribution system operators to price renewable energy communities with different rates in the event of a reduction of grid congestion. However, this indirect promotion of energy sharing is proving difficult in practice, as grid operators come to different conclusions with regard to reducing grid congestion. In Denmark, energy sharing using the public grid is only possible if energy communities assume the same responsibility as any other energy supplier. For renewable energy communities, this is usually only feasible in cooperation with an electricity trading company that can take over all supplier obligations. In Denmark, the assessment of the benefits of shared electricity use via the public grid is subject to the assessment of the grid operators (Nordic Energy Research 2023). In Denmark, too, the rights and responsibilities when cooperating with the grid operator are important points of discussion.

Clear regulations have also been established in Italy and Austria for cooperation between renewable energy communities and grid operators. This concerns the right to grid access through registration procedures and the receipt of necessary information on grid connection levels and substations, the installation of smart metering systems and the provision of measured data through to the calculation of shared electricity volumes. Both countries use web platforms. The energy behaviour of members of renewable energy communities can be mapped and their energy sharing quantities calculated in Italy through a state energy service provider and in Austria, the communication platform Energiewirtschaftlicher Datenaustausch (EDA) and the information platform ebUtilities (e-control 2021). Denmark has already been using a central data hub for several years to store and make measurement data available.

Central to the exchange of data between RE (renewable energy) and CE (citizen energy) communities on the one hand and grid operators on the other is the installation of intelligent metering systems or smart meters, which has been fully implemented in Denmark and almost fully implemented in Italy. Austria had reached a penetration rate of around 70 per cent by the end of 2023.

	Austria	Denmark	Italy
Status quo legal implementation	RE and CE communities legally implemented Simultaneous energy sharing indirectly promoted Multiple participation in up to five energy communities	RE and CE communities legally implemented Energy sharing via electricity trading companies possible with all rights and obligations Distribution system operators may price simultaneous energy sharing themselves according to their own assessment.	RE and CE communities legally implemented Direct and indirect promotion of simultaneous energy sharing Favouring renewable energy communities under municipal management
Origin of electricity [15]	Pro rata from a joint plant	Electricity and heat common property	Pro rata from a joint plant
Power quality Energy sharing (green vs. grey)	Green	Not yet planned	Green
Accounting	15 minutes	No regulation yet	Hourly
Procurement in close proximity	Local RE community: all members connected to low-voltage substation (NE 6 and 7) Regional RE community: all members connected to medium-voltage substation (NE 4 or 5) BE community: no geographical restriction[16], Austria-wide (NE 1 to 7)	The geographical proximity is not defined in more detail.	RE communities must be physically connected to the same substation. CE communities have no geographical limits.[17]
Monetary incentive	Energy-sharing electricity exempt from supplier obligations Reduced grid charges of 28 to 64 per cent on the energy price share Reduced levies on energy-sharing electricity volumes (no green electricity flat rate, no electricity levy) Market premium only for a maximum of 50 per cent of the surplus electricity of the renewable energy community Funding for investment costs amounting to a maximum of 50 per cent of the total costs of certain renewable energy communities	Distribution system operator entitled to own rates from RE community depending on benefits for reduction of grid congestion	Direct subsidisation via premium for jointly generated and simultaneously consumed electricity (energy sharing) 6 to 12 ct/kWh for 20 years Direct premium for PV plants depending on geographical location 1 ct/kWh for 20 years Promotion of a maximum of 40 per cent of the total investment by renewable energy communities
Full provision for participants	No, two suppliers can be selected (renewable energy community and residual electricity supplier)	No regulation	No, two suppliers can be selected (RE community and residual electricity supplier)

	Austria	Denmark	Italy
Rollout of smart meters	70 per cent at the end of 2023	100 per cent	At least 98 per cent
Participants	RE and CE communities: natural persons, SMEs, municipalities, other public bodies	RE and CE communities: associations, cooperatives, partnerships, corporations or similar organisations with legal personality	RE communities: natural persons, SMEs, local authorities including municipalities, research and educational institutions, religious institutions, non-profit and environmental organisations and local administrations CE communities: natural persons, small businesses, local authorities including municipal administrations, research and educational institutions, third sector and environmental protection organisations, religious institutions and the administrative bodies included in the list of public administrations listed administrative organisations

Table 3: Overview of the applicable framework conditions for energy sharing in CE and RE communities in the EU countries Austria, Denmark and Italy

6.1 Austria

The Renewable Energy Expansion Act Package (EAG Package) adopted on 7 July 2021 and the amendment to the Electricity Industry and Organisation Act (ElWOG) created the legal basis for the definition, establishment and operation of energy communities. Austria is thus transposing key requirements from the European Union's 'Clean Energy for all Europeans Package' (CEP) into national law (Climate and Energy Fund 2023a). A distinction is made in Austria:

- Joint generation plants according to section 16(a) of the ElWOG
- Renewable energy communities (REC) pursuant to section 16(b) of the ElWOG
- Renewable Energy Communities (RE communities) pursuant to section 16(c) of the ElWOG

Energy communities within buildings (section 16(a) of the ElWOG) are already widespread throughout Austria and are handled under established standardised framework conditions.

The new legal framework enables people to join together across building boundaries and using the public electricity grid in RE communities and CE communities to generate, store, sell and consume energy.

In the case of renewable energy communities, a distinction is made between local and regional areas. In the local area, they include low-voltage local grid lines within grid levels 6 and 7, connected to a transformer station. In the local area, the members (of the energy community) are also connected to medium-voltage lines at grid levels 4 (only the medium-voltage busbar in the substation) and 5 and utilise several transformer stations. CE communities, on the other hand, are geographically unrestricted and use all grid levels.

15 According to Ritter et al. 2023, p. 50, 'origin' means the following: '"Origin" here refers to the operator of the generation plant: is it the community ("shared" plant), is it the individual community members ("private plant") or is it "grid electricity" that cannot be individually assigned to a system?'

16, 17 Grid-supportive energy sharing within the scope of the study is due to a geographical limitation of the community. As there is no geographical limitation for CE communities, these are no longer listed in detail below.

For RE communities with several generation plants, several participants and several grid operators, fundamental extensions to the IT systems are necessary in order to be able to map the calculation and energy allocation (Österreichs Energie, no year). To this end, the Austrian regulatory authority in the electricity and natural gas industries has also updated the market communication for renewable energy communities pursuant to section 16(c) of the ElWOG with 'mixed generation of several generation plants with several participants and grid operators' as part of the 'Other Market Rules for Electricity' (SoMA) (e-control 2023b). The Energy Data Exchange (EDA) communication platform and the ebUtilities information platform (e-control 2021) play a central role here.

6.2.1 Funding

The Austrian federal government has launched a funding programme worth €4 million to promote energy communities and has entrusted the Austrian Climate and Energy Fund (KLIEN) with the implementation of the funding. The Climate and Energy Fund was also commissioned to set up the Austrian Coordination Centre for Energy Communities (KEK) in order to bundle the promotion of energy communities and establish it in Austria. To this end, it aims to optimise the Austrian models of RE and CE communities and provide assistance in setting them up. The aim is to ensure that processes for setting up and operating are uncomplicated, efficient, fast and transparent and that the entry threshold for new energy communities is kept low while at the same time ensuring quality. The promotion of energy communities takes place through tendering procedures in Austria. The funding programme supports energy communities that serve as role models for model projects with an innovative character. Funding of up to 50 per cent of the net costs is possible for such lighthouse projects. In addition, a bonus can be granted if the establishment or expansion of the energy community is proven within six months by a grid access contract or a statement of account from the energy community to its members. A total of €3 million was available from the Climate and Energy Fund for the Energy Communities 2022 programme. The maximum funding including bonus was €15,000 (Climate and Energy Fund 2022). A new edition was launched in October 2023 with the Energy Communities 2023 programme. A total of €5 million was made available from the Climate and Energy Fund for this purpose. The maximum funding including bonus was increased to €20,000 (Climate and Energy Fund 2023b).

Energy is supplied to members of renewable energy communities at reduced rates due to reduced grid fees, taxes and levies. Depending on the grid connection level, participants in a renewable energy community are subject to reduced unit prices of the grid charge of between 28 and 64 per cent for shared energy volumes. Furthermore, the renewable energy subsidy (green electricity flat rate) and the electricity levy will no longer apply to electricity generated from the renewable energy community. Up to 50 per cent of the electricity generated and not consumed internally by the RE community or the CE community can be subsidised with the market premium. The members do not receive any market premiums for the energy volumes consumed within the RE and CE communities themselves.

6.2.2 Interaction between energy communities and grid operators

Energy communities must register their formation with the grid operator. This requires the establishment of a legal entity (RESCoop.eu 2023). They need to register as a market participant in Austria in the www.ebutilities.at database in order to receive a market partner ID, which is required for registering the community with the grid operator. At the beginning of 2023 (retrieved on 15 March 2024), 1,640 RE communities and 380 CE communities were registered in the database (www.ebutilities.at)(ebUtilities 2024). Grid users have a legal claim against the grid operators to participate in CE communities and RE communities (ElWOG of 6 December 2023). The mandatory tasks of the grid operator include

- Response to requests for network access within two weeks
- Installation of a smart meter within two months of application
- Conclusion of a contract with the energy community
- Measurement of members' consumption and feed-in/procurement from generation plants of an energy community
- Provision of 15-minute measurement data for the producers and consumers of an energy community on the following day, free of charge and online
- Allocation of (dynamic or static) shares in generation between members

The ElWOG supports the expansion of energy communities with the Metering Equipment Introduction Ordinance (IME-VO) of January 2022, which stipulates that at least 95 per cent of all metering points must be equipped with smart meters by the end of 2024. At the end of 2023, the equipment rate achieved was 70 per cent. The IME Ordinance also sets out extensive reporting and monitoring obligations for the distribution system operators and the regulatory authority (e-control 2023a and 2024b). Section 84(7) of the ElWOG authorises the national regulatory authority e-control to issue ordinances on the requirements for smart metering devices and the handling of metering data. Back in 2011, e-control issued the Intelligent Metering Equipment Requirements Ordinance (IMA-VO 2011), which sets out the minimum technical requirements for metering systems, such as a bidirectional communication connection to external quantity measuring devices and a 15-minute transmission of energy deliveries. The Data Format and Consumption Information Presentation Ordinance (DAVID-VO 2012) of 2012 regulates the form and time periods in which metering data must be made available to consumers (e-control 2024a).

6.2.3 Energy sharing

The usual supplier rights and obligations do not apply to electricity supplies within energy communities. Only if an energy community supplies third parties who are not participants in the energy community does it legally require a electricity supplier licence (section 7(1)45 of the ElWOG 2010). The members of a renewable energy community must be connected via the local low-voltage grid (levels 6 and 7) or regionally via the medium-voltage grid (levels 4 and 5) in order to ensure geographical proximity. The grid operator must provide information on the grid level at which the generation and consumption systems of a potential RE community are located (Tual et al. 2023, Climate and Energy Fund 2023b).

Since April 2024, both full feeders and surplus feeders as well as pure consumers can be members of several energy communities. Each generation or consumption system can participate in up to five energy communities at the same time, provide electricity to these energy communities or purchase electricity from them (Climate and Energy Fund 2024).

6.3 Denmark

CE communities and RE communities within the meaning of the EU regulations have been regulated in the Act on the Promotion of Renewable Energy (lov om fremme af vedvarende energi; concerns RE communities) and in a supplementary implementing regulation of the Electricity Supply Act (elforsyningsloven; concerns RE and CE communities) since 2021. Both forms of energy communities are generally referred to in Denmark as energy communities (Danish: Energifælleskaber), whereas it is rare to make a distinction between CE communities (Danish: Borgerenergifællesskaber) and RE communities (Danish: VE-fællesskaber).

In Denmark, energy communities can be organised as associations, partnerships (e.g., I/S), cooperatives or corporations (e.g., A.m.b.A). They are often initiated by municipalities, housing cooperatives or eco-friendly villages that have the necessary technical and legal expertise.

6.3.1 Funding

There are currently no specific remuneration or incentive models for energy communities and energy sharing in Denmark. However, Denmark has a good basis for energy communities and energy sharing due to the long history of community energy projects there. For example, small renewable energy generation plants now have many advantages, the smart meter rollout is complete and the measurement data is made available on a central data hub.

Lower approval requirements apply for plants with an output of up to 10 MW. Consumers pay a fee for the necessary grid expansion as a public service (Public Service Obligation, or PSO for short) when RE plants are built (see Roberts et al. 2014), which is greatly reduced for PV plants up to 50 kW and for wind turbines up to 25 kW. PV prosumer plants with hourly metering are completely exempt from PSO fees and grid charges (BEK 999/2016; see Martín et al. 2021). This also applies to non-subsidised tenant electricity plants (without public grid use) that are in the sole possession of the property owner if the amount of electricity used is reported to the grid operator on an hourly basis. The supply of electricity and heat has been a public good in Denmark since 1999, which has favoured the growth of citizen-led energy projects. This is because a non-profit principle applies to energy service providers, according to which surplus income must be passed on to consumers (see Gorroño-Albizu et al. 2019). In addition, net metering has been in place for a long time, whereby the difference between the electricity fed into the grid and the electricity drawn from the grid is balanced and billed via the same bidirectional electricity meter (or dual-rate electricity meter). Denmark has not levied electricity tax on this since 1999. This was an important reason for the successful complete smart meter rollout of all 3.3 million connection points by 2020. Denmark also uses the central Green Energy Hub, a data hub platform on which all data measured hourly by smart meters is stored and made available (see Martín et al. 2021).

Rate and incentive models for energy communities and energy sharing are currently being proposed and discussed. Currently, distribution system operators have been able to specifically price energy communities depending on their contributions to the public grid on the basis of new rate legislation (Nordic Energy Research 2023) since 2023. In practice, however, compliance with this regulation is difficult because the distribution system operators assess energy communities differently. This has led to some energy communities giving up again due to administrative obstacles (Nordic Energy Research 2023, RESCoop.eu 2023).

6.3.2 Interaction between energy communities and grid operators

Distribution system operators in Denmark are obliged by regulation to co-operate with energy communities if their activities can reduce the load on the grid. Danish energy communities are currently not allowed to operate their own distribution grids (Nordic Energy Research 2023; see Frieden et al. 2020, Klima-, Energi- og Forsyningsministeriet 2019), but the use of the public grid can be circumvented for electricity customers and electricity producers with a connected load of 10 kV and higher by building their own commercial direct lines that connect electricity producers and electricity consumers directly (Global Legal Insights 2023, Energinet 2022).

6.3.3 Energy sharing

Energy sharing in energy communities using the public grid takes place via an electricity trading company, which handles billing and distribution by means of an electricity supply contract. The supply contract covers both the energy consumed jointly and the additional electricity required to cover all the members' energy demands. The shared use of electricity via the public grid is always subject to the general rates and taxes. If the energy community wants to take on these activities itself, it must fulfil all supplier obligations (Nordic Energy Research 2023).

6.4 Italy

In 2021, Italy transposed RECs into national law with Legislative Decree 199/21 and CE communities into national law with Decree 210/21 in accordance with RED II and EMD. A capacity cap of 1 MW per community plant applies to RE communities. In addition, all connection points must be connected to the same low or medium voltage substation, which limits the geographical radius. RE communities must be organised as a legal entity in order to be able to carry out all activities. RE communities receive a premium for the energy they consume themselves and compensation for the lower grid costs and can sell surplus electricity on the market. As part of the Italian National Recovery Plan, the Italian government is also subsidising investments to expand energy communities in municipalities with fewer than 5,000 inhabitants with a total of €2.2 billion until 2026 (Gennaro Sposato 2021).

Several regions have developed their own framework for energy communities that fits the national context but takes into account specific local circumstances following the creation of national regulation in 2020 (RESCoop.eu 2023). For example, the northern Italian region of Lombardy, which has around 10 million inhabitants, has set itself the goal of creating 6,000 energy communities with a total capacity of 1.3 GW by 2024 and is investing €22 million in this endeavour. With the subsidies adopted and the legal and regulatory framework created for energy communities and collective self-consumption, it is assumed that various renewable energy communities will be established throughout Italy (BMWK 2022, Bellini 2022). Current Italian studies put the number of active renewable energy communities at 104 and assume an increase of up to 191 due to planned projects. Many energy communities are run by municipalities or private companies (Skujins and Morandotti 2023).

6.4.1 Funding

The investment funding in the National Recovery Plan for the implementation and development of renewable energy communities supports up to 40 per cent of expenditure. The renewable energy communities must have a total output of at least 2 GW or a production of at least 2,500 GWh/year (Rödl & Partner 2024).

Italy also promotes the self-consumption of energy communities (energy sharing) with a premium rate paid by the energy service provider (GSE) for a period of 20 years. The rate consists of a fixed and a variable component and depends on the size of the system and the market price of the electricity. The rates are between 6 ct/kWh and 12 ct/kWh. A further surcharge of 1 ct/kWh is provided for PV plants, depending on the location. The (surplus) electricity generated in energy communities can also be sold on the market. RE communities must fulfil the following requirements in order to benefit from the subsidy rates:

- Maximum nominal capacity 1 MW per plant of the renewable energy community
- Generation plants and procurement points use the electricity grid and are all connected to the same substation.
- Any surpluses from the subsidy rate may only be used for the benefit of consumers that are not companies and/or for social purposes that have an impact on the areas in which the generation plants are located.
- Only SMEs can participate as shareholders or members.
- Plants must fulfil performance and environmental protection requirements (Chamber of Commerce Bolzano 2024, Rödl & Partner 2024).

The subsidy rates apply to a plant with a capacity of up to 5 GW, which must be reached by the end of 2027, and for a period of 20 years.

6.4.2 Interaction between energy communities and grid operators

RE communities must register in the register of the state energy service provider (GSE), which carries out a general authorisation check. The Italian electricity authority ARERA regulates the cooperation between distribution system operators and the transmission system operator (Terna) in order to ensure the implementation of energy communities. This also includes the rules for calculating shared electricity volumes and non-shared electricity volumes. Distribution system operators are obliged to record data on the basis of hourly measured values; the smart meters that have been installed since 2005 are sufficient for this purpose. GSE is responsible for the payment of subsidy rates and market premiums for energy fed into the grid. The distribution system operators are primarily required to designate the substation that is relevant for the respective energy community before (Tual et al. 2023, RESCoop.eu 2023).

6.4.3 Energy sharing

Italian regulations and laws offer very favourable conditions for energy communities and energy sharing. A particular focus of the legislator is on the joint self-consumption of renewable energy communities with a simultaneous reduction of grid congestion. RE communities receive a premium for the energy they consume themselves and compensation for the lower grid costs and can sell surplus electricity on the market. This promotes the simultaneous generation and consumption behaviour of the members of RE communities (Tual et al. 2023).

7. Outlook

The practical implementation of energy sharing, while taking into account energy industry obligations, is complex. At the same time, the fulfilment of energy industry tasks and obligations is important and necessary in order to continue to operate the electricity system safely and stably in future, to process trade correctly and to enable transparency for consumers. This is because the tasks that an 'active customer' does not perform for electricity supplies, for example, must be fulfilled by another player. A change in the distribution of burdens that may result from privileges for ESC must be weighed up.

The basic models listed in section 4 outline a possible depiction of the energy industry implementation, the fulfilment of market roles and tasks and the exchange of data. This makes it clear that an ESC can also outsource tasks to service providers, meaning that not everything has to be fulfilled by the ESC itself. Models 1 and 2 with the involvement of a central supplier or an intermediary that is familiar with energy industry processes are easier to implement and at least partially feasible within the framework of existing regulation. Implementation will be particularly challenging according to model 3, where trading takes place without intermediaries and the ESC itself assumes supplier obligations. This model is not possible within the current legal framework. However, this model in particular offers great economic potential for the future and, as part of the implementation of EMD III, there is a chance that this will be realisable in practice in the future. At the same time, the implementation and further development of ESCs offers opportunities for the development of new business models – also for established and innovative companies in the energy industry. Regulatory adjustments should consider different variants of ESC and test them in practice so that operating models for different stakeholder constellations and framework conditions locally can be developed that actually enable participation on a broad scale.

The WUNergy pilot project in Wunsiedel should make an important contribution to advancing ESC in Germany. In the project, the practical introduction of an ESC is being tested under current conditions. In order to set up in the real-world environment under current conditions, it is essential that a municipal utility be involved in various roles. Together with the partners in the pilot project and the accompanying research, the project shows how digital infrastructures and technologies as well as data flows and exchanges can be designed in practice in order to realise energy sharing that also serves the entire energy system. In addition to the energy industry implementation, the aspects of cost structure and profitability, contract concepts including dynamic rates with incentive structures, possibilities for grid-friendly behaviour and also the activation of members will be examined.

Above all, the question is: Will ESCs be able to efficiently realise local balancing of generation and consumption in competition with the existing market elements that have so far provided balancing. From these practical experiences, indications can be derived for possible adjustments to the legal and regulatory framework that could be favourable for the development of energy sharing communities. The results of the investigations in the pilot community in Wunsiedel, the accompanying research (IZT, B.A.U.M.) and the comprehensive discussions with the members of the expert group will be incorporated into a guideline at the end of the project. This can show both established players in the energy industry and interested citizens, as well as those responsible for promoting the energy transition, what potential energy sharing offers and how it can be realised.

Table of figures

List of tables

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List of abbreviations

ARERA	L'Autorità di Regolazione per Energia Reti e Ambiente (Italian regulatory authority for energy, networks and the environment)
BBEn	Bündnis Bürgerenergie e. V.
BDEW	Bundesverband der Energie- und Wasserwirtschaft e. V.
BEE	Bundesverband Erneuerbare Energie e. V.
REC	Renewable energy community under German law
CE community	Citizen energy community (refers to Austrian, Danish or Italian law in section 6)
BRP	Energy balancing responsible party
BMWK	Federal Ministry for Economic Affairs and Climate Action
bne	Bundesverband Neue Energiewirtschaft e. V.
BNetzA	Federal Network Agency
CEC	Citizen Renewable Energy Community under EU law
CEP	Clean Energy for all Europeans Package
CLS	Controllable Local System
ct/kWh	Euro cent per kilowatt hour
DAVID-VO	Data Format and Consumer Information Presentation Ordinance (AT)
DGRV	Deutscher Genossenschafts- und Raiffeisenverband e. V.
E	Producer
EAG package	Renewables Expansion Act Package (AT)
EE	Renewable energy
EEG	Renewable Energy Sources Act
RE community	Renewable energy community (refers to Austrian, Danish or Italian law in section 6)
EERA	European Energy Research Associates
eG	Registered cooperative (in Germany)
ElWOG	Electricity Industry and Organisation Act (AT)
EMD	Directive (EU) on common rules for the internal market for electricity (Directive (EU) on common rules for the internal market for electricity)
EnWG	Energy Industry Act
ES	Energy Sharing
ESC	Energy Sharing Community
ESCo	Energy supply companies
FfE	Forschungsstelle für Energiewirtschaft e.V.
GbR	Company under civil law (in Germany)
GEA	Decentralised power generation plant
GmbH	Limited liability company (in Germany)
GmbH & Co. KG	Limited liability company & limited partnership (in Germany)
GSE	Gestore dei Servizi Energetici SpA (state operator of the energy service system in Italy)
GW	Gigawatt
GWh	Gigawatt hour
HEMRM	Harmonised Electricity Market Role Model
IKT	Information and communications technology
IMA ORDINANCE	Intelligent Measuring Equipment Requirements Ordinance (AT)
IME ORDINANCE	Intelligent Measuring Equipment Introduction Ordinance (AT)
iMSys	Intelligent Metering System
IT	Information technology
IZT	Institute for Futures Studies and Technology Assessment
KEK	Coordination centre for energy communities in the Climate Fund (AT)
KLIEN	Climate and Energy Fund (AT):
SME	Small and medium-sized enterprises

kV	Kilovolt
kW	Kilowatt
MaStRV	Core energy market data register
MPO	Metering point operator
MW	Megawatt
GO	Grid operator
NE	Grid level
P2P	Peer-to-peer
PPA	Power purchase agreement
PSO	Public Service Obligation (DK)
PV	Photovoltaics
REC	Renewable Energy Community according to EU law
RED	Directive (EU) on the promotion of the use of energy from renewable sources
SMGW	Smart Meter Gateway
SoMa	Other market rules for electricity (AT)
StromNEV	Electricity Grid Charges Ordinance
StromStG	Electricity Tax Act
StromStV	Ordinance on the Implementation of the Electricity Tax Act
UBA	Federal Environment Agency
V	Consumer
DSO	Distribution system operator
VPP	Virtual Power Plant

Appendix:
List of initiatives surveyed

The description of the initiatives can be found in the following publication: Deutsche Energie-Agentur (Hrsg.) (dena, 2024): Energy Sharing in Deutschland: Zusammenfassung befragter Initiativen

Allensbach
BENG eG Munich
Brunnthal
Bürgerwindpark Janneby eG
Dorfenergie eG Eppishausen
Energiedorf Fuchstal
Energiegenossenschaft Ilmtal eG
EnergieVersorgung Sprakebüll eG
EnergieWende Erlangen and Erlangen-Höchstadt eG (EWERG eG)
Energiewende Hunsrück-Mosel eG
EWS Elektrizitätswerke Schönau eG
Green Planet Energy eG
Isarwatt eG Munich
Neue Energien Forum Feldheim
Rehfelde-EigenEnergie eG
Stadtwerk Haßfurt

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