



Paikallisen energijärjestelmän kehittäminen Pohjanmaalla  
Development of the regional energy system in Ostrobothnia

## WP3 Business models

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### ABSTARCT

Within the scope of the PEAK project Work Package 3 (WP3), the aim was to develop carbon-neutral energy system business models that can be successfully implemented in the Ostrobothnia region in Finland. To support this objective, a literature review was conducted to systematically synthesize existing knowledge on international, experience-based business models relevant to regional carbon-neutral energy systems.

As energy systems become more interconnected and technology-driven, there is a growing need for innovative, sustainable business models that translate climate objectives into practical, socio-economic solutions. These models are shaped by the three key drivers of transformation: decarbonization, decentralization, and digitalization, which together redefine how value is created, delivered, and captured in modern energy systems.

The study investigates and develops business models by analyzing the roles of key actors such as prosumers, energy communities, and system operators, while identifying regulatory, market, and technical barriers. It highlights that business models in energy systems act as a critical link between emerging technologies and their commercialization, requiring stakeholders to rethink traditional business and operational logic.

The findings categorize energy system business models into key archetypes, including community-based models, flexibility and aggregation models, energy-as-a-service models, and digital platform-driven models. These models vary in their mechanisms of value creation but are strongly influenced by regulatory frameworks and policy incentives.

Overall, the study concludes that transitioning to carbon-neutral energy systems requires a combination of innovative business models, supportive regulatory conditions, and collaboration among stakeholders, with a stepwise development approach to ensure feasibility and scalability in regional contexts.

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### Abbreviations

BM	Business Model
BRP	Balance Responsible Party
BSP	Balance Service Provider
CEC	Citizen Energy Community
DER	Distributed Energy Resource
DSO	Distribution System Operator
EC	Energy Community
ECBM	EC Business Model
ESS	Energy Storage System
BESS	Battery Energy Storage System
HVAC	Heating, Ventilation, and Air Conditioning
LEM	Local Energy Market
LFM	Local Flexibility Market
P2P	Peer-to-Peer
PV	Photovoltaic
REC	Renewable Energy Community
EV	Electric Vehicle
SME	Small and Medium-sized Enterprises
TSO	Transmission System Operator
VPP	Virtual Power Plant
FTM	Front-the-Meter
BTM	Behind-the-Meter
FCR	Frequency Containment Reserves
DR	Demand Response
EaaS	Energy-as-a-Service
PPAs	Power Purchase Agreements
TPO	Third-party Ownership
FiTs	Feed-in Tariffs
SES	Shared Energy Storage



## 1 Introduction

### 1.1 Purpose of the Study

Within the scope of the PEAK project Work Package 3 (WP3), the aim was to develop carbon-neutral energy system business models that can be successfully implemented in the Ostrobothnia region. To support this Objective, WP3 conducted a literature review to understand better and systematically synthesize existing knowledge on international, experience-based business models relevant to the regional carbon-neutral energy systems. This review examined the evolution of key research themes in this field. This review also helped to identify and analyze relevant case studies and provide concrete suggestions for future business model development. This review was based exclusively on peer-reviewed literature indexed in a highly used academic database (SCOPUS) to ensure academic reliability.

### 1.2 Significance of Carbon-Neutral Energy Systems

The increasing concern about global climate change has accelerated a major shift in energy policy and development strategies worldwide. This transition has been strongly shaped by the Paris Agreement<sup>1</sup> adopted in 2016, under the United Nations Framework Convention on Climate Change<sup>2</sup> (UNFCCC), which aims to limit global warming to well below 2 °C and to pursue efforts to limit it to 1.5 °C<sup>3</sup>. This ambitious global objective has initiated a worldwide commitment among diverse entities, including nations, local governments, corporations, and financial institutions, to promote carbon neutrality and net-zero emissions.

However, the transition towards carbon-neutral energy systems is a complex and complicated process. This requires fundamental changes in all sectors, including energy, transport, industry, and agriculture/forestry/waste. This transition demands a joint push to adopt low-carbon technologies. This transition also requires introducing sustainable practices and essential changes to current

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<sup>1</sup> [Paris Agreement 2016- United Nations Framework Convention on Climate Change \(UNFCCC\)](#)

<sup>2</sup> [United Nations Framework Convention on Climate Change](#)

<sup>3</sup> [IPCC special report on the impacts of global warming](#)



production and consumption patterns. These measures are not only aimed at adapting to climate change but also at preventing environmental disasters. In addition to preventing catastrophes, these changes also offer significant benefits.

The Paris Agreement 2016 has also identified the action plan framework for achieving global climate targets worldwide. This framework can easily be implemented at different national, local, corporate, and even individual levels. Achieving carbon neutrality requires adopting advanced technologies and changing operational and market structures. As systems become more interconnected and technology-driven, there is a growing need for innovative, sustainable business models that translate climate objectives into practical socio-economic solutions.

In response to these global policy commitments and sector-wide transformations, there is a need for significant changes in the energy sector. These changes are mostly driven by the rapid integration of non-fossil fuel resources and the need for transition from centralized, commodity-based energy systems toward decentralized, service-oriented, and sustainable models (Gitelman and Kozhevnikov, 2023). In this context, more innovative business models are required to support the integration of distributed energy Resources (DERs), e.g., Electric Vehicles (EVs), Battery Energy Storage Systems (BESS), and Demand Response (DR) into existing markets and regulatory frameworks (S. Burger et al., 2017). The transformation is commonly understood through the framework of the three D's

- Decarbonization
- Decentralization
- Digitalization

Decarbonization refers to replacing fossil-based systems with low and zero-carbon alternatives. Decentralization describes the shift from centralized generation toward distributed and coordinated energy resources. While Digitalization facilitates this by providing data-driven control, automation, optimization, and new platform-based value creation mechanisms. Together, these three drivers are reshaping how value is created, delivered, and captured in modern energy systems.

### 1.3 Aim and scope of WP3

WP3 focuses on investigating, analyzing, and developing realistic business models for regional energy systems. Business models should be developed to facilitate a shift to a carbon-neutral energy system. The study focuses on determining the positions of various actors within the energy system. These actors include prosumers, energy communities, DSOs, and other market players. The objective of WP3 is to analyze how they create, deliver, and capture value. This objective is especially important against the backdrop of the development of flexibility, decentralized energy production, and innovative services.

Furthermore, WP3 aims to identify critical bottlenecks in implementing the business models. Such bottlenecks include regulatory and market barriers, as well as constraints on resource availability and skills. Identifying such bottlenecks is necessary to ensure the feasibility of the proposed business models. WP3 builds on the techno-economic results of WP1. It also builds on insights from stakeholders and the community in WP2. By combining these inputs, WP3 links technical feasibility with stakeholder needs and market implementation.

WP3 is structured into four main tasks. Each task supports the development and validation of business models.

- **Task 3.1: Background Study**

This task includes a literature review. It focuses on international business models. The aim is to identify models suitable for regional and carbon-neutral energy systems.

- **Task 3.2: Sketching of Business Models**

Initial business models are developed. These are based on results from Task 3.1, WP1, and WP2. The models are presented to stakeholders in a workshop. Stakeholders discuss and evaluate the models. The most relevant models are selected for further development.

- **Task 3.3: Legal Framework Analysis**

This task examines regulatory conditions. It includes interviews with key actors such as policymakers and system operators. The shortlisted business models are presented to the interviewees. The aim is to identify legal barriers and opportunities for implementation.

- **Task 3.4: Business Model Development**

Selected models are further developed. This is done in collaboration with stakeholders through workshops. The models are refined and strengthened. The task also identifies challenges, bottlenecks, and resource and skills gaps.

## 2 Background study of energy systems business models

### 2.1 Theoretical Categorization

Business models in the energy systems act as the critical link between emergent energy technologies and their commercialization in the marketplace. They define how value is proposed, created, delivered, and captured. As energy systems become increasingly decentralized and flexible, they require the energy sector stakeholders to fundamentally reimagine their business and operational logic (Wojtaszek, 2025).

Reviewing the extensive literature available in the academic database shows that the field of energy business models is very broad, complex, and diversified. Existing studies identify a wide range of archetypes, e.g., flexibility and aggregation, community and prosumer empowerment, utility evolution, energy-as-a-service (EaaS), the circular economy, and data-powered digital platforms. Categorizing this literature helped to reveal the dominant business model archetypes shaping the future of the energy sector.

Several studies illustrate the diversity of existing classification approaches. Burger (2017) identifies 144 business model archetypes for distributed energy resources (DERs). Brzóška (2022) presents the conceptual structures and antecedents necessary for creating renewable energy models. Similarly, Rieksta (2021) maps 37 business models for different technologies and energy sectors to create simulations of how these would affect the dynamics of the clean energy transition through complex system dynamics modeling.

This transition is even more complex when examined from a global socio-economic perspective. In the comprehensive analysis of renewable energy business models worldwide, Engelken (2016) highlights how industrialized nations place significant emphasis on climate change mitigation and efficiency, while developing nations focus more on microfinance and basic energy needs. This states that most DER business models are often driven by policy factors rather than technological factors (S. P. Burger and Luke, 2017).



optimisation. It also shows that EV research is heavily focused on grid integration rather than solely on vehicle technology. The yellow cluster (innovation and sustainability) is driven by business model innovation and sustainability. This cluster represents the forward-looking aspect of the map while connecting it to broader environmental goals, such as emission control, decarbonisation and climate change. The purple (strange and circular) cluster represents a highly specialised subgroup that links physical technologies, such as lithium-based battery energy storage systems, directly to life cycle concepts, including the circular economy, circular business models, and life cycle-driven approaches, driven by business model innovation. Ultimately, this visualization illustrates how foundational literature on business models serves as a central link connecting new technological applications to future sustainability goals.

## 2.2 Energy System Business Model Archetypes

The literature on energy system business models identified a wide range of categories and archetypes, including Flexibility, Demand response, Distributed Generation, Aggregation, Local Energy Communities, Energy-as-a-Service (EaaS), Smart Energy Management (IoT/AI), and Distributed Energy Systems. Building on the key differences in value-creation logic, actor configurations, and enabling technologies identified in the literature. This Study clusters energy system business model archetypes into four domains: (1) Community- and prosumer-centric models, (2) Flexibility & aggregation models, (3) Energy-as-a-service models, (4) Digital platform & data-driven business models. These domains are not independent but rather analytical categories representing how value is typically created and delivered in modern energy systems. Many business models extend multiple domains due to the intersecting nature of technology, actors, and market mechanisms.

### 2.2.1 Community & Prosumer-Centric Models

One of the most prominent fields in modern energy business model innovation is community empowerment, which enables the transition from passive consumers to active prosumers. These models emphasize decentralized ownership, local value creation, and participatory governance structures.

### 2.2.1.1 Energy Communities (RECs/CECs) and Energy Cooperatives

The increased formalization of Renewable Energy Communities (RECs) and Citizen Energy Communities (CECs) through specific policies enforced by the European Union has contributed to a significant systemic transition towards energy self-sufficiency as well as local energy independence. Barabino (2023) highlights the significance of community models in coordinating decentralized generation and local consumption, which are essential for accelerating the energy transition. Similarly, López (2024) state that new EU legal frameworks have granted the legal right to end-users to independently consume, share, store, or sell their generated energy.

To fully explore the structural mechanism of this emerging field, Reis (2021) offer a comprehensive overview of EC business model archetypes and explain why value propositions based on community-driven differ from traditional utility models. Building on this, Kubli and Puranik (2023) introduce a highly detailed "morphological box"<sup>4</sup> with 25 precise business model design options. These options enable communities to customize an operational framework for their distributed energy resources to suit their local socio-economic settings.

Functionally, these models enable self-consumption at scale. When integrated with "prosumagers"<sup>5</sup> (prosumers equipped with battery storage), collective operation can help to manage grid technical constraints and lower individual electricity costs (Iazzolino et al., 2022). However, ECs move beyond just economic indicators and create a broader form of value. Barnes (2024) emphasizes that value creation avenues in ECs are inherently linked to principles of energy justice, social cohesion, and the democratization of local infrastructure. As hybrid entities, ECs must balance profit-oriented activities with social and environmental objectives. To support this, Kahla (2017) calls for the adoption of strategic management tools, such as the Balanced Scorecard, to assess and maintain hybrid business models in citizen renewable energy companies.

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<sup>4</sup> A morphological box is a structured brainstorming tool used to generate innovative solutions for complex, multi-dimensional problems by breaking them down into key parameters and mapping all possible variations

<sup>5</sup> prosumers equipped with battery storage

The technical design and governance of RECs also have an impactful role in determining their economic viability and internal stability. Cielo (2021) explains that optimal implementation of an EC requires multi-objective optimization methods that can size active assets accurately, specifically solar PV and battery storage systems (BESS), to maximize community self-sufficiency. Apart from operational considerations, there should be a mechanism to make everything fair. Fioriti (2021) highlights the importance of equitable revenue-sharing mechanisms and clearly defined exit clauses to ensure long-term stability. At the same time, it prevents the "agency problem"<sup>6</sup> that arises when the aggregator or Energy Service Company (ESCO) manages all community assets.

### 2.2.1.2 Peer-to-Peer (P2P) Trading and Local Energy Markets (LEM)

Energy Communities are commonly built based on ownership cooperation and collective self-consumption. However, other prosumer-centered archetypes are emerging in energy systems, commonly known as Local Energy Markets (LEMs) and Peer-to-Peer (P2P) trading. These mechanisms represent a fundamental shift away from conventional vertically integrated electricity markets by disintermediating the traditional utility-consumer relationship. In such systems, prosumers are no longer limited to exporting excess energy and flexibility services back to the distribution grid but can instead trade with one another.

Comprehensive systematic reviews by Chen and Zhao (2022) and Schwidtal (2023) identify P2P trading and energy sharing models as being the most important drivers of energy democratization. These models generate values by mitigating curtailment of variable renewable generation and reducing the need for capital-intensive grid reinforcements by improving overall system efficiency. Similarly, Facchinetti (2016) conceptualizes LEM business model patterns to explain how localized optimization can maximize independence over energy constraints while providing necessary financial incentives to prosumers who wish to disassociate themselves from conventional retail structures.

Building on these conceptual frameworks, scholars have employed simulation methods to assess the economic feasibility of decentralized markets. For example, Lovati (2020) used agent-based

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<sup>6</sup> The agency problem is a conflict of interest arising when an agent (e.g., manager) acts on behalf of a principal (e.g., shareholder), but prioritizes personal gain over the principal's interests.

modeling to simulate the complex financial and energy flows in P2P networks. The findings suggest that local trading increases PV self-consumption and reduces dependence on external subsidies, which ultimately provides more favorable electricity prices for individual building owners. Expanding upon the trading of energy, Bâra and Oprea (2025) introduce bottom-up business models that directly address Local Flexibility Markets (LFMs). Within these configurations, aggregators operate as intermediaries in the LEM by scheduling decentralized devices, such as smart appliances and electric vehicles, to reduce procurement costs for retailers while directly compensating prosumers who shift their consumption away from peak demand periods. Despite the techno-economic advantage of P2P trading, implementations of these open models face substantial structural hurdles (Montakhabi et al., 2022).

### 2.2.1.3 Distributed PV, Shared Solar, and Third-Party Ownership (TPO)

Although community cooperatives and local energy markets describe some of the most integrated forms of prosumerism<sup>7</sup>, Distributed Photovoltaic (DPV) commercialization formed the largest global driver of decentralized generation to date. The literature suggests that the diffusion of DPV is driven less by incremental technological innovation. Instead, it relies more on effective technology transfer and large-scale market disruption. This is especially important for overcoming high upfront capital costs and complex regulatory environments. Firms have successfully adapted the existing regulatory framework to create mainstream conditions for solar adoption through the pioneering Third-Party Ownership (TPO) and solar leasing models (Huijben et al., 2016). Under these arrangements, a commercial company installs, owns, and operates the PV system on the host's site, selling electricity or leasing back equipment from the consumer. This model literally removes the capex barrier. According to a literature review by Ahlgren Ode and Lagerstedt Wadin (2019), this mechanism has strong geographic portability as evidenced by the successful deployment of United States TPOs models into European Markets. Similarly, customized Power Purchase Agreements (PPAs) and leasing models have driven rapid scale-up in Thailand (Tongsopit et al., 2016) and demonstrated high economic viability in Brazil (Faria et al., 2024).

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<sup>7</sup> Prosumerism is the social and economic concept where individuals simultaneously act as producers and consumers, actively participating in the creation and use of goods, services, or energy.

TPO and shared solar business models are increasingly utilized not only for market expansion but also as a tool for advancing socio-economic equity. O’Shaughnessy (2020) shows that community solar finance, specifically third-party ownership (TPO) models, greatly enhances income equity in solar adoption by allowing low to moderate-income households to access clean energy without the upfront capital or prime credit scores. In addition, Pitt and Nolden (2020) explain that post-subsidy PV business models such as localized energy distribution schemes are intentionally designed for the purpose of addressing fuel poverty in multi-occupancy social housing. Another important dimension of shared solar systems lies in their organizational structure. Funkhouser (2015) provides an operational distinction between utility-sponsored community solar and Special Purpose Entities<sup>8</sup> (SPEs). They also define both structures as types of community-based solar systems that expand access to solar energy for renters and property owners with unsuitable rooftops.

However, the broader policy environment is evolving. Governments are gradually phasing out attractive Feed-in Tariffs (FiTs), which is placing pressure on the financial advantage of PV business models. Karneyeva and Wüstenhagen (2017) examine post-grid parity environments and find that the removal of subsidies shifts most of the investment risk onto the prosumer, thus requiring self-sustainable, market-based business models. Similarly, in the United Kingdom (UK), Brown (2019) observes that prosumers are now increasingly dependent on stacked value propositions based on smart meters, batteries, and EV integration to achieve economic viability in the post-PV subsidy era.

### 2.2.2 Flexibility & Aggregation Models

Flexibility and aggregation models combine distributed energy resources, such as solar panels, batteries, and flexible loads, into a single entity that can respond in real time to the grid's needs. By pooling these assets, such models contribute to power system stability, enhance the balance between supply and demand, and improve overall efficiency in dispatch and system management.

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<sup>8</sup> A Special Purpose Entity (SPE) is a legally separate company created to achieve a specific, narrow objective while isolating financial and legal risks from its parent company.

### 2.2.2.1 Aggregator and Virtual Power Plants (VPPs)

The increasing penetration of variable renewable energy is accelerating the development of aggregator business models that rely heavily on demand-side flexibility to maintain grid stability. Aggregators play a fundamental role as intermediaries connecting multiple small-scale distributed assets to wholesale electricity markets. Lu (2020) outlines the operational principles of these DR resource aggregators, demonstrating how they aggregate the flexibility of diverse consumers to provide balancing, capacity, and ancillary services. A prominent application of this concept is the aggregation of distributed loads into Virtual Power Plants (VPPs), where commercial and residential assets are pooled to function as a single coordinated entity (Ma et al., 2017). Similarly, Sisinni (2017) explains that these models can be scaled spatially and temporally, e.g., by aggregating entire blocks of buildings to access a significant amount of demand flexibility that was previously inaccessible.

These models have very different structural implementations depending on the regulatory environment. Burger and Luke (2017) identify distinct aggregator model archetypes, including independent market-based models that participate directly in wholesale markets and utility-based models that enable secure capacity for regulated entities. Across both archetypes, aggregators play an important role in integrating variable renewable power by deploying demand response (DR) contracts to overcome the uncertainty associated with wind and solar generation (Campaigne and Oren, 2016).

The economic feasibility of these aggregators and flexibility models depends on the interaction between advanced market mechanisms and well-defined business strategies. Value is primarily captured in these models through demand shifting in liberalized markets (Gordijn and Akkermans, 2007). However, in practice, aggregators often rely on timing-based strategies. Specialized timing-based business models are implemented to capture economic value, shifting consumption away from peak price periods toward times of abundant and lower-cost supply (Helms et al., 2016). To support the monetization of these complex value streams, Hamwi (2021) introduces the Demand Response Business Model Canvas, a strategic tool designed to map the multi-sided relationships required for effective flexibility provision.

### 2.2.2.2 EV Aggregation & Vehicle-to-Grid (V2G)

EV penetration in the transport sector has unlocked a new era of flexible business models that view Electric Vehicles not just as forms of transportation but as coordinated mobile battery storage units. Sovacool (2020) highlights the need for diverse stakeholders and complex innovation ecosystems to enable the commercialization of Vehicle-to-Grid (V2G) systems, emphasizing their transformative potential for grid management. At the heart of this transformation is the evolving role of Charge Point Operators (CPOs). Goncearuc (2022) explains how V2G technology enables flexible CPOs (charge point operators) to transition from passive infrastructure providers to active flexibility aggregators. These CPOs can extract high value from ancillary service markets by enabling bidirectional energy flows, especially through the provision of Frequency Containment Reserves for grid frequency stabilization (Goncearuc et al., 2023). However, advanced operational architecture is required to monetize these mobile assets. At the same time, a strong, smart charging framework is required to address the technical limitations of EV batteries (Afentoulis et al., 2022) while data-driven competitive bidding strategies are needed to enable EV aggregators to participate in day-ahead and real-time electricity markets (Chen et al., 2019).

The scalability and economic feasibility of these V2G models are highly dependent on pricing structures and geographic configurations. For example, commercial parking garages in dense urban areas are highly attractive aggregation points for V2G aggregators to pool significant amounts of energy from battery storage, as vehicles are often idle during peak working hours (Brandt et al., 2017). Despite these promising use cases, the profit margins for bidirectional charging models, including Vehicle-to-Home (V2H), Vehicle-to-Building (V2B), and V2G (collectively V2X), remain highly vulnerable to regulatory volatility and battery degradation costs (Dossow and Kern, 2022). Alternative ownership and operational structures have been explored to mitigate some of these capital and operational risks. Christensen (2012) examines the EV battery brokerage model (famously pioneered by Better Place<sup>9</sup>), which sought to disassociate battery ownership from vehicle ownership, enabling grid integration through battery swapping tactics. Although this model was not a commercial success, it

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<sup>9</sup> [Better Place was a venture-backed international company that developed and sold battery charging and battery switching services for electric cars.](#)

highlighted the continued need for business model innovation to unlock the grid-balancing potential of electric mobility fully.

### 2.2.2.3 Battery Energy Storage Systems (BESS) & Shared Storage

Despite significant technological advancements, the rapid deployment of Battery Energy Storage Systems (BESS) remains limited by high upfront capital costs. To achieve economic viability in this domain, Hamelink and Opdenakker (2019) emphasize business model innovation as one of the most important drivers of a company's performance in the energy storage sector. One key way to address these financial barriers is revenue stacking, in which storage operators create business models that can offer more than one grid service, like frequency regulation, peak shaving (reducing demand at peak times), and energy arbitrage from a single asset (Mir Mohammadi Kooshknow and Davis, 2018).

In Addition, Lombardi and Schwabe (2017) suggest considering sharing economy principles regarding BESS in order to improve the optimization of an asset dimensioning and profitability. This concept enables shared configurations in which centralized, utility-scale storage is partitioned into "virtual blocks" that can be leased to multiple decentralized prosumers/communities. Such arrangements reduce the need for costly behind-the-meter investments while improving asset utilization (Ben-Idris et al., 2021). The adaptation of these commercialization models is particularly important in developing markets, where storage plays an important role in balancing the rapid and variable expansion of solar and wind generation (Paul et al., 2021).

Beyond generic grid support, more specialized business models are emerging to facilitate the management of complex energy-intensive clusters and decentralized networks (Hargroves et al., 2023). For example, Shared Energy Storage (SES) models are optimized for Data Center Clusters where they address sophisticated trade-offs between energy arbitrage opportunities and battery degradation costs (Bian et al., 2024; Han et al., 2023).

### 2.2.3 Energy-as-a-Service (EaaS) and Servitization Models

The classic utility business model, based on the volumetric sale of electricity by the kWh, becomes increasingly incompatible with decentralized, highly flexible energy systems. At the same time, a

broader structural change is occurring in industry driven by servitization. In this emerging field, energy suppliers no longer derive value only from delivering standardized energy inputs, but increasingly from guaranteeing performance-based outcomes related to energy services and mobility.

### 2.2.3.1 Servitization and Multi-Commodity EaaS

This shift towards Energy-as-a-Service fundamentally reshapes the economic incentives for both power providers and consumers. Iria and Soares (2023) argue that traditional volumetric tariffs fail to provide the necessary compensation to prosumers for the flexibility they offer. They proposed an enhanced EaaS model in which aggregators offer prosumers free electricity in exchange for the right to centrally operate and access their existing distributed flexibility assets across multiple markets. This approach reflects a broader transition toward service-based value capture.

From a financial perspective, such models are increasingly attractive. Loock (2012) notes that the financial investor tends to favor more service-driven renewable business models than pure technology-driven or price-oriented models. Service-driven renewable business models have potential for more stable and diversified revenue streams.

At the operational level, this servitization is heavily driven by Energy Service Companies (ESCOs), which are continuously adapting to facilitate comprehensive low-emission transitions for large consumers (Sułek and Borowski, 2024). For example, Bolton and Hannon (2016) highlight how local municipal authorities can act as ESCOs to deploy sustainable district heating infrastructure.

In parallel, researchers also emphasize the importance of synthesized multi-commodity ecosystems integrating electricity, heating, and cooling (D'Souza et al., 2018). Advanced technological applications of this multi-vector servitization include the combined offer of solar photovoltaics with heating, cooling, and flexibility into Integrated Energy Services (Yu et al., 2022), commercialization of solar thermal HVAC-as-a-Service (Kalair et al., 2021), as well as techno-economic optimization of energy management contracts for solar-heat pump water heaters (Li et al., 2022).

### 2.2.3.2 Smart Mobility as a Service (eMaaS)

The electrification of the transport sector has given rise to a new category of Energy-as-a-Service (EaaS) focusing on smart, outcome-oriented mobility solutions. Anthony (2023) and Anthony (2021) state this concept within the context of smart, where data-enabled digital systems facilitate Electric Mobility-as-a-Service (eMaaS). In such ecosystems, dispersed charging infrastructure is transformed into integrated, value-added smart grid services. To ensure the long-term commercial viability, Sabyasachi (2024) proposes a generic business model framework that integrates Charge Point Operators (CPOs) and e-mobility Services Providers (EMSPs) within an integrated charging ecosystem.

In parallel, Specialized mobility models are emerging to fill gaps in physical infrastructure. This range from decentralized, solar power-based EV charging stations developed specifically to bypass grid constraints (Robinson et al., 2014) to advanced optimization models for leasing truck-mounted mobile charging stations, which utilize energy arbitrage during idle periods to maximize operator profitability (He et al., 2025).

The eMaaS archetype also generates value beyond private vehicle ownership, through shared and autonomous architectures. For example, the introduction of EV carsharing and car clubs (Nieuwenhuis, 2018), autonomous shuttle mobility services (Kim and Yang, 2021), and the considerable business model innovations faced by Logistics Service Providers shifting towards electrified road freight transport on battery-electric vehicles (Gillström et al., 2024).

### 2.2.4 Digital Platform and Data-Driven Models

The growing decentralization of the energy grid demands an optimized level of data processing and orchestration, which makes digital platforms and technology-enabled models the central players for modern energy business models. This archetype supports the development of a mature smart grid, which enables new monetization opportunities by transforming passive consumers into data-enabled prosumers (Rodrigues et al., 2025). This digital transformation is largely driven by the Internet of Things (IoT). For Example, Paukstadt and Becke (2021) conceptualize core IoT technologies like sensors and data analytics as foundational enablers for developing smart energy business models. Similarly, Chasin (2020) classifies eight unique smart-energy Internet-of-Things (IoT) archetypes.

With these IoT architectures in practice, Distributed Energy IoT frameworks can be deployed that allow the aggregation and management of real-time virtual prosumer networks (Park et al., 2021).

Advanced analytics further reduce transaction costs, enabling personalized, data-driven domestic energy services (Aranda et al., 2023). At a system-wide scale, the increasing volume of data necessitates centralized Energy Data Hubs that facilitate smart tariffs and reduce market entry barriers (Küfeoğlu and Üçler, 2021). Moreover, data itself has emerged as a highly monetizable asset, which can be utilized through advanced renewable energy forecasting in wholesale markets (Bessa et al., 2022).

Beyond asset monitoring, smart tools and digital ICT also enable participation in energy markets, e.g., ICT-based renewable energy trading (Gunarathna et al., 2022). These Multi-Sided Platforms (MSPs) enable automated trading of flexibility between prosumers, aggregators, and system operators (Lynch et al., 2017). Researchers also stated that using ICT-enabled technologies, e.g., blockchain-enabled P2P trading and the use of smart contracts, eliminates the need for traditional intermediaries, thereby lowering costs for consumers and prosumers (Leelasantitham, 2020).

On the other hand, these increasingly complex digital ecosystems require more sophisticated frameworks and coherent ontologies capable of facilitating the automatic evaluation, coordination, and optimization of energy business models over such environments.

### 2.3 Summarizing Case Studies and Regional Examples

The previous sections review various concepts at the archetype level, while the literature on energy system business models synthesizes many distinct, generally non-cohesive configurations of a business model. Literature on business models tends to focus on specific technologies (e.g., PV, storage) or market mechanisms (e.g., demand response), resulting in multiple overlapping business model types based on the roles of actors involved (ESCOs, aggregators).

To avoid confusion and provide a clearer overview, Table 1 summarizes some selected cases and examples of business models identified throughout the literature. The table categorizes these

models based on their core value propositions, key actors, revenue streams, and main influencing factors. Table 1 offers a comparative framework that also complements the higher-level archetype classification developed in this study.

Energy system business models differ significantly in terms of value creation, value delivery, and value capture as indicated in Table 1. Although models like demand response and aggregation are more oriented towards grid balancing and flexibility provision, others, such as distributed PV and community-based models, place a greater emphasis on decentralized ownership and local value creation. On the other hand, service-oriented and financial models utilize performance-based agreements and return on investment.

Across these diverse configurations, the viability and scalability of business models are largely determined by regulatory frameworks and policy incentives that emerge across configurations. This illustrates the close interplay between market design, policy environments, and business model innovation in achieving transitions to carbon-neutral energy systems.

## PEAK – WP3 Business models

Business Model Archetype	Core Value Proposition/Service	Key Actors/Customers	Primary Revenue Streams	Key Influencing Factors	Relevant Regions /Examples
Market-based DR	Grid balancing, Capacity/ Reserve	C/I/M customers	Brokerage fees, Subscription fees	Restructured markets, Bid-size rules	North America
Utility-based DR	Grid balancing, Capacity/ Reserve	Residential, C/I/M customers	Subscription fees, Brokerage fees	Regulated markets, Regulatory compulsion	North America, Europe
EMS Providers	On-site energy optimization	C/I/M, Industrial customers	Shared savings, Software subscriptions	Local energy needs, Self-provision enablement	Global
Energy Storage for Network Services	Grid stability, Network constraint mitigation	Utilities, System operators	Asset sales/financing, Service sales	Legislative mandates (e.g., AB 2514)	California, Europe
Energy Storage End-User Optimization	Bill management, Backup power, Self-consumption	Residential, C/I/M customers	Asset sales/financing, Shared savings	Solar PV profitability, Demand charges, Cost declines	Global
Energy Storage Co-optimization	End-user cost reduction, Market participation	C/I/M, Industrial customers	Asset sales, Brokerage fees, Shared savings	Market integration regulations, Aggregation rules	Europe, New York
Solar-plus-Storage Co-optimization	Firm solar, Virtual Power Plants	Residential, C/I/M, Industrial customers	Asset sales/financing, Market brokerage	Market integration regulations for DERs	Global
Distributed PV Finance & Installation	Capital cost reduction, Energy provision	Residential, C/I/M, Industrial customers	Direct ownership, Leases, PPAs	Policy incentives (e.g., ITC, FIT, Net-metering)	U.S., Europe
Utility-scale PV Finance & Install	Large-scale energy provision	Industrial, utility customers	Market sales, PPAs, and REC sales	Renewable portfolio standards	Global
Community Solar Providers	Solar access for unsuitable sites	Consumers, Utilities	Brokerage fees, Equity stakes	Policy-friendly environments,	U.S., Europe
Energy Service Companies (ESCOs)	Enhanced building energy performance	Public/Private organizations	Incentives, Service fees	Energy performance contracts (EPCs)	Global
Energy Cooperatives	Participatory energy generation, Community benefits	Community members	Member fees, Energy sales	Participatory governance, Distributive justice	Europe

Table 1: Key International Business Model Archetypes

## 2.4 Benchmarking

While previous sections focus on theoretical classification, this section provides an empirical classification of energy system business models. However, it is equally important to examine their real-world implementation. Therefore, Table 2 presents a benchmarking analysis of selected real-world flexibility platforms and energy marketplaces. Table 2 also compares their key functions, operating methods, and geographical coverage. This benchmarking analysis aims to bridge the gap between theoretical business model archetypes and their practical applicability in modern energy systems.











Platform / Marketplace	Country / Region of Operation	Key Functions	Operation Mechanism
Next Kraftwerke 	Europe (Germany, Belgium, France, Austria, etc.)	Aggregation of distributed generation & industrial DSM	Assets connect via control units/interfaces; central software forecasts, dispatches, and bids into markets
Fortum 	Finland, the Nordic region, parts of Europe	Aggregation of flexible assets (batteries, loads) for grid services & markets	Connects flexible assets to its platform; optimizes and dispatches flexibility to markets and ancillary services
NODES 	Nordic & European markets	Marketplace for flexibility matching system operators and flexibility service providers	DSOs/TSOs post flexibility needs; providers bid; platform supports reservation & activation steps
GOPACS 	Netherlands	Congestion management / redispatch solution using flexibility	Combines flex bids from different trading platforms into a virtual order book; matches to congestion needs
Piclo Flex 	UK and international	Marketplace to procure flexibility from DERs / flexibility providers	Providers register assets, bid; DSOs publish needs; matching, settlement, dispatch via platform; API integration
Tiko 	Switzerland (primarily)	Aggregation of residential/small-scale flexibility	Controls devices/loads to respond to grid signals; aggregates into flexibility offers
Electron 	UK	Asset registry and coordination platform for flexibility	Maintains registry of participating assets; coordinates among grid actors, facilitates flexibility offers
EPEX SPOT 	Europe (multiple countries)	Electricity market operator (day-ahead, intraday)	Market exchange: matching supply & demand, clearing transactions
Statkraft 	Norway + European operations	Flexibility / VPP / optimization of generation & storage	Operates generation, storage, and flexible assets; optimizes them across markets
Sympower 	Europe (multiple markets)	Demand response & balancing/flexibility services	Interfaces with client assets; controls & bids flexibility into balancing/grid markets

Table 2: Benchmarking of Selected Energy Flexibility Platforms and Marketplaces

### 3 Sketching of business models

After completing T3.1, the next task, T3.2, of this study was to identify and shortlist the findings of the literature review to propose potential business models that are relevant to the regional context of the PEAK Project. The purpose of this task was to translate the technical findings of Work Packages 1 and 2, along with the background study (T3.1), into business-oriented concepts to support the development of a flexible and resilient energy system in Ostrobothnia. This task was divided into two main subtasks, T3.2.1 and T3.2.2. First, T3.2.1 was mainly to draft business models based on earlier project results. Second, T3.2.2 was to present the identified business models to relevant stakeholders at a workshop or event. After evaluating the potential of each proposed business model, the model perceived as most relevant and realistically implementable was then selected for further development.

#### 3.1 Analytical basis for business model sketching

According to the results of T3.1, no single business model can be applied directly in the local context of the PEAK project without adaptation. So, T3.2 was planned to be executed to outline and compare different business model options that appear most suitable for further development in the Ostrobothnia region. The review findings showed that business model suitability depends on several factors, such as local regulation, network conditions, actor capabilities, and the availability of distributed energy and flexible resources. The findings also highlighted that aggregators and technology-enabled digital platforms are becoming central enablers of local flexibility. While community-based models often have high social acceptance, they usually face financing and scaling challenges.

The sketching of business models was also aligned with the empirical results of WP1, which mapped the regional energy growth potential of the Ostrobothnia region under the ESSE Elektro-Kraft distribution network. For example, WP1 T1.1 report identified five wind power projects in the planning stage with a combined capacity of 693 MW, as well as two photovoltaic projects in Kauhava expected to add 170 MW by 2028. These findings indicated that regional transition is likely to involve a more decentralized asset base in the network. At the same time, T1.2 report showed that the local electricity network already contains meaningful flexibility potential in customer groups such as

residential heating, retail, farming, and public institutions. Battery storage was further identified as a relevant option for peak shaving, voltage support, and improved hosting capacity. T1.3 demonstrated through the techno-economic analysis that energy storage can create value through local flexibility provision and participation in the reserve market. Based on these findings, potential business models were selected that focused on the aggregation and commercialization of local flexibility resources.

### 3.2 Preliminary business model sketches

Three preliminary business model sketches were selected for closer consideration. Each model helps leverage the regions' existing assets, WP2 identified opportunities, and WP1-listed flexibility potential. These three models were also selected because they envision complementary approaches to promote market-based flexibility, improve community-based coordination, and enable technology-driven integration. The proposed models are shown in Table 3.

- Flexibility Aggregation / Virtual Power Plant (VPP)
- Local Energy Communities & Peer-to-Peer (P2P) Energy Model
- EV & Storage integration model (BESS + V2G services)

Proposed Business Model	Core Components	Main Functions / Value Creation
<b>Flexibility Aggregation / Virtual Power Plant (VPP)</b>	Demand Response (DR), Distributed Energy Resources (DERs), Energy Storage Systems (ESS), EV flexibility, digital aggregation platforms	Aggregates distributed assets to participate in flexibility and balancing markets. Optimizes demand–supply in real time, reduces grid congestion, and enables new revenue streams from ancillary services.
<b>Local Energy Communities &amp; Peer-to-Peer (P2P) Energy Model</b>	Shared renewable generation (PV, wind), local microgrids, smart metering, peer-to-peer trading platforms	Enables collective ownership and local energy exchange. Maximizes self-consumption, improves energy resilience, and reduces dependence on centralized systems while empowering consumers as “prosumers.”
<b>EV &amp; Storage Integration Model</b>	Battery Energy Storage Systems (BESS), EV smart charging, Vehicle-to-Grid (V2G), energy management systems	Integrates transport and power sectors by using EVs and storage as flexible grid assets. Supports peak shaving, load shifting, and long-term grid stability while enabling new service-based revenue models.

Table 3 Proposed Business Model

### 3.2.1 Aggregator / Virtual Power Plant (VPP) Model

The Aggregator/Virtual Power Plant (VPP) model emerges as a promising approach for smart energy systems, unlocking the full value of distributed flexible resources. These models operate within the broader flexibility value chain, which defines how distributed resources are aggregated and monetized. To understand these models, the flexibility value chain dynamics must be understood, including how decentralized assets such as electric vehicles, battery energy storage systems (BESS), and demand response (DR) connect to various energy markets and grid stakeholders.

#### 3.2.1.1 Flexibility value chain

The flexibility value chain (FVC) provides conceptual information on how flexibility is generated, aggregated, traded, and monetized across the electricity system. According to the USEF White paper: Flexibility Value Chain (2018) framework, flexibility originates at the prosumer level (e.g., households, commercial users, etc.) that consume, generate, and store electricity. Their flexible assets (e.g., smart appliances, EVs, heat pumps) are the fuel for the flexibility value chain. Other key roles in this value chain include aggregators (BRP, BSP), energy producers, and System operators (DSO & TSO). Two pathways of flexibility valorization are shown in Figures 1 and 2, respectively.

- **Implicit flexibility:** responding to price signals (e.g., time-of-use tariffs).
- **Explicit flexibility:** direct trade energy in the ancillary service market via an aggregator.

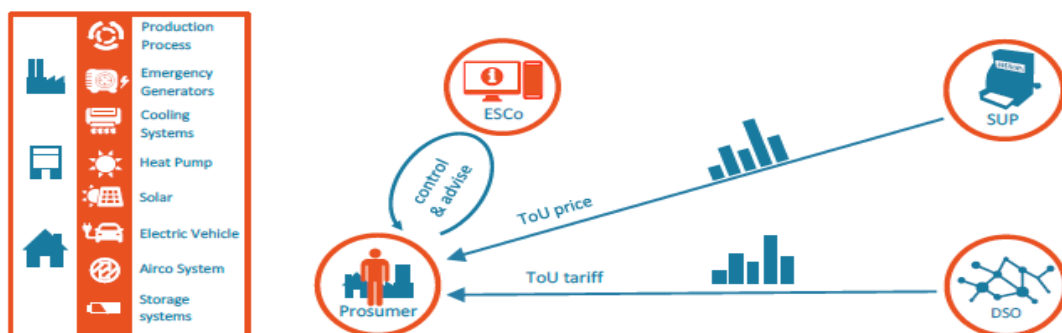


Figure 2: USEF Flexibility Value Chain for implicit demand-side flexibility<sup>10</sup>

<sup>10</sup> [USEF: The Flexibility value chain Framework for implicit demand side flexibility - Update 2021](#)

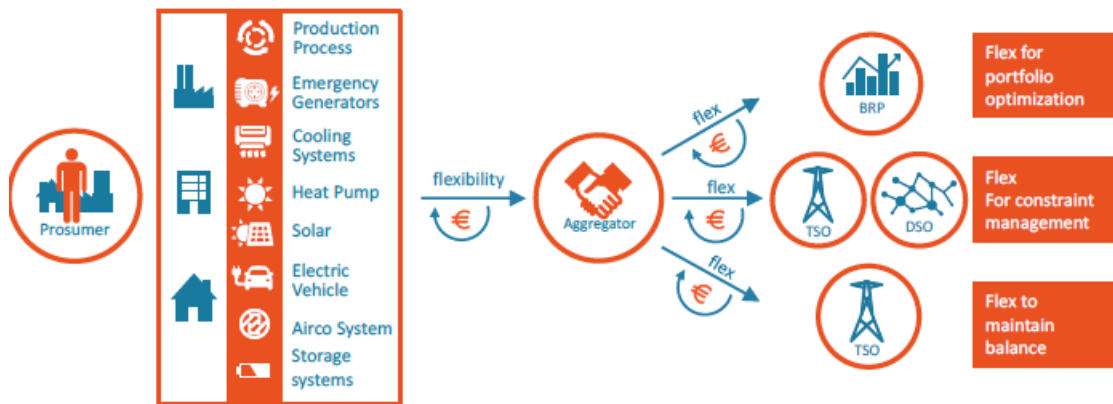


Figure 3: USEF Flexibility Value Chain for explicit demand-side flexibility<sup>11</sup>

The Aggregator (Flexibility Service Provider, FSP) is a key component of the Flexibility Value Chain (FVC). The Aggregator acts as an intermediary market player between Active Customers (Prosumers) and Flexibility Requesting Parties (BRP, DSO, TSO). One of the Aggregator’s key tasks is to acquire flexibility from Prosumers. This flexibility includes adjustments to electricity consumption and production. The Aggregator then aggregates this flexibility into a portfolio and develops services based on it. These services are offered to different market parties according to their operational roles, e.g., Balancing Service Provider (BSP), Congestion Management Service Provider (CMSP), and Commercial Service Provider (CSP), as shown in Figure 4.

This benefits the system operator by maintaining stability, managing network constraints, and balancing supply and demand in the electricity network. For performing these services, the aggregator earns financial value, which is partly transferred to Active Customers. As part of the incentive, customers are encouraged to change their behavior regarding their consumption or production of electricity.

<sup>11</sup> [USEF: The Flexibility value chain Framework for explicit demand side flexibility - Update 2021](#)

As previously highlighted, explicit demand-side flexibility is usually managed by an aggregator, while implicit demand-side flexibility is managed by an energy service company (ESCo). Both roles can be performed by the same entity or by a separate entity, depending on the market arrangements. However, Certain regulatory and operational restrictions are imposed if there is a conflict of interest.

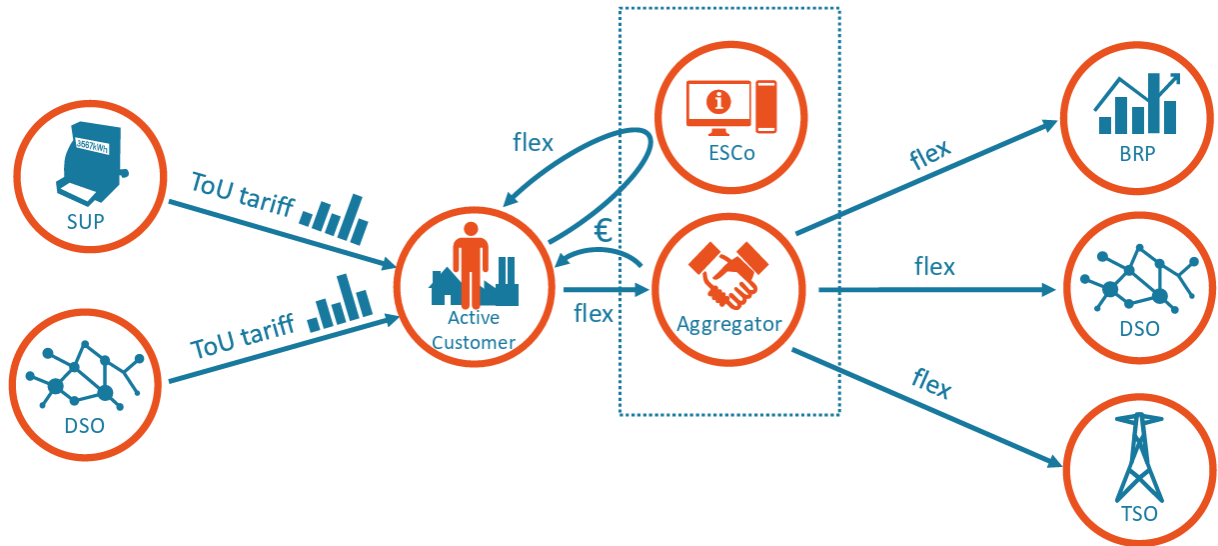


Figure 4: USEF Role of Aggregator: Combination of implicit and explicit Distributed Flexibility<sup>12</sup>

The flexibility value chain comprises explicit services delivered by an aggregator to different market parties and implicit services provided to prosumers through an ESCo. Implicit services focus on local optimization, such as shifting electricity use to cheaper times (Time-of-Use), balancing self-generated energy, reducing peak demand, and providing backup power. These services mainly help customers lower costs and improve energy efficiency, as shown in Figure 5.

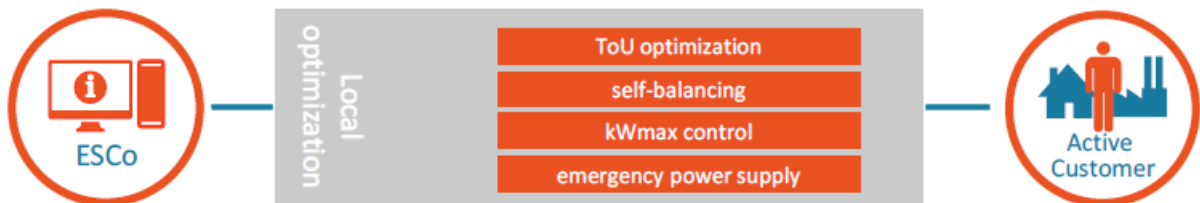


Figure 5: USEF Implicit Distributed Flexibility (DF) services<sup>13</sup>

<sup>12</sup> [Combination of implicit and explicit Distributed Flexibility – USEF framework Updated 2021](#)

<sup>13</sup> [Implicit Distributed Flexibility \(DF\) services – USEF framework Updated 2021.](#)

However, the explicit flexibility services are managed by the Aggregator. These services are grouped into four main categories: wholesale services (reducing energy costs and balancing supply and demand), constraint management (supporting grid stability and avoiding overload), balancing services (maintaining system frequency), and adequacy services (ensuring enough long-term electricity supply), as shown in Figure 6.

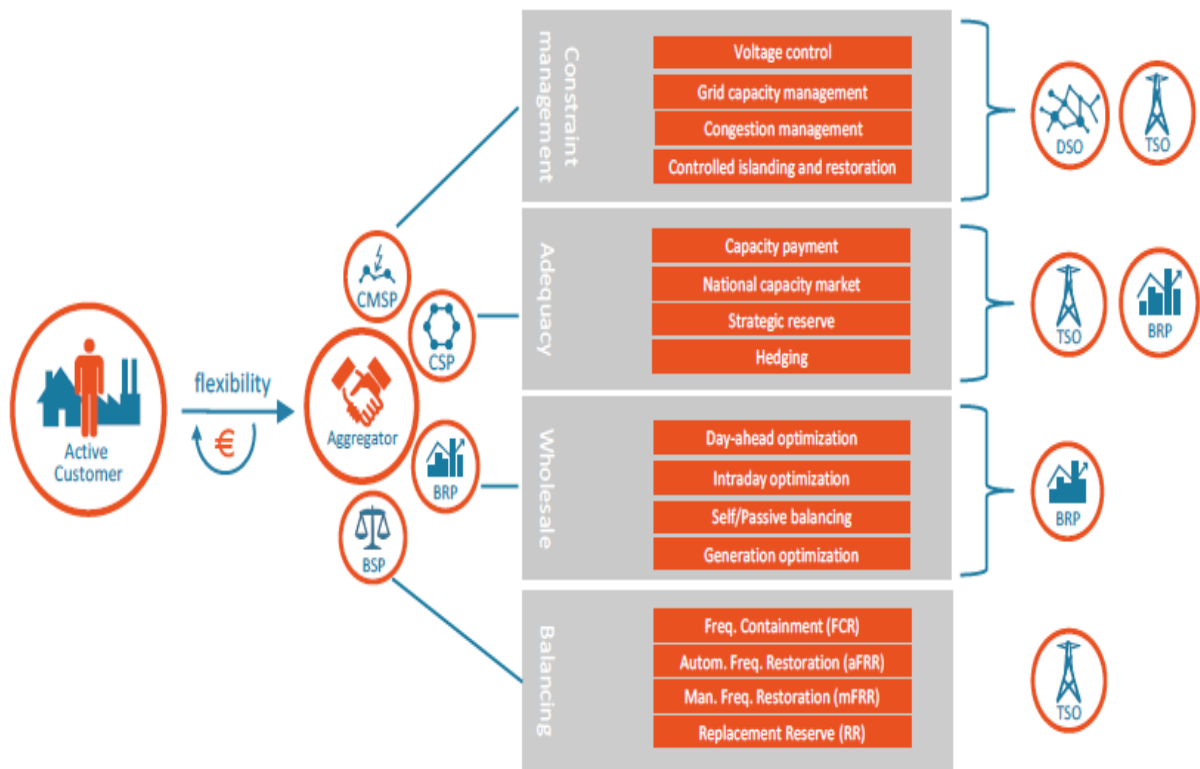


Figure 6: USEF Explicit Distributed Flexibility (DF) services<sup>14</sup>

### 3.2.1.2 Aggregator Business Model

Aggregating business models are mainly classified into two types:

- combined-role aggregators
- independent aggregators.

<sup>14</sup> [Explicit Distributed Flexibility \(DF\) services – USEF framework Updated 2021.](#)

In combined-role aggregation models, the aggregator is usually involved in other activities in the energy market. In contrast, in independent-role aggregation models, aggregators operate independently of other players in the electricity market, such as suppliers and BRPs, as shown in Figure 7.

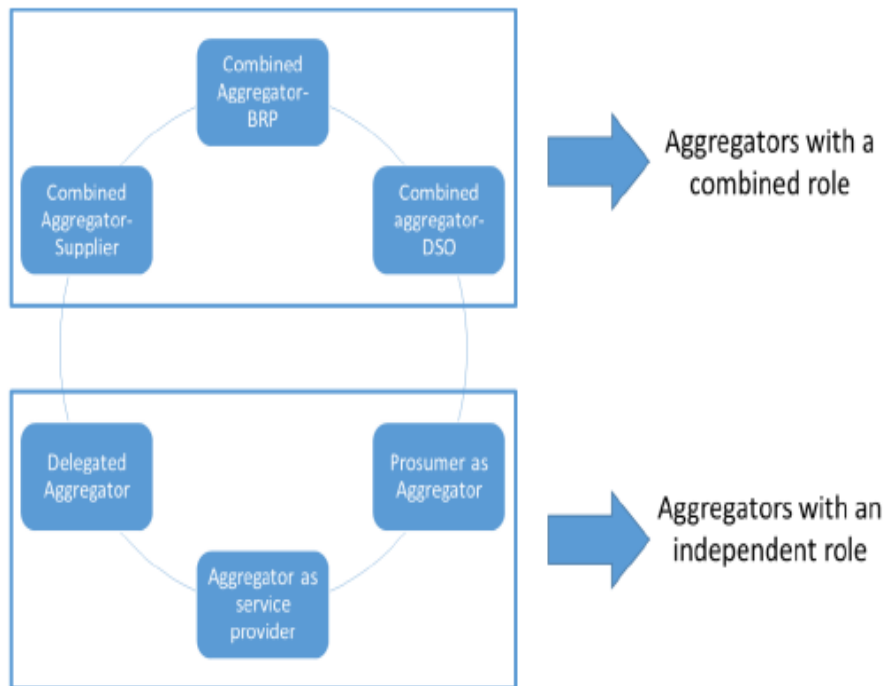


Figure 7: Aggregator business models<sup>15</sup>

Combined-role aggregator business models are further classified into three types. The first type is the aggregator–supplier business model, characterized by the same organization acting as both an electricity supplier and an aggregator. Supply and aggregation services are combined, resulting in only one BRP per connection point. The second type is the aggregator–BRP business model, in which the aggregator serves as the Balance Responsible Party, while the supplier continues to provide electricity. Therefore, in this model, two BRPs are present at the same connection point, for example, one for the supplier and another for the aggregator. Finally, there is a third type known as the

<sup>15</sup> [Aggregator business models – BestRES 2016](#)

aggregator–DSO business model, which is generally complex since it combines regulated and non-regulated roles as shown in Figure 8.

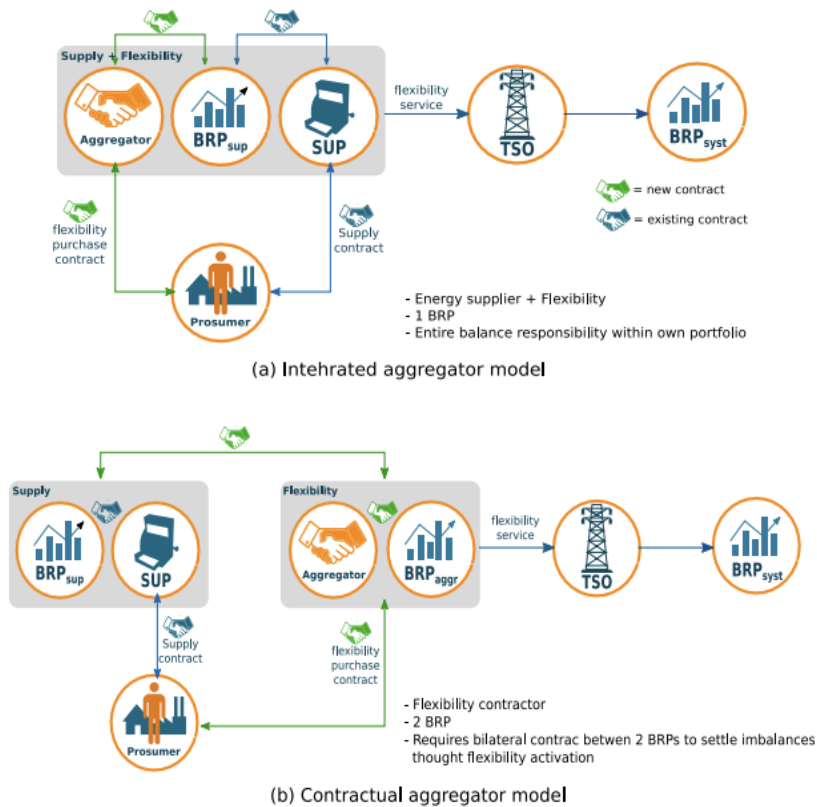


Figure 8: Aggregator with a Combined Role (López et al., 2024)

In the case of independent aggregators, the aggregator functions separately from suppliers and BRPs. There are three types of independent aggregators. The first is the independent aggregator acting as a service provider, without any responsibility function, as it offers services to other market players without taking on balancing or financial risks. The second type is the delegated aggregator, where all responsibility lies with the aggregator, as it operates independently and sells services to other market participants at its own risk. The third type is the prosumer-as-aggregator, where the consumer or prosumer manages their own resources, as shown in Figure 9.

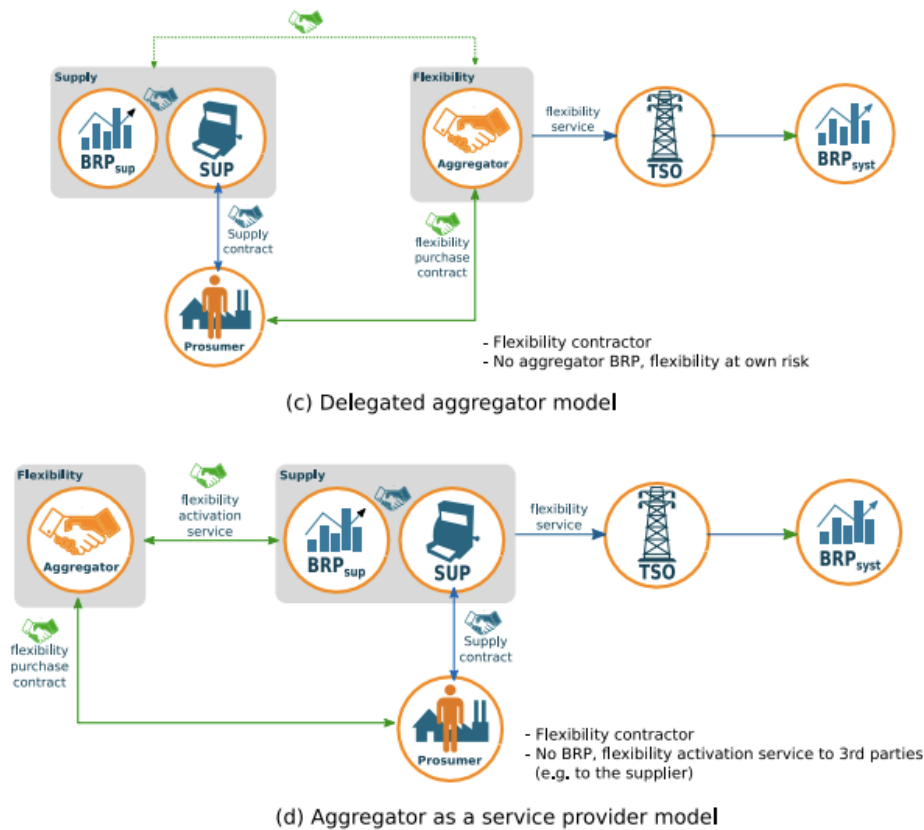


Figure 9: Aggregator with an Independent Role (López et al., 2024)

### 3.2.1.3 Virtual Power Plant Business Model

The concept of a virtual power plant is to aggregate all renewable energy resources, networked through remote control units via digital platforms, to provide grid services. Like an aggregator business model, a VPP does not require the DER to be connected to the same network; it generates electricity from a single centralized plant. VPP operators pool small-scale assets owned by residential, commercial, and industrial consumers. VPP clusters them all and manages them as a unified resource with the help of digital smart infrastructure. This aggregation enables VPPs to participate in energy markets by offering multiple services, e.g., reserve, capacity, or ancillary services, which, in turn, is favorable for both grid operators and participating customers.

Revenues are usually generated from payments by utilities for services that include grid stabilization, reduction of peak load, and provision of stored energy to wholesale market operators or utilities. The VPP model is unique in that a considerable proportion of expenses goes toward encouraging

## PEAK – WP3 Business models

consumer involvement rather than constructing large-scale physical infrastructure. Users get paid for controlling their energy consumption, eliminating the need to install expensive peaking power stations and grid connections.

From an operational perspective, the VPP model is supported by digital platforms that enable real-time communication, forecasting, and optimization of distributed assets. VPP operators employ data analytics techniques to forecast energy demand and control DER deployment. Some VPPs focus on participating in utility retail programs, while others opt for the wholesale electricity markets. VPPs operating in different regions have different levels of market involvement depending on the region's regulatory framework, as shown in Figure 10.

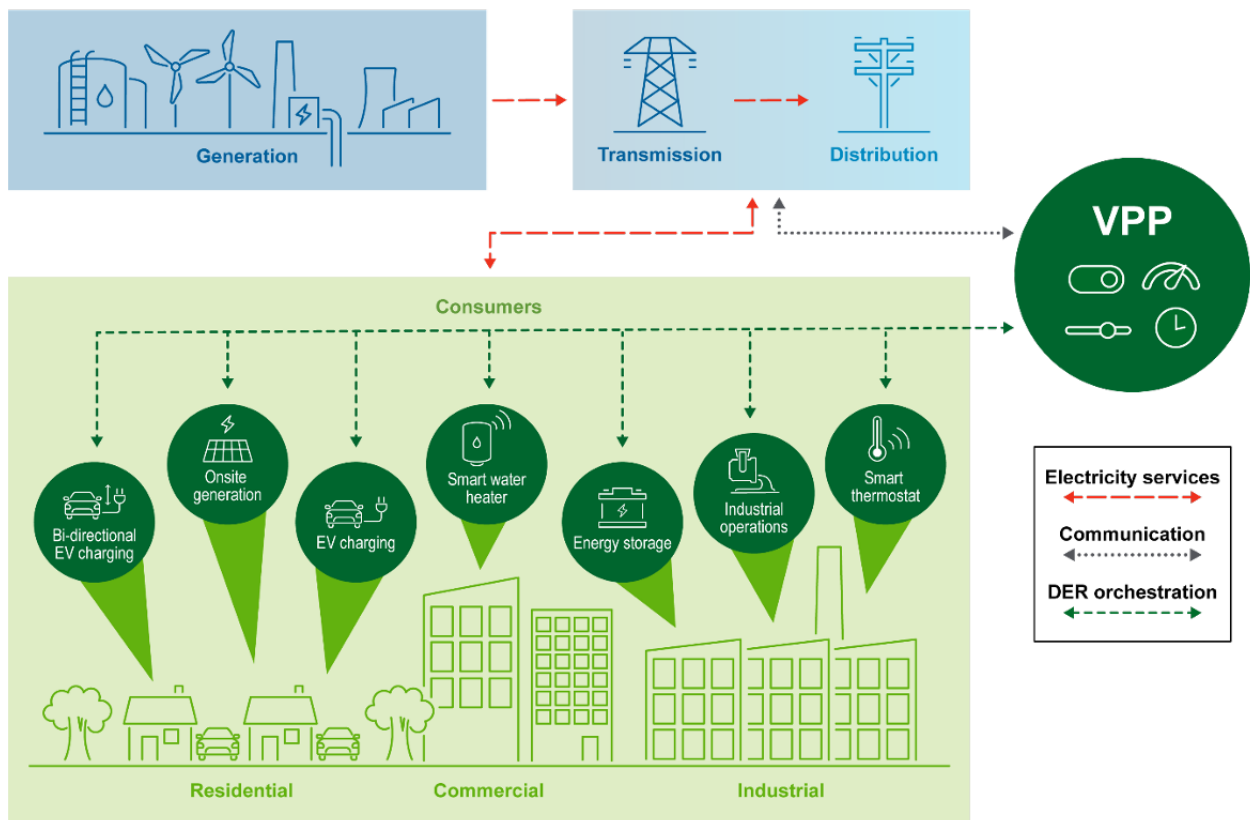


Figure 10: Virtual power plant VPP<sup>16</sup>

<sup>16</sup> [Pathways to Commercial Liftoff: Virtual Power Plants](#)

### 3.2.2 Local Energy Communities & Peer-to-Peer (P2P) Energy Model

The Local Energy Communities (LEC) or Peer-to-Peer (P2P) energy trading model has been identified in recent literature as a distinct socio-technical business model with high social acceptance. It is seen as the opposite of purely market-based business models, such as the aggregation model. It also differs from the VPP model, whose primary business objective is to participate in various energy markets and therefore monetize the flexibility provided by Distributed Energy Resources (DERs). Energy communities focus on local ownership of energy assets and on improving them for local purposes. Energy communities are explicitly backed by the European Union's Clean Energy Package, especially by RED II (Renewable Energy Directive). Renewable Energy Communities (RECs) and Citizen Energy Communities (CECs) are also recognized as new market participants by the European Union's Clean Energy Package. These models facilitate energy consumers to participate in the system as energy producers and asset owners.

#### 3.2.2.1 Concept of Local Energy Communities

Local Energy communities comprise small household users, small companies, local government, or public actors. They collaboratively invest, generate, consume, and distribute local energy resources. These communities are usually built around a jointly owned renewable power source such as a solar PV system, wind turbines, or battery storage.

The main objective of energy communities is to:

- Maximize local self-consumption of renewable energy
- Reduce dependency on centralized energy markets
- Enhance energy resilience and security at the local level
- Promote social acceptance and participation in the energy transition

Energy communities models also contribute to decentralizing the energy system, which further helps to improve the grid hosting capacity and minimize the grid load. These Community-led business models are mostly centered on energy sharing and microgrid management rather than focusing on financial earnings and profits. The main focus of these business model implementations is to reduce energy cost and improve grid reliability.

### 3.2.2.2 Energy Communities Business Model

There are multiple types of energy community business models (ECBM) in Europe. Each has its own Ownership structure, operational objectives, and actor roles. According to Reis (2021), eight common types are listed below:

- **Energy cooperatives** – citizen-owned, democratic
- **Community prosumerism** – produce & consume
- **Local energy markets** – peer-to-peer trading
- **Community collective generation** – shared solar assets
- **Third-party-sponsored communities** – externally funded
- **Community flexibility aggregation** – pooled flexibility
- **Community ESCO** – efficiency services
- **E-mobility cooperatives** – electric transport

Energy Cooperative is a highly relevant LEC business model type from a Finnish regional perspective, as shown in Figure 11. At the same time, the Community collective generation and Community flexibility aggregation will soon be the most promising ones in the coming years.

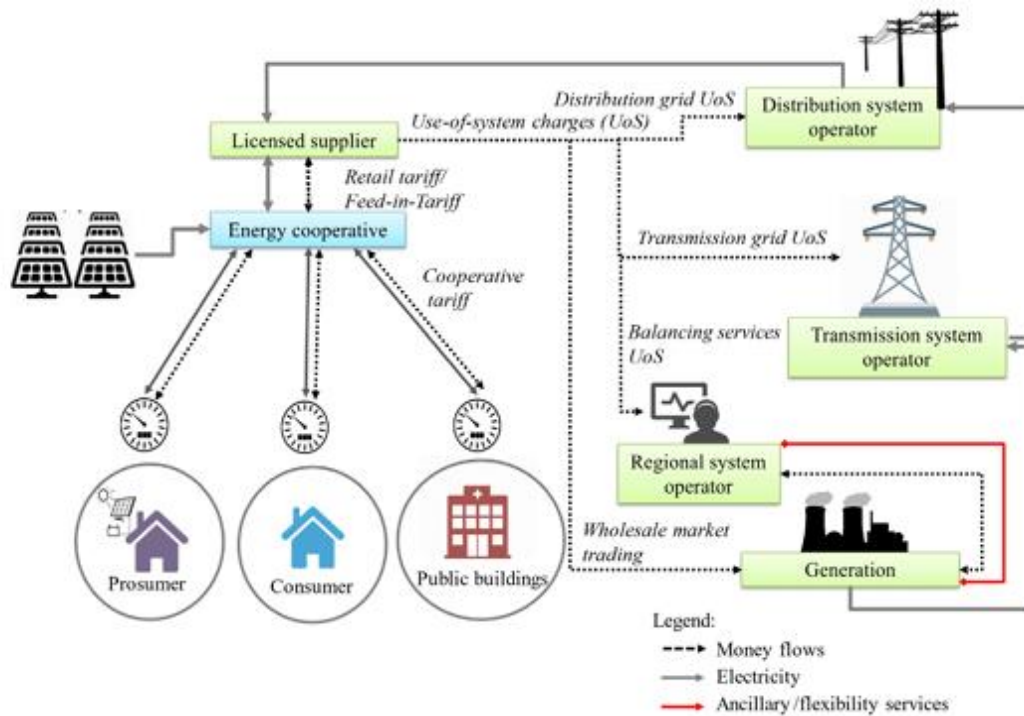


Figure 11: Energy cooperatives business model(F.G. Reis et al., 2021)

### 3.2.2.3 Peer-to-Peer (P2P) Energy Model

Although Peer-to-Peer (P2P) energy trading falls under the energy communities model, it is a distinct mechanism that enables participants to build a self-integrated energy network infrastructure. The main focus of this prosumer-led collaboration business model is to improve self-sufficiency and reduce dependency on energy trading with external entities. The model allows participants to construct their energy infrastructure, enabling direct electricity exchange among themselves, rather than selling surplus electricity back to the grid at wholesale or retail prices through net metering. Prosumers can easily trade energy locally with other participants, e.g., neighbors.

P2P trading relies on:

- Digital platforms for matching supply and demand
- Smart metering infrastructure for accurate measurement and settlement
- Automated pricing mechanisms (fixed, retail, or market-based)

- Licensed Supplier
- Advanced ICT

This model enables the efficient use of locally produced renewable energy, e.g., community solar PV, thereby increasing economic benefits for prosumers. It also provides greater transparency and control for community representatives over their own energy consumption, as shown in Figure 12. However, in practice, fully open P2P trading is constrained by strict regulatory frameworks. So, energy sharing is only permitted through virtual sharing models or with the same distribution network system operators through net metering.

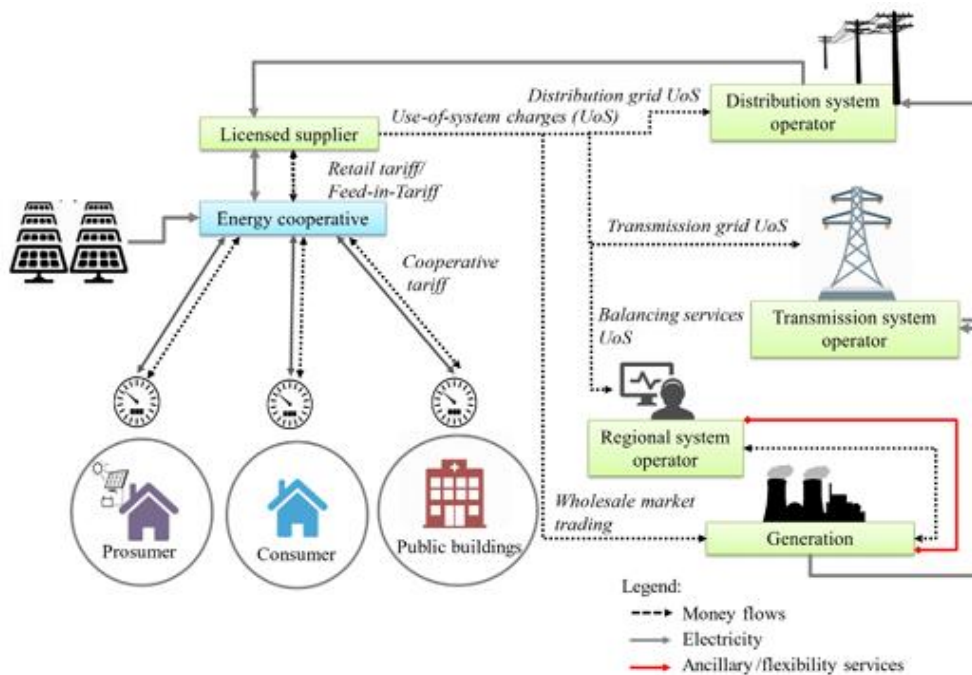


Figure 12: Community LEM based on P2P trading(F.G. Reis et al., 2021)

### 3.2.3 EV & Storage integration model (BESS + V2G services)

The EV & Storage Integration Model can be described as the technology-led model that emphasizes the integration of Electric vehicles (EV) and energy storage solutions (e.g., BESS) within the electricity network. These models become one of the major facilitators of sector coupling through combining the electricity and mobility sectors.

Unlike Aggregator/VPP and Energy Community models, which focus on markets and community initiatives, respectively, the EV and Storage-integrated model is based on infrastructure and flexibility services provided by controllable assets, such as Battery Energy Storage Systems (BESS) and electric vehicles (EVs). There is an increased emphasis on carbon neutrality and zero emissions across European countries, and the electrification of transport and the integration of storage systems are now seen as flexible energy sources. The proposed model is also consistent with the sustainability goals of Europe and Finland concerning energy transition, in which higher penetration of renewable energy requires more flexible sources to balance the electricity system. This can be provided by electric vehicles and storage at both local and system levels.

### 3.2.3.1 Concept of EV & Storage Integration

EV & Storage integrated models are considered mostly effective solutions for supporting grid stability. These distributed storage assets (EV batteries and BESS) can easily store energy as backup and dispatch it back at the desired time. These assets enable:

- Optimal energy storage and consumption
- Load shifting and peak shaving
- Ancillary services like frequency control

The operation capability lies in the coordinated control and optimization of these assets through a digital energy management system and smart charging infrastructure. Their effectiveness depends on forecasting and automated control mechanisms. EVs have intelligent charging features that charge the vehicle battery for mobility services, but if advanced infrastructure implementations are employed at some sites, e.g., Vehicle-to-Grid (V2G). Then, at the idle state or desired time, EV batteries can also supply energy back to the grid.

On the other hand, BESS systems are usually installed at various sites across the electricity generation and distribution network, e.g., residential, commercial, and industrial sites, depending on the need. BESS can also be installed at specific nodes of the distribution network, from which it can provide services to improve grid efficiency and reliability.

### 3.2.3.2 Energy Storage Business Models

The energy storage systems have a significant function in enhancing flexibility and resilience in energy systems, as they both use and produce electrical power. This characteristic of being able to produce and utilize electricity allows energy storage systems to be considered as one of the most valuable assets within the electricity chain by providing added value at different stages in the value chain.

From a system perspective, energy storage applications are typically categorized based on their position within the electricity value chain, as shown in Figure 13.

- Front-of-the-Meter (FTM), when located in a transmission/distribution network and providing services on the system level
- Behind-the-Meter (BTM), located at the consumer site, to optimize costs

Energy storage systems play multiple roles within the electrical power system. At the system level (FTM), their services include ancillary services such as frequency control, voltage support, and system recovery to improve grid reliability. In addition, they play the role of providing capacity and flexibility services, namely peak load reduction, peak load shifting, and resource adequacy, that assist in the supply-demand balance. At the system and customer levels (FTM and BTM), energy storage systems provide market services, such as energy arbitrage, in which electricity is purchased when prices are low and then resold when prices are high. At the customer level (BTM), energy storage systems offer services such as backup power, improved self-consumption of local renewable energy resources, and reduced demand peaks.

Economic feasibility for energy storage business models depends on three core value streams. The first one is cost savings. This can involve lowering costs through peak shaving or energy efficiency. The second is deferred investment. In this case, energy storage systems delay or even avoid expensive investments in electricity transmission lines and transformers. The third is energy arbitrage. Here, businesses earn money from differences in energy prices between times or locations. However, energy storage systems may employ a combination of all three approaches at once.

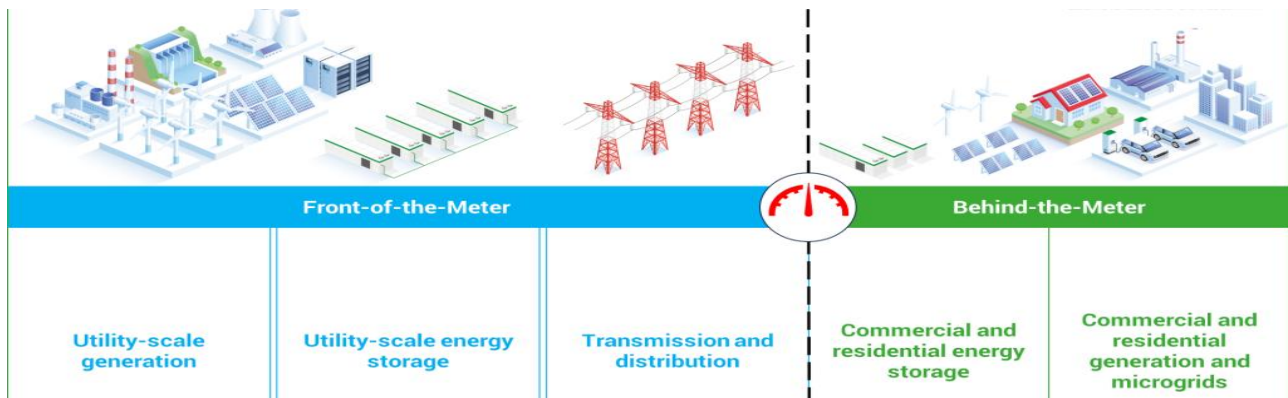


Figure 13: Behind-the-meter vs. Front-of-the-meter<sup>17</sup>

### 3.3 Stakeholder Workshop

The next objective of Task 3.2 was to shift the proposed business model concepts into an operational, regionally grounded business model and validate these through stakeholder engagement. Task 3.2 also aimed to identify the most relevant and promising models for future development, integrating perspectives from key actors throughout the region.

#### 3.3.1 Stakeholder Engagement Approach

Early stakeholder feedback was gathered during a public engagement event at the Ytterresse Energy Park open day. Questions were formulated on how participants define energy flexibility. Responses ranged from resilience and reliability to cost savings and sustainability. It became clear that flexibility is interpreted differently across actor groups.

Given this wide variation, a lead-actor-driven approach was adopted to ensure that business model development is grounded in realistic implementation conditions. Esse Elektro-Kraft (EEK) was selected as the pilot actor for its central role in the regional energy system and its experience in electricity distribution, local energy production, and market participation.

<sup>17</sup> [Behind the Meter vs. Front of the Meter – What’s the difference?](#)

### 3.3.2 Workshop Implementation

A structured co-creation workshop was organized with Esse Elektro-Kraft (EEK) to refine and prioritize business model concepts. This workshop was structured to be interactive and co-creative, using presentations, facilitated discussions, and hands-on exercises. The workshop began with a short session introducing the preliminary business model concepts identified in Task 3.2. After the presentation, a discussion on EEK's potential roles within these concepts was conducted. This discussion ensured that participants understood the theoretical concepts and could easily relate them to systematic realities.

Right after this discussion, three interactive exercises were conducted. All three exercises are correlated and help to interpret the findings into the successful development of the business models.

#### 3.3.2.1 Exercise One (Mapping current system conditions)

The first exercise was focused on establishing a baseline understanding of EEK's current position within the regional energy system. To conclude this exercise, an instruction sheet and an exercise worksheet were provided to help them understand the goals and how to evaluate them. This exercise aimed to map current system conditions.

- Strategic goals (e.g., customer retention, participation in frequency markets, enabling flexible services)
- Core competencies and assets (e.g., distribution grid, hydropower, SCADA systems, smart meters)
- Current value chain (e.g., production → distribution → sales → balancing markets)
- Resources and key partners (e.g., Autocric, Herfors)
- Stakeholder landscape (e.g., households, farmers, small industries, technology providers)

### 3.3.2.2 Exercise Two (Identifying opportunities and barriers)

The second exercise was focused on linking current assets to future value creation by identifying challenges and opportunities. To conclude this exercise, an instruction sheet and an exercise worksheet were provided. Participants worked through a structured mapping process covering:

- Assets: smart meters, SCADA systems, hydropower combined with storage, consumer PV
- Challenges/limitations: limited human resources, lack of critical mass, regulatory constraints, ROI uncertainty, contractual complexity, market entry thresholds
- Opportunities: development of flexibility services, increased demand response participation, leveraging existing service providers
- New value created: reduced energy consumption, peak load reduction, improved system efficiency

This exercise concluded that technical assets are in place, but regulatory, operational, and market barriers remain key challenges.

### 3.3.2.3 Exercise Three (Introducing Business Model Canvas)

In the third exercise, the Business Model Canvas<sup>18</sup> (BMC) developed by (Osterwalder and Pigneur, 2013) was introduced in the workshop. This is a globally accepted tool for understanding business models. A visual framework that explains how an organization co-creates, delivers, and captures value. The tool consists of nine interconnected building blocks (Value proposition, Customer segments, Customer relationships, Key partnership, Key activities, Key resources, Channels, Cost structure, and Revenue streams) that together provide a holistic view of a business model, as shown in Figure 14.

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<sup>18</sup> [The Business Model Canvas](#)

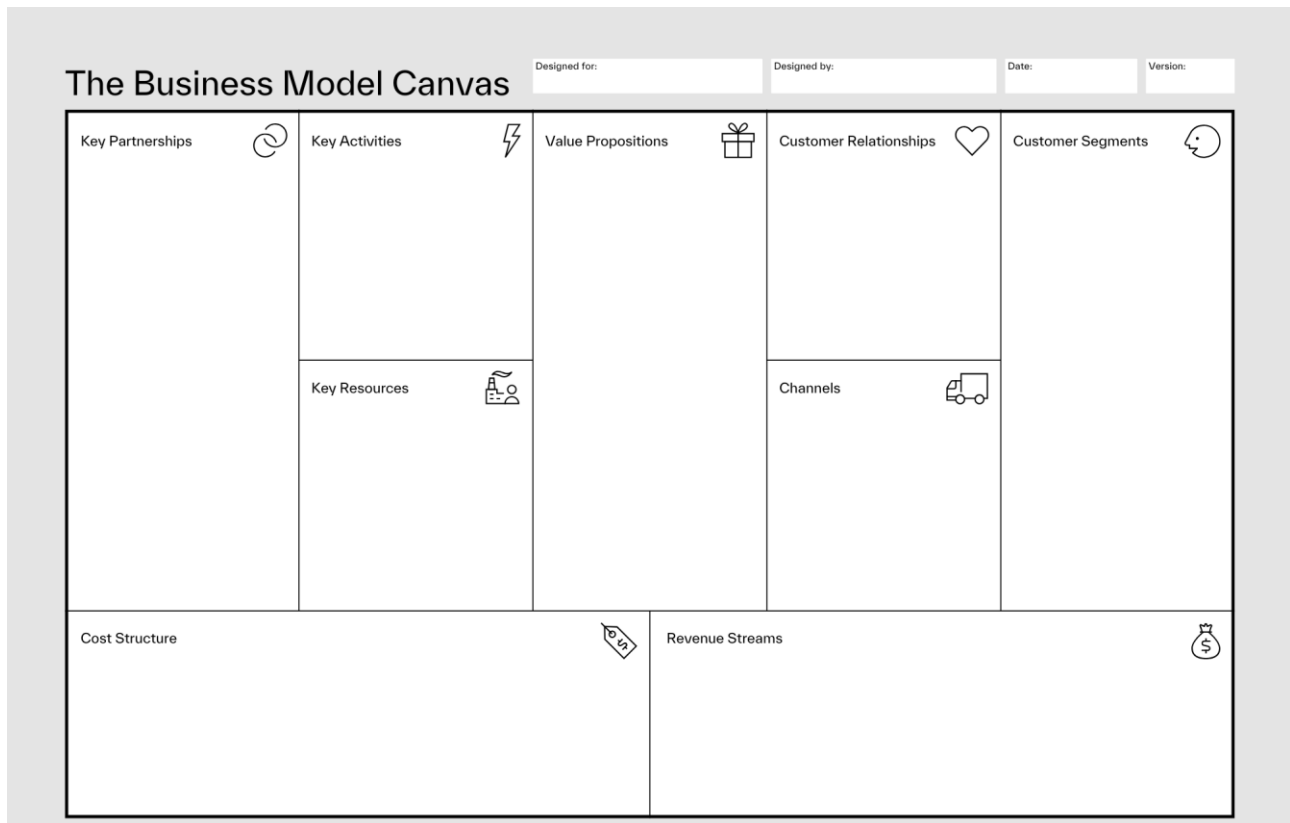


Figure 14: Business Model Canvas (Osterwalder and Pigneur, 2013)

WP3 considered the Business Model Canvas an appropriate tool for this workshop due to its simplicity, visual nature, and suitability for a collaborative workshop. The BMC is also particularly valuable for early-stage innovation processes, as it enables more iterative development and helps identify potential opportunities and constraints in a systematic way. It allowed the workshop outcomes to be interpreted into concrete, actionable business model ideas.

### 3.3.3 Refined Business Model Concepts

According to the workshop results, three business model drafts have been outlined that are particularly relevant for further development. They reflect a combination of EEK's existing competencies and opportunities in the local energy system.

### 3.3.3.1 The DSO-led Local Flexibility Platform

The first model positions EEK as a local flexibility coordinator, capitalizing on its visibility of the grid and digital infrastructure (SCADA systems and smart meters) to procure and manage flexibilities from distributed energy resources. That model has a solid foundation in terms of EEK's current operational capacity and data architecture. This primarily enables the creation of value by reducing demand peaks and avoiding costly investments in grid reinforcements. However, its deployment is bound by regulatory boundaries, e.g., how distribution system operators can earn revenue.

### 3.3.3.2 Partnership-based Aggregation Model

The second model is based on cooperation between EEK and external aggregators or service providers to access national flexibility and balancing markets. In this model, EEK will provide local system knowledge and network access, while partners will play a market-participation role and perform other aggregation functions. The model benefits from EEK's existing partnerships and market experience, enabling value creation through revenue sharing from flexibility services and improved utilization of distributed resources. However, major issues include addressing market access requirements and securing enough aggregation scale to participate meaningfully in flexibility markets.

### 3.3.3.3 Local Energy Community and Flexibility Pool

Finally, the third model is designed to facilitate and encourage local energy communities that integrate distributed generation (in particular, PV), energy storage, and demand response. The model is an extension of EEK's extensive local experience and geographic reach across customers and regional stakeholders. Creating value through self-consumption, increasing customer engagement, and increasing local energy system resilience. At the same time, the model faces challenges related to legal complexity, governance structures, and coordination among multiple actors.

Across all three models, the workshop highlighted that EEK possesses a strong technical and organizational foundation. However, the successful implementation of these business models will depend on overcoming regulatory, market, and coordination-related barriers.

## 4 Legal framework conditions for business models

The next task, T3.3, was to analyze the legal and regulatory framework conditions affecting the implementation of the business models identified in Task 3.2. To gain an understanding of current legal regulations and restrictions, we have conducted multiple interviews with Finland's national legal experts.

In Finland, Flexibility-based business models are highly influenced by national legislation and the evolving European Union regulatory framework, particularly those related to electricity markets, energy communities, and distributed energy resources. Although recent regulatory shifts have enabled new forms of market participation, several structural and legal constraints continue to limit the implementation of innovative business models.

The Clean Energy for All Europeans package at the European level introduced the concept of energy communities to promote decentralized and citizen-driven energy systems. Energy communities are defined in those frameworks as entities aimed at delivering that can collectively generate, consume, store, and share energy, focusing on environmental, economic, and social benefit rather than profit maximization (European Union, 2019<sup>19</sup>; Ministry of Economic Affairs and Employment of Finland, 2023<sup>20</sup>). However, in Finland, the practical implementation of energy communities is still limited. Under the current regulation, energy sharing can occur only within a single property or a small group of closely interconnected properties, usually via virtual net metering agreements (REScoop; EU, 2023<sup>21</sup>). As a result, the scalability of energy community-based models is limited, which limits their applicability to broader regional energy systems.

Meanwhile, the Finnish regulatory environment is transitioning towards facilitating more flexible and decentralized market participation. One important development is the introduction of independent aggregation, which unlocks the distributed flexibility. As highlighted by a legal expert in an interview:

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<sup>19</sup> [European Union. \(2019\). Directive \(EU\) 2019/944 on common rules for the internal market for electricity \(recast\).](#)

<sup>20</sup> [Ministry of Economic Affairs and Employment of Finland. \(2023\). Energy communities.](#)

<sup>21</sup> [REScoop.eu. \(2023\). Energy community definitions: Finland](#)



*“...with the independent aggregation, you don't need to have the BRP [Balance Responsible Party] if you participate only through the independent aggregations”.*

This indicates that regulations are shifting towards integrating more small, decentralized assets into electricity markets through different pathways. However, independent aggregation is still an emerging model, although it has been introduced gradually across various reserve markets and is not yet fully finalized.

However, even with these positive developments, market participation remains limited by several technical and market-related barriers. In Finland, Flexibility markets have very strict technical criteria for activation speed, measurement capabilities, and prequalification procedures. Furthermore, the minimum bid size thresholds restrict entry for smaller participants, necessitating their aggregation to gain access to the market. As highlighted by a legal Expert:

*“...technical requirements and minimum bid size ... can be a barrier for smaller resources...you need to aggregate them to meet the minimum bid size....small resources, they can't participate on their own... they have to have this aggregator or then go through their electricity supplier...”*

Although ongoing regulatory initiatives aim to lower these thresholds, they remain a significant constraint for regional and community-based business models for now. Another important regulatory aspect concerns the role of Distribution System Operators (DSOs). The Finnish electricity market regulation imposes strict unbundling rules, requiring that network operations be separated from competitive market activities. According to the legal expert:

*“...the network company side... needs to be kind of separated since that's like a natural monopoly, so that's why they need to be separated from any other market business...the starting point is that they shouldn't own even the batteries to provide some great service for themselves. They should procure it on the market...”*

This imposes structural restrictions on business models that position DSOs as active players in the market, such as DSO-led flexibility platforms. In such cases, value creation is primarily indirect, for

example, through avoided grid reinforcement costs, rather than through direct revenue generation from market participation.

However, regulatory developments are increasingly recognizing the role of DSOs in enabling flexibility. More specifically, it is anticipated that DSOs will procure flexibility services to manage congestion and enhance the effectiveness of electrical grids. A Finnish legal expert highlights this view:

*“...regulation moving towards that direction, namely DSO should procure flexibility services as part of their operation”*

This transition opens new pathways for market-based procurement mechanisms. Allow open participation in flexibility procurement: As explained by the legal expert during an interview:

*“...any market party can offer the flexibility of the service for the local network ...they [the affiliated companies] are in competition with any other flexibility provider...and the regulator has accepted our terms and conditions, so how the marketplace works. So that’s kind of the basis...any market party can offer the flexibility...”*

The regulatory framework for energy communities and distributed systems is fragmented and still developing, characterized by overlapping regulations and unclear guidelines for implementation. (Finnish Energy, 2025<sup>22</sup>; REScoop.EU, 2023<sup>23</sup>). Although some forms of energy sharing at the local level are permitted, community-driven models face difficulties from a legal and organizational perspective. According to the legal expert:

*“...if you have a housing company, so you could have solar panels and then share the energy between the customers who have their own electricity contracts and metres and so on. So it's possible to share the energy within the housing company...(but)...have solar panels on your*

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<sup>22</sup> [Finnish Energy. \(2025\). Energy policy positions and EU framework consultation response.](#)

<sup>23</sup> [REScoop.eu. \(2023\). Enabling frameworks and support schemes for energy communities: Finland](#)



*summer cottage and then use the energy in your city apartment. But so that's not possible today”*

It becomes clear that this significantly limits the development of energy communities and the flexibility pools model discussed in Task 3.2. However, there is hope that such restrictions will eventually be overcome due to evolving regulations that allow for collective involvement. The legal expert also stated this future vision as:

*“...I would assume that this will be solved in the future. And also the energy community, so they are kind of group of individuals and individuals when they can already participate. So why couldn't the kind of group of individuals as well as a community?...”*

Current market conditions favor commercial-scale and industrial-flexibility resources, especially in reserve markets with existing revenue streams. Economic incentives are the primary motivator for market participants, and national-level markets will see most demand for advanced flexibility. This is why aggregation-based and industrial demand response models are more likely to be implemented in the short term than community-based and small-scale models.

In conclusion, the study shows that while Finland is well on its way to a more flexible and decentralized energy system, the current regulatory framework is partially enabling and partially restrictive. Expansion of independent aggregation, reserve market opportunities, and the increasing role of DSOs in flexibility procurement are the key enabling trends. At the same time, significant barriers exist, particularly related to:

- Unbundling restrictions on DSOs
- Technical and market entry requirements
- Limited legal frameworks for energy communities
- Uncertainty in regulatory implementation timelines

Business Model	Key Legal Enablers	Key Legal Barriers	Current Feasibility	Future Outlook
<b>DSO-led Local Flexibility Platform</b>	DSO allowed to procure flexibility for grid operation	Unbundling rules prevent market participation and profit generation	Medium (operationally feasible, limited revenue model)	Increasing role of DSOs in flexibility procurement
<b>Partnership-based Aggregation Model</b>	Independent aggregation is enabled in multiple markets	Technical requirements, minimum bid size, and prequalification barriers	High (already emerging in the market)	Strong growth expected as aggregation expands
<b>Local Energy Community &amp; Flexibility Pool</b>	Energy sharing is allowed within a single property	Restrictions across property boundaries and an unclear legal framework for communities	Low–Medium (limited implementation scope)	High potential with future regulatory development

Table 4: Examination of the legal framework conditions for business models

Table 4 demonstrates that the practical success of the business models identified in Task 3.2 is highly conditional on regulatory alignment. However, some models can exist within the existing framework, while others require further regulatory development and clarification. Consequently, the reflections generated in Task 3.3 constitute an important basis for further elaboration and design of business models that will take place in Task 3.4.

## 5 Business models Development

The last task, T3.4 of WP3, is the final business model development, which follows a staged pathway approach and hence defines the implementation plan for three business models over time. This approach was adopted based on T3.3 results, which indicate that the transition towards a flexible and decentralized energy system cannot be achieved through a single model. Instead, it requires a step-wise progression that builds capabilities, reduces risks, and aligns with evolving regulatory and market conditions.

The structured approach comprises three phases: the short-term, mid-term, and long-term. These three phases indicate different stages of maturity. However, each phase depends on the one that precedes it. This ensures an incremental approach to growth. The step-by-step development process of the business models is highlighted in the implementation roadmap presented in Figure 15. The implementation roadmap translates the three phases of the business models into a structured path. The business models are linked to the business operations, the responsibilities of the stakeholders, and the income-generation strategies, with the technical and regulatory requirements.

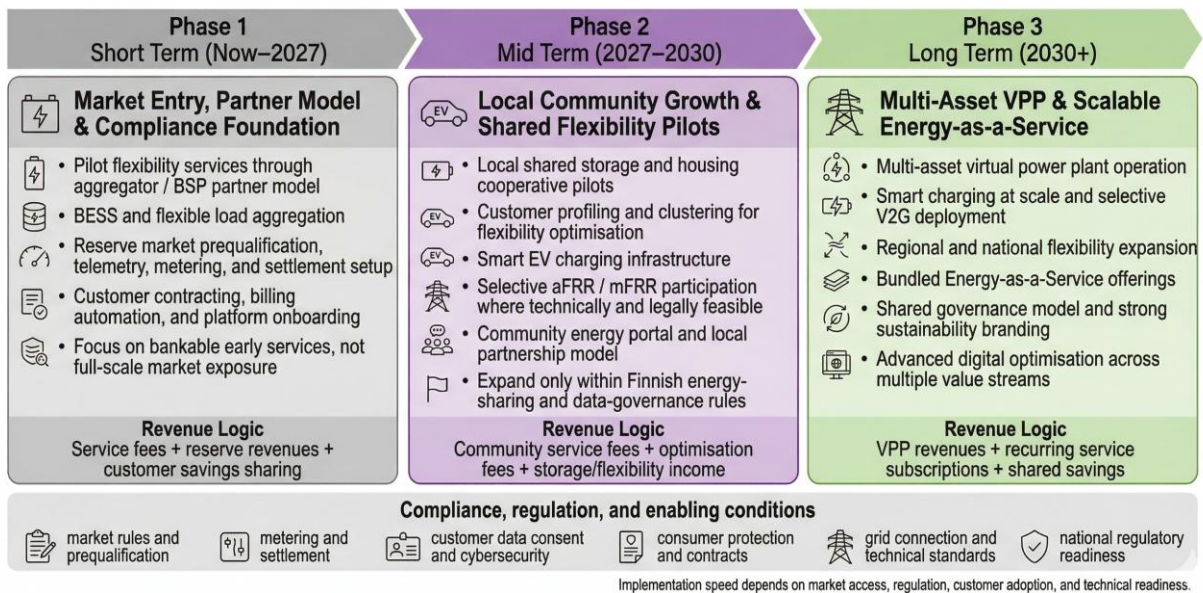


Figure 15: Staged business model pathway for regional flexibility services.

### 5.1 Classification of Final Business Model

#### Short Term Business model (0-3 Years)

This model refers to an immediate implementation model based on the existing market structure and resources. The main aim of this model is to facilitate participation in the existing flexibility markets, especially in the frequency containment reserves (FCRs). This model is considered low risk because it facilitates the provision of flexibility services within existing frameworks.

The model is based on existing market roles and uses larger flexible assets, such as battery energy storage systems (BESS), photovoltaic systems, and flexible industrial loads, e.g., heat pumps. Key actors involved in the business model include asset owners, industrial customers, large prosumers, aggregators, and balancing responsible parties (BRP/BSP). These actors jointly collaborate to aggregate and provide flexibility services, which are then sold to national reserve markets.

The main value of this model lies in its practicality and alignment with current Finnish market conditions. It enables early revenue generation through participation in the reserve market, service fees, and shared savings mechanisms. At the same time, it supports operational learning and capability building, which are essential for future scaling.

However, the model also faces certain limitations. The primary challenges relate to regulatory and market requirements, including clear role separation between actors and the technical prequalification of assets. These constraints define the implementation of boundary conditions and highlight the importance of compliance and market readiness in the early stages.

Overall, the short-term business model serves as a foundation phase within the staged pathway. It allows stakeholders to enter the flexibility market, test business concepts, and build the necessary technical and organizational capabilities for further development. The Business Model Canvas for a short-term business model is shown in Figure 16.

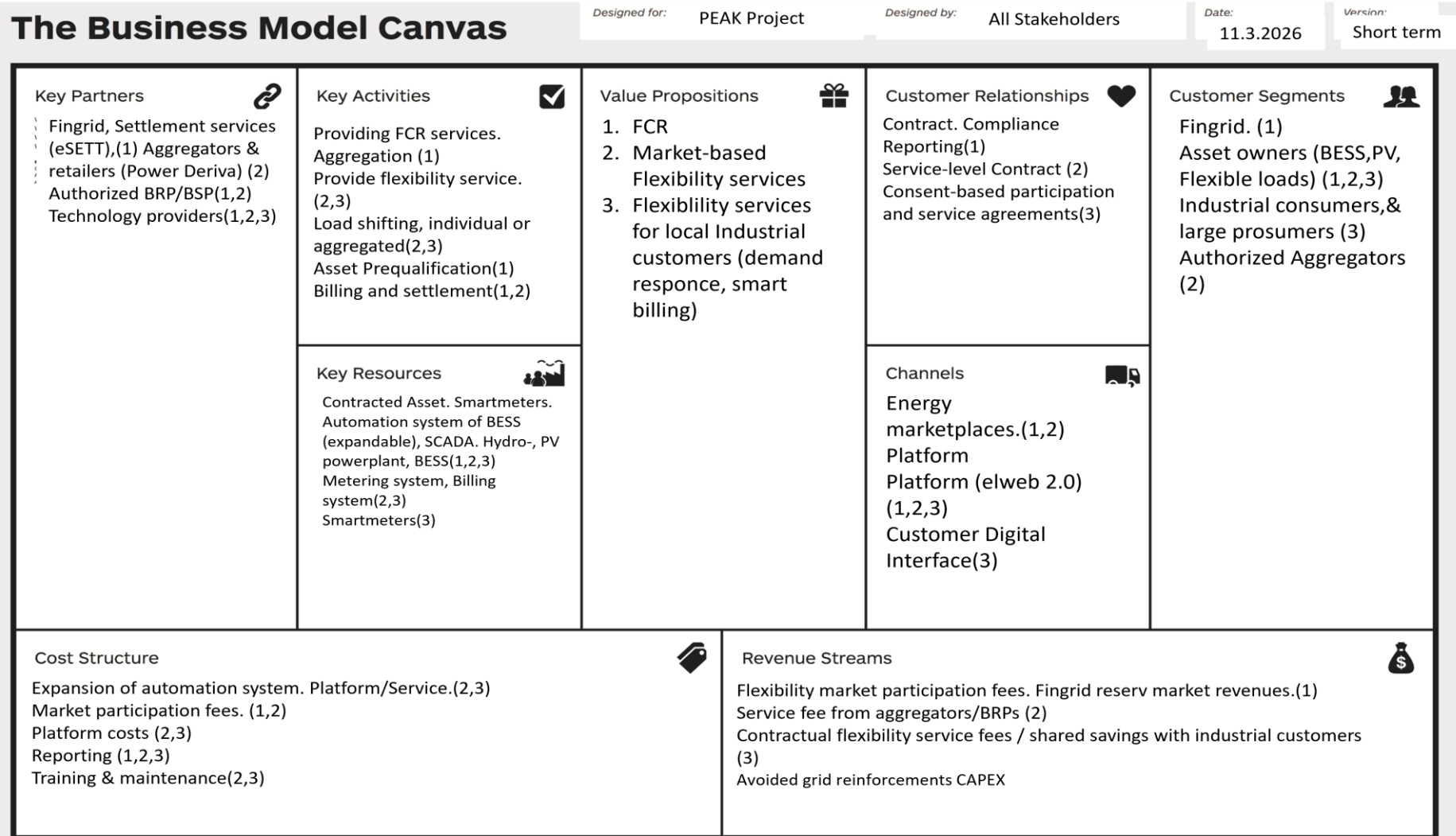


Figure 16: Short-Term Business Model (0–3 years): Market Entry and Feasible Implementation

### Mid-Term Business Model (3–7 years)

The mid-term model emphasizes the scalability and flexibility of services and the regional and community-level application of these services. This is a shift from the concept of individual assets providing flexible services to that of coordinated, collaborative energy solutions. The mid-term business model builds on the skills developed in the short-term model but adds greater complexity.

This model extends flexibility services to community-based solutions, such as shared battery storage facilities, as well as platform-based services that involve billing and account management. This will lead to greater integration and customer convenience when managing energy resources, allowing more parties to participate in the process.

Key actors in this phase include small and medium-sized enterprises (SMEs), housing companies, prosumers, electric vehicle users, and community-level operators. In addition, platform providers and service companies play an important role in enabling coordination, billing, and balancing services. The model, therefore, relies on a more diverse and interconnected stakeholder ecosystem compared to the short-term phase.

The main value of this model lies in its ability to move from isolated flexibility provision towards coordinated community services. This enables improved system efficiency, greater potential for flexibility, and new revenue streams through service-based offerings. However, the implementation of this model depends on the development of appropriate governance structures, digital platforms, and regulatory clarity.

Key challenges in this phase include energy-sharing limitations, particularly across property boundaries, as well as the need for clear governance models and stakeholder coordination mechanisms. These constraints highlight the importance of regulatory development and institutional arrangements in enabling community-based energy solutions. The Business Model Canvas for a short-term business model is shown in Figure 17.

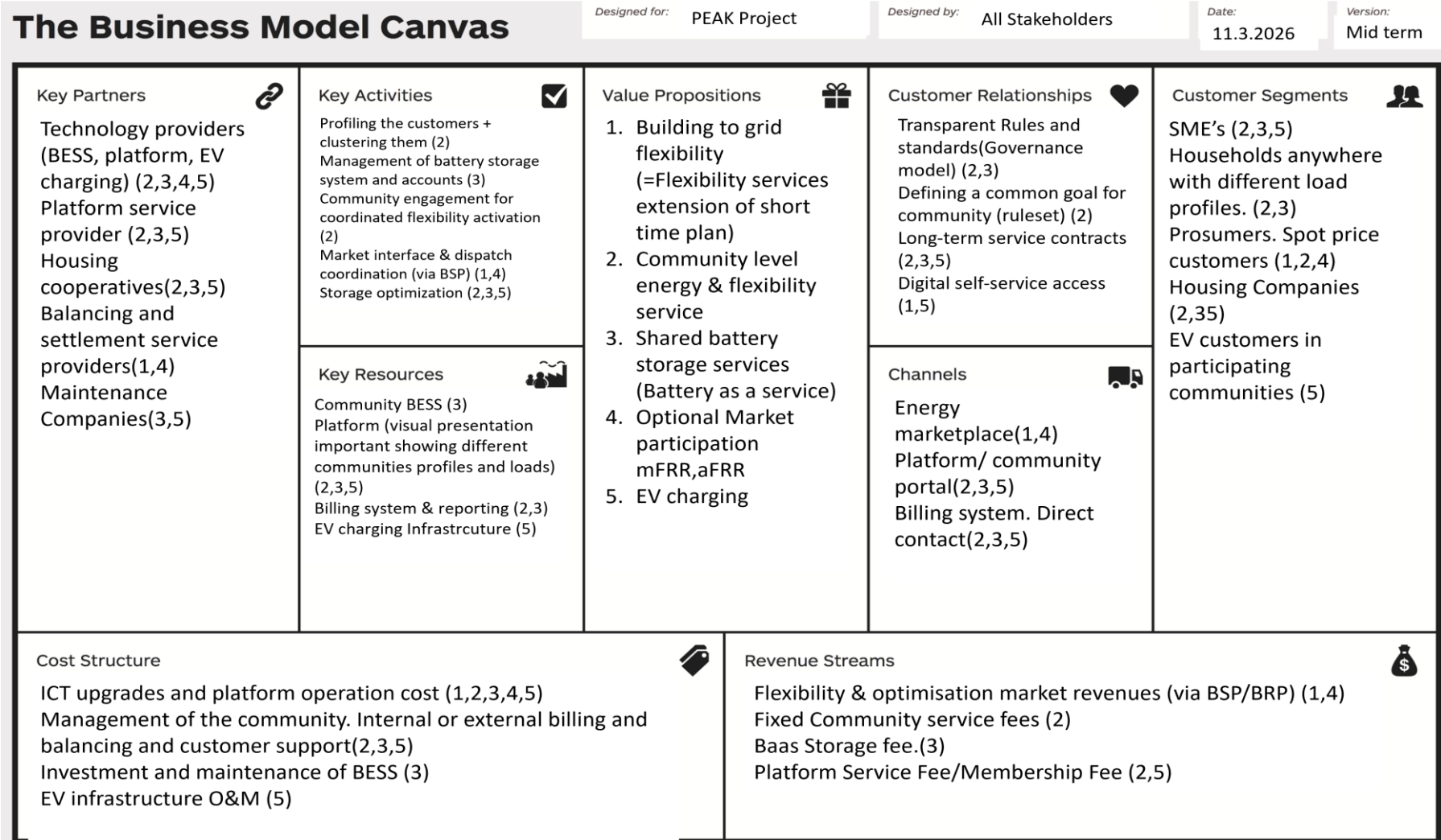


Figure 17: Mid-Term Business Model (3–7 years): Scaling and Community Integration

### Long-Term Business Model (7+ years): System Integration and Strategic Transformation

The long-range business model is a clear, prospective picture of how completely an entire regional energy system could move toward integrated management. It is oriented towards the delivery of coordinated energy resources, meaning the use of digital platforms to provide comprehensive, flexible services at scale.

The proposed model integrates functionalities from blockchain-based Virtual Power Plants (VPP), vehicle-to-grid (V2G), and data-driven optimization. It leverages decentralized resources to form a regional flexibility market and enables advanced market services and Energy-as-a-Service solutions.

Several actors are involved during this phase. This includes municipalities, industries, energy communities, fleet operators, and system-level actors. The integration and coordination process of this model mainly relies on technology providers and TSO/DSO interfaces.

The main value of this model lies in system-wide optimization, improved efficiency, and new service-based revenue streams. However, this phase depends on future developments in regulation, technology, and market structures. It also requires significant investments in digital infrastructure and new skills.

Overall, the long-term model represents a phase of transformation. It defines the strategic direction for a flexible, integrated, and carbon-neutral energy system. The Business Model Canvas for a short-term business model is shown in Figure 18.

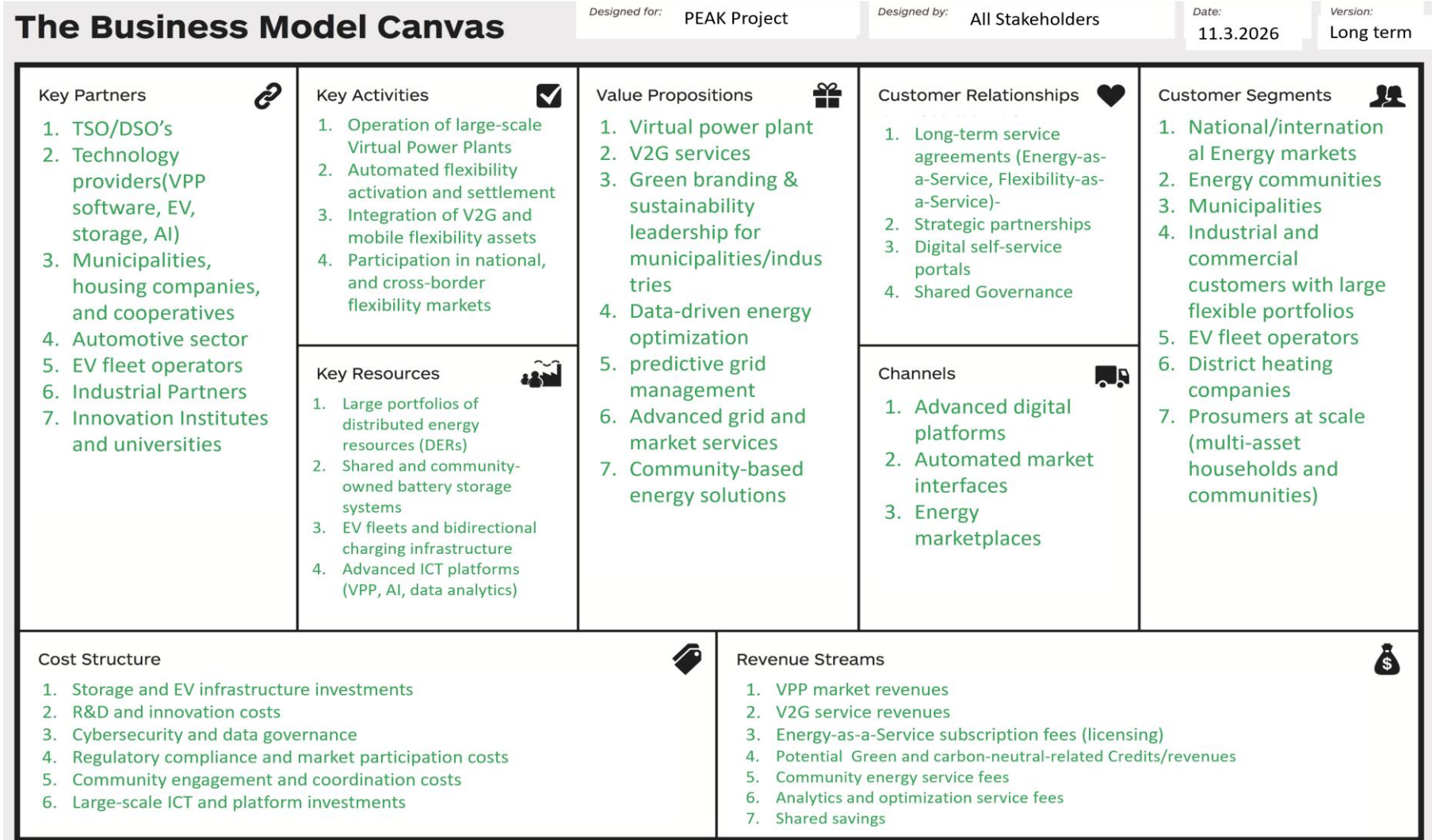


Figure 18: Long-Term Business Model (7+ years): System Integration and Transformation

Along with the business model, WP3 has also identified key challenges, bottlenecks, and resource and skills gaps that are summarized in Table 5. These challenges directly influence the feasibility and scalability of the proposed business models, particularly in terms of regulatory constraints, investment requirements, and stakeholder coordination.

Category	Specific Barriers	Impact on Business Models
<b>Technical</b>	Intermittency & Variability of Renewables	Increased operational costs, Need for costly storage/backup
	Limitations of Energy Storage Systems	High capital costs, Scalability issues, and reduced efficiency
	Inadequate Grid Infrastructure	Grid instability, High modernization costs, Integration hurdles
	Lack of Advanced Technologies (e.g., CCUS)	Limited decarbonization in hard-to-abate sectors, High deployment costs
<b>Economic &amp; Financial</b>	High Initial Capital Costs	Deterred private investment, Limited accessibility for low-income regions
	Limited Financial Incentives & Green Financing	Weak motivation for adoption, Difficulty securing large-scale project funding
	Revenue Uncertainty (e.g., volatile carbon prices)	Financial instability, Discouraged long-term investments
	Socio-economic Disparities	Unaffordability for low-income households, Widened energy access gap
<b>Policy, Regulatory, &amp; Governance</b>	Inconsistent & Fragmented Policies	Confusion, Uncertainty, Deterred long-term investments
	Ineffective Enforcement & Regulatory Gaps	Non-compliance, Undermined regulation efficacy, Integration hurdles
	Lack of Inter-sectoral Coordination	Inefficiencies, Missed synergistic opportunities
	Governance Risks (e.g., corruption)	Deterred foreign investment, Unpredictable operating environment
<b>Social &amp; Cultural</b>	Behavioral & Cultural Resistance	Slow technology adoption, Entrenched practices
	Aesthetic Concerns & NIMBYism	Public opposition, Project delays/cancellations
	Lack of Public Engagement & Misinformation	Reduced adoption rates, Eroded trust, Dampened momentum
	Workforce Skill Gaps	Impeded technology implementation, Operational inefficiencies

Table 5: Categorization of Key Challenges and Barriers to Regional Carbon-Neutral Energy System Business Models

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