Intelligent Assistants for Flexibility Management
(Grant Agreement No 957670)

D5.7 Final market analysis and iFLEX business models

Date: 2024-04-30

Version 1.0

Published by the iFLEX Consortium

Dissemination Level: PU - Public

Co-funded by the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement No 957670

Document control page

Document file: D5.7 - Final market analysis and iFLEX business models-v1.0
Document version: 1.0
Document owner: **ENERIM**

Work package: WP5 Consumer engagement, incentive mechanisms and economic sustainability
Deliverable type: R - Document, report

Document status: ☒Approved by the document owner for internal review
☒ Approved for submission to the EC

Document history:

Version	Author(s)	Date	Summary of changes made
0.1	Janne Huvilinna (ENERIM)	2024-01-31	Initial table of contents and draft
0.2	Christos Simoglou, George Korosidis, Gerasimos Takis-Defteraios (OPTIMUS)	2024-03-26	Updates in Section 3 and 5 (Greece)
0.3	Jesper Thestrup (IN-JET) Janne Huvilinna (ENERIM), Matej Fajgelj (ELE), Kristijan Koželj (ELE), Anton Kos (ELE)	2024-04-28	Added new Chapter 4 with BMs & input Updated content for Chapter 3 (Slovenia) Partner contributions added and version ready for internal review
1.0	Janne Huvilinna (ENERIM)	2024-04-30	Comments addressed and final version submitted to the European Commission

Internal review history:

Reviewed by	Date	Summary of comments
Christos Simoglou (OPTIMUS)	2024-04-30	Accepted with minor corrections and comments
Anne Immonen (VTT)	2024-04-29	Accepted with minor changes.

Legal Notice

The information in this document is subject to change without notice.

The Members of the iFLEX Consortium make no warranty of any kind with regard to this document, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The Members of the iFLEX Consortium shall not be held liable for errors contained herein or direct, indirect, special, incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Possible inaccuracies of information are under the responsibility of the project. This report reflects solely the views of its authors. The European Commission is not liable for any use that may be made of the information contained therein.

Index:

1 Executive summary

This deliverable is an update of deliverable *D5.1 Initial market analysis and iFLEX business models* that was submitted in April 2021 (M6 of the project). The deliverable describes the overview of the current and future energy market context in the target demonstration countries: Greece, Slovenia and Finland as well as at European level. The aim of the deliverable is also to develop the business model framework. In addition, the deliverable aims to identify the business opportunities for innovation in incentive design and consumer engagement on the basis of defined obstacles.

The deliverable begins with the Energy market context surrounding the iFLEX project. Overall market stakeholders, retail, wholesale, balancing, and flexibility markets are described in the target demonstration countries and at European level. These areas are compared and summarized in the conclusions section.

The main contribution of this deliverable is the assessment of the iFLEX business models and use cases. Different use cases are assessed from three distinctive perspecitves: consumer-driven flexibility, aggregator-driven flexibility, and virtual energy communities. These use cases are validated by using the 360 Business Model Evaluator and the e3 value sensitivity analysis methods.

In addition, different drivers, obstacles, and business opportunities are evaluated in the target demonstration countries. Although drivers can be found in every demonstration country, there are also obstacles. Economical, technical and regulatory obstacles can be found, for example lack of regulatory reform, current status of metering infrastructure and lack of incentives. Since the amount of intermittent generation is increasing, the need for flexibility service provider is increasing as well.

Business opportunities are divided into different categories: presence of DR-related policy/regulation, enhancement of infrastructure and reliability, management and reduction of energy costs, market reforms, minimization of the environmental impact by reducing electricity usage, and partnerships between different stakeholders. Under these categories, potential business opportunities for DR have been identified, such as consumers will have the opportunity to gain control over their energy usage and assist in maintaining grid reliability during emergency and relieving network congestion.

2 Introduction

2.1 Purpose, context and scope

The purpose of this document is to provide an overview of the current and future energy market context especially in Greece, Slovenia, and Finland. In addition, the purpose of the document is to develop the business model framework and to identify stakeholders. The document also identifies the drivers, obstacles and business opportunities for innovation in incentive design and consumer engagement.

The document is part of the WP 5 "Consumer engagement, incentive mechanisms and economic sustainability" and more specifically part of the *Task 5.1 Analysis of markets and obstacles to innovation* and *Task 5.2 Business model development*.

Chapters 3 and 5 address task 5.1, while Chapter 4 addresses task 5.2 .

2.2 Content and structure

The reminder of the Deliverable is structured as follows; Chapter 3 starts with the discussion about the energy market context especially in the target demonstration countries: Greece, Slovenia and Finland. First the stakeholders, namely: end-consumer, energy communities, prosumer, TSO, DSO, retailer, balancing service provider and balance responsible parties, aggregator and ESCO companies are presented by dividing each chapter by the countries. Also, the retail, wholesale, balancing market and flexibility market are discussed by countries. These are then summarized in the conclusions section of Chapter 3. This Chapter was updated with the latest available market information since the previous deliverable.

Chapter 4 provides a summary of the methodology used in iFLEX for business modelling and the work done with the initial business models. It then introduces three overall value models based on the business use cases and results from the iFLEX pilots, before presenting the assessment of the final business use cases and models.

Chapter 5 first discusses the identified drivers and obstacles for innovation in incentive design and consumer engagement. Then the possible business opportunities are identified on the basis of the identified obstacles.

Chapter 6 concludes the deliverable.

3 Energy market context

Energy market context is presented in terms of how it poses obstacles for innovation. The drivers and obstacles are analytically presented in Chapter 5, so Chapter 3 focuses on the presentation of the energy market context in target demonstration countries: Greece, Slovenia and Finland.

This Chapter starts with the discussion of stakeholders and then the focus is on the retail, wholesale, balancing and flexibility markets. A country-specific overview is provided in all relevant subsections. The last section 3.9 summarizes the main points.

Following latest available data and trends, the Energy Market context for Greece, Slovenia, and Finland has been updated accordingly in Sections 3.2 – 3.9.

3.1 Stakeholders

3.1.1 End-consumer

3.1.1.1 Greece

The Greek economy relies primarily on the service sector, which accounts for over 80% of the gross domestic product (GDP). The industry sector accounts for less than 15%, and the rest is made up of the primary sector (agriculture, fisheries and forestry). Tourism, public sector and shipping dominate within the service sector with the public sector accounting for 40% of the GDP.

In 2021, the total final consumption (TFC) of Greece was equal to 637 PJ, presenting a decrease of -20% with respect to 2011, mainly because of the economic downturn after the financial crisis (see Fig. 1). Oil is the most significant fuel and the country remains almost entirely dependent on oil imports. Oil accounts for over half of the energy in TFC (51.8%), mainly because of its dominance in transport and large shares in the industry and residential sectors. Electricity is the second-highest energy source (27.8%), especially in the commercial sector. Natural gas has been gaining ground (9.7%) in both the electricity generation as well as for heating and industrial use and the country is also almost entirely dependent on gas imports.

Regarding the sectoral breakdown of the total final consumption, in 2021 the transport sector was the largest energy consumer, accounting for 36.4% of TFC, followed by the residential (27.5%), industry (16.9%), and commercial and public services (11.2%) sectors (see Fig. 2).

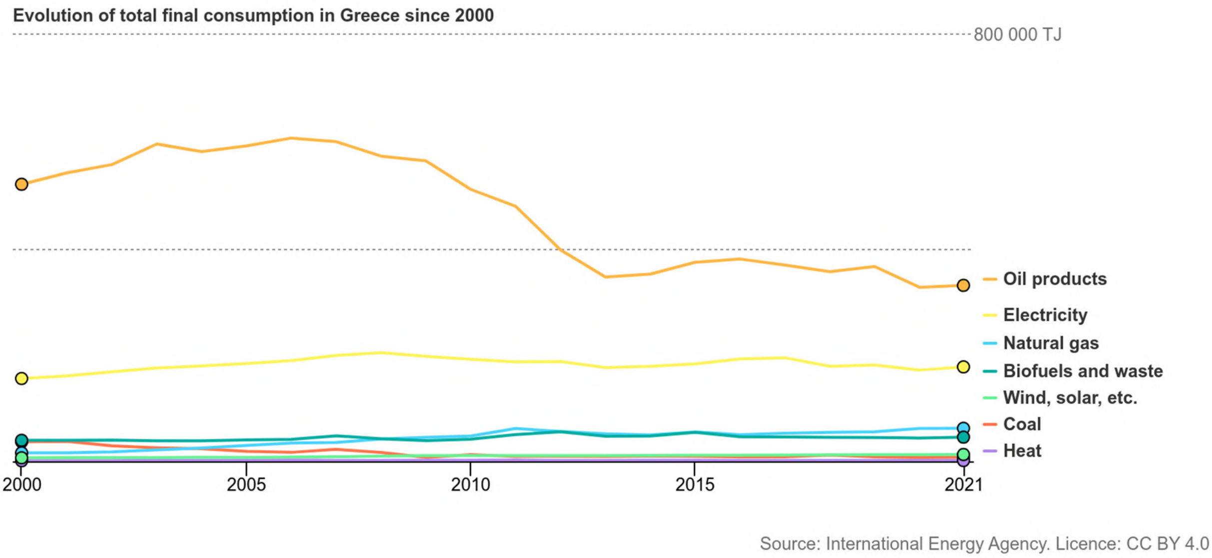

Figure 1. Total Final Consumption in Greece by source 2000-2021 (Source: IEA)

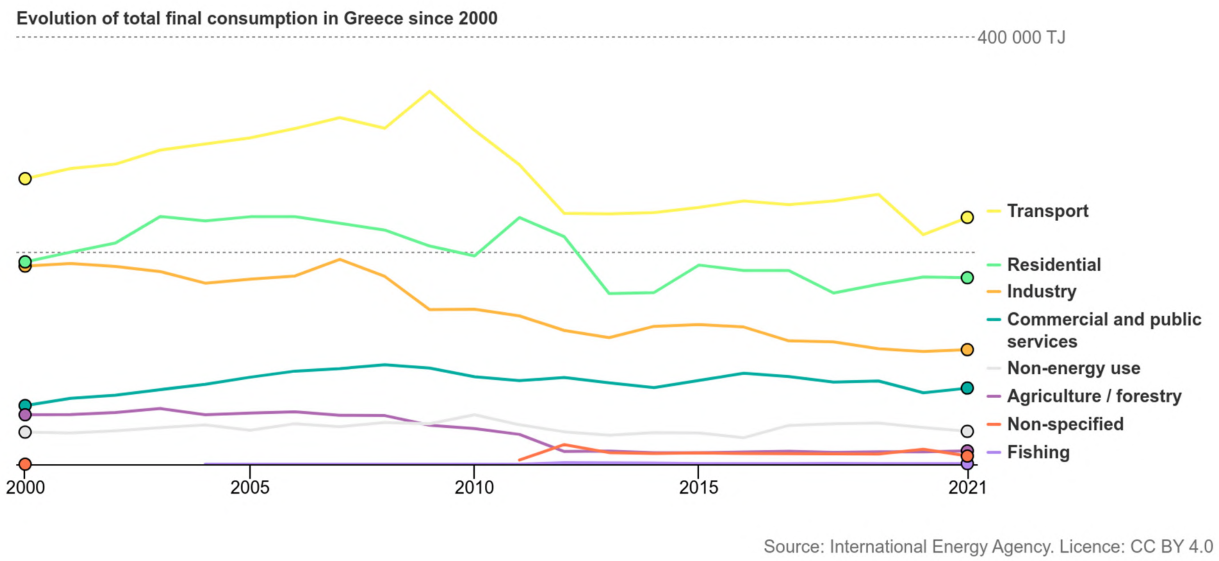

Figure 2. Total Final Consumption in Greece by sector 2000-2021 (Source: IEA)

Regarding the electricity sector, electricity consumption in the Greek mainland (interconnected) power system (excluding non-interconnected insular power systems) during the period 2011-2021 lies in the range ≈ 50-53.5 TWh/year, whereas peak load demand lies in the range 9,000-10,500 MW. However, the continuing economic recession after the economic crisis of 2008 led to a notable decrease of the total electricity consumption until 2018, as compared to the historical peak consumption recorded in 2008 (56.3 TWh / 10,217 MW). The COVID-19 pandemic lockdowns during the year 2020 suspended the increasing trend of the system load demand that started during 2019 and continued from 2021 onwards, following the anticipated positive prospects of the Greek economy.

From 2011 to 2021, electricity generation decreased from 59 TWh to 55 TWh and experienced a significant change in the resource mix. Over this period, lignite-fired generation dropped strongly from 31 TWh to 5.3 TWh. The reduction in lignite-fired generation has been conuterbalanced by increased gas-fired generation (from 14 TWh to 22 TWh), higher renewable generation (8.1 TWh to 22 TWh) and increased electricity imports. The growth in renewable generation came mostly from increased wind generation (3.3 TWh to 10 TWh) and solar PV generation (0.6 TWh to 5.3 TWh). Hydro generation is highly variable depending on water availability, reaching a historic peak of 7.5 TWh in 2010. Because of continuing trends of lower precipitation, hydro generation has been falling and reached 5.9 TWh in 2021. There was also a small decrease in oil-fired generation (5.9 TWh to 4.7 TWh), used mainly in non-interconnected islands. Oil-fired generation is expected to be minimized in the next few years, following the gradual interconnection of almost all Greek islands with the mainland by the end of the current decade along with the increasing penetration of renewable generation in these islands.

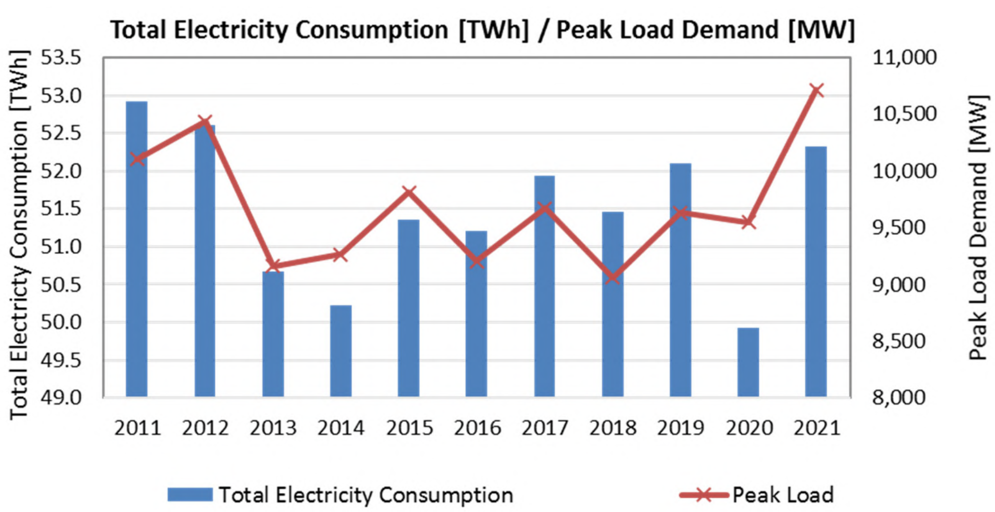

Figure 3. Total Electricity Consumption / Peak Load Demand of mainland Greece (2011-2021).

In Greece, electricity consumers are divided in three main categories on the basis of their voltage level and electricity consumption profile, namely:

- *HighVoltage (HV) Consumers:* There are ~40 large industrial consumers (e.g. metals, minerals, iron and steel, lignite mines, petroleum refineries, cement, chemicals, pumping) which are connected to the HV Network (150 kV) and account for ~15% of the total electricity consumption.
- *MediumVoltage (MV) Consumers:* There are ~11,000 consumers that are connected to the MV network (20 kV), including medium-size industrial consumers, commercial buildings, hospitals, supermarkets, schools, etc. and account for ~22% of the total electricity consumption.
- *LowVoltage (LV) Consumers:* All other electricity consumers (e.g. households, small enterprises, etc.) are connected to the LV network (400/230 V) and account for ~63% of the total electricity consumption.

HV consumers present a rather constant electricity consumption profile during each hour of the day (~600-700 MW/h in total), however not presenting particular daily or seasonal variations. On the other hand, the electricity consumption of MV and, particularly, LV consumers is rather dependent on seasonal, daily, environmental or other conditions, such as time of day, temperature, holidays, etc. This volatility of electricity consumption profiles for MV and LV consumers sets the ground for the successful and large-scale implementation of DR schemes.

3.1.1.2 Slovenia

In Slovenia, in 2022, domestic production of increased electricity covered 70% of final consumption, the share of renewables in total production was 33.6%, the number of final customers increased, and 0.6% of users in the distribution system already acted as customers and producers. On all Slovenian borders the European target model was established for the allocation of intermodal transmission capacity. The volume of trading on the Slovenian stock market increased, while the prices of band and peak energy on the market for the day before increased. Wholesale electricity market remains well-developed with a high level of liquidity. On retail market there were ast the end of 2022 17 active suppliers, supplying 976,623 consumers, and final electricity prices rose. According to the purchasing power standard, the price of electricity supply for a typical household customer in Slovenia was below the EU average, and also lower than in Austria and Italy, but higher than in Croatia and Hungary

27.382 production devices were already in operation with electricity generated from renewable sources, while the total number of new lectric vehicles increased in year 2022 on 2293 (33% more than previous year).

Share of renewable energy sources in Slovenian gross final energy consumption in 2022 was estimated at 23%, and that is still we well behind the set 25% target share for 2022. In the field of energy efficiency, Slovenia is, according to the European commission between 15 countries, making a cumulative commitment final energy savings are met on an ongoing basis. In 2022 800.8 GWh electricity was produced from renewable sources under the support scheme. If they were on public calls selected projects carried out could be production electricity from renewable sources in 2024 more than doubled.

Consumption of natural gas by end customers has slightly decreased to 9,012 GWh, the lease of connection points for transmission of natural gas to Croatia. Supply with it was undisturbed by natural gas; 18 suppliers supplied 135,619 end customers with natural gas. Final land prices gas prices in Slovenia decreased slightly and remained below the average price for household customers in the EU.

Almost half of the heat supplied was produced from coal (45.5 %) and less than from renewable sources (23%). Mostly heat was produced by cogeneration of heat and electricity. Finally, the average monthly retail price of heat for household consumers increased on average by 24.7% in comparison with the previous year.

Slovenia is characterized by four strategic advantages that enable it to effectively adapt to the constantly changing international environment: geostrategic logistics location, skilled workforce, high level of digitalization, well-developed infrastructure.

Slovenia has a relatively small but fast-growing and export-oriented economy. It was considered the most economically developed part of the former Yugoslavia, and after independence, a long period of stable growth began with privatization and internationalization.

Economic growth today is driven primarily by private consumption, investment and exports. Slovenia is one of the few European countries that constantly shows a surplus of exports over imports.

The most important industry in Slovenia is the automotive industry. Almost 300 companies operate in the automotive industry segment in Slovenia. Their total revenues amount to four billion euros. This industry accounts for ten percent of Slovenian GDP. Suppliers in this industry are 80 percent exporters. There are currently around 40,000 jobs directly and indirectly connected to the automotive industry.

The pharmaceutical industry is also important export industry involving more than 550 companies.

Given that Slovenia is the second most forested European country, it is understandable that little manufacturing and furniture industry developed in the early years. The chemical industry has been growing in recent years mainly due to the successful operation of some successful companies.

The tourism industry has grown steadily over the last twenty years. This enabled marketing under the I feel Slovenia brand.

Around 400 companies and 100 knowledge institutions connected in eight strategic development and investment partnerships: Smart Cities and Communities, Smart Buildings and Home with a Wood Chain, Networks for the Transition to a Circular Economy, Sustainable Food Production, Sustainable Tourism, Factories of the Future, Health - Medicine, Mobility and Development of materials as products.

The amount of energy intended for end use in Slovenia in 2022 amounted to 4,810 ktoe (source: Energetski kazalniki po: KAZALNIK , LETO. SiteTitle (stat.si)). The majority of energy is consumed in the transport sector (41%), so petroleum products have the largest share in energy consumption (47%). Source: Energetska statistika, 2022

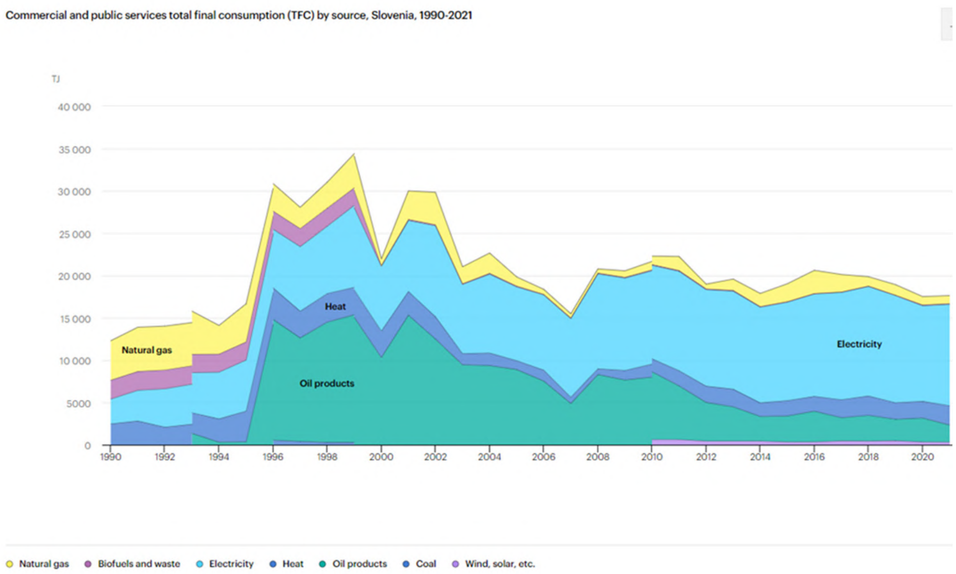

Figure 4. Total Fuel Consumption in Slovenia by source 1990-2021 (Source: IEA)

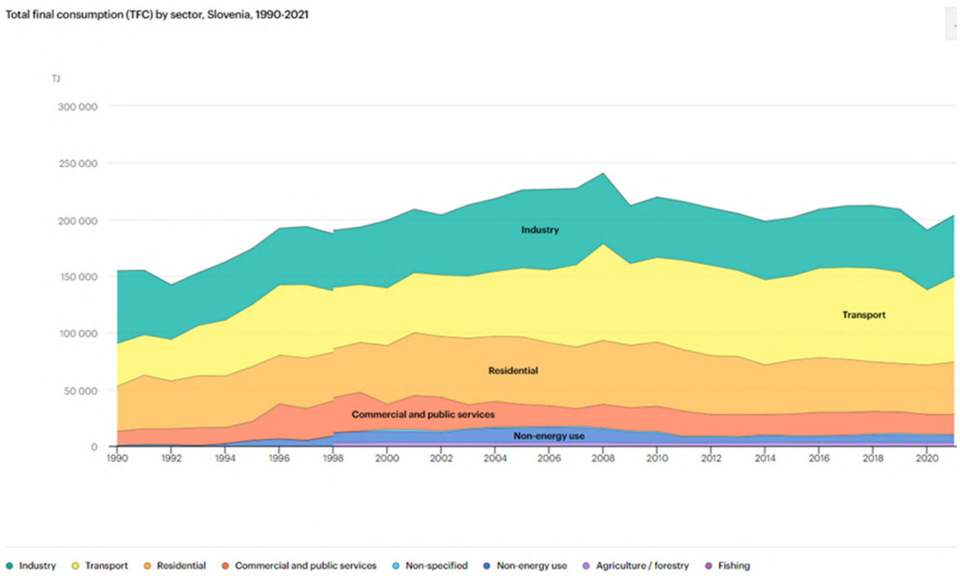

Figure 5. Total Fuel Consumption in Slovenia by sector 1990-2021 (Source: IEA)

In Slovenia, in 2022, 70% of the consumption of final customers was covered by domestic electricity production, and the share of renewable sources in total production amounted to 37.1%.

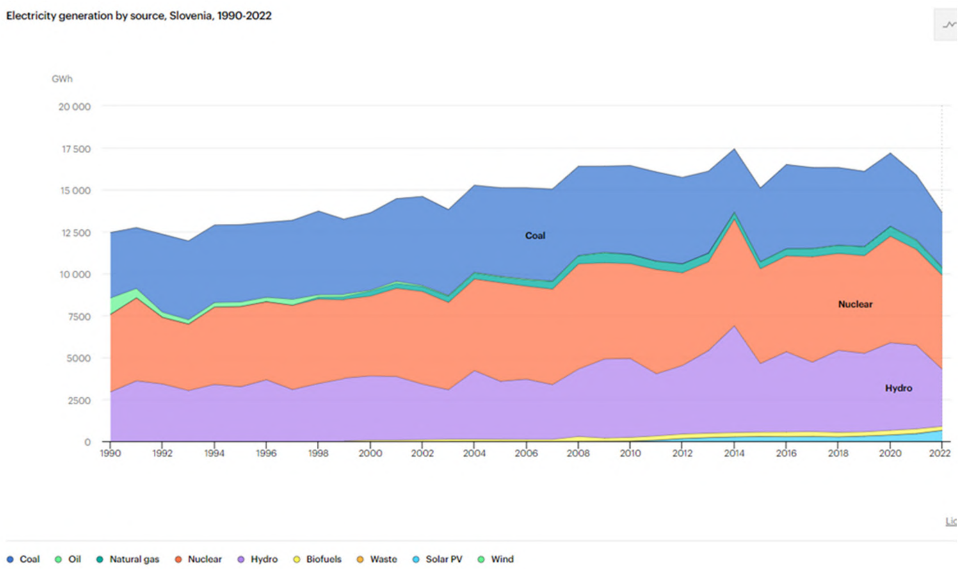

Figure 6. Electricity generation by source in Slovenia 1990-2022 (Source: IEA)

At the end of 2022, a total of 976,623 end electricity consumers were connected to the Slovenian power system. Electricity consumers are separated in three main categories on the basis of the system they are connected to, namely:

- Consumers connected to the Transmission System
- Consumers connected to the Distribution System
- Consumers connected to the closed Distribution System

The majority of customers are connected to the Distribution System. The distribution network consists of three voltage levels:

- High voltage [110 kV]

- Medium voltage [between 1 kV and 35 kV]
- Low voltage [0.4 kV]

The orientation of the Slovenian pilot is households and small business users (prosumers and consumers) connected at the low voltage level.

The number of final consumers of electricity by type of consumption	**2020**	**2021**	**2022**
Business consumers in the transmission system	3	3	3
Avče PSHPP consumption in the pumping regime	1	1	1
Total number of final consumers in the transmission system	**4**	**4**	**4**
Business consumers in the distribution system	108,505	110,766	110,552
Household consumers	855,039	860,776	865,857
• single-tariff metering	251,112	251,243	257,307
• dual-tariff metering	603,927	609,533	608,552
Total number of final consumers in the distribution system	**963,544**	**971,542**	**976,409**
Business consumers in closed distribution systems	231	203	210
Household consumers	0	0	0
Total number of final consumers in closed distribution systems	**231**	**203**	**210**
TOTAL NUMBER OF END CONSUMERS	**963,779**	**971,749**	**976,623**

Figure 7. Number of end consumers by consumption type (Source: www. https://www.agen-rs.si/)

3.1.1.3 Finland

The total final energy consumption (TFC) of Finland during the years 1990-2018 is presented in Figure 8. The electricity and oil products are the most significant energy source. In addition, biofuels and waste and heat have a big share of energy source in Finland.

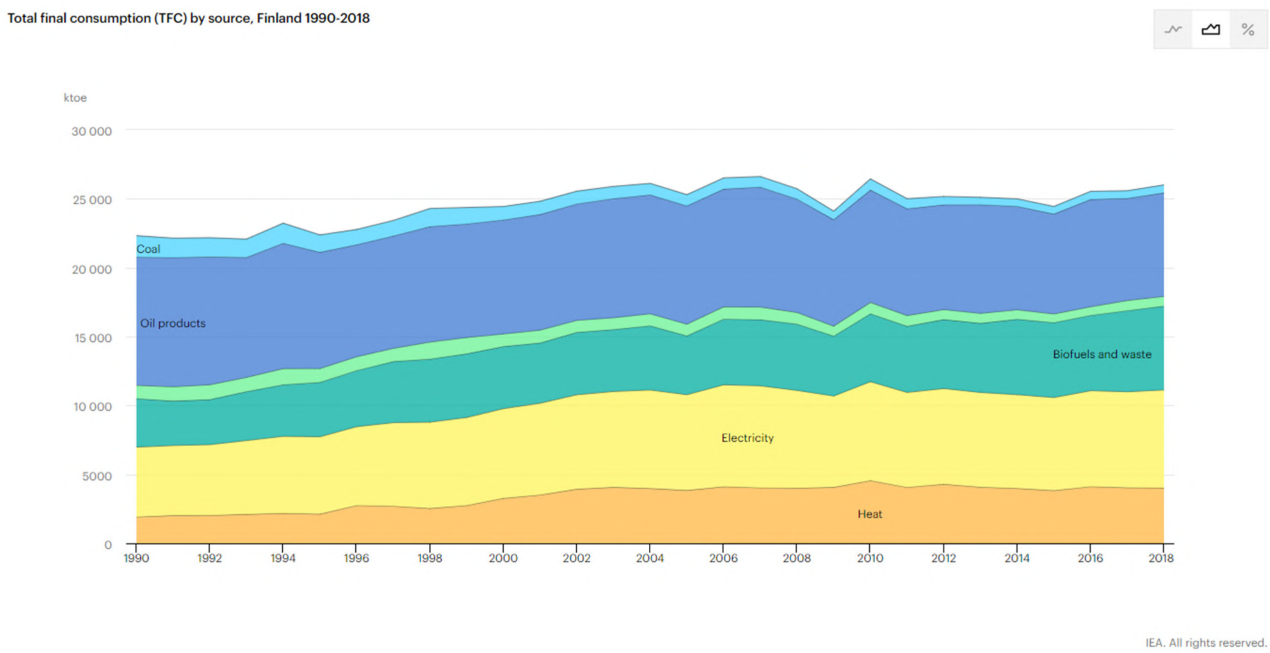

Figure 8. Total Fuel Consumption in Finland by source 1990-2018 (Source: IEA)

The final energy consumption by sector is presented in Figure 9. The industry is the largest energy consumer of total consumption in Finland.

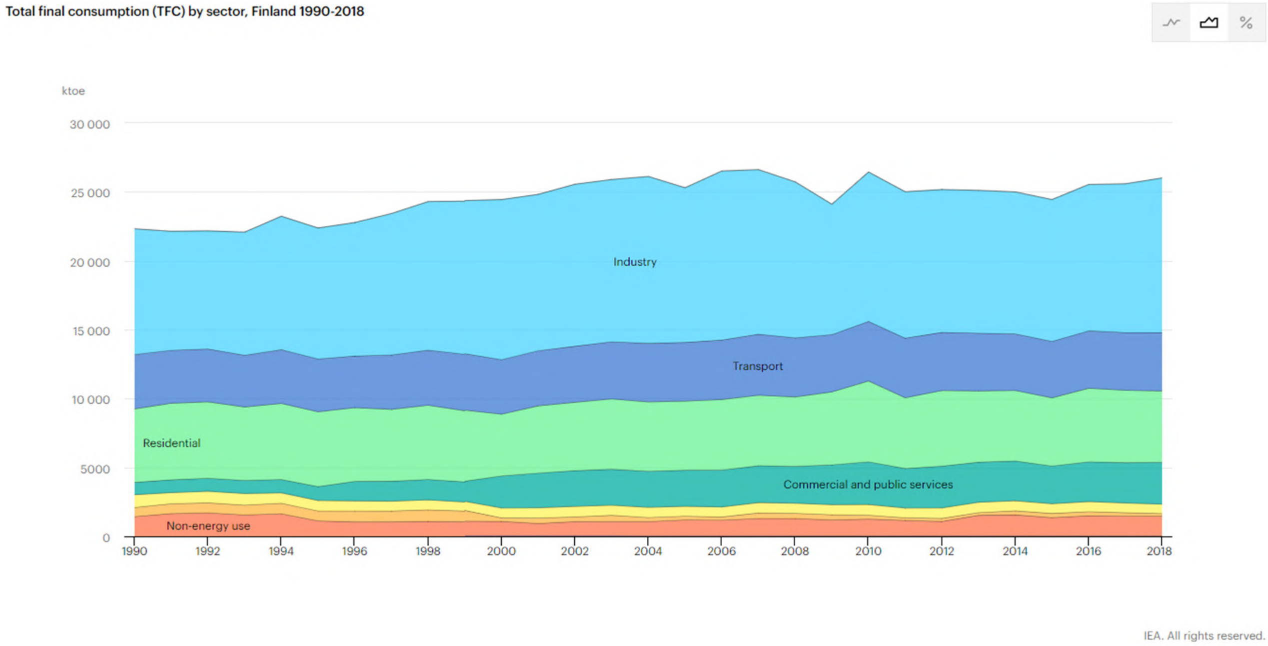

Figure 9. Total Fuel Consumption in Finland by sector 1990-2018 (Source: IEA)

Figure 10 shows the electricity consumption in Finland during the years 1980-2020. Electricity consumption in 2020 was 81 TWh and it decreased by 6% as compared to the previous year.

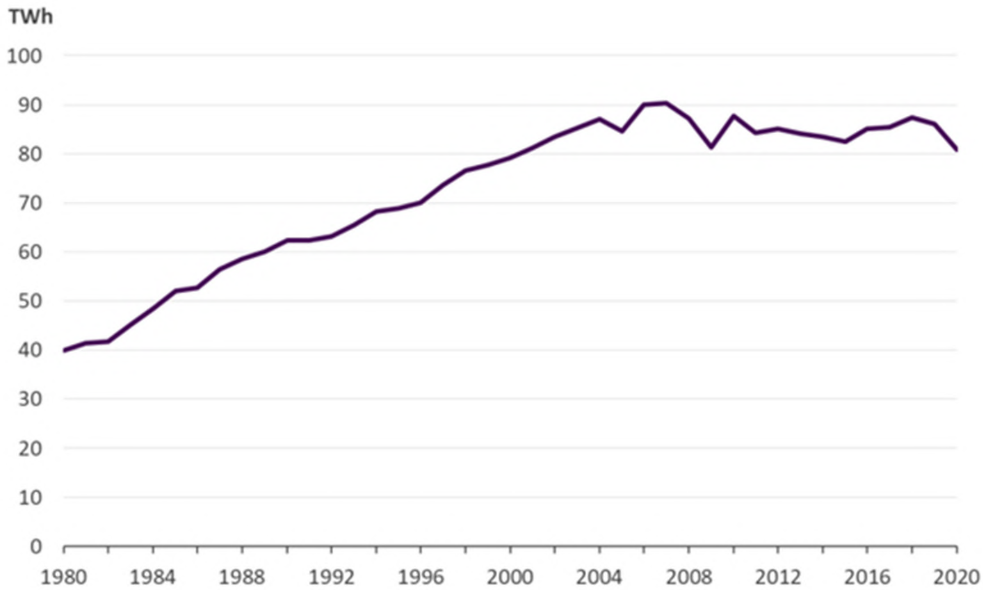

Figure 10*. The use of electricity in Finland (Source: Energiateollisuus)*

3.1.2 Energy communities

Energy Communities constitute a new and integrated institutional intervention supporting social economy in the energy sector. The main goal of the energy communities is to promote social economy values and innovative energy solutions, as well as to produce, distribute and exchange energy from renewable energy sources, in local or regional scale. Energy Community is an initiative for citizens, social organizations, local or city authorities, small and medium-sized local businesses to take part in energy projects as producers and consumers at the same time (prosumers).

The energy communities can strengthen the decentralized growth model, since incentives and benefits of clean energy production and management in local scale can be diffused across society to full extent. Locality is strengthened yet synergies and partnerships with public and private energy stakeholders are promoted.

The main idea is to bring together individuals, initiatives, social actors and the social economy, which are strengthened by the rule of democracy within the Energy Community, which is guaranteed by the parity of the participants, irrespective of the cooperative share.

Energy Communities enhance solidarity in favor of social economy, as well as attract and increase investment locally. Energy self-sufficiency, sustainability and environmental protection are the expected result, by making use of all available tools in the energy market, such as offsetting energy, netting energy, smart meters and more.

The concept of the energy community is introduced at the EU level in the “Clean Energy for all Europeans” package (EC, 2019) as a new provision on the energy market design and frameworks to engage EU citizens and activate the full benefit of distributed RES. Specifically, the recasts of the renewable energy directive (REDII) (DEU, 2018) and the electricity market directive (EMDII) (DEU, 2019) provide basic definitions and requirements for the activities of individual and collective self-consumption as well as for the energy community. According to these directives, the energy community defines as a legal entity based on open and voluntary participation, which is controlled by shareholders. The primary purpose of the energy community is to provide environmental, economic or social community benefits for its shareholders, rather than financial profits (Dorian Frieden et al, 2019).

The EU directives did not define any particular structure for the energy community. However, they address some principles that the efficient structure can be defined based on. The main principles related to the network operation of the energy community, are as follows (Nylund, 2018):

- Participation in an energy community is voluntary, and shareholders or members are allowed to leave it;
- EC are subject to fair, proportionate and transparent procedures and cost-reflective charges;
- Member states can decide whether energy communities are entitled to own, establish, or lease community networks and to autonomously manage them;
- where relevant, the energy community may conclude agreements with the DSO to which their network is connected on the operation of the community network;
- where relevant, energy communities are subject to appropriate network charges at the connection points between the energy community network and the distribution network outside the energy community. Such network charges shall account separately for the electricity fed into the distribution network and the electricity consumed from the distribution network outside the energy community.

Following these EU directives, each member of the EU defines the EC by setting a national regulatory framework. A survey of energy community regulation for relevant countries to this Project are as follows:

3.1.2.1 Greece

In Greece, the concept of Energy Communities was first introduced and established by Law 4513/2018, following the transposition of the related EU Renewable Energy Directive 2018/2001 into the Greek legal framework. Since 2018, several energy communities have been formed and currently there is a significant number of energy projects under development by these communities. Due to abundant renewable energy sources potential (mainly wind and solar), it is foreseen that energy communities are expected to gradually play a key role in the radical transformation of the domestic power system during the current decade moving towards the full transition to a climate neutral economy by 2050. Law 5037/2023 published on March 2023 introduced provisions for Renewable Energy Communities (RECs) and Citizen Energy Communities (CECs) denoted as successors of Energy Communities, thus transposing the relevant EU provisions.

The operation of Energy Communities (as well as RECs and CECs), beyond the direct benefits for its members, is expected to facilitate the application of successful technological examples of energy autonomy, especially in those regions in Greece that are mostly affected by the ongoing plan to terminate lignite use for electricity generation (i.e. Western Mecedonia, Peloponnese) with the ultimate goal of becoming self-sufficient and autonomous in energy, while also contributing significantly to the economic and social progress of its members. To date, Energy Community projects are mainly: (a) self-production projects aimed at meeting the energy needs of members (virtual net-metering projects) and (b) commercial RES projects, which generate profits for community members through market participation.

In December 2023, 1,689 active Energy Communities are recorded (+20% compared to 2022). Of these, 1,673 are Energy Communities under Law. 4513/2018, while 11 Renewable Energy Communities (RECs) and 5 Citizens' Energy Communities (CECs) were established under the new institutional framework (Law 5037/2023). Most connected RES projects by energy communities (306.2 MW) are located in Central Macedonia. Thessaly (266.6 MW) is in second place, even though it ranks fifth with regard to the number of energy communities, and is followed by Eastern Macedonia – Thrace (180.6 MW), Central Greece (112.7 MW) and Western Macedonia (80.5MW), the latter rank, respectively, sixth, seventh and second place in terms of number of Energy Communities.

An online map has been designed[1], including all Energy Communities registered until September 2020. The information incorporated into the online map consists of the name, title, registration date, activity status, and address details, i.e. region, and postal code, of each Energy Community. Figure 11 illustrates -in a static form- the online dynamic map.

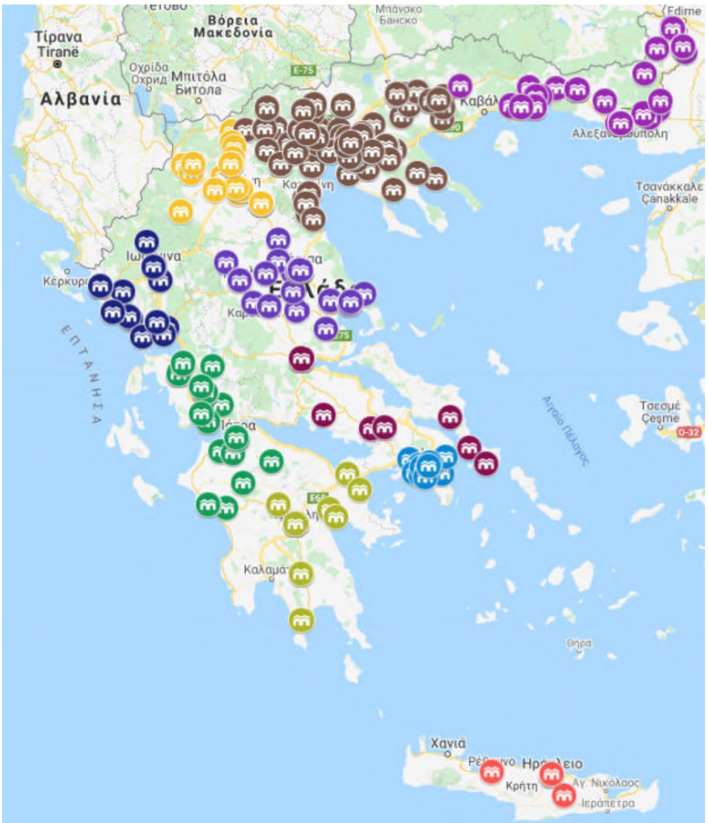

Figure 11. Existing Energy Communities in Greece (September 2020).

3.1.2.2 Slovenia

Energy communities in Slovenia are just being introduced into the electricity supply system. On the 12th of October 2020, the Directorate for Energy at the Ministry of Infrastructure published a proposal, the Electricity Supply Act (ZOEE), with a 1-month public consulation procedure at which the interested public could make their suggestions or comments on the proposed content.

---

1 https://www.google.com/maps/d/u/2/edit?mid=1lb0zwm5fQACnQbmlUU_nPxjd2YwEMIVN&ll=39.27454471657137%2C24.624370578524548&z=7

With the new Act new rules for the operation of the energy market, production, transmission, distribution, storage and supply of electrical energy are put in place. It also brings about new provisions for the protection of end users, methods and forms of public utilities in the fields of transmission and distribution of electrical energy as well as on the energy market.

The content of the new Act also determines the principles and measures required in order to achieve a reliable supply of electrical energy and also regulates measures for the prevention of energy poverty amd other issues connected with the supply of electrical energy.

Due to the adoption of EU legislation, the following areas also need to be regulated or determined:

- aggregation services
- rights of end users
- advanced measurement
- introduction of active customers and energy communities
- defining energy poverty
- energy storage (regulating the ownership and management of energy storage facilities)
- obligations regarding system services
- energy regulator receives new powers

In the existing legislation - the Decree on Self-Sufficiency with Electrical Energy from Renewable Sources (Official Gazette of the Republic of Slovenia, nos. 17/19 and 197/20) – the connection of self-sufficient community power plants is already regulated, whereby more end users can set up a solar power plant and use of part of the produced amount for their own consumption.

In 2019, the village of Luče has become the first Slovenian self-sufficient energy community that can fully cover the needs for electricity only on the basis of production from RES. Thanks to the Compile project, which is part of the EU Horizon 2020 program, the village is completely energy self-sufficient for certain periods of time. Together with partners Elektro Celje and the Faculty of Electrical Engineering of the University of Ljubljana, the largest Slovenian energy company Petrol, d.d. take care of the technical integration of the network. The lights were exposed to the challenge of a weak electricity grid, so they were encouraged to look for innovative solutions in the field of electricity supply. As part of the project, Petrol installed 102 kW of solar power plants at nine facilities, a system battery connected to the part of the network that supplies 35 metering points, and five house batteries that enable island operation of individual facilities and improve voltage conditions at the facility. They installed a public charging station for electric vehicles and renovated the transformer station to allow connection of the system battery and control of switches and terminals via t. i. micro-grid controller. They arranged the connection to the Tango system, which enables further management, analysis and optimization of operation. Within the project, Home Energy Management System (HEMS) was developed, which is intended for processing metering data from connected devices and managing systems. Based on all this, they achieved 5 times higher production from solar power plants than the network initially allowed.

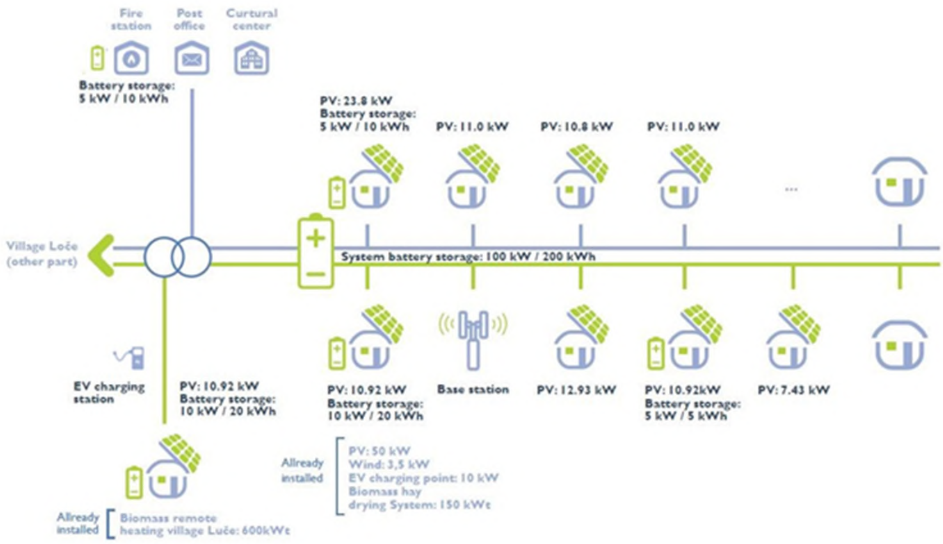

Figure 12. Energy Communitiy in Luče, Slovenia.

3.1.2.3 Finland

In Finland, the smart grid working group was commissioned by the Ministry of Economic Affairs and Employment to review and present concrete actions that would improve consumers' opportunities to participate in the electricity market and that would promote the security of supply. This Working group provide their suggestion for the regulatory framework of Energy Communities (EC) in Finland in 2018. The report can be found in (Pahkala et al, 2018). Here the suggestion of the working group, including three structure for EC, is briefly reviewed.

EC within a housing company: Fig. 13.a shows a diagram for this structure, when all members of EC, including the production, are located in one housing company and have one physical connection point with DSO. In this case, for the energy produced (for unit smaller than 100 kW) and consumed inside the EC, electricity tax and network service cost do not need to be paid; and consequently the related VAT. The virtual net metering and billing service for this energy will be on DSO duty for now. However, the housing company needs to define the division model of benefit and informed the DSO.

EC crossing property boundaries: Fig. 13.b shows a diagram for this case, when members of EC are located in one property with one connection point to the DSO, but the production site is out of their property. In these circumstances, the EC can build its network to avoid paying network service and electricity tax. Generally, In Finnish legislation, constructing an electricity network over two or more properties required a license, working as DSO. This principle is important as the construction of parallel networks is not cost-effective from society's point of view. However, the new EC framework suggests allowing connecting the source located outside of properties using the EC owned network, but it is not accepted yet by the ministry.

Distributed energy communities: Fig. 13.c shows a diagram for this case when members can be distributed over the country. In this case, the virtual net metering needs a central measuring database, called Datahub, as mentioned in Section 3.1.1. The EC members need to pay electricity tax and network service cost since they will use TSO and DSO services.

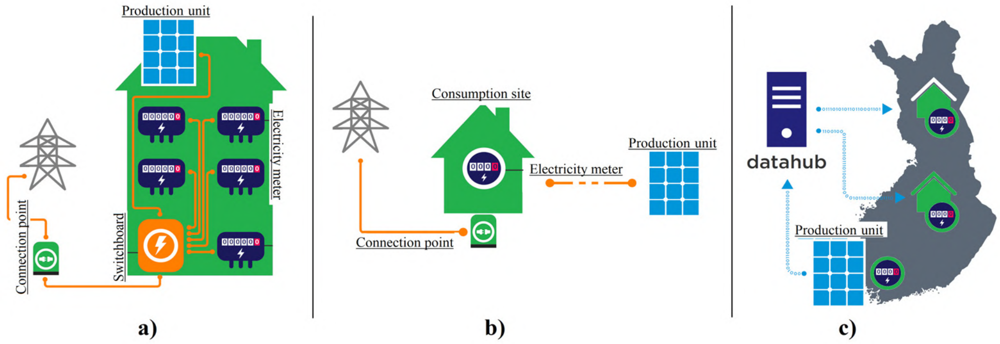

Figure 13. Three different cases suggested by the smart grid working group for Finland [18]. A) EC within a housing company, b) EC crossing property boundaries, c) distributed EC

At the moment, from the beginning of 2021, the first structure accepted by the ministry and can be followed as legislation. Several projects currently research and develop solutions for smart grids and smart cities in Finland. They are following this update in the legislation of electrical system to form the energy communities having the electrical energy as a heart and use power-to-X technologies to interact with other energy domains. They aim to demonstrate the advantages and possible challenges of this new regulation. This new regulation and suggestion of the smart grid working group are analysed briefly in (Divshali, 2020) and further suggestions are proposed. However, having an energy community in the broader meaning is not limited to the recent projects. Several energy co-operatives formed long ago in Finland. For example, Perho Energy Co-operative[2], which formed to share the local district heating and the participants provide wood chips from their forests. So far, energy communities in Finland have been mostly used for distributing solar power proceeds inside the housing company.

3.1.3 Prosumer

3.1.3.1 Greece

In Greece, small end-consumers (e.g. households, small enterprises) were first allowed to be involved in the electricity generation activity in 2009, where a scheme supporting electricity generation by rooftop PV installations of up to 10 kWp through a guaranteed Feed-in Tariff (FiT) was established. In fact, that scheme followed a variant of the "net-billing" principle, according to which the amount of electricity produced by the PV system was directly injected to the grid and was remunerated on the basis of a guaranteed FiT, while the entire electricity consumed by the end-consumer's electrical installation was charged on the basis of the agreed retail tariff. Given that the enacted FiTs for the injected energy were significantly higher than the retail tariffs, the end-consumers were usually credited the net amount (= remuneration for electricity injection - charge for electricity consumption, expressed in €) in every billing period. However, in this framework there were no economic incentives provided to the end-consumer to maximize self-consumption, since each installation (rooftop PV and internal electrical installation) operated (and was remunerated) independently.

Given that this scheme posed significant economic burden on all other end-consumers that were not possessing any rooftop PV, it was abandoned in 2013 and replaced by a new self-consumption scheme that was based on the "net-metring" principle and was legally established in December 2014 (Ministerial Decision 3583B/31.12.2014). The new self-consumption scheme, which is still in force until today, allows for the installation of RES systems (mainly PV units) connected to the LV or MV distribution network to primarily cover each prosumer's own electricity needs. With the Law N.4414/2016 the net-metering scheme was expanded in order to include additional technologies for self-production besides PV systems, including small wind turbines, biomass-biogas-biofluid stations, small hydroelectric stations and heat and power cogeneration facilities. Finally, Law 5037/2023 provides that the limit on Net-Metering capacity is set at 10,8kW for domestic customers and at 100kW for non-domestic customers, as opposed to the previous general limit of 3MW. Additionally, the limit on Virtual Net-Metering capacity is set at 100kW for power stations with agricultural use.

The operating principle behind the net-metering scheme is that the excess electricity that is produced by the onsite RES unit and is injected into the grid can be used at a later time to offset consumption during times when onsite renewable generation is absent or not sufficient. In other words, consumers use the grid as a backup (storage) system for their excess power production. If the total amount of electricity injected to the grid

[2] http://web2.vtt.fi/virtual/afbnet/perho-engl-2.pdf

(I) is greater than the amount of absorbed energy (A) during the billing period (e.g. one month), the consumer is credited with the relevant surplus (which is expressed as the negative difference A-I) in energy units (kWh) instead of monetary units (€) for the next billing period. The maximum time period that the surplus RES generation can be credited to subsequent billing periods is equal to three years. Any surplus electricity fed into the grid that remains in the prosumer's account after the three-year period is zeroized without any obligation for remuneration.

Although prosumers under the net-metering scheme are not adequately incentivized to maximize self-consumption (since, in fact, the remuneration price for the energy injected to the grid is identical to the agreed retail tariff), the maximization of self-consumption rate (leading to the minimization of the amount of absorbed (A) and injected energy (I)) contributes towards the minimization of regulated charges and, therefore, prosumers can indirectly enjoy lower electricity bills. This is justified by the fact that the entire installation of the prosumer (RES unit combined with the internal electrical installation) when operating under maximum self-consumption rates poses minimum burden on the transmission and distribution network operation.

Since 2018, farmers, Municipalities, Charitable Institutions and Energy Communities are also able to install and operate a RES unit under the "virtual net metering" scheme. This way it is possible to offset the energy produced by a RES unit to the energy consumed by one or more self-consumption facilities, while the production facility is not necessarily located in the same (or adjacent) property with the electrical installation and directly connected to it.

However, in early 2024, the Greek Ministry of Energy is considering to abolish net-metering for self-production and replace it with a net-billing formula following objections raised by the European Commission, promoting the latter approach as most appropriate for self-consumption.

Besides the aforementioned schemes, currently there are no other commercial schemes allowing for the active involvement of prosumers in the electricity market.

3.1.3.2 Slovenia

Potential providers of flexibility services are all users of the power system that have active elements - sources of flexibility in the form of resources, consumers and energy storage devices. They are characterized by the fact that they can be influenced, which makes them suitable for the provision of flexibility services. In general, we can say that flexibility service providers are active customers. The term active customer refers to a customer who, with its sources of flexibility, adapts to price signals (implicit flexibility based on tariff signals) and actively responds to direct calls to activate the provision of flexibility services according to the state of availability of its flexibility resources (dispatched explicit flexibility).

In households, energy sources are mainly photovoltaic systems, energy storage devices are mainly battery systems, and consumers are heat pumps, heating, cooling and ventilation systems, refrigerators, heaters, washing machines and dishwashers and the like. For many years we have option of two tariff system, which means, that if households use electricity between 10 pm and 6 am or during weekends, they pay less. This is a simple system to incentivize the change peak power consumption.

The benefits accruing to customers through the provision of flexibility services include: savings in the calculation of network charges based on tariffs, savings in the calculation of energy supply based on tariffs, improved optimization of energy costs due to options combining different energy sources, different suppliers, etc.,peak power management, self-sufficiency to cover own consumption and increased energy independence, the possibility of using the system despite external limitations (island operation, emergency power supply, etc.), the possibility of participation in energy communities, direct payments for the provision of explicit flexibility services (participation in frequency and non-frequency system services, participation in wholesale market services), market access (eg directly or through aggregators).

Since January 2016, a decree on self-supply of electricity from renewable energy sources that regulates a net-metering programme is valid in Slovenia.

The net-metering support scheme is available for households and small businesses with power demand up to 43 kW (fuses 3x63A). The aim of the policy is not to encourage electricity production for export but for self-consumption, hence if at the end of the calendar year there was more electricity sent to the grid than acquired, the surplus will not be remunerated.

Accounting period is occurring at the end of each calendar year. The max electrical production power is limited to 80% of max. power that can be taken from the grid. Only PV with that or lower power can participate in the programme.

All renewable energy installations are eligible to participate in the net metering. Installations participating in the net meting are not allowed to benefit from feed-in tariff and premium support scheme.

The net-metering works on the basis of measuring the production and consumption of electrical energy. When the solar power plant produces more electricity than the facility consumes, it transmits the surplus to the grid (during the day). At night, when the solar power plant does not produce energy, the facility takes electricity from the grid. In this way, the electrical network acts as a store of electricity.

Net-metering is a special way of connecting and billing electricity and represents a changed approach from the current system of support to producers of electricity from solar power plants.

The accounting period of the net measurement covers the entire calendar year. Because the amount of electricity produced in solar power plants in the summer months is higher than in the winter, the surplus electricity produced in the summer can be used free of charge in the winter.

The proposal for a regulation sets out measures to promote self-sufficiency in electricity from renewable sources, conditions for connecting a device for self-sufficiency in electricity from renewable sources, safety requirements, the method of billing for transmitted and received electricity and the administrative procedure for connecting the device to the building's internal installation.

The essence of the regulation on self-sufficiency in electricity is as follows:

- Net-metering of electricity runs on an annual basis. Net-metering allows the owner of a self-supply device to inject electricity to the grid when production is higher than local consumption and to take it back from the grid at times that its consumption exceeds its production capacity.
- Owners made for self-sufficiency will thus receive only one electricity bill throughout the year, which will take into account the difference between the electricity consumed and produced. If the self-sufficiency device is properly dimensioned, the owner of the devices will have virtually no electricity costs, as it has produced as much as it has consumed over the years.
- In the event of excess energy, you can take over the electricity supplier, with whom the owner of the devices has a net supply contract, free of charge.
- The owner of the device still has to pay the costs of the network in contributions for CHP and RES, which are related to the max. power of the measuring point of consumption.
- As the self-supply device is connected inside the installation, the existing measuring point does not need to be changed.
- The only change that is needed is to replace the existing electricity meter with a new two-way meter, which also allows remote reading. Therefore, that also greatly simplifies the administrative procedure.
- The owner of the device will have to apply to supplement or change the existing consent for connection and conclude a net supply contract with the supplier.

3.1.3.3 Finland

In Finland, the end-users of electrical energy need to pay the cost of energy generation and all the grid units involved in transmission and distribution. Currently, the price of electricity for end-users consists of three parts: the price of electrical energy, the price of the electricity network service (DSO and TSO), and taxes. This section shortly explains these parts. More details can be found in (Divshali, 2020)

Tax:

Although the tax is not a cost of energy, it is a big part of the end-user bill. Therefore, it plays a significant role in their decision. Currently, end-users pay value-added tax (VAT) and electricity tax (TE). The VAT is proportional to all other costs, 24% (will be increased to 25,5% in 2025) in Finland and the electricity tax is based on measured consumption, currently 2.793 (2.252 + 24% VAT) Euro cents per kWh for regular customers. Some customers, such as data centre and energy producers including battery storage system operator can use the class II tax, which is 0.0781 (0.063 + 24% VAT) Euro cents per kWh.

Electrical Energy

The end-user must pay the cost of the electricity they use, which they can buy from electricity providers (retailers). Electricity providers are companies that purchase electricity from the wholesale electricity market and sell it at a retail level to the end-user. They are also responsible for keeping the balance between the production and consumption of their customers.

Electricity providers estimate the aggregated consumption of their customers and buy the required energy from the day-ahead market, intra-day market or from their own resource. In Finland, the day-ahead market is called the NORD POOL day-ahead market, which has an average price of about 6.66 Euro cents per kWh in 2023 incl. VAT. When the retailer has some error in the estimation of the consumption, it results in some real-time mismatch, which should be traded in the imbalance power market. By looking at the selling offers of large energy providers in Finland, it can be realized that the balancing service would not be very costly for the retailers.

Most of the electricity providers in Finland offer also hourly prices based on the hourly rate of the day-ahead market plus a small margin (e.g. 0.3 Euro cents per kWh). This small margin should cover the imbalance cost. Therefore, the average imbalance cost in the current situation is less than 7% on average. However, it may be increased in the future due to self-consumption. In addition to this margin, the energy electricity providers usually charge a fixed monthly fee to cover their costs, such as billing (e.g. 5 € per month).

Network Service

In order to deliver the electrical energy from generators to end-users, the distribution system operator (DSO) collects the network service charge from end-users. This money is used to cover e.g. the cost of the new investments, the maintenance of electricity networks, the cost of losses and maintaining the stability of the power system.

The network operators typically are split into two main levels: 1) transmission system operator (TSO), who operates the high voltage (HV) network and provides the stability of power system, 2) DSO, who operates medium voltage (MV) and low voltage (LV) grids. There is no competition among system operators and they have to provide service to all end-users in their area. System operators have local monopoly positions due to the fact that it is economically ineffective to build parallel electricity distribution networks inside the same area. Since there is no competition, the energy authority monitors the network operator profits. Therefore, the network tariff can practically represent the network cost. The breakdown of the network service cost is as follows: HV network cost, ancillary service cost, MV network cost, LV network cost, and Billing cost.

Fig. 14 shows two examples of approximate shares of energy bills for a normal house having electric heating (annual consumption of 18,000 kWh). The inner plot shows the break down when the house located in a city area (the network service cost from Helen, DSO of Helsinki) and the outer plot depicts when the house is in a rural area (the network service cost from kajava, one of the most expensive DSO in Finland). It can be seen that the energy cost (plus the corresponding VAT) has only 36% - 45% of total electricity cost. The network service is responsible for 34% - 47% of the total electricity cost. It is worth mentioning that since VAT is proportional to other costs, it is shown separately from the electricity tax.

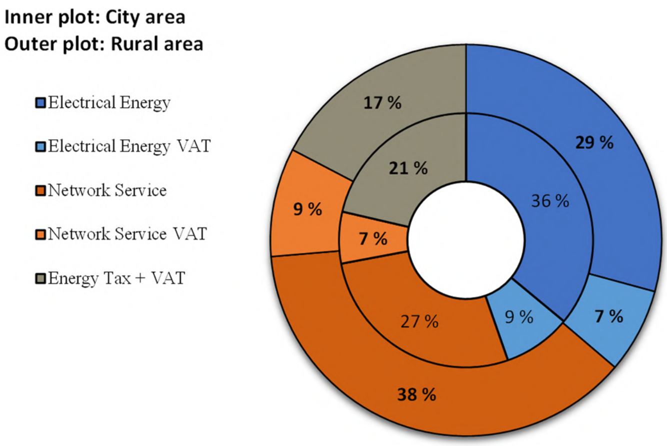

Figure 14. The approximate share of different parts of the energy bill for a normal house with electric heating in the city area (inner plot) and rural area (outer plot) of Finland.

It is worth mentioning that currently there are no feed-in tariff incentives in Finland. This scheme has stopped since 1 November 2017 for new wind power plants and on 1 January 2019 for biogas and wood fuel power plants. The prosumer normally can sell the extra production to the retailer with the hourly price of the wholesale market.

3.1.4 TSO, DSO

3.1.4.1 Greece

Independent Power Transmission Operator (IPTO)

The Independent Power Transmission Operator (IPTO or ADMIE) S.A. was established in compliance with Law 4001/2011 and Directive 2009/72/EC. According to Law 4001/2011, ADMIE undertakes the role of the Transmission System Operator (TSO) in Greece. As such, it performs the duties of system operation, exploitation, maintenance and development so as to ensure the electricity supply in Greece in a safe, efficient and reliable manner.

ADMIE is the sole owner of the Greek Transmission System, in compliance with the Independent Transmission Operator (ITO) model provisioned by Directive 2009/72/EC. Although it is a 100% subsidiary of Public Power Corporation (PPC), the ex-monopolist in the Greek electricity sector, ADMIE is entirely independent from its parent company in terms of its management and operation, retaining effective decision-making rights, in compliance with all relevant independence requirements provisioned by the legislative framework. Its mission is to ensure the electricity supply in Greece in a safe, efficient and reliable manner while promoting the development of competition in the Greek electricity market and guaranteeing the non-discriminatory treatment of System users.

Regarding flexibility, Greek IPTO is the Balancing Market Operator, where flexibility is procured by the Balancing Services Providers (BSPs) to address system imbalances with respect to the prior solution of the Day-Ahead and Intra-Day Markets. Balancing Market consists of the a) Balancing Reserve Market, for the ex-ante procurement of the necessary amount of system reserves by the eligible reserve providers and b) the Real-Time Balancing Energy Market, for the activation of balancing energy to address system imbalances in real-time. In this context, ADMIE acts as the central counterparty, both in the Balancing Services Procurement (with the BSPs) and the Imbalance Settlement (with the Balancing Responsible parties, BRPs), thus guaranteeing an adequate provision of all types of Balancing Services at all times and to all locations within its area of responsibility.

Additionally, Greek IPTO was the Operator of the Transitional Flexibility Remuneration Mechanism (TFRM) that was active in the Greek electricity market for the period 2018-2020. TFRM was an auction mechanism that rewarded capacity availability of dispatchable power plants, which were eligible as flexibility providers on an annual (or quarterly) basis. Through the auction, the system procured availability of eligible plant capacities, which resulted into annual (or quarterly) capacity contracts with the plant owners. The plants which were eligible to participate were subject to a pre-qualification procedure. The eligible plants participated in the auction as bidders, offering pairs of capacity quantities and prices with accumulated quantity bid being less or equal the amount of pre-qualified capacity. The auction winners concluded capacity contracts with the TSO for receiving capacity remuneration. Failing to comply with minimum availability requirement specified in the contract, implied financial penalties for the power plant up to the amount foreseen annually for remuneration. TFRM scheme was terminated at the end of 2020, just before the implementation of the new Target Model-based wholesale electricity market in Greece, since it was considered that all domestic flexibility requirements could be fully covered and adequately remunerated through the operation of the new Balancing Market in Greece.

Finally, Greek IPTO was the Operator of the Interruptibility Mechanism for the compensation of interruptibility services provided by eligible HV consumers through the conclusion of Interruptible Load Agreements. In principle, the EC final decision (7374/2014/EU) compensated certain undertakings located in the Greek interconnected system that entered into contracts with the Greek IPTO (ADMIE) to agree to reduce their electricity consumption ("load shedding") for a given period of time and given a stated notice time ("Power Reduction Order"). As it is common in various European countries (similar schemes are currently implemented in seven EU Member States: France, Germany, Ireland, Italy, Poland, Portugal and Spain), industrial users agreed with the TSO to temporarily reduce (or "interrupt") their electricity demand to cover imbalances in the supply and off-take of electricity from the network, in accordance with Directive 2009/72/EC (the "Electricity Directive") which stated (recital 41) that "*…Member States or, where a Member State has so provided, the regulatory authority, should encourage the development of interruptible supply contracts."* The said Interruptibility Mechanism was terminated at the end of 2021.

In the place of both these supporting (out-of-the-market) mechanisms for safeguarding adequate available flexilibilty resources for the secure, reliable and efficient operation of the Greek power system, the formulation of a new Long-Term Capacity Remuneration Mechanism (CRM) is currently being discussed. Greek long-term CRM is expected to be formulated as a volume-based and market-wide mechanism, where Reliability Options

(“ROs”) will be traded in central auctions managed by the Greek TSO (in accordance with the respective mechanism already established in Italy) aimed at procuring the quantity of capacity required to ensure generation adequacy and protecting consumers while the market evolves.

Hellenic Electricity Distribution Network Operator (HEDNO)

The Hellenic Electricity Distribution Network Operator (HEDNO) S.A. was formed by the separation of the Distribution Network Department from PPC, according to Law 4001/2011 and in compliance with Directive 2009/72/EC. It is a 100% subsidiary of PPC, however, it is independent in operation and management retaining all the independence requirements that are incorporated within the aforementioned legislative framework.

Company tasks include the operation, maintenance and development of the electricity distribution network in Greece as well as the assurance of a transparent and impartial access of consumers and all network users in general.

HEDNO S.A. is responsible for the development, operation and maintenance under economically advantageous terms of the HEDN (Hellenic Electricity Distribution Network), so as to assure its reliable, efficient and safe operation as well as its long-term capability to respond to the reasonable needs of the electricity, also caring for the protection of the environment and the energy efficiency. In addition, it is responsible for the assurance of the users’ access to HEDN with the most economical, transparent, immediate and impartial way, so as to execute their activities according to the Management Permit and the Management Code of HEDN.

The absence of appropriate technical infrastructure in the LV network (e.g. smart meters, IT infrastructure) does not allow for large-scale provision of flexibility services by small electricity consumers (e.g. households, offices, small enterprises). In this context, HEDNO is currently inactive regarding the wide implementation of DR programs in LV consumers. It is expected that the ongoing project related to the replacement of all conventional (electro-mechanical) electricity meters (around 7,5 million) with smart meters will enable the large-scale deployment of demand response programs. This will allow HEDNO to actively procure flexibility services by millions of electricity consumers, thus transforming HEDNO to an active player in the wholesale and retail electricity market.

3.1.4.2 Slovenia

TSO

The Slovenian transmission electricity network is owned by the system operator, the company ELES, d.o.o., who also manages the network.

The Slovenian transmission network consists of facilities with voltage levels of 110 kV, 220 kV and 400 kV. These facilities are predominantly overhead lines (transmission lines) and distribution-transformer stations. The Slovenian transmission network also consists of a few shorter cable lines. All major Slovenian production units are connected to it. All five public distribution networks are supplied from this network for domestic needs. In addition, some of the largest Slovenian electricity consumers are directly supplied from it.

The Slovenian transmission network is also well integrated into the European electricity system, as it is connected to the networks of neighboring countries Austria, Croatia, and Italy by power lines, while the connection with Hungary is still in the preparation phase. These connections have a significant impact on the safety of the Slovenian electricity system, as they enable mutual assistance in the event of operational problems. In the period after the opening of the market, these connections are largely used for cross-border trade in electricity, mainly since Slovenia is located among countries with very different wholesale electricity prices.

The transmission system operator must always ensure a balanced flow of energy, which is reflected in the balancing of operating and reactive power. The active power - frequency and reactive power - voltage ratios are used. When compensating for active power, the reserve for frequency maintenance (hereinafter RVF), automatic frequency recovery reserve (hereinafter aRPF) and manual frequency recovery reserve (hereinafter rRPF). The required energy is provided by system balancing services. These are already paid flexibility services. On the basis of annual or multi-annual tenders, the system operator concludes direct contracts with major production units, aggregators and consumers that provide aRPF and rRPF services. Both the readiness to perform system services and their activation are payable. RVF is not currently a paid service, but all units connected to the 110 kV, 220 kV and 400 kV network are obliged to perform it in accordance with the legislation.

The system operator purchases the balancing energy of the replacement reserve (hereinafter RN) for the purpose of releasing the regulatory ranges aRPF and rRPF on the balancing market of the market operator for the needs of the control area of the Republic of Slovenia, in accordance with the Rules for Balancing the Electricity Market. The market operator (Borzen d.o.o.) determines the list of products (in cooperation with the system operator) and the procedure for activating offers on the balancing market of the market operator. The system operator purchases the required amount of balancing energy through the trading platform, followed by the activation of offers and the supply of balancing energy by registering a closed contract with the market operator.

Most of these frequency system services are still provided by conventional sources of flexibility today. In the future, it will increasingly be possible to use the resources of more numerous but smaller network users, combined and coordinated by aggregators, to provide system services by providing flexibility services. Frequency system services are not limited locally.

They can be performed by all appropriate (qualification procedure) consumer or production units within the electricity system. This also includes all units connected to the distribution network (the system operator explicitly regulates the aggregation of sources connected to the distribution system in the new rules) and are thus only indirectly connected to the transmission network, which requires appropriate coordination between the respective electricity operators.

Non-frequency system services for the needs of the system operator are location-based with the location in the network. Flexibility services for the needs of the system operator could in the future also include cooperation in voltage regulation, network capacity management, congestion management as well as managed island operation.

DSO

The distribution network is connected to the transmission network via distribution and transformation stations. It consists of transformer stations and power lines of various voltage levels (110 kV, 1-35 kV and 0.4 kV), which are intended for the distribution of electricity to end customers. Smaller electricity producers are also connected to the distribution network.

The distribution system operator, the company ELES, d.o.o., performs the economic public service of the electricity distribution operator on the territory of the Republic of Slovenia. It provides more than 933,000 users of the distribution network in Slovenia with a reliable, safe and efficient electricity supply.

Pursuant to the contract on the lease of electricity distribution infrastructure and the provision of services for the electricity distribution system operator, the following distribution companies carry out distribution activities on behalf of ELES:

a) Elektro Celje, d.d.,
b) Elektro Gorenjska, d.d.,
c) Elektro Ljubljana, d.d.,
d) Elektro Maribor, d.d. and
e) Elektro Primorska, d.d.

The basic task of the distribution operator is to ensure the uninterrupted supply of electricity to customers and to ensure the uninterrupted use of the network to other users, such as distributed sources. The voltage parameters at the point of connection to the mains must comply with the standards.

When operating the distribution network, it is essential to ensure appropriate voltage profiles and to prevent overloading of individual network elements (e.g. lines, transformers). The classical approach to network operation is based on passive network users who do not participate in network operation. This means that the network needs to be dimensioned significantly richer, which means larger investments in network infrastructure. In an alternative approach, active network users use flexibility to provide voltage regulation, network capacity management (congestion prevention, loss reduction), congestion management, as well as island operation. By using flexibility, it is also possible to shift investments in distribution network infrastructure. However, caution is needed, as despite the use of flexibility, it is necessary to ensure the modernization and development of distribution networks. Flexibility services are suitable for solving problems in distribution networks that occur only occasionally and to a limited extent.

The provision of flexibility services for the needs of the distribution operator is limited locally and is carried out only in parts of the distribution network where necessary. Therefore, information about the location of the service is crucial for the distribution network. In such a part of the network, the provision of flexibility services to other flexibility users is only possible if they support the effects that the distribution operator wishes to achieve by providing flexibility services. Such a restriction shall apply as long as those flexibility services necessary for the smooth operation of the distribution network are provided for the needs of the distribution operator. This category certainly includes the prevention of overloading of network elements and the provision of voltage profiles.

3.1.4.3 Finland

TSO

The Finnish Transmission System Operator is Fingrid, whose owners are the Finnish state and Finnish pension insurance companies. The mission is to secure the supply of energy in the Finnish society in all circumstances and to promote a clean, market-based power system.

The Finnish power system is part of the joint Nordic power system. Electricity is constantly flowing from one country to another, and Finland is also connected to the Central European power system through electricity transmission connections. Finland also has transmission connections to Estonia and Russia, which has not been used since 2022 Ukraine invasion. These cross-border connections safeguard the power system's security even in the coldest winters. On the other hand, sufficient transmission connections are also the best guarantee of a functioning electricity market.

Fingrid has two main services: Main grid services and Electricity market service. The aim of the grid services is to secure a reliable transmission system capable of meeting the needs of electricity companies and energy-intensive industry. The grid services include:

- ***Connection to the main grid.*** Fingrid implements the main grid connections that our customers, including DSOs, need. Fingrid ensures that the main grid and the customer networks are compatible. We guarantee the electricity transmission capability at the connection points.
- ***Network design.*** Fingrid develops the main grid by anticipating the needs of customers and society.
- ***Electricity transmission and the use of the electricity system.*** Fingrid ensures that the electricity system of Finland functions reliably 24/7. Maintenance measures and transmission outages are planned carefully in advance. Fingrid also prepares for exceptional conditions.

In addition to the grid services, Fingrid offers all market participants a unified bidding area in Finland and the benefits of open European electricity markets. The market services include:

- ***A unified electricity market.*** Ensure that Finland is a single bidding area and offer access to the European electricity market using its cross-border connections. In this regard, it provides the highest transmission capacity possible for the market continuously and develops the rules of the market.
- ***Reserve market.*** Maintain and develop the marketplaces for reserve and balancing power.
- ***Balance services.*** Determine electricity balances and provide imbalance power for the balance responsible parties.
- ***Datahub services.*** Develop an effective platform for information exchange for parties operating in the retail market.
- ***Guarantees of origin.*** Guarantee the origin of electricity for renewable forms of energy.
- ***Open data on the electricity market.*** Provide information on the electricity market openly and free of charge.

DSO

Finland has about 80 distribution network companies, which develop and operate the distribution system. The high voltage distribution systems are operated by 10 companies, which are managing the connection between the main transmission grid and the distribution networks in Finland.

Finland's largest DSOs are Caruna Oy, Elenia Verkko Oyj and Helen Sähköverkot Oy. In total, the fifteen largest DSOs in Finland cover more than 70% of the distribution networks, electricity users and the companies' turnover. The smallest electricity network companies in Finland operates in the territory of one municipality and serve a few thousand customers. Most DSOs in Finland are owned directly or indirectly by municipalities.

3.1.5 Retailer

An electricity retailer (henceforth, “Retailer”) has been among the key participants in the electricity market, as it acts as intermediary between electricity producers and consumers and, in principle, operates as an entity that is independent of any generation or distribution company. The core business of the Retailer is to purchase energy from various resources (through bilateral contracts with conventional and RES producers and/or imports, directly from the wholesale market, etc.) and resell it to end-consumers through differentiated and competitive retail contracts aiming at the maximization of its own profits and market share.

3.1.5.1 Greece

Law 3426/2005 promoted the acceleration of the liberalization of the Greek electricity market within the framework of the harmonization to the provisions of Directive 2003/54/EC (2nd EU Energy Package). Among others, it introduced the full opening of the electricity market and since July 2007 all end-consumers have had the right to freely choose their electricity supplier (retailer).

A growing number of electricity retailers has entered the market since then, especially after July 2013, when retail electricity prices became fully liberalized. The only retail tariffs that still remain regulated are those under Public Service Obligations, i.e. the social tariffs (equal to all vulnerable customers who meet the requirements set by Ministerial decree) and the prices offered under the Supplier of Last Resort and Universal Service Supplier services.

According to the latest available data (Dec. 2023), the retail market share of the ex-monopolist Public Power Corporation (PPC) is currently equal to 55.6%, although around 20 private alternative suppliers are now active in the retail market. There are four main alternative suppliers, each with a market share of 5.6– 10.8%, and the rest of alternative suppliers (fifteen companies) have gained a total share of 12.9% so far. Figure 15 illustrates the current market shares of the five largest electricity suppliers in Greece.

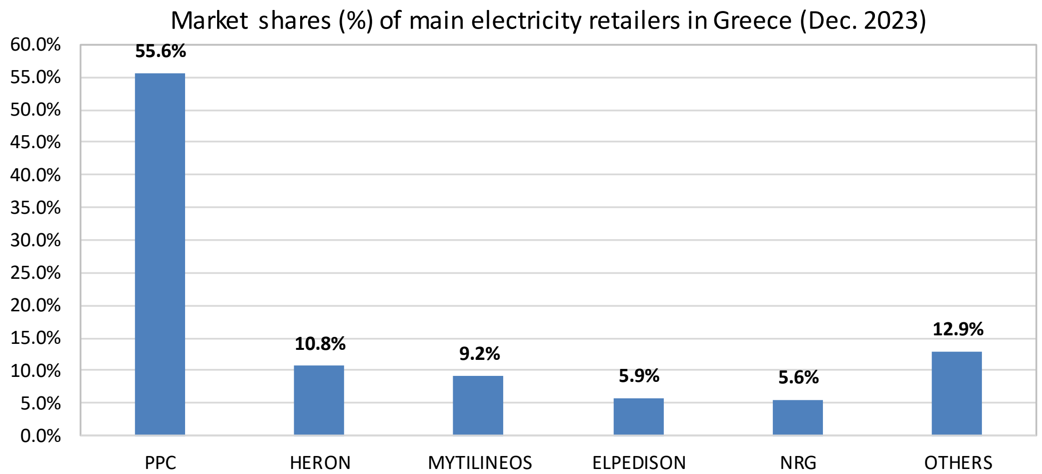

Figure 15. Electricity retailers with largest market shares in Greece (Dec. 2023)

Although there are plenty of competitive products and services provided by the vast majority of the alternative electricity suppliers, Regulatory Authority for Energy has identified that end-consumers are reluctant to switch supplier. Customer inertia, market inequality, regulatory disincetivization and the complexity of understanding the electricity bill, including several non-electricity related items, such as municipal tax, television use charges and other costs, have been identified as possible barriers to changing electricity supplier.

Regarding gas market, the delayed opening of the wholesale market and structural competition issues have been the main reasons for the sluggish development of the gas market in Greece. Until recently, at the wholesale level there have been limited supply options with subsequent effect on prices and portfolio diversification. Similarly, the limited competition at the supply side has also delayed the retail market opening, as retailers could not diversify their supply portfolio, having practically the option to purchase gas only through the Public Gas Corporation (DEPA) until recent years, with the exception of LNG shipments. However, an increasing number of electricity retailers have been granted licenses to become alternative suppliers in the retail gas market too. Gas supply prices are now also completely deregulated, while transmission and distribution tariffs are regulated. Most retailers offer combined (electricity and gas) competitive products to all end-consumers categories in order to expand their customer portfolio and, thus, increase their market share in both sectors.

3.1.5.2 Slovenia

The electricity market in Slovenia was opened in 2001, for business customers at metering points that exceeded 41 kW of connected power. In 2004, the market was liberalized for all measuring points of business customers.

With the complete opening of the electricity market (1 July 2007), i.e. also for households, electricity has become a marketable commodity. Prior to that, distributors had a monopoly position on their distribution network. Now the market in Slovenia is completely open, which means that all customers are free to choose their electricity supplier. Distribution and supply of electricity are separate, so the choice of supplier does not affect the quality of supply.

In Slovenia there are 22 active suppliers in the retail market, supplying 976,623 customers in 2022. ECE is second largest supplier in Slovenia.

The exchange of data between suppliers and DSO takes place through a single entry point. Larger amounts of data can be exchanged through online services, which suppliers incorporate into their information system. This saved a lot of time and the quality of the data is better and the possibility of errors is significantly lower.

SUPPLIER	Supplied Electricity [GWh]	Market Shares
GEN-I	2,685.0	20.7%
ECE	1,963.8	15.2%
Petrol	1,864.0	14.4%
Energija plus	1,515.6	11.7%
E 3	1,485.8	11.5%
HEP	1,054.9	8.1%
Elektro energija	631.4	4.9%
Others	552.8	4.3%
HSE	546.7	4.2%
TALUM	342.0	2.6%
Acroni	315.2	2.4%
Total	**12,957.1**[86]	**100%**
HHI of suppliers to all final consumers	**1,273**	

Figure 16. *Electricity retailers with largest market shares in Slovenia 2022 (www.agen-rs.si)*

According to the purchasing power standard, the electricity supply price for typical household customers in Slovenia was below the EU average in 2022.

3.1.5.3 Finland

The electricity market Act was passed in Finland in 1995 and since then the electricity market was gradually opened to competition. Since late 1998, all electricity users, including private households, have been able to choose their preferred electricity supplier (retailer).

There are approximately 75 electricity retailers in Finland. The electricity market also allows electricity consumers to practice small-scale electricity production and sell the energy on the market. Thus, households are becoming active players in the electricity market.

3.1.6 Balancing Service Providers and Balance Responsible Parties

3.1.6.1 Greece

In Greece, besides Greek TSO (ADMIE) who is the central Balancing Market Operator, the stakeholders associated with the operation of the Balancing Market are separated in two main groups, namely Balancing Service Providers (BSPs) and Balance Responsible Parties (BRPs).

The Entity is a physical unit or a portfolio of physical units which is subject to Imbalance Settlement. Each Entity bears a Market Schedule as a result of its participation in the previous wholesale market segments (Forward, Day-Ahead and Intra-Day Markets).

The Entities are differentiated in Balancing Service Entities (BSEs) and Balance Responsible Entities (BREs). The Balancing Service Entities are represented by BSPs, whereas the Balance Responsible Entities are represented by BRPs. A Participant can simultaneously be BSP for some Entities and BRP for other Entities for which it is the Registered Participant in the respective Entities' registries. For instance, this is the case of a vertically integrated energy company that owns conventional generating units (BSEs), dispatchable RES portfolio (BSE), non-dispatchable RES portfolio (BRE) and non-dispatchable load portfolio (BRE).

The Balancing Service Entities (BSEs) are qualified to provide Balancing Energy and/or Balancing Capacity and comprise of the following categories:

- Generating Unit: A conventional dispatchable generating unit with an installed capacity above 5 MW, which can provide Balancing Services to the Transmission System Operator. This category includes also the Dispatchable CHP Units above 35 MWe, as referred to in the Independent Transmission System Operation Code. A Generating Unit is represented by a Producer
- Dispatchable RES Portfolio: A portfolio of individual RES Units, comprising a set of physical RES units having concluded a Contract for Differential State-Aid Support with the RES and CHP Unit Registry Operator, of a specific RES technology connected at a specific Bidding Zone, which, based on its technical capability, can provide Balancing Services on a portfolio basis to the Transmission System Operator. A Dispatchable RES Portfolio can be represented by a RES Producer, a RES Aggregator or by the Last Resort RES Aggregator.
- Dispatchable Load Portfolio: A portfolio of individual loads connected at a specific Bidding Zone, which can provide Balancing Services on a portfolio basis to the Transmission System Operator. A Dispatchable Load Portfolio is represented by a DR Aggregator or a Self-Supplied Consumer. A Dispatchable Load Portfolio can include one or more individual loads.

The Balance Responsible Entities (BREs) include all aforementioned BSEs and the following Entities:

- Non-Dispatchable RES Portfolio: A portfolio of individual RES Units, comprising a set of physical RES units having concluded a Contract for Differential State-Aid Support with the RES and CHP Unit Registry Operator, of a specific RES technology connected at a specific Bidding Zone that cannot provide Balancing Services to the Transmission System Operator. A Non-Dispatchable RES Portfolio is represented by a RES Producer or by a RES Aggregator.
- Non-Dispatchable Load Portfolio: An individual load or a portfolio of individual loads, which cannot provide Balancing Services to the Transmission System Operator. A Non-Dispatchable Load Portfolio is represented by a Supplier or a Self-Supplied Consumer.
- RES FiT Portfolio: A portfolio (aggregation) of RES units of a specific RES technology and connected at a specific Bidding Zone, remunerated under a Feed-in Tariff system, which does not provide Balancing Services to the Transmission System Operator. A RES FiT Portfolio is represented by the RES and CHP Units Registry Operator.

The latest wholesale Market Schedule of each Entity in the responsibility area of the TSO is notified to the TSO and considered as binding thereafter, thereby incurring the Entity's responsibility for delivering such schedule in real-time operation (this defines the notion of Balance Responsibility).

The binding nature of the Market Schedules is established by penalizing any schedule deviations in real-time for all BREs, as follows:

- The Non-Dispatchable Entities (e.g., Non-Dispatchable Load Portfolios, Non-Dispatchable RES portfolios, etc.) are penalized for their imbalances in real-time operation, which are calculated as the difference between their real (metered) quantities and their Market Schedules.

- The Dispatchable Entities acting as BSPs (e.g., Generating Units, Dispatchable Load Portfolios) receive real-time Dispatch Instructions by the TSO, which incorporate the Balancing Energy activated over their Market Schedules (instructed deviations); they are then penalized for their imbalances, which are calculated as the difference between their real metered quantities and their real-time Dispatch Instructions (uninstructed deviations).

In this context, all Entities (whether they are BSPs or not) are considered as BRPs, which shall be penalized for their imbalances through an appropriate Imbalance Settlement process.

Figure 17 provides a graphical representation of the basic elements of the Balancing and Ancillary Services Market, and emphasizes the central role of the TSO. More details on the structure and operation of the Balancing Market in Greece are provided in Section 3.4.

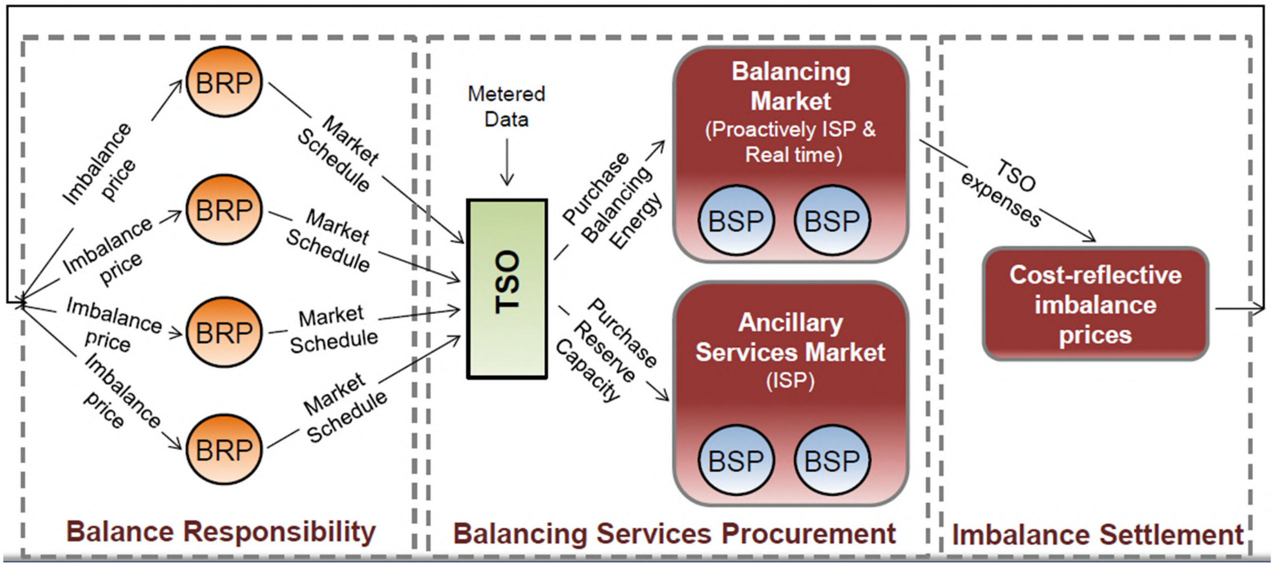

Figure 17. *Basic elements and interrelations of the Balancing and Ancillary Services Market in Greece*

3.1.6.2 Slovenia

The Slovenian organized electricity market is basically divided into wholesale and retail markets. The retail market consists of suppliers and customers who enter open contracts, with which the quantities of supplied energy and the time course of delivery are not determined in advance. Customers pay for the supplied energy on the basis of the actual amount of electricity consumed, measured by appropriate meters. Participants (traders and suppliers) participate in the wholesale electricity market, concluding closed contracts with each other. A closed contract is a contract by which the amount of electricity supplied is predetermined for each time interval. This means that such a contract is independent of the amount of electricity actually supplied. Deviations of quantities from the closed contract with the actually delivered ones are the subject of the balance sheet.

Electricity trading on the Slovenian market takes the form of bilateral trading, in which contracts are usually concluded for periods longer than one day, and trading on the stock exchange, with which day-ahead contracts are concluded. There also exists an intraday market and a balancing market. The intraday market starts trading after the end of the day trading in advance. Unlike day-ahead trading, which takes place on the principle of auction trading (all buy and sell offers are combined in the supply and demand curve after the end of trading, and their intersection determines the market even), intraday trading is based on the online trading principle, which means that the deal is done as soon as supply and demand meet at some point. In the last hour before the start of delivery, the intraday market is transformed into a balancing market, in which the transmission network operator acts as the only buyer of balancing energy (positive or negative). While the day-ahead market is traded for every hour of the day, we have a 15-minute market interval in addition to the hourly market in the intraday market and the balancing market.

According to the energy legislation in Slovenia, the operator of the Slovenian electricity market, the company Borzen d.o.o., is obliged to record all contracts concluded on the organized market. Thus, the market operator records all contractually agreed obligations in which electricity is bought or sold in Slovenia or energy is transferred through the regulatory area. This includes recording all contracts concluded between the members of the balance scheme, all export and import closed contracts and transactions concluded on the stock exchange. In addition, Borzen also records contracts between suppliers and customers and electricity producers in the form of operational production and consumption forecasts.

Balancing Service Provider and Balance Responsible Parties can provide expected daily revenues if their realization of production and consumption are in line with the forecast profiles. Penalties must be paid in case of deviations. The use of flexibility by network users makes sense if the cost of flexibility services is lower than the cost of penalties for deviations. Balance Responsible Parties can also use the flexibility services of network users to do so encourage network users to use energy at intra-day intervals, when energy prices in the market are lower. With active and current participation of the balance group in the electricity market, it is also possible by using flexibility services encourage changes in the consumption and production of electricity by users network in the event of rapid price changes. Balancing Service Provider and Balance Responsible Parties can thus generate surpluses according to the announced profile, which can then, at a significantly higher price than the penalties for derogations, sold in the market. The Balancing Service Provider and Balance Responsible Parties could do the same in the case of a larger one falling prices, where flexibility services could also encourage lower energy consumption prices. In the described cases, it is about improving the business results of the balance group, which they are enabled by the provision of flexibility services to network users. That would be it it makes sense to ensure that payment for the provision of services is flexible in proportion to the balance group revenue generated by this service. Such the approach could significantly increase interest in providing flexibility services and possibly also to purchase additional devices such as energy storage devices.

The implementation of flexibility services for the needs of the Balancing Service Provider and Balance Responsible Parties are not locally dependent and can be implemented anywhere on the network.

3.1.6.3 Finland

In Finland, Fingrid (Finnish TSO) is responsible for maintaining a continuous power balance and for the nation-wide imbalance settlement. However, each party operating in the electricity market must take continuous care of its power balance, i.e. the party must maintain a continuous power balance between its electricity production/procurement and consumption/sales. In practice, an electricity market party cannot do this by itself, which is why it must have an open supplier which balances the power balance of the party. A party whose open supplier is Fingrid is referred to as a balance responsible party.

The open delivery between Fingrid and a balance responsible party is agreed upon through a balance service agreement, whose terms are public and equal to all. Besides, the balance responsible party signs an imbalance settlement agreement with eSett Oy, which is the company that providing imbalance settlement services to electricity market participants in Denmark, Finland Norway, and Sweden. The eSett company is jointly owned by the four Nordic TSO and takes over the operational responsibility for the imbalance settlement and invoicing of the market participants. The detailed instruction and rules for participants in the imbalance settlement market of the Nordic area can be found in the handbook published by eSett (eSett, 2020).

3.1.7 Aggregator

An Aggregator is a grouping of agents in a power system (i.e., consumers, producers, prosumers or any mix thereof) to act as a single entity when engaging in power system markets (both wholesale and retail) or selling services to the Market and/or System Operator (MIT, 2016).

Aggregators are usually separated in two categories regarding the group of assets/agents that they represent, namely RES Aggregators (representing renewable energy sources plants, either dispatchable or non-dispatchable) and Demand Response (DR) Aggregators (representing dispatchable loads that can contribute to the provision of demand response services as well as energy storage facilities). However, it is also possible that a single Aggregator manages both generation and consumption assets, depending on the established country-specific regulatory framework.

The role of the DR Aggregator is viewed as critical for the participation of DR resources in the markets, since it successfully handles multiple issues that individual loads face and consequently work as deterring factors for their participation. More specifically, by aggregating different loads of varying characteristics, the DR Aggregator manages to:

- Minimize the unpredictability of individual dispatchable loads, through diversification of the load portfolio, treated as a single source. The diversification of the aggregated loads ensures that the committed capacity will be delivered even if some individual loads may not be able to perform.

- Make the separation of consumers' voltage level unnecessary, since the technical characteristics of multiple individuals are grouped together under a single (equivalent) load and are provided to the electricity system / market as such.
- Remove prequalification and testing requirements from "small" consumers that would otherwise find it difficult to offer their load flexibility to the market; however, a DR Aggregator's success is entirely dependent upon the successful participation of individual dispatchable loads in the respective DR programs.
- Provide the required communication / technical infrastructure (hardware and software), in order to be able to receive signals for load curtailment (from the TSO) as well as metering capabilities/infrastructure to determine the magnitude of load curtailed, that would otherwise would have to be possessed by each individual alone.

The role of the DR Aggregator can be played by the Load Representative, however, cases from various EU markets have shown that for the DR aggregation service to be successful and lead to market growth, the DR service should be preferably unbundled from the sale of electricity. As such, and in order to enable the participation of independent aggregation service providers, the relationship between the Load Representatives (equivalently, "Retailers"), Balancing Responsible Parties (BRPs) and the independent DR Aggregators must be clearly defined. Standardized processes for information exchange, transfer of energy, and financial settlement between these parties constitute a critical requirement, in order to facilitate the smooth functioning of the electricity markets

3.1.7.1 Greece

In Greece, RES Aggregators and DR Aggregators are separate entities that participate independently in the various segments of the wholesale electricity market. Specifically, according to the current legal and regulatory framework of the Greek electricity market, RES Aggregators are allowed to participate in the Day-Ahead Market, Intra-Day Markets and Balancing Market, while DR Aggregators are allowed to participate only in the Balancing Market for the provision of balancing services.

Regarding RES Aggregators, the commercial management of Renewable Energy Sources (RES) has recently changed drastically. According to the European Commission's State Aid Guidelines for the Environment and Energy (2014-2020), new RES producers must be reimbursed through market-based mechanisms and be subject to balancing costs if production forecasts differ from actual production levels.

Towards this direction, Law 4414/2016 established the transition to the direct participation of RES units (above certain thresholds of installed capacity) in the wholesale electricity market, in the balancing mechanism and the imbalance settlement carried out by the Greek Independent Power Transmission Operator (ADMIE), including an additional premium on the market clearing price (through a "Contract for Differential State-Aid Support" – or "Feed-in Premium Contract"). Thus, RES producers will gain increased incentives to be competitive, while at the same time they will undertake the responsibility of forecasting their production accurately, namely they will be financially responsible for the additional balancing cost of the power system when this is caused by imbalances between their forecasts and their actual production.

The above framework, in combination with the adaptation process of the Greek market to the European electricity Target Model, implies a direct decentralization of procedures which, until now, were under the central control of the IPTO. In other words, the balancing responsibility is transferred from the IPTO to individual RES producers. RES Aggregators, through which many RES producers participate (indirectly) in the market and in the balancing mechanism within larger portfolios, already play an important role in this context. The contribution of RES Aggregators will be important in limiting the deviations between forecasts and real power output, due to the phenomenon of spatial dispersion that mitigates significantly the uncertainty and variability of RES plants' electricity generation.

Regarding DR Aggregators, the legal framework has already introduced the concept of DR Aggregators and the everyday participation of DR Aggregators is now technically feasible only for the large (industrial and commercial) consumers, which are exclusively connected to the HV and MV levels. In addition, DR Aggregators currently participate only in the Balancing Market, since the related regulatory framework and detailed technical decisions pertaining various operational aspects regarding the participation of DR in the Day-Ahead Market are still under formulation and are expected to be finalized soon.

The lack of appropriate IT infrastructure (e.g. smart meters), which would allow for real-time access to massive electricity consumption data, further aiming at the extended deployment of DR programs for end-consumers that are connected to LV distribution networks is the main barrier for the large-scale implementation of DR to all end-consumers.

3.1.7.2 Slovenia

The flexibility service of smaller production and consumer units cannot be used directly to provide ancillary services, as the availability, power and energy of these units are insufficient to conclude direct contracts with TSOs, Balance Responsible Parties or DSOs or direct participation of smaller customers in organized markets cost and complexity. Therefore, as an intermediary between the user of flexibility services and smaller flexibility service providers, the aggregator appears as a new role in the market. This aggregates the offers of flexibility service providers and thus overcomes the stated obstacles or enables the customer indirect access to the regulated market. For its operation, the aggregator needs an appropriate communication connection with users and providers of flexibility services, appropriate software for conducting trades and, of course, trading rules. In doing so, the aggregator aggregates (collects) demand for the provision of flexibility services, and the transactions themselves are concluded on the flexibility market.

Flexibility services can be performed at different time intervals and require different response times. The aggregator's communication links with users and flexibility service providers must also be adapted to this. If flexibility services were to be used, for example, for the RVF service, extremely fast and reliable communication links and instantaneous responses would be required, while flexibility-based services require aRPF and rRPF services within seconds and minutes. In all cases, flexibility service providers are activated immediately or in a very short time, which is in principle not related to typical daily production and consumption profiles (15-minute profiles available in the NMS). The same applies to the activation of service providers by Balance Responsible Parties in the event of current changes in prices on the energy market. In the context of response time requirements and related data exchange, it is necessary to verify whether a reliable Internet connection compatible with the universal broadband internet access service is sufficient for communication or whether other appropriate communication should be provided. A completely different category includes flexibility services that can be predicted a few hours in advance, usually based on production and consumption profiles, weather conditions, time of day, day of the week and month, and month of the year. To provide such flexibility services, existing internet or other, relatively slow communication links are quite sufficient.

Several aggregators can operate on the market at the same time. Because a particular market participant can perform several roles, we distinguish between an independent aggregator (the entity performs this role exclusively) and a supplier (or Balance Responsible Party), which also performs the role of aggregator.

The relationship between the independent aggregators and retailers or the Balance Responsible Parties depends on the model of aggregation or related rules. When introducing a flexibility market, e.g., ensure that energy supply contracts should not also be linked to the provision of flexibility services, as this restricts the independence and competition between different aggregators: this would mean that balancing groups would gain a monopoly over the provision of flexibility services through energy supply contracts. network users. Resource aggregation in the context of one or more independent aggregators may at the user level result in several balance contracts of different entities on the same connection.

According to the Energy Agency, it is necessary to provide a coherent normative framework in which the aggregator will be able to provide services to any potential customer and will ensure that all interested stakeholders are sufficiently informed and, if necessary, compensated for the aggregator's actions. The aggregator framework needs to be integrated with existing market mechanisms, while introducing new markets if they are not already in place (eg local markets for congestion management and capacity management). By introducing an optimal aggregation model and standardizing market processes and data exchange, it is possible to provide all market participants with easy access to the market with flexibility, while eliminating the need for bilateral agreements between an independent aggregator and a supplier (OBS). market flexibility.

3.1.7.3 Finland

In Finland, there is no distinction between RES and DR aggregators.

The aggregation of different resources is already permitted in all electricity marketplaces in Finland.

At the moment, independent aggregators can provide frequency-controlled reserves (FCR-N, FCR-D and FFR) and a pilot project tests their participation in the balancing energy markets (mFRR) There is not a legal framework for the independent aggregation in place yet. (Fingrid,a)

Business models of the aggregators can be divided into three (3) categories based in (Ohrling, 2019)

- Balance-responsible aggregator archetype: This business model is based on aggregating loads into electricity market places by balance responsible parties, usually energy companies. These services are already at realized stage,
- Independent aggregator archetype: In this business model, the aggregator provides bids to the electricity market without balance responsibility. This is a new area where the services are mostly at concept level,
- Sub-aggregator archetype: This business model provides aggregation service for the aggregators and doesn't itself directly participate in the markets.

3.1.8 ESCO companies

Energy Service Companies (ESCOs) are specialized companies in energy issues with sufficient expertise and experience, with the required funds and undertake interventions to improve energy efficiency and energy savings at final consumers' premises. The company's remuneration is mainly derived from the energy savings (which should be verified) and hence the reduction in the cost of the customer's cost.

The first ESCOs were created in the period of the energy crisis of 1970 in the U.S. and Canada. The European Union Directive 2006/32/EC set the legal basis for the establishment of ESCOs in the EU Member States.

3.1.8.1 Greece

The ESCO market in Greece remains negligible. Given the very small size of the existing ESCOs in Greece, there is much more potential for partnerships (i.e industrial and manufacturing associations) than competition. Various policy developments have been put in place, addressing some important barriers: Law 3855/2010 describes the context and principles of an Energy Performance Contract (EPC), provides a model contract, and prescribes the allocation of obligations and responsibilities between the ESCO and the client, while Ministerial Decision D6/13280/07.06.2011 provides further insights on Operation, Register, Code of Conduct and related provisions for energy service providers and new financial support measures promoting the use of ESCOs. Despite these developments, the Greek ESCO market remains stagnant, with very few projects implemented (A-D. Braimioti, 2019).

A registry of ESCOs is available at www.escoregistry.gr, managed by the Directorate of Energy Policy and Energy Efficiency of the Ministry of Environment and Energy. The registry contains information on ESCOs, either as natural or legal persons. By the end of September 2023, 132 ESCOs were registered in the relevant registry maintained by the Greek Ministry of Environment and Energy. It is noted that many ESCOs have shown interest in improving energy efficiency through EPCs by implementing relevant interventions to the associated buildings and undertakings.

In order to boost the market, pilot projects are planned, and the involvement of JESSICA is foreseen. In this context, JESSICA is a modern financial engineering instrument, and its scope is the ''recyclability" of Structural Funds' financial resources through a mechanism which will provide funding – equity, loans and guarantees – to eligible urban development projects, and will utilize the returns – for instance loan repayments – to reinvest in new urban development projects, thereby bolstering sustainability. Energy efficiency improvements seems to be one of the areas that JESSICA should focus on in the case of Greece, considering that energy efficiency constitutes a major component of sustainable urban development.

Support and monitoring of these projects will be provided in order to standardize procedures and remove regulatory barriers to the implementation of energy efficiency measures in public sector buildings through EPCs.

3.1.8.2 Slovenia

The Energy Efficiency Directive (2012/27 / EU) in point (c) of Article 18 (1) requires that Member States shall promote the market for energy services and access to that market for small and medium-sized enterprises (SMEs) by publishing and regularly update the list of available energy service providers.

With the adoption of the Energy Act, the concept of energy contracting was also implemented into Slovenian law in point 29 of Article 4, where the law repeats the diction of the concept of "contractual provision of energy savings", as written in the Energy Efficiency Directive, but the Energy Act in the continuation, the institute of contractual provision of energy savings is not regulated in more detail.

The Ministry of Infrastructure published Guidelines for the implementation of energy efficiency improvement measures in public sector buildings according to the principle of energy contracting. The guidelines provide explanations, instructions and recommendations for the implementation of energy efficiency improvement measures in public sector buildings according to the principle of energy contracting.

Energy contracting is defined as a contractual reduction of energy costs, which is not only a method of financing, but is a contractual model that, in addition to planning and installation of new devices, also includes financing, operation and control, servicing and maintenance, troubleshooting and motivating energy consumers. It is based on a more or less extensive contract concluded for an agreed period of time between the owner of the infrastructure or devices that use energy and the energy service company, the contractor.

In the context of energy contracting, according to practice on the market, contracts are concluded for a period of 5 to 15 years. The contractual period depends on the amount of the investment and the anticipated anergy and financial savings. Theoretically, the minimum contract duration is determined by payback calculation. The maximum duration of the contract depends on the set of measures and the financing conditions that the provider of measures can offer for the implementation of the investment.

At the ministry responsible for energy, the list of energy service providers that already provide energy contracting services according to the model of contractual provision of energy savings is published. Currently six ESECO companies are registered for offering energy contracting services on the Slovenian market.

The list of ECSO companies includes all energy service providers who have already successfully implemented investment measures to ensure energy savings and provide energy contracting services according to the model of contractual provision of energy savings. The list is regularly updated, and interested energy service providers must submit a completed Application Form and the relevant proof, ie as submission of a reference project with a properly completed form Reference certificate, which shows that the energy service provider already provides such a service.

3.1.8.3 Finland

In order to support the ESCO projects in Finland, there is an energy aid, which aims to promote the development of innovative solutions for replacing the energy system with a low-carbon alternative in the long term. In Finland, Business Finland is responsible for support of the following activities under energy aid funding:

1) the production or use of renewable energy, which in turn promotes new technology and its commercial utilisation involves investments in a new plant, or is a replacement investment that significantly increases the production volumes of renewable energy or that allows the achievement of some other positive energy impact that complies with the goal,
2) energy savings or improving the efficiency of energy production or use and the purpose of which is not to fulfil an obligatory environmental obligation is not a compulsory energy audit that companies must carry out under the Energy Efficiency Act (1429/2014),
3) otherwise replacing the energy system with a low carbon one.

Energy aid is discretionary, and priority is given to projects involving new technology. The aid can also be considered for projects using conventional technology, with priority for well-prepared projects and carefully compiled aid applications. In this regard, the energy aid can support the investments promoting energy savings and energy efficiency when the ESCO service is used (up to 25%).

As a general rule, support for conventional technology projects will only be granted to those who have signed energy efficiency contracts. By way of exception, investment aid for conventional technology projects carried out with the ESCO service may also be granted to a company or entity not covered by an energy performance contracting. In that case, the maximum amount of aid is 15%. There are no conditions affecting the eligibility of the project for the length of the service or contract period of the ESCO project.

Support for conventional technology for energy-saving projects shall not exceed 20% for companies and entities that have signed an energy efficiency agreement. If the company or entity that has joined the energy efficiency agreement carries out the conventional technology project with the ESCO service, the aid will not exceed 25%.

If a so-called new technology project is implemented as an ESCO project, the project may also receive additional support for new technology, up to 40% (Support percentages in 2020). Support for ESCO services is conditional on a savings guarantee of at least 50% and verifiable savings must account for at least 80% of the total savings during the verification period, calculated in euros.

ESCO projects are promoted at a higher rate of support (so-called ESCO support; also applicable to projects where the end customer is not covered by energy performance contracting), as they verify the realization of energy savings through measurement and monitoring and usually lead to higher and / or lasting energy savings. To ensure these benefits, ESCO projects receiving higher support will be subject to stricter conditions than conventional energy efficiency projects. If the project does not qualify for ESCO support, but the applicant is covered by energy efficiency agreements, the project can still receive support as a normal energy efficiency project. More details regarding the ESCO and aid support can be found in Busines Finland webpages 3.

3.2 Smart meters

3.2.1 Greece

In Greece there is very slow progress regarding the installation of smart metering infrastructure that would allow for the deployment of large-scale demand response programs. Current percentage of smart metering deployment is almost zero. In fact, only the ~40 High-Voltage (HV) and ~11,000 Medium-Voltage (MV) consumers are currently tele-measured (i.e. 15-min real-time consumption data are collected by ADMIE and HEDNO, respectively, and used mainly for billing purposes), while around 7.5 million Low-Voltage (LV) customers are still equipped with conventional (electroc-mechanical) metering infrastructure allowing only for aggregated consumption data reading (monthly or four-monthly time intervals are usually used by the electricity suppliers to invoice their customers for their aggregated real consumption). Therefore, currently no IT infrastructure that would allow for unidirectional or bidirectional communication between HEDNO/Suppliers and the end-consumers and, in turn, for the massive deployment of DR programs is available.

In the near future, HEDNO is planning to replace all these conventional electricity meters with smart meters. This ambitious large-scale project is expected to allow for real-time access to massive electricity consumption data, further aiming at the extended deployment of demand response programs as well as the strong engagement of all end-consumers towards more efficient use of energy.

3.2.2 Slovenia

The advanced metering system (AMI) includes a set of measuring devices, information technology and communication channels, which enables automatic (remote) selection, processing and transmission of metering data and the possibility of two-way data exchange between the metering center and the electricity meter. In addition, the system also provides support for other services and applications for clients, such as operation of home automation devices, consumption adjustment, data collection from other energy and water meters, etc. As part of exploiting synergies, an advanced metering system can effectively support the deployment of smart grids with its data services.

Advanced electricity metering could have a major impact on the development of the energy market and related services, the promotion of energy efficiency, as well as the development of the energy networks of the future. The European Union has called on the Member States to introduce advanced metering systems that encourage the active participation of customers in the energy supply market. The decision on the mass deployment of advanced metering systems should be based on an economic assessment of the long-term costs and benefits (hereinafter CBA) for the market and individual users, which should include an assessment of the most appropriate form and timeframe for deployment.

The Energy Agency was tasked with carrying out an economic cost-benefit analysis of the introduction of advanced metering in Slovenia. The purpose of the analysis was to assess the impact of the introduction of advanced metering for electricity and natural gas in Slovenia on various directly and indirectly participating market participants using different implementation scenarios and to make a qualitative and quantitative assessment of the desired scope and framework for the introduction of advanced metering. In addition, qualitative assessments of role and responsibility models in the advanced measurement system, functionalities and services of the advanced measurement system, and additional costs and benefits that could only be assessed outside the CBA framework were performed.

In 2015, the Government of the Republic of Slovenia issued a decree prescribing measures and procedures to ensure the introduction and connectivity of advanced metering systems in the Republic of Slovenia, on the basis of which the distribution network operator issued a Plan for the introduction of advanced metering systems in the electricity distribution system. to complete this project in Slovenia by 2025.

The project of introducing an advanced metering system into the electricity distribution system of Slovenia, which the distribution system operator began to accelerate in 2016 on the basis of the Plan for the introduction

[3] https://www.businessfinland.fi/en/for-finnish-customers/services/funding/energy-aid

of an advanced metering system into the electricity distribution system of Slovenia, is one of the key smart grid projects, if not the most important in Slovenian distribution, which ensures the establishment of basic conditions for the efficient operation of the entire electricity market and its further development. It is an important national project from the point of view of implementing EU legislation and empowering all key stakeholders and communities to achieve the national goals of the green transition.

The project of introducing an advanced metering system is extremely important for distribution system operator as well as for the end users of the electricity distribution network and the wider social environment. The project has a significant impact on all network users as well as suppliers, aggregators, system operators and energy service providers based on efficient energy management. With the introduction of advanced metering system, the key players in the electricity retail market will be enabled to adapt more actively to market conditions.

The role of the advanced metering system is crucial in the application of new dynamic tariffs and the establishment of a flexibility market. During the implementation of the project, which is entering its final phase, a number of new Acts of the Energy Agency (AGEN) came into force, which relate to the provision, processing, forwarding and use of measurement data, which was one of the key goals and one of the fundamental reasons for the project of introducing advanced metering system in Slovenia.

According to the schedule, the advanced metering system project will be completed at the end of 2025. Energy Agency (AGEN) and the Ministry of Infrastructure as clients, according to the Regulation on measures and procedures for the introduction and connectivity of advanced electricity metering systems, expect high-quality and timely implementation, which must be based on the initial advanced metering system Implementation Plan, adjusted and updated according to the additional requirements of the legislation and regulations adopted in the interim period, taking into account as much as possible the already announced requirements of the directives, national strategic plans and the guidelines given by the regulator Energy Agency AGEN.

The trend of introducing smart meters within the advanced metering system by distribution areas and for the whole of Slovenia is shown in the attached figure below.

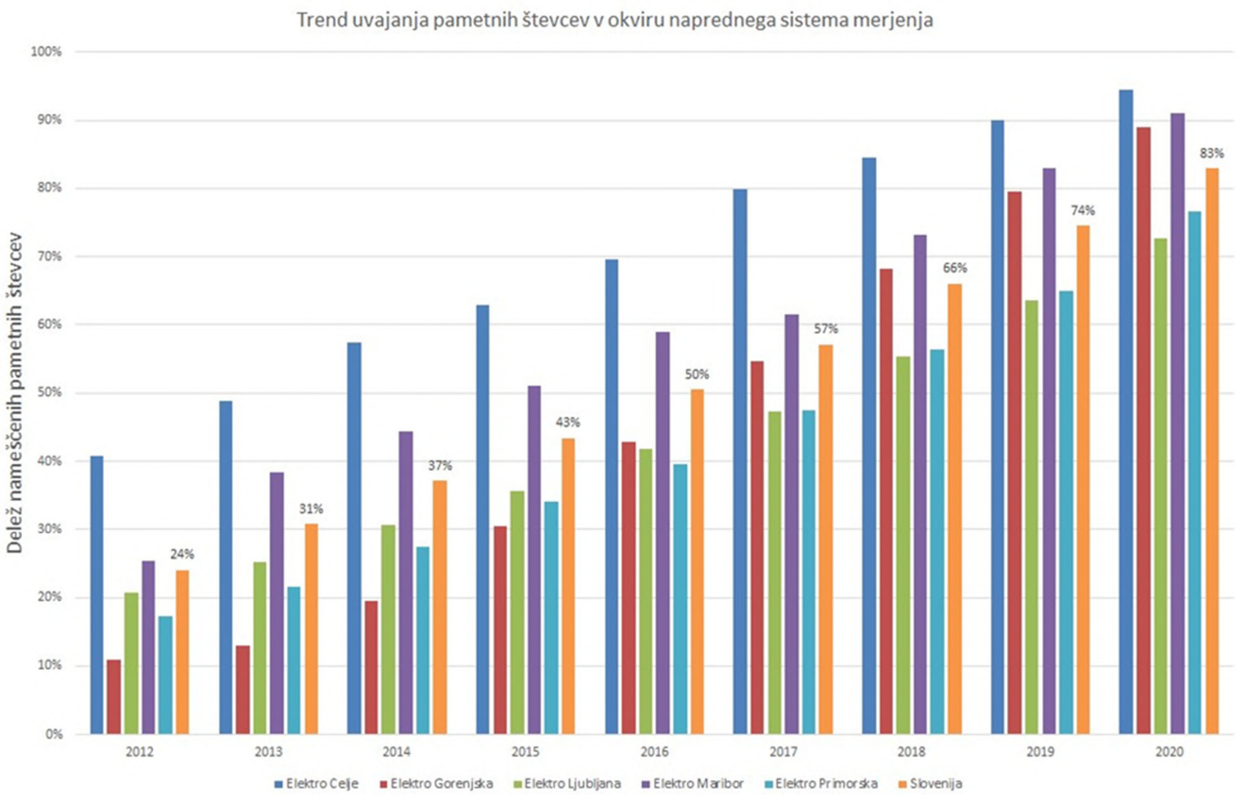

Figure 18. *The trend of introducing smart meters within the advanced metering system in Slovenia (2012-2020)*

3.2.3 Finland

Finland is the first country in the world to have adopted smart electricity metering (hourly metering and remote reading) on a large scale. The consumption and production of electrical energy in almost every one of the 3.7

million electricity metering points are measured on an hourly level, and the validated metering data is available the next day for use by the customer, balance settlement and the electricity markets. (ET,2017). This was a requirement by national degree 66/2009. Smart electricity meters with hourly measurement resolution were effectively installed to all customers already in 2013 (MEAEF, 2020).

The local DSO is responsible for electricity metering and making the metering data available to the customer, balance settlement, and the markets. It was a major investment for all 80 Finnish DSOs to equip all customers with the first generation of the smart metering system. In practice, the technical service life of the meters is about 10-15 years.

The design, procurement and commissioning of meters and metering systems is a process lasting several years. As the majority of DSOs have installed remotely read meters for most of their customers in 2009-2014, the designing and procurement of the next-generation meters and systems are already started. For this process, the DSOs require a clear vision of the criteria set on next-generation electricity meters in Finland. In this regard, the Finnish smart grid working group suggests that load control functionality should be included in the next-generation smart meters for those customers with significant controllable loads.

Currently, DSOs are responsible to meter the data and share it among the customer, balance settlement and the electricity markets. There are 80 DSO in Finland and therefore the current system cannot exchange information very quickly and effectively. Information exchange is needed, for example, when a consumer switches the electricity supplier, and approximately 400,000 such switches take place every year in Finland. As a solution, a shared system called Datahub has been developed to clarify and speed up this exchange of information. Datahub will improve the operation of all parties – the electricity consumers, electricity suppliers and the parties responsible for electricity transmission – since all data and transactions associated with the consumption of electricity are located in a single system, are up-to-date and equally available for all eligible parties.

Since Datahub is a centralised information exchange system, the data stored therein will be accessed by approximately 100 electricity suppliers and over 80 DSOs responsible for the transmission of electricity. Centralising the data from operator-specific systems into a single location will also improve the service experience of all electricity consumers. Data associated with electricity contracts, accounting points and their consumption will be more rapidly available for various parties, which will improve customer service. For example, changing the electricity supplier will be quicker. A shared system will also enable the development of new types of applications for the electricity consumers, such as apps that enable the user to save energy or monitor electricity consumption[4].

3.3 Retail

3.3.1 EU

According to Eurostat, the total number of retailers that sell electricity to final customers in the various EU countries from 2003 to 2019 are depicted in the table below.

Table 1. Total number of electricity retailers to final consumers, 2003-2019

[4] https://www.fingrid.fi/en/electricity-market/datahub/

Total number of electricity retailers to final consumers, 2003-2019

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Belgium	45	48	54	23	28	31	34	37	31	33	42	37	52	60	60	56	55
Bulgaria	8	12	13	13	7	7	17	36	45	24	24	29	37	54	57	53	48
Czechia	365	238	286	285	293	281	281	324	356	360	382	380	390	389	399	411	409
Denmark	113	75	70	65	38	36	33	33	33	55	49	50	49	55	39	38	41
Germany	940	940	940	1 042	1 020	940	>1 000	>1 000	>1 000	~1 000	1177	1226	1238	1404	1404	1485	1430
Estonia	42	41	40	43	40	37	40	41	40	42	49	53	46	49	46	45	50
Ireland	6	8	9	9	9	9	9	8	6	6	7	7	8	9	12	12	14
Greece	5	4	4	4	2	2	3	11	:	14	7	8	8	10	19	25	26
Spain	375	383	382	375	394	459	142	202	188	121	225	273	267	300	291	323	341
France	166	166	166	160	>177	177	177	177	183	183	164	167	171	178	185	172	162
Croatia	1	1	1	1	2	2	2	3	7	9	6	7	7	7	9	9	8
Italy	390	400	430	380	400	350	360	268	347	412	472	534	579	627	638	705	775
Cyprus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Latvia	1	4	4	4	6	4	4	4	5	6	8	12	17	21	26	25	22
Lithuania	8	8	7	7	7	8	9	15	27	27	24	23	17	21	22	21	22
Luxembourg	11	11	11	12	13	14	11	11	11	11	9	10	10	10	10	10	10
Hungary	12	12	17	12	17	24	35	38	39	43	44	51	52	42	42	39	37
Malta	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Netherlands	42	33	32	38	39	38	32	36	35	35	45	46	51	53	48	48	52
Austria	160	125	125	136	160	141	>140	129	155	152	154	149	155	162	171	171	174
Poland	175	202	265	168	158	137	150	146	135	134	145	140	134	134	190	185	2 008
Portugal	5	9	10	4	4	4	6	10	10	10	13	14	19	25	27	29	32
Romania	8	20	40	48	51	48	47	56	61	54	60	86	95	105	105	96	91
Slovenia	8	7	11	13	14	14	17	16	16	13	14	13	18	20	21	23	22
Slovakia	18	23	34	35	36	47	67	77	68	71	60	66	72	74	71	73	68
Finland	>100	>100	>100	>100	>100	>100	>100	>100	~100	~100	100	100	100	100	100	92	92
Sweden	127	130	122	119	120	113	75	134	121	120	155	160	172	179	171	166	184
Norway	223	226	223	:	163	173	184	184	201	203	195	197	191	191	197	188	191
Montenegro	:	:	:	:	:	:	:	:	:	:	2	2	2	5	5	5	6
North Macedonia	1	1	1	1	1	1	2	3	9	11	5	6	7	11	19	20	23
Serbia	:	:	:	:	:	:	:	:	6	:	2	7	8	14	19	18	13
Turkey	5	130	165	245	263	317	362	466	647	767	774	260	255	213	216	216	214
Bosnia and Herzegovina	:	:	:	:	:	:	:	:	:	:	28	27	26	26	26	24	24
Kosovo*	:	:	:	:	:	:	:	:	:	:	1	1	1	1	1	1	1
Moldova	:	:	:	:	:	:	:	:	:	:	4	4	4	4	4	6	7

The electricity prices for household consumers in the first half of 2020 per EU country are illustrated in the figure below.

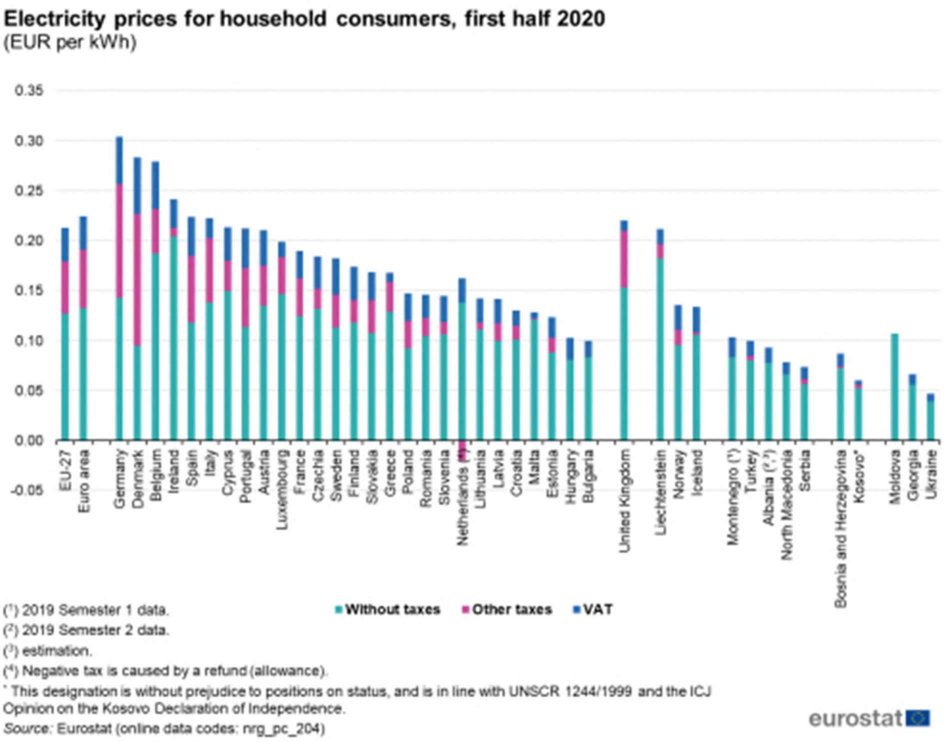

Figure 19. Electricity prices for household consumers, first half 2020

The evolution of the retail prices for household consumers in EU for period 2008-2020 is depicted in the figure below.

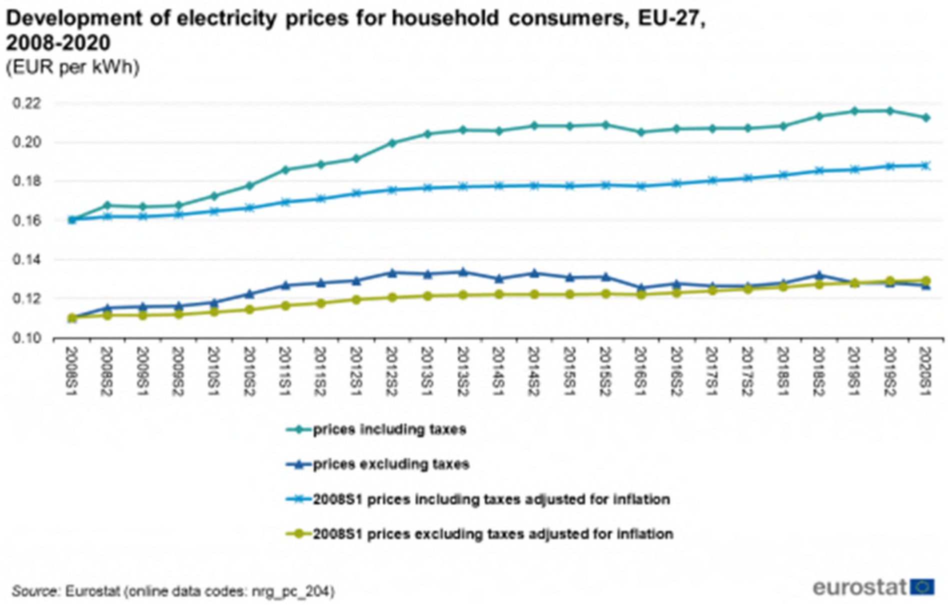

Figure 20. Development of electricity prices for household consumers, EU-27, 2008-2020

Final electricity prices are derived from three different components:

- Supply costs include the commodity price (i.e. the cost paid by the supplier for electricity generation), plus the cost of interactions with consumers (such as billing) and administrative costs, plus supplier profits and other costs of running the business.
- Transmission, distribution and network costs are the costs of distributing electricity to customers, including maintaining the grid and load balancing.
- Taxes and additional costs include any components of the price related to taxes, levies, social subsidies or public service obligations, as well as any costs not covered by the other categories.

The units in which these data components can be presented are:

- Fixed element – fixed amount (i.e. it does not depend on kWh consumed).
- Variable element – depending on the amount of kWh consumed for a certain period of time.

Also, the weight of taxes and levies differs greatly among EU member states as depicted in figure below.

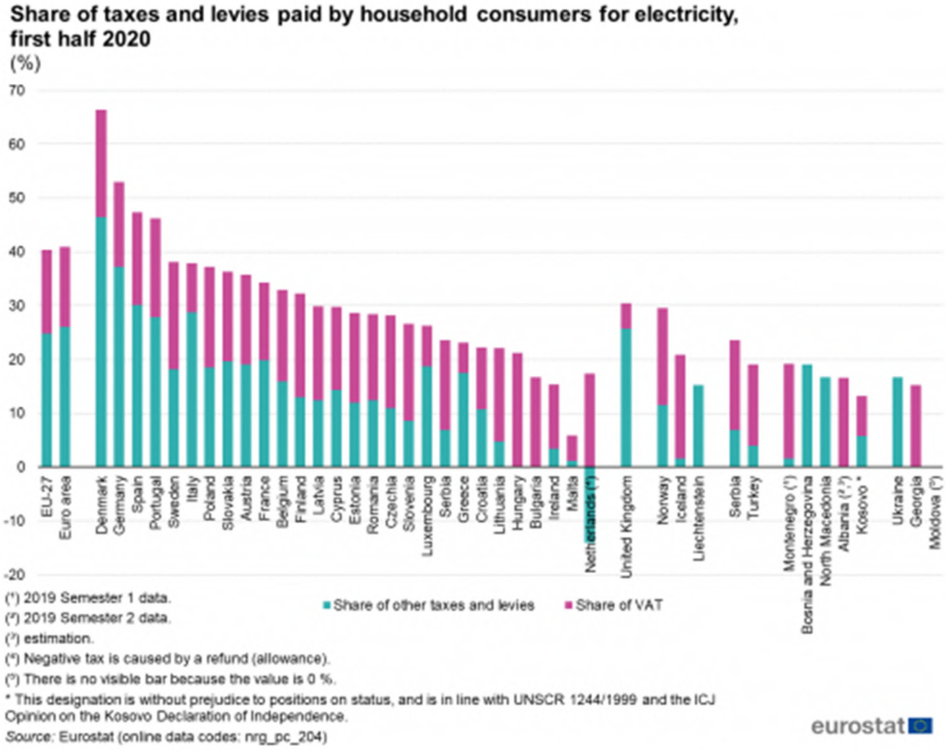

Figure 21. Share of taxes and levies paid by household consumers for electricity, first half 2020

Retail energy prices are an important part of household and industrial consumers' expenditure. The joint publication of the EU Agency for the Cooperation of Energy Regulators (ACER) and the Council of European Energy Regulators (CEER) outlines the state of play of the retail energy market and consumer protection in the European Union and the Energy Community Contracting Parties (ACER and CEER, 2023).

In the above report, it is concluded that consideration could be given to incentives for positive behaviour, such as payments for changing consumption patterns to use energy at off-peak times or when renewables are more prevalent, or the use of simple means to improve the energy efficiency of homes. Demand shifts by a portion of consumers could bring a benefit to all through lower peak prices.

A certain percentage of consumers still need to be shielded from the impact of high energy prices. In 2022, consumer expenditure on electricity, as a percentage of household income, increased. A key lesson from 2022 is the need for further targeting of support measures (where necessary) and the creation of incentives for further reductions in energy consumption.

Incentivising demand reduction while ensuring that support is well targeted. Taking broad-based measures to reduce energy prices for all, such as lowering taxes or levies on energy consumption, tend to benefit high-energy consumers the most. Such supporting measures do not provide incentives to reduce energy demand. On the other hand, there are several good policy measures that incentivise consumers' behaviour. One such example is Austria, where a certain percentage of a standard household's energy consumption is provided at a social rate, while the rest is exposed to market prices (maintaining the price incentive). Where support for vulnerable consumers and the energy poor citizens is needed (beyond the energy crisis), this approach could be fine-tuned over time to include variables such as household composition and the energy efficiency of buildings. Such approaches should be combined with or strengthened by information campaigns to raise consumer awareness. One example mentioned in the report is ESB Networks' 'Beat the Peak' campaign, which provided consumers with information on when it is appropriate to use (or not to use) energy. In the future, to improve consumer information about their energy needs, such opt-in services could be applied more widely in EU electricity markets. Financial benefits can also encourage changes in consumer behaviour (in the medium to long term) to reduce and/ or shift consumption to times when it is more beneficial to the energy system. A focus on incentivising demand reductions and adjusting consumer behaviour will be key as part of the clean energy transition.

3.3.2 Greece

Consumer Contracts in Greece

Currently in Greece, two main categories of billing contracts are used, namely residential and business contracts with different static tariffs according to the contract type/program the consumers choose to follow. A more detailed description of the static tariffs categorization is provided in the following paragraphs.

- *Residential Tariffs:* Residential tariffs are LV tariffs for households. Several programs are launched by the retail companies with variations on the competitive part of charges. Residential customers who are subject to a bi-zonal tariff program (day and night rates for electricity consumption) need to install a time-based charging meter in their power supply, that is a meter that registers the aggregated consumption (in kWh) in two time periods separately, a time period of the regular charge (day zone) and the time period of the reduced charge (night zone). The tariffs for the time-period of regular charge and the time-period of reduced charge are defined by the retail companies, whereas the configuration of each time zone (e.g. start hour, end hour) is defined seasonally by the Distribution System Operator (HEDNO).

- *Business Tariffs:* Business tariffs are addressed to customers for commercial use (offices, shops, warehouses, infirmaries, shopping centres, etc.), industrial use (workshops, craft industries, small industries, bakeries and other businesses), general use (public areas, warehouses, parking spaces) and for large businesses/industries in MV and HV customers. Different schemes are encountered per business type depending on the contracted capacity and connection voltage.

In addition, the Greek retail companies have started promoting combined products for electricity and gas supply for residential customers and small business enterprises to expand their customer portfolio and, subsequently, increase their market shares in both sectors.

Billing Cycle

Customers of the Greek Public Power Corporation (PPC) integrated in the 4-month metering period receive 6 bimonthly bills annually, 3 “Estimated” bills and 3 “Actual” bills (residential and non-residential customers with capacity up to 25 kVA). Customers integrated in the monthly metering period (customers with capacity over 35 kVA are integrated into this category) receive 12 monthly Actual bills annually.

The actual consumption bill results from the value of electricity usage and the regulated tariffs according to the relevant meter reading provided by HEDNO for the actual consumption period, which is typically four (4) months, and any amounts paid in the previous estimated bills for electricity usage and regulated tariffs for the same period will be offset against the sum.

The billing cycle among retail companies varies between monthly, bimonthly, and quarterly invoices after receiving the certified metering readings from HEDNO. In most retail companies, the billing cycle includes the issuance of monthly estimated consumption bills, so that the customer keeps his financial provisions in check, and the issuance of actual consumption bills every four (4) months. For MV customers, retail companies may issue monthly actual bill since HEDNO provides at the end of each month the certified consumption of each represented meter in a 15-minute resolution.

Overview of Bill Charges

All the retail companies that are activating in the liberalized market of electricity, they should operate in accordance with EU directives adapted to national Laws 2773/99 and 3426/05 as well as with the Code of Supply to Customers and they are obliged to provide their customers with detailed analysis on charges for the electricity consumed and should be paid.

In this context, customers receive explicit information for their bills stating separately the charges for each activity regarding electricity, that is, its supply to the final consumer (competitive charges regarding the electricity usage) and its transmission and distribution (regulated charges) as well as additional charges.

A more detailed analysis of the billing charges implemented in the supply of electricity is described below:

1. *Competitive tariffs:*

The competitive tariffs vary from one supply company to another according to its policy and the offered billing programs for residential, business and industrial customers. These tariffs include the electricity usage charges (fixed tariff and electricity rate) which are calculated based on the energy consumed and the current applied price list (competitive tariff charges). The electricity rate (€/kWh) along with the fixed rate (€/month, €/quarter), if any, are aligned with the commercial programme of the retail company that the customer selects for his bill. In addition, these tariffs may also include discounts offered by the retail company, if any, which are set according to the commercial programme chosen or the customer's agreement.

For instance, tariffs for LV (residential) customers range approximately between 0.04317-0.11000 (€/kWh) whereas for MV and HV customers range between 0.05-0.065 (€/kWh) and 0.04-0.06 (€/kWh).

2. *Regulated tariffs:*

These are tariffs which are the same for all retail companies and consumers, depending on the contractual capacity, bill program (residential/business) and regardless of choice of supplier. These tariffs are imposed on all consumers using the Transmission and Distribution network, and also include the special levy for Greenhouse Gas Emissions Reduction (SLGGER or ETMEAR in Greek), the costs for Public Service Obligations (PSo or YKO in Greek), along with the other tariffs imposed by the legislation in force for the proper operation of the market. These charges include the following:

a) Transmission Use of System (TUoS) Charge:

This charge covers the operation, maintenance and development expenses of the Transmission System that transfers electricity in high voltage lines through pylons from power plants to urban substations so as the power to reach the final consumers of the country through the Distribution Network in middle and low voltage. It includes a fixed charge (deriving from the power supply agreed) and a variable charge (depending on the consumption).

Calculation formula: [kVA x Days /365 x UFC (€/kVA & year)] + [kWh x UVC (€/kWh)]

b) Distribution Use of System (DUoS) Charge:

This charge covers the operation, maintenance and development expenses of the medium and low voltage network. It includes a fixed charge (deriving from the power supply agreed) and a variable charge (depending on the consumption).

Calculation formula: **[kVA x Days /365 x UFC (€/kVA & year)] + [kWh x UVC (€/kWh)/pf]**

Where:
UFC: Unit Fixed Charge,
UVC: Unit Variable Charge,
kWh: kilowatt hour consumed,
kVA: Contractual Capacity: it is the maximum capacity which the customer is entitled to consume from PPC network, and it is stated in the Power Supply Contract,
pf: power factor. It is referring to certain categories of customers with high contractual capacity and it is calculated on the basis of the active and reactive energy. For all other customers, the power factor is considered to be equal to one (pf=1).

c) Other Charges:

These are charges imposed by the legislation applied for the smooth operation of the market.
Calculation formula: **kWh x Unit Charge (€/kWh)**

d) Public Service Obligations (PSOs):

According to the decision of the Minister of Development (Greek Government Gazette Issue B' 1040/07), the following services are characterized as Services of General Interest (SGI): a) power supply to consumers of the non-interconnected islands, using the same billing methods per consumer category with the billing methods applied to consumers in main land, b) power supply with special tariffs to large families and to vulnerable groups of population as defined by the existing legislation, c) power supply with special "Social Residential Tariff" to vulnerable consumers as defined based on the equivalent Ministerial Decision. The unit charges for the Services of General Interest are based on the in-force legislation and d) power supply with "Solidarity Services Tariff" to all legal persons governed by public Law providing welfare services, such as church-charity institutions, non-profit bodies governed by private law that provide social welfare services etc.

Calculation formula: **kWh x Unit Charge (€/kWh)**

e) Special levy for Greenhouse Gas Emissions Reduction (SLGGER):
According to the existing legislation, this duty, according to the existing legislation, it is destined to the payment of the electricity producers from Renewable Energy Sources (RES). It constitutes our contribution to the reduction of greenhouse gas emissions.

Calculation formula: **kWh x SLPE value (€/kWh)**

3.3.3 Slovenia

The retail market consists of suppliers and customers who enter open contracts, with which the quantities of supplied energy and the time course of delivery are not determined in advance. Customers pay for the supplied energy on the basis of the actual amount of electricity consumed, measured by appropriate meters. All market participants, which want to operate as an electrical energy supplier in the retail market must be registered in any of the countries of the European Union. Before activity start, a supplier must be a member of the Balance Scheme and fulfil the obligations set by the Energy Act and executive regulations. This mainly refers to the requirements regarding the functional unbundling of the activities of a supplier from distribution activities in related undertakings.

According to the Energy Act (EZ-1), two types of contract are possible: closed contract where the volume and supply period are fixed and known; and open contract that determines the customer's balance group, while the volume depends on actual consumption from the electricity grid. In the retail market, suppliers and traders conclude open contracts, in which the quantities of supplied electricity and the time profile of supply are not set in advance. Consumers pay for the supplied electricity according to actual consumption. Consumers with very big volume can sighn closed and open contract with different supplier.

In order to settle the imbalance, suppliers are obliged to submit to the market operator an operational forecast of their supply points within the deadlines set by the Rules on the Operation of the Electricity Balancing Market.

In EZ-1 we have obligation that residential and small business users can be bind with contract maximal 12 months. After this period, customer can change supplier free of charge.

In Slovenia we have monthly bills. If the metering point is equipped with a voltage metering technique, then the electricity actually consumed is charged monthly. However, if the metering technique does not enable remote data acquisition, then the estimated consumption is charged monthly, and at least once a year the supplied electricity is settled. The monthly electricity bill combines charges related to the different stakeholders in the electricity system and can be broken down into groups:

- Energy
- Grid usage
- Taxes
- Excise duty
- Vat

Billing is performed on either one-tariff and two-tariff billing system. The two-tariff system consists of a high tariff and a low tariff. High tariff is charged on working day between 6 am and 10 pm, outside of that time period is electricity charged by low tariff. Energy Agency start the project to update billing tariffs.

Electricity prices are known in advance to most customers. New energy law predict, that biggest supplier should offer variable price to residential users. This option is currently available just for business customer with very big yearly volumes.

Currently there are 22 retailers of electrical energy registered in the Slovenian market 14 of those has a contract with SODO for joint charging of electricity, network charges and contributions. For households is normal to get one bill with all items charged. Payment deadline is negotiable but almost all household and small businesses have 15 day payment deadline.

In the electricity bills issued to final customers and in their promotional materials, electricity suppliers are obliged to reveal the shares of individual energy sources in production of the supplied electricity in the previous year. These shares must be represented in the form of table and pie chart in which determines the percentage shares of individual production. Information regarding CO2 emissions and radioactive waste from production sources should also be provided to the consumers. If electrical products like "100% energy from renewable sources", are provided to the customer the supplier is obligated to specify the share in the overall structure of the company, as well as the structure relating to the particular electricity product.

The methodology for determining the shares of production sources and the manner of their presentation is set by the Act laying down the mode of determining shares of individual production sources and the manner of their presentation. This Act, which is force from September 2013, determines that the shares of electricity produced from renewable sources can be proved only through cancellation of Certificates of Origin, while the shares of other sources can be proved through the national and European residual mix.

3.3.4 Finland

There are more than 70 electrical retailers in Finland with different operating models. Since 1998 when the electricity market opened in Finland, all consumers (households and companies) have been free to choose their own electricity retailer. The electricity retailer is responsible to provide the energy and the cost is paid by the customer according to the contract as mentioned in section 3.1.3. People chose among the retailer based on their wish and criteria, such as

- Origin of electricity generation, e.g. solar, water, wind, biomass, nuclear or fossil
- Price per kWh
- Social responsibility
- Locality

In addition, the type of contract can be one of the following concerning average consumption and price:

- Temporary
- Valid for the time being
- Exchange electricity

It is worth mentioning that almost all of the electricity retailer suggest a contract with the hourly-based price, The price is usually the wholesale market price + a small margin, e.g. 0.25 Euro cents per kWh. This type of contract is very useful for the customers who want to manage their consumptions and supports naturally demand response activities. However, due to the complexity of the price structure for the public and/or a lower profit margin for the retail company, it is not a popular scheme and only about 10% of customers chodes this kind of energy contract.

3.4 Wholesale

3.4.1 EU

The electricity generated at a power plant is frequently bought and sold a number of times in bulk quantities in the wholesale market before reaching the final consumer. Wholesale prices are highly sensitive to available production and transmission capabilities because energy must be produced when needed and cannot be stored on an industrial scale. Hence, electricity has a different value over time. Moreover, since transmission lines have certain capacities and have to be operated within safe limits, the value of electricity is location-dependent. Also, production and consumption have to matched to each other at all times to avoid risks of blackout (and preferably locally to avoid costly investments for transmission line upgrades). Energy flexibility (i.e., the ability to increase/decrease energy production/demand at short time scales) can help balance the energy production to the demand and therefore it is a tradeable asset.

Prices may also be influenced by false information on the availability of these capabilities, or by reducing the production. Since plenty of energy is also traded across borders, it has traditionally been difficult to detect this kind of price manipulation as national regulators have not had access to cross-border data. In response, the EU has passed regulations ((EU) 2019/943 and 1227/2011/EU) to detect market abuse and level penalties.

With respect to time scales in which they apply, an overview of the electricity EU markets is depicted in Figure 22.

3.4.1.1 Forward Energy Markets, Forward Transmission Markets

Starting from the longer-term markets, electricity is traded in forward energy markets from about four years up to one month before actual delivery. Either a financial exchange organizes the transactions by means of standardized exchangeable products or market participants reach bilateral over the counter (OTC) agreements. The energy prices that are negotiated in these markets are more-or-less determined by the boundaries of the bidding zones for the forward energy markers, which mostly overlap with national borders (see Figure 23). If any party wishes to negotiate exchanges (and their respective prices) outside its bidding zone, long-term cross-zonal transmission rights have to be acquired on the Joint Allocation Office (JAO)] platform, which is a service jointly run by TSOs. The cross-zonal transmission rights and allocation rules are regulated based on the Forward Capacity Allocation Guideline (FCA GL). When respective rights are in place, electricity is traded across bidding zones in Forward Transmission Markets.

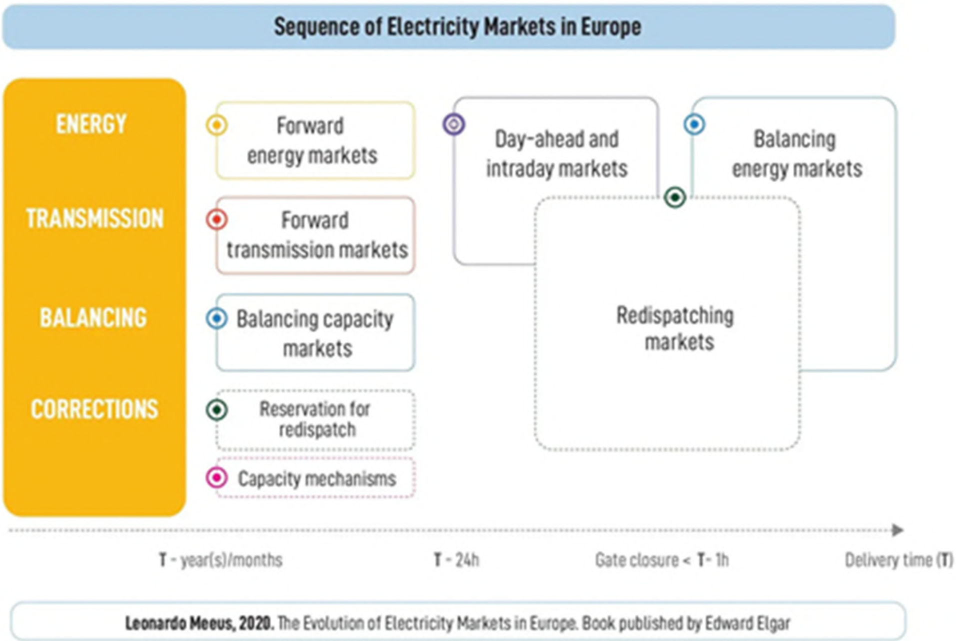

Figure 22: The landscape of wholesale electricity markets in Europe. (MEEUS, 2020)

Figure 23. The bidding zone configuration for forward energy markets in Europe.

3.4.1.2 Forward Capacity Markets

Apart from forward energy and forward transmission markets, in the longer-term timeframe, EU Member States can decide to set up a capacity mechanism if deemed needed for adequacy reasons. Capacity mechanisms exist in many forms and are often organised by the TSO. The capacity procurement takes place one to about four years before delivery in Forward Capacity Markets.

3.4.1.3 Wholesale Markets

The day-ahead market consists of one pan-European auction at noon for the 24 hours of the next day. All accepted bids are paid the marginal offer. Trading is organised by one or several power exchanges (PXs) per Member State. At the time of writing, the Single Day Ahead Coupling (SDAC), allowing for efficient trade between all European bidding zones in the day-ahead timeframe, is almost finalised.

3.4.1.4 Spot Markets

After the day-ahead market is cleared, the intraday market opens. Spot markets are often used to adjust long-term positions closer to delivery. Importantly, although volumes traded in the wholesale markets are, in some cases, only a fraction of the final volume of generated electricity, the wholesale prices serve as the price reference in long-term contracts. Currently, trading in the intraday market is done via continuous trading (as on a stock exchange) in some countries and via auctions in other countries. Recently, it has been decided that the future intraday European model will consist of a combination of continuous trading with three European-wide auctions at pre-defined times.

3.4.1.5 Balancing markets (balancing capacity and balancing energy markets)

After trading in the intraday market closes, the balancing mechanism is in place to ensure that supply equals demand in real-time. Each TSO is responsible for the real-time balance in its control area. To do so, each TSO organises balancing markets where it procures the resources needed to balance the system. Balancing markets consist of balancing capacity markets and balancing energy markets. In balancing capacity markets, contracted Balancing Service Providers (BSPs) are paid an availability payment. Contracting is done one year ahead up to one day ahead of delivery in order to make sure that there will always be enough balancing energy available in real-time. The BSPs contracted in the balancing capacity market (as well as other BSPs without contracted balancing capacity) then offer their balancing energy in the balancing energy markets. The volume of activated energy depends on real-time imbalances.

3.4.1.6 Transmission re-dispatch “markets” (Reservation for re-dispatch and re-dispatching markets)

Redispatch is needed when the market outcome (in this case the day-ahead or intraday market) results in generation and consumption schedules that would lead to a potential violation of operational limits (e.g. thermal limits, voltage ranges, etc.) of a certain network element within a bidding zone. Such a situation occurs regularly, as typically transmission network elements within a bidding zone are not considered when trading in wholesale markets. Only the physical limits of network elements between bidding zones are considered (so-called zonal pricing). Typically, re-dispatch involves increasing or decreasing the output of a generator at the ends of a potentially congested line. The Clean Energy Package prescribes to organize re-dispatching by default in a market-based manner (Electricity Regulation, Art. 13). Currently, in most EU Member States generators are still legally obliged to participate in re-dispatch, and prices are regulated, i.e. the audited costs (in case of upward activation) or foregone opportunity costs from the wholesale market (in case of downward activation) are paid to the owner of the re-dispatched resources. Some Member States have merged the balancing energy and re-dispatching markets.

3.4.2 Greece

The Greek wholesale electricity market was organised as a pure mandatory pool from its inception in 2005 until the end of 2020, when it was replaced by the new market organization that follows the provisions of the European Target Model.

From February 2012 onwards, an ITO model (as opposed to an ISO) was adopted for the Greek market and this implied the re-structuring of the former TSO into two discrete entities:

- The Market Operator (LAGIE), which solves the day-ahead market, conducts its clearing, and engages into contracts with renewable producers.
- The System Operator (ADMIE), which owns the network, as a subsidiary of PPC, conducts the real time dispatch, the clearing of the imbalance market and the settlement of all other charges or payments.

Given the above development, the market code was decomposed into the Grid Code and the Transactions Code (Code documents on Greek).
RAE determined the principles for the certification of the new ITO in accordance with the Law 4001, which reflected the EC directive. The TSO’s certification process is expected to be completed by the end of 2012. A Distribution Network Operator was also formed and RAE is currently assessing its compliance procedure.

Law 4512/2018 defined the following markets:

1. *Forward Market:* This market allows participants to conclude electricity purchase and sale contracts, with physical delivery obligation, as they will be set out in the relevant market code and to trade in energy financial instruments.
2. *Day ahead Market:* This market allows participants to submit electricity transaction orders with obligation of physical delivery on the next day. In the day ahead market, the energy quantities committed through the conduct of forward product transactions are also declared, which were realised either through the forward products wholesale market or outside it. At the same time, there will be implicit allocation of the transmission capacity at interconnections, through the coupling of the day ahead markets of European countries.
3. *Intraday Market:* This market allows participants to place transaction orders for physical delivery on the date of fulfilment of the physical delivery, after the expiry of the deadline for placing transaction orders at the day ahead market, taking into consideration the energy quantities committed through the conduct of transactions in forward electricity products which they have realised, the day ahead market results, as well as any limitations emerging from the balancing market. Participants may carry out transactions to minimise the imbalance of their net position arising from transactions in all markets, from the quantities sold/purchased in real time.

4. *Balancing Market:* The balancing market includes the balancing capacity market, the balancing energy market and the imbalance settlement process. Participants are required to submit bid with a physical delivery obligation for their total available capacity, both in the balancing energy market and the balancing capacity market.

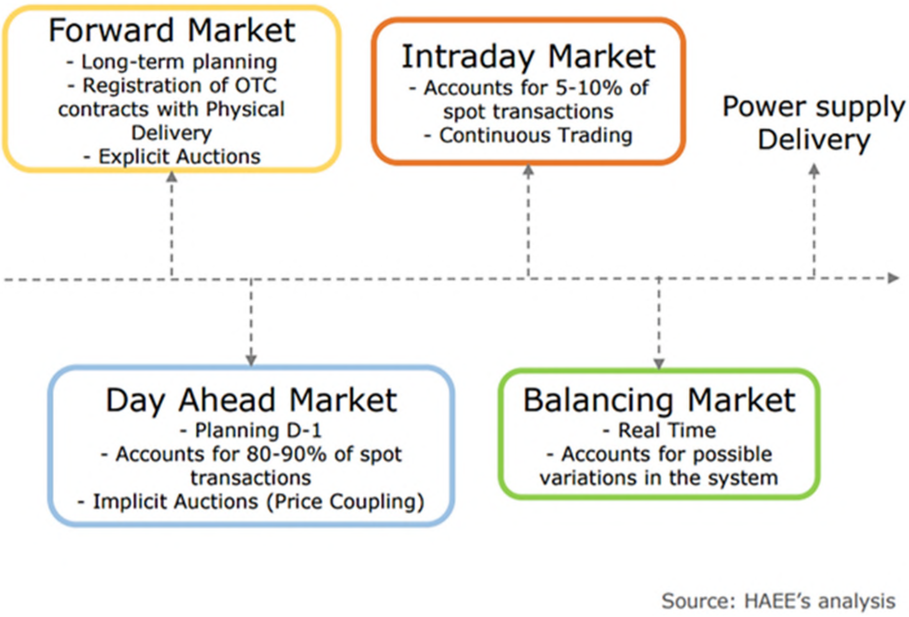

Figure 24. Overview of Wholesale Electricity Market in Greece under the Target Model provisions.

3.4.2.1 Forward Market (HAEE, 2019)

The Forward Market refers to bilateral agreements for buying or selling a specific amount of electricity, at a specific price on a specific future date.

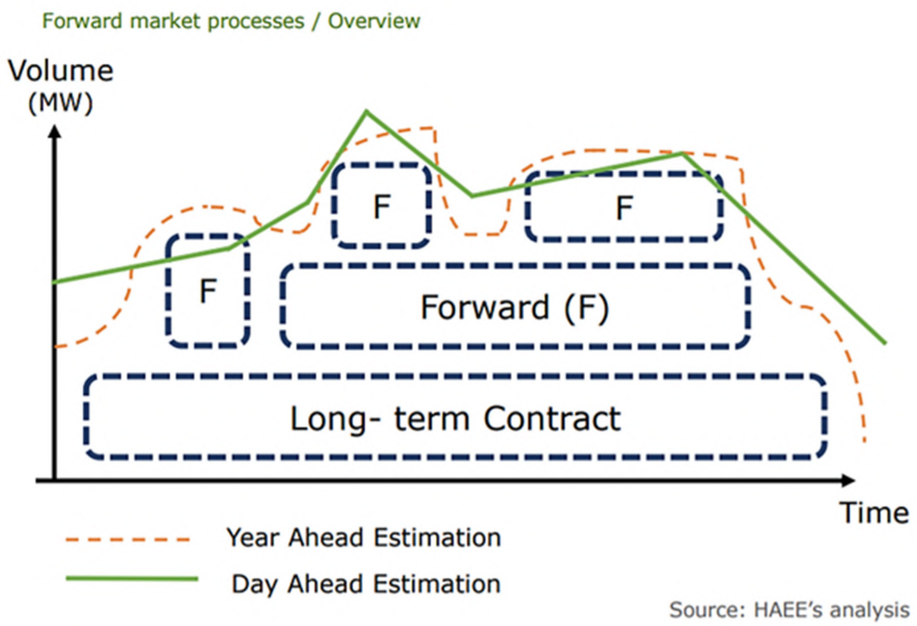

Figure 25. Forward Market Overview

The Forward contracts include standardised elements that consist of: (i) the underling title, (ii) the delivery date and (iii) the contract size. These standardized contracts are designed to be Monthly, Quarterly or Yearly contracts. The settlement price of the contracts in not recorded the transaction system. The buyer of the bilateral agreement is obliged to buy the certain amount of energy while the seller has to sell the certain amount of energy of the contract terms, on the pre-agreed future date.

The suppliers that participate in the Forward Energy Market are able to "pre-determine" the price and the agreed quantity and it also has the flexibility to differentiate its position within the contract's horizon. The types of orders that could be submitted in the Forward market are the following:

- Market Order: Transactions meant to execute as quickly as possible at the current market price.
- Limit Order: sets the maximum or minimum price at which buyers or sellers are willing to complete the transaction, respectively.
- Linked Orders: linking several delivery periods together.
- Iceberg Order: Large single orders that have been divided into smaller limit orders.

Furthermore, the Forward market includes the registration of over-the-counter (OTC) contracts with physical delivery obligation.

3.4.2.2 Day-Ahead Market (HAEE, 2019)

The Day-Ahead energy market includes transactions for each D-1 calendar day, where electricity supply contracts are auctioned for each time-slot (1 hour) of the physical delivery in day D. More precisely, the delivery day, D is divided in 24 time-slots. The gate opens at 10:30 (D-1) and closes at 13:00 (D-1) (duration 150 min). The trading mechanism is a double-sided (generation and demand) auction that matches for every hour the generation and demand at a single price.

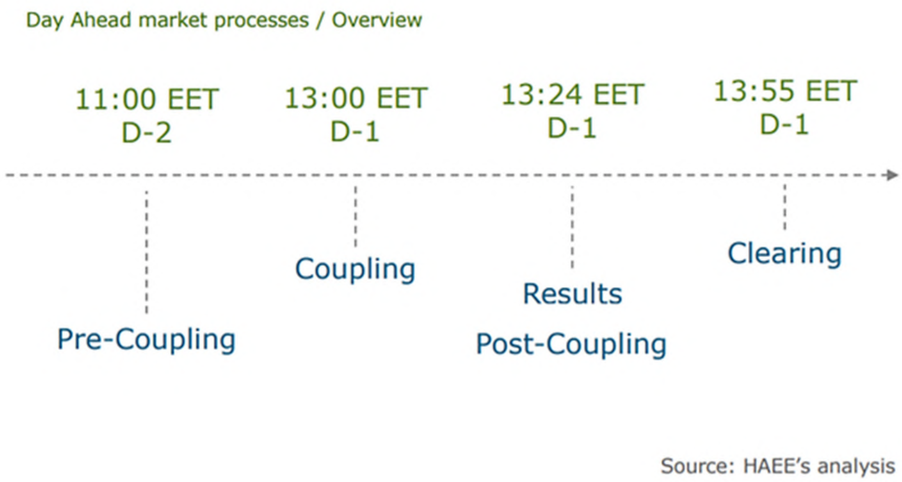

Figure 26. Timeline of Day - Ahead energy market

The product traded is an hourly contract. The contract terms are the size in MWh and the value in €/MWh of the traded energy. Each bid includes the participants details, the type of the bid (i.e., buy or sale), the hour of the delivery day D, the quantity, and the price. The participants in the Day-Ahead market are generators, traders, suppliers, and large consumers.
After receiving the bids, a verification and validation process is performed. Sellers' bids include the quantity and the minimum price at which each seller is willing to supply electricity and buyers' bids include the quantity and the maximum price, each buyer is willing to pay.
The bids are anonymous and are collected until the transaction system closes at 13.00 (D-1). Then, under an auction algorithm computation, the clearing price is determined for every hour of the delivery day D. The clearing price for every hour is settled when demand and supply curves intersect. The types of orders that can submitted in the Day – Ahead market is step-wise orders, linear orders and block orders.

3.4.2.3 Intraday Market (HAEE, 2019)

Intraday Market follows the Day – Ahead Market. In the Intraday Market are auctioned transactions to buy or sell energy after the gate closure of the Day – Ahead Market and for physical delivery at the day D. The participation in the Intraday Market is optional.
Currently the Intraday energy market includes three Local Intraday Auctions (LIDAS) in isolated (non-coupled) mode (EnEx). The Intraday Market serves as an extension of Day – Ahead fine-tuning, since participants can update their trading position as approaching to real-time.

3.4.3 Slovenia

In the wholesale market, producers, traders and suppliers of electricity sell and buy electricity from each other. In doing so, they conclude closed contracts, in which the quantities and time course of the supply of contractual quantities of electricity are determined in advance, and the price does not depend on the actual realization of the contracts. Participants can conclude transactions bilaterally or on energy exchanges in Slovenia and abroad. Energy can be traded on exchanges for the day in advance, within the day and for the purposes of balancing the system. Futures products can also be traded, which usually cover longer periods of time than day-ahead trading.

The activity of the energy exchange with electricity in Slovenia is performed by the company BSP Energetska Borza, d.o.o. (hereinafter BSP SouthPool). This exchange offers day-ahead and intraday trading. Day-ahead trading, which takes the form of auction trading, is included in the Multi-Regional Coupling (or MRC for short) with Slovenia's borders with Austria and Italy. Intraday trading is based on the principle of real-time trading and is not yet included in merging intraday markets. The only exception is intraday trading with Italy, which takes the form of two complementary implicit auctions, MI2 and MI6 (MI5). This form of trading, which was introduced as a pilot project in 2016, has been well received by traders. On BSP SouthPool, it is also possible to register transactions in the settlement and financial settlement system (OTC clearing). OTC clearing means the registration of bilateral contracts, ie transactions concluded outside the stock exchange market, in the financial settlement system of BSP SouthPool. OTC clearing is performed after entering and confirming a transaction between the seller and the buyer of electricity in the trading application. The conclusion of transactions for OTC clearing takes place 24 hours a day, from 3 pm on the day before the start of physical delivery to one hour before it. The operator of the Slovenian electricity market, Borzen, is in charge of recording all contracts concluded on the wholesale electricity market. It thus records all contractually agreed obligations in which electricity is bought or sold in Slovenia, or energy is transferred across the border of the regulatory area. This includes recording all contracts concluded between the members of the balance scheme, all export and import closed contracts and transactions concluded on the stock exchange. The market operator also monitors the forecast of the implementation of open contracts between suppliers and customers and producers of electricity, which it receives from individual suppliers in the form of operational forecasts of production and consumption.

Due to the small size of the market (14 TWh of annual consumption), the Slovenian wholesale market is strongly tied to domestic electricity production. Major production resources are divided into two pillars, the companies DEM, SENG, HSE ED Trbovlje and TEŠ operate within the group of Holding Slovenske elektrarne (HSE), which is the first energy pillar on the Slovenian wholesale market. The second energy pillar is the GEN energija group, which owns SEL and TEB and, in accordance with the interstate agreement between Slovenia and Croatia, also half of the Krško Nuclear Power Plant. At the same time, the GEN energija Group owns 51% of HESS, and the remaining share of this company belongs to the HSE Group.

There are also domestic and foreign wholesalers on the market, which do not have larger production units, but the trading volumes of the providers are smaller. The Slovenian market is connected to the European market, therefore, European directives have been transposed into legislation, as a result of which all transactions are recorded in accordance with REMIT. The REMIT Regulation (Regulation (EU) No 1227/2011) is a key basis for ensuring the integrity and transparency of the energy market. It provides an integrated regulatory framework for monitoring and controlling the European wholesale electricity and gas market.

The reference exchange for setting the price of long-term products is the Hungarian Hudex. However, the transaction can also be concluded on any other exchange, whereby the cost of cross-border transmission capacity must be added to the price for physical delivery. The price of the latter is determined by auction (www.jao.eu). Slovenia has a direct connection with 3 neighboring countries Austria, Italy and Croatia. With Hungary, the construction of a connecting transmission line is in the final stages.

3.4.4 Finland

Finland is a very energy-intensive society. Electricity plays an important role for both households and industrial processes. Finland is part of the Nordic electricity market, which covers Norway, Sweden, Denmark, and Finland. Based on Eurostat, the share of electricity that Finland imports to the total electricity consumption is one of the highest in Europe; Finland imports around one-third of the needed electrical power during peak hours in the wintertime and around 20-25 % of the annual consumption. It is important to highlight that 1 500 MW of the import capacity comes from third countries, namely Russia. The commercial transmission capacity from Russia to Finland is 1300 MW and 320 MW from Finland to Russia. There are two modes of power trade between Russia and Finland: bilateral trade and so-called direct trade. Fingrid and the Russian parties confirm the bilateral trade volumes for the next commercial day (D) on the morning of the previous day (D-1). The confirmed trade volumes have to be bid into the day-ahead and intraday markets of the Nordic Power Exchange. The volumes of the direct trade are determined by the given bids on the day-ahead market and intraday market of the Nordic Power Exchange and the corresponding Russian power markets. More information on trade on the FI-RU interconnector can be found on Fingrid's web page5.

The Nordic electricity market operated by the nordpool group. The future market can be divided into the day-ahead market and intraday market. In Finland, there are no formal or informal price limits in day-ahead and intraday markets other than the technical limits currently applied within European single day-ahead and intraday coupling as set out in Article 41(1) and 54(1) of Regulation 2015/1222 (CACM). There are also no formal or informal rules or requirements that limit generators' ability to freely price their offers in the wholesale markets, other than set in the requirements in Regulation 1227/2011 (REMIT), 2017/2196 (ER) and in case of a national emergency based on national Emergency Powers Act 2011/1552. There are also no rules or provisions that would require the TSO to release generation reserves based on market prices (MEAEF, 2020).

The process of the day-ahead market in Finland (Nord pool) is as follows:

1) at 10:00 CET available capacities on interconnectors and in the grid are published - buyers and sellers have until 12:00 CET to submit their final bids to Nord Pool for the auction for delivery hours the next day.
2) Submitted orders are matched with other orders in the market coupling process - the Single Day-Ahead Coupling (SDAC) - through a common algorithm called Euphemia. In the matching process, the single price for each hour and each bidding zone is set where the curves for sell price and buy price meet, taking into account network constraints. Finland is one bidding zone in the Nordic electricity market.
3) Hourly clearing prices are typically announced to the market at 12:42 CET or later. Following the publication of the prices, the individual result is reported to each buyer and seller. The physical obligation to deliver/consume the purchased or sold energy follows as Nord Pool nominates the trades to the imbalance settlement process applicable in each country.

After closing the day-ahead market, the participants can continue to trade the energy in the intra-day market to balance their portfolio. With the increasing amount of RES production, interest in trading in the intraday markets is increasing. Being balanced on the production and consumption for the participants closer to delivery time is beneficial for both market participants and power systems operators. It reduces the need for reserves and associated costs. Besides, the intraday market is an essential tool that allows market participants to take unexpected changes in consumption and outages into account.

The intra-day market is a continuous market, with trading taking place every day around the clock until one hour before delivery, and in some cases right up until the delivery hour. Prices are set based on a first-come, first-served principle, where best prices come first – highest buy price and lowest sell price. Nord Pool provides a wide set of order types available for buyers and sellers to match the dynamics of the demand or supply they are offering.

3.5 Balancing market

3.5.1 EU

The Third Package of European energy legislation defined the ecosystem, known also as the Target Model, for the development of a single European EU balancing market that would harmonise the balancing products, increase the liquidity of short-term markets by encouraging cross-border trade, increase competitiveness and ensure that all consumers can purchase energy at affordable prices.

To this end, the Agency for the Cooperation of Energy Regulators (ACER) defined a set of high-level, non-legally binding principles and objectives (Framework Guidelines) that paved the way for ENTSO-E (the European Network of Transmission System Operators for Electricity) to describe technical, operational, market rules and obligations (Network Codes) ensuring that the system frequency is maintained at predefined limits at the lowest cost. After a negotiation process between European Commission and Member States, the European Parliament approved the legally binding Regulation 2017/2195 that identified different critical system states (normal state, alert state, emergency state, blackout state and restoration state) and set out rules for

[5] Cross-border Connections between Russia and Finland. Fingrid in English https://www.fingrid.fi/en/electricity-market/rajajohto-informaatio/400-kv-cross-border-connectionsbetween-russia-and-finland/

the procurement of balancing capacity, the activation of balancing energy and the imbalance settlement. Individual Member States would need to consider local particularities and, eventually, implement this regulation as national law.

Transmission System Operators (TSOs) were appointed responsible for keeping the power system balanced in and near real time by permanently matching supply and demand. Imbalances occur when forecasted consumption/ generation of Balance Responsible Parties/BRPs (e.g., generators, retailers/suppliers, demand response operators, etc.) does not match actual/measured one. In order achieve system stability, TSOs need to procure balancing services from BSPs, such as generators and demand response operators among others, who bid for capacity and energy on a voluntary basis. On TSO's request, BSPs (Balancing Service Providers) may alter their power output and/or affect power intake in both directions (i.e., increase or decrease) depending on system condition. The balancing services are part of frequency-related ancillary services that can be further divided into:

- Frequency Containment Reserve (FCR): active power reserves that can be immediately activated (typically automatically) for responding to a frequency disturbance with activation times up to 30 seconds.
- Frequency Restoration Reserve (FRR): active power reserves that are activated if the frequency deviation lasts longer than 30 seconds. FRR can be distinguished between reserves with automatic activation (aFRR) and reserves with manual activation (mFRR). Usually, the aFRR is the second to react in case of a disturbance, while mFRR usually follows if balance is not restored. Each of those typically has maximum activation time of 15 minutes.
- Replacement Reserve (RR): active power reserve that can be manually or semi-automatically activated, following (or complementing) FRR with activation time from 15 minutes up to couple of hours[6].

The following properties have been defined for standardizing balancing energy and capacity products:

- Preparation period: The period between the activation request by the TSO and start of the ramping period;
- Ramping period: The time required for the active power output to increase or decrease from the current set point;
- Full Activation Time (FAT): The period between the activation request by the TSO and full delivery of requested power;
- Minimum and maximum quantity: Represents the activated power in MW offered to the platform by the BSPs;
- Deactivation period: The time required from full delivery to the previous set point;
- Minimum and maximum duration of delivery period: The time period when the BSP delivers full requested change of power to the system;
- Validity period: Represents the time in which the submitted bid can be activated by the provider;
- Mode of activation: Can be either automatic or manual and represents the way system operator can activate the relevant bid.

Imbalance settlement is the third key activity of TSOs. It represents the financial settlement mechanism with the goal of settling the costs incurred by the deviations from BRPs' net positions (imbalances). BRPs need to pay for any deviations from the scheduled net positions in negative direction and to receive financial compensation for any deviations from the scheduled net positions in positive direction if Imbalance price is positive and vice versa if Imbalance price is negative. The deviations are calculated by comparing the scheduled market plan of the BRP with the actual realization.

[6] Note that if imbalances are not expected to be resolved after the activation of RR, e.g., when imbalances are triggered by a power plant outage, TSOs can purchase balancing energy from the wholesale market.

3.5.2 Greece

The Greek electricity market is compliant with the European Target Model. The TSO, who is responsible for the balancing market, purchases balancing capacity, activates balancing energy and performs the imbalance settlement process. The whole process has been explained in detail in Section 3.5.2.

3.5.3 Slovenia

The Electricity Balancing Market is an organized form of collecting and engaging bids for the sale and purchase of balancing energy. The goal is to resolve in a transparent and economically efficient manner imbalances in the electricity system.

The Balancing Market is part of activity within public utility service organizing the electricity market organized under the scope of company Borzen, d.o.o.. The method for implementing the Balancing Market is stipulated in the Rules on the operation of the electricity balancing market.

Trading on the Balancing Market is implemented through a platform for collecting purchase and sale bids for electricity through which the System Operator (ELES) buys and sells electricity intended for the settlement of imbalances in the electricity system. Trading on the Balancing Market is carried out together with Intra-day trading, and further on, one hour after the closure of the Intra-day trading and until actual supply of the product. All companies included in the Balance Scheme of the electricity market and which acceded to trading on the Balancing Market and Intra-day trading can participate in trading.

Trading Schedule

Trading on the Balancing Market is carried out 24 hours a day, seven days a week, and at most one day in advance. Trading with hourly, 15-minute, base-load and peak-load products is enabled. 15-minute, hourly, base-load, and peak-load products are available for trading from 15:00 p.m. each day before the start of actual supply. Entry and concluding transactions with these products are possible up to the start of actual supply.

Based on the Rules for the Operation of the Electricity Balancing Market, Borzen. after due coordination with the System Operator defined the list of products, bid restrictions and types of restrictions on the balancing market.

In implementing the Balancing Market, Borzen co-operates with the BSP SouthPool energy exchange which offers a trading platform for the implementation of the Balancing Market with all necessary functionalities.

The Balancing Market is one of the activities under the framework of an obligatory public utility service of organizing the electricity market and the method for the implementation of the Balancing Market is stipulated in the Rules on the operation of the electricity balancing market published in the Official Gazette of the Republic of Slovenia.

Clearing and Financial Settlement of claims and liabilities arising from the Balancing Market is carried out by the Clearing Agent. Clearing Agent is liable for the fulfilment of financial liabilities for transactions concluded on the Balancing Market in the scope of submitted and redeemable financial guarantees.

Financial settlement of transactions concluded on the Balancing Market is executed one (1) business day after the issuing of invoices. Detailed explanation regarding the Clearing and Financial Settlement of the transactions concluded on the Balancing Market is available in the Clearing Rules.

3.5.4 Finland

Reserves in Finland is divided in different groups:

- Fast Frequency Reserve (FFR)
- Frequency Containment Reserves (FCR), reserve for disturbances and reserves for normal operation
- Frequency Restoration Reserves (FRR), manual and automatic
- Replacement Reserves (RR) are not used in Nordic power system

In the Nordic system, the obligations for maintaining reserves are agreed between the transmission system operators in Finland, Sweden, Norway and East Denmark. It's up to the TSO to decide how each country procures its share. Trading of reserves can be done also between countries but part of the reserves must be maintained nationally. Procurement of reserves in Finland is done via yearly and hourly markets and from other Nordic counties. In the case manual frequency restoration reserves via balancing energy and balancing capacity markets and also in Fingrid's reserve power plants and leasing power plants.(Fingrid, b)

In FCR yearly market bidding competition is organised in autumn for next year. In the bidding competition volumes for each provider and a fixed yearly market price (same for all providers, corresponds the most expensive accepted bid). In the previous day the reserve provider submits hourly FCR volumes. For hourly markets, hourly reserves bids are submitted day before. Fingrid purchases needed amount and every hour has its own price. Capacity that is contracted to yearly market cannot participate hourly market. (Fingrid, 2021)

By balancing capacity markets capacity is procured with weekly bidding competitions. If bid is accepted, the provider is obliged to deliver up-regulation bids. The reserve provider receives capacity payment for submitted bids to the balancing energy market, and energy payment if bids are activated.

In Finland production and consumption resources are able to participate in all reserve markets. Procurement is market-based and participation is optional. In markets usually marginal pricing is used, expect aFRR where pay as bid –principle is used. (Fingrid, c)

Fingrid covers the maintenance costs of reserves with a grid network tariff and payments collected in balance services. The costs of the balancing power market are covered by imbalance power.

At the moment Fingrid in conducting a pilot about independent aggregation in the balancing energy market. The purpose of the pilot is to test scalability of the solutions tested in previous pilots and increase participation of the aggregated flexibility into balancing energy market.

3.6 Flexibility markets & demand response

3.6.1 EU

Market liberalization, economic pressures, and environmental regulations are all moving towards a path of fewer traditional central power plants and more distributed energy resources (DER) to address future energy needs. Towards this direction, policy makers and energy market participants concur that Demand Response is a critical resource for achieving an efficient and sustainable electricity system at a reasonable cost. This has been reflected within the European Energy Efficiency Directive and Network Codes. In particular, the most relevant and recent Directives and Regulations that enable and foster consumer participation in DR programs are the amending Directive on Energy Efficiency (2018/2002, 2018), the new Electricity Regulation (2019/943, 2019) and the amending Directive on Electricity (2019/944, 2019) (SEDC, 2017).

Demand Response (DR) refers to changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments. Demand response programs are designed to lower electricity use at times of high wholesale prices, or when the system reliability is jeopardized.

Demand response programs are classified in two main categories: (i) Implicit (price-based) demand response programs and (ii) explicit (incentive-based) demand response programs.

3.6.1.1 Implicit (price-based) DR

In implicit price-based demand response programs consumers react to dynamic pricing signals and change their electricity usage accordingly.

- *Time of Use (ToU) (IRENA, 2019):* In ToU tariff scheme, participating consumers can adjust their electricity consumption voluntarily (either through automation or manually) to reduce their energy expenses. These energy rates are differentiated by peak and off-peak (and possibly shoulder) periods.

Day/night ToU differentiation is very common in Europe. For instance, in Italy, all low-voltage consumers are mandatorily exposed to ToU pricing if they do not choose a supplier in the liberalised market.

- *Critical Peak Pricing (CPP) (IRENA, 2019):* CPP is a rate in which electricity prices increase substantially for a few days in a year, typically during times the wholesale prices are the highest.

CPP is applied to a smaller extent in the UK, Lithuania, Portugal, Romania, and France. Particularly, French Tempo tariff is a contract with a fixed price all year except for a maximum of 22 days with very high prices.

- *Real-Time Pricing (RTP) (IRENA, 2019):* Prices are determined close to real time consumption of electricity and are based on wholesale electricity prices. Electricity prices are calculated based on at least hourly metering of consumption, or with even higher granularity (e.g., 15 minutes). Such tariffs are mostly composed of the wholesale price of electricity plus a supplier margin, however, several new services are moving away from margin models to wholesale passthrough models, whereby the consumer pays the actual market price.

Estonia, Romania, Spain, Sweden and UK applied such tariffs. For example, in Estonia and Spain between 25 % and 50 % of all households incur their supply charges based on hourly pricing.

- *Variable Peak Pricing (VPP) (IRENA, 2019):* A hybrid of static and dynamic pricing, where the different periods for pricing are defined in advance, but the price established for the on-peak period varies by market conditions.

These apply in Denmark, Norway, and Sweden, where electricity consumers incur spot-market-based pricing through the monthly average wholesale price.

3.6.1.2 Explicit (incentive-based) DR

Explicit DR programs enable demand side resources to participate and trade in the wholesale, balancing, and, where applicable, Capacity Mechanisms. The participating consumers are requested by wholesale market participants (TSOs, DSOs, Retailers) to change their energy consumption (or generation) patterns and receive direct payments if they do so. These requests are triggered due to energy imbalances, high wholesale prices or system's emergencies. Consumers are able to participate in explicit DR programs directly (in case of large-scale consumers) and earn from their consumption flexibility individually or by contracting with an aggregator: either a third-party aggregator or the customer's retailer (SEDC, 2017).

Art. 15.8 of the the Energy Efficiency Directive (2012/27/EU, 2012) establishes consumer access to energy markets, either individually or through aggregation.
In detail the Article states:

- "*Member States shall ensure that national regulatory authorities encourage demand side resources, such as Demand Response, to participate alongside supply in wholesale and retail markets*."
- "*Subject to technical constraints inherent in managing networks, Member States shall ensure that transmission system operators and distribution system operators, in meeting requirements for balancing and ancillary services, treat Demand Response providers, including aggregators, in a non-discriminatory manner, on the basis of their technical capabilities.*"
- "*Member States shall promote access to and participation of Demand Response in balancing, reserves and other system services markets, inter alia by requiring national regulatory authorities […] in close cooperation with demand service providers and consumers, to define technical modalities for participation in these markets on the basis of the technical requirements of these markets and the capabilities of Demand Response. Such specifications shall include the participation of aggregators*."

In the following, we present the technical modalities for Demand Response according to JRC.

- Demand Response programme design.
- Competitive framework: Auctions constitute an efficient mechanism tha encourage consumer participation in a transparent manner and fosters competition.
- Required size of a bid: The minimum bid size should be small in order to facilitate market participation and increase competition.
- Duration of the call: Event duration and/or availability requirements constitute a barrier for consumers. The event duration (length of time a consumer is asked adjust her consumption) should be as short as possible.
- Frequency of activations/short recovery periods: Depending on the type of market, consumers require sufficient time between two activations.
- Provide the option of asymmetric bidding: Increase/decrease consumption equally (symmetrical bids) constitutes a significant barrier for consumer participation. In Member States where the TSO is willing to enable Demand Response, asymmetrical bids are allowed.
- Measurement & verification:
- The baseline methodologies should be fair and transparent and be publicly available.
- The pre-qualification, measurement and verification processes should be defined and take place at the aggregated level. The communication protocols implemented should be between oparetor and the aggregator.

- The payments that are offered should encourage consumer participation in demand response, be fair, transparent, and strengthen competition
- Penalties enhance conformance to demand response programs and ensure reliability of demand side resource.

In Figure 27 below presents the status of Explicit Demand Response activity in Europe.

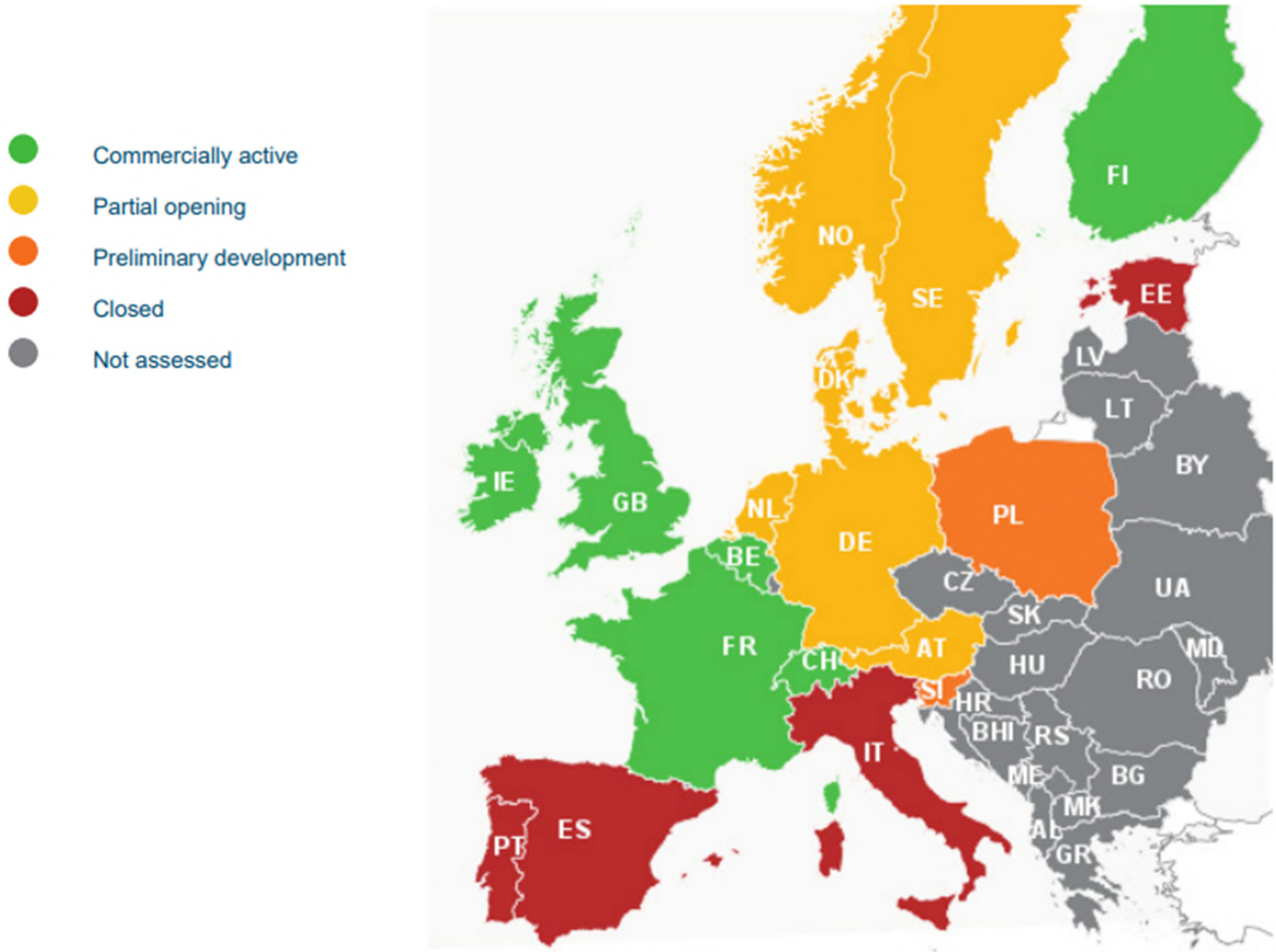

Figure 27: Map of Explicit Demand Repose Development in Europe (SEDC, 2017)

More precisely, the most mature regulatory framework for demand side participation in wholesale electricity markets exists in Switzerland, France, Belgium, Finland, Great Britain, and Ireland, addressing the role of independent aggregator and including standardised roles and responsibilities of market participants.

Austria, Denmark, Germany, Netherlands, Norway, and Sweden are marked yellow since regulatory barriers exists that prevent the market growth. Several markets in these countries are open to Demand Response, however, programme requirements continue to exist which are not adjusted to enable demand-side participation.
In Slovenia, Italy, and Poland a gradual opening of markets takes place during the latest years, however significant barriers still exist that prevent consumer participation. Finally, in Spain, Portugal, and Estonia the regulatory framework has not evolve significantly to include aggregated demand-side flexibility.

3.6.2 Greece

Regarding interruptible load services (ILS) the Greek Law 4342/2015 (Official Government Gazette FEK A' 143/09.11.2015) integrated EU Energy Efficiency Directive (henceforth EED) 2012/27, which required among others, a) member states to adopt demand response measures, b) legal and personal entities to provide balancing and/or ancillary services and c) the regulator to expand its monitoring role for the successful implementation of the energy efficiency directive in the market.

During the period that the ILS contracts were in force, TSO had the right to interrupt load services of the eligible High Voltage consumers in the interconnected system for a specific period, at a pre-defined maximum Load level. For its action, the TSO compensated the eligible High Voltage consumers in the interconnected system for the provision of the demand response measures. A Reserves Account for Security of Supply had been issued by the TSO. The financing of the account was based on a levy imposed to all the active generators. The implementation of the ILS framework was terminated at the end of 2021.

Law 4425/2016 along with the amendments introduced to it by Law 4512/2018 and Law 4546/2018:

- Introduces the role of an Aggregator (which by means of the amendments introduced to it by Law 4512/2018 also includes the RES aggregation) and provides that it is: "*The legal person who collectively represents in the Electricity Markets one or more producers or consumers or potential Participants for one or more connection points for either production or for electricity demand and assumes the respective obligations and requirements resulting from their participation in the relevant Electricity Markets*.", and

- Article 17 introduces to the Greek legal framework many of the provisions of Article 40 of the upcoming (Council of the European Union - Directive, 2019) relative to Demand Response and provides that the TSO should act in this respect in accordance with the secondary legislation provisions as they are specified in the Power Exchange and Balancing Market Rules.

Greece has recently established a specific market framework for the direct participation of DR Aggregators in the wholesale electricity market. Based on this framework, the everyday participation of DR Aggregators is now technically feasible only for the large (industrial and commercial) consumers, which are exclusively connected to the HV and MV levels. In addition, DR Aggregators currently participate only in the Balancing Market, since the related regulatory framework and detailed technical decisions pertaining various operational aspects regarding the participation of DR in the Day-Ahead Market are still under formulation and are expected to be finalized soon.

The lack of appropriate IT infrastructure (e.g. smart meters), which would allow for real-time access to massive electricity consumption data, further aiming at the extended deployment of DR programs for end-consumers that are connected to both MV and, mostly, LV distribution networks is the main barrier for the large-scale implementation of DR to all end-consumers.

3.6.3 Slovenia

In May 2020, the Energy Agency completed the initial set of public consultations on the establishment of a market with the flexibility of active consumption in Slovenia and published an updated consultation document. It contains a substantive upgrade, corrections, explanations and the Agency's views on particularly highlighted topics in the public hearing.

The introduction of a flexibility market in Slovenia is in its infancy, only certain topics have already been addressed in a narrower sense, but their comprehensive treatment indicates the existence of a number of obstacles and the complexity and interdisciplinarity of the issue. Introducing a market with flexibility therefore requires a holistic approach and the involvement of different stakeholders. Notwithstanding the fact that the harmonization process at EU level will gradually build a framework of norms and rules and good practices based on the recommendations of the European Commission and the results of cooperation between European electricity operators, on the basis of which certain aspects of the market can be implemented with flexibility at national level. the removal of perceived barriers that are nationally conditioned should begin as soon as possible.

As part of the harmonization process, the question of what to standardize, what to recommend and what to leave to market players will need to be answered. Effective updating of existing legislation will also be crucial to ensure full compliance with the third set of EU directives and to ensure that these requirements are operationalized, thus ensuring minimum conditions for implementing the new requirements of the Clean Energy Package for all Europeans and network codes. The implementation of the said package and network codes is the basis for further development of the system and the market in the context of exploiting flexibility.

However, it makes sense to use this consultation process to introduce new roles and responsibilities and flexibility mechanisms and concepts in line with this package in the normative regulation at the secondary level, which have already matured today and are not in conflict with current energy legislation.

At the same time, it will be necessary to prepare and coordinate an operational plan for the implementation of all necessary activities for gradual and effective market introduction with flexibility, which must address the issue of investment in new technologies and be coordinated at the level of stakeholders and properly placed in the context of national strategies. The Agency is well aware of its role, tasks and obstacles, which it must address in this consultation process. Through its active work, it will continue to try to motivate interested stakeholders to work together to achieve these goals.

The Energy Agency estimates that the publication of the consultation document has achieved quite a few intermediate goals: to develop and publicly publish a comprehensive expert basis that addresses all key aspects of establishing a market with flexibility at the level of high-level treatment. It achieved the establishment of a common level of understanding of the issue and the establishment of an effective consultation process for a broader professional discussion of the highlighted topics in support of the implementation of the Clean Energy package for all Europeans. It has achieved the objective of formulating certain preliminary positions of the Agency and clarifying the aspects of the national regulatory authority that are included in this document. With the active participation of stakeholders in the consultation process, it was possible to identify common positions and close certain thematic areas.

Other thematic areas could be sharpened and clarified somewhat better in the initial set of consultations, which represents a good basis for future activities within the further sets of consultations. The public consultation on the establishment of a flexibility market will continue with the treatment of selected thematic strands, supported by new consultative content. At the end of all planned sessions, the Agency plans to publish the final umbrella positions. The interim results of the consultation will be expert bases and supporting documentation (responses of participating stakeholders) and intermediate positions of the Agency on selected topics under consideration in each consultation, which in the Agency's opinion are important in the implementation of the Clean Energy for All Europeans package. and secondary legislation (SONDSEE, Rules for the functioning of the electricity market, etc.).

The next planned strands under this consultation process are: the (independent) aggregator model and related content, and market processes and trading platforms.

3.6.4 Finland

In Finland flexibility markets at the moment organised at TSO enabled balancing markets that are described in previous section 3.4. All resources, generation, consumption and storage, are able to participate these markets.

Flexibility can be traded at NordPool wholesale market via balance responsible parties. Besides normal day-ahead and intraday trading flexi-order-type can be traded.(Nordpool)

Balance responsible parties might use flexibility to optimize their own operations, e.g. imbalance and portfolio management.

Time of Use tariffs are very typical with the Finnish households who have electric heating and there is around 10 MW demand response potential and dynamic load control potential of 14 MW in the domestic households. (SEDC, 2017)

The current regulatory framework of the DSOs needs to be updated before the next regulatory period starting in 2024 to meet the requirements of the Electricity Directive 2019/944. DSOs need to consider the use of flexibility in thenir investment planning and operations and this might lead to new flexibility markets or products and also DSOs procuring flexibility. There are some demonstrations (Fortum, 2020 and Caruna, 2020) around using battery flexibility for security of supply in distribution networks. This topic is a burning issue and probably in near future new type of flexibilities would be required.

3.7 Energy sector integration

Energy sector integration refers to linking of different energy vectors such as electricity, gas and heat. Sector integration is driven by electrification and it supports the utilization clean and renewable energy all over the society, including heating, industry and transportation. European Union defines energy system integration as "*the coordinated planning and operation of the energy system 'as a whole', across multiple energy carriers, infrastructures, and consumption sectors*"[7].

From the iFLEX project point of view, sector integration between district heating (DH) and electricity is an interesting opportunity as it provides new possibilities for consumer empowerment and demand response. In Finland, district heating has 46% market share in residential, commercial and public buildings. DH is especially popular in cities and its market share in apartment buildings is 88%.[8] In contrast to electricity where the markets are global and open, district heating networks are local and heat is typically produced by as single company. However, open district heating concepts that utilize waste heat e.g. from industry and supermarkets are also emerging[9] [10].

Sector integration provides interesting possibilities for demand response. Buildings have a large thermal mass that acts as a natural energy storage that provides a cost-efficient solution for demand response. This flexibility could be provided to a DH company to make their networks more dynamic and this way help them reduce losses and costs. Moreover, district heating is typically generated with Combined Heat and Power (CHP) plants that produce electricity as a by-product. Therefore, demand-side flexibility in the DH network directly contributes also to the electricity sector as it influences the flexibility of CHP generation.

Another interesting opportunity for sector integration are heat pumps, which are becoming more popular in renovated apartment buildings to provide an alternative for DH. Building with heat pumps and DH are interesting sector integration point as they provide means to reduce consumer's energy bill by optimizing across electricity and DH vectors. This is especially interesting with dynamic electricity and/or DH prices. Moreover, aggregated heat pump resources provide interesting explicit demand response opportunity for DH companies as they allow heat to be produced with electricity when the prices are low and with DH when the prices are high to maximize the profits.

Although there are interesting opportunities in DH-electricity sector integration, there are still many open issues. For instance, the market structures for DH are underdeveloped and there is a lack for clear models to support flexibility from consumers and aggregators.

3.8 Conclusion

This section provides an overview of the energy market at European level as well as in the target demonstration countries: Greece, Slovenia and Finland. This review begins with a brief description of different stakeholders involved in the energy sectors in each country and then focuses on electricity market players, including a high-level description of the retail, wholesale, balancing, flexibility and DR markets. Finally, this section defines the energy sector integration and opportunities from the iFLEX project perspective.

Among the target countries, Finland has the largest energy consumption, the peak of annual total energy consumption is about 26 Mtoe, while this value is 15.2 and 5.5 Mtoe for Greece and Slovenia, respectively. The same trend is followed by the electricity consumption in these countries. The maximum annual electricity consumption in Finland, Greece, and Slovenia is about 90, 53.5, and 17.5 TWh, respectively. In other words, the share of electricity to the total energy consumption is higher in Finland as compared to the other two countries.

This section also detailed the role and the uptake of the different stakeholders, such as Energy Communities, Retailers, TSOs/DSOs, Retailers, BSPs/BRPs, Aggregators, ESCO companies is provided at EU as well as at country-specific level for the target demonstration countries: Greece, Slovenian and Finland.

Attention is also paid to describe the roll-out of smart meters in the three pilot countries:

In Greece there is very slow progress regarding the installation of smart metering infrastructure that would allow for the deployment of large-scale demand response programs. Current percentage of smart metering deployment is almost zero. In fact, only the ~40 HV and ~11,000 MV consumers are currently tele-measured, while around 7,5 million LV customers are still equipped with conventional metering infrastructure allowing only for aggregated consumption data reading (monthly or four-monthly time intervals are usually used by the electricity suppliers to invoice their customers for their aggregated real consumption). Therefore, currently no IT infrastructure that would allow for unidirectional or bidirectional communication between HEDNO/Suppliers and the end-consumers and, in turn, for the massive deployment of DR programs is available.

[7] https://ec.europa.eu/energy/sites/ener/files/energy_system_integration_strategy_.pdf
[8] https://www.euroheat.org/knowledge-hub/district-energy-finland/
[9] https://www.helen.fi/en/companies/heating-for-companies/open-district-heat
[10] https://www.opendistrictheating.com/

In Slovenia, an advanced metering system is used which includes a set of measuring devices, information technology and communication channels enabling automatic (remote) selection, processing and transmission of metering data and the possibility of two-way data exchange between the metering centre and the meter.

In Finland, 15-minute interval metering and remote reading has been adopted. Two-way communication of the meters are becoming more available as new meters are installed, however this capability is not used commercially.

The Greek electricity market is compliant with the European Target Model with a Forward, Day-Ahead, Intraday and Balancing Market being in force. The TSO, who is responsible for the balancing market, purchases balancing capacity, activates balancing energy and performs the imbalance settlement process.

In Slovenia, the trading on the Balancing Market is implemented through a platform for collecting purchase and sale bids for electricity through which the System Operator buys and sells electricity intended for the settlement of imbalances in the electricity system. In Finland, the procurement of the reserves in the Balancing Market is executed by the TSO. All BRPs, such as resources, generation, consumption and storage, are able to participate in the balancing and flexibility markets.

The role of the DR Aggregator as a stakeholder is viewed as critical for the participation of DR resources in the different market segments and especially in the flexibility market.

In Greece, RES Aggregators and DR Aggregators are separate entities that participate independently in the various segments of the wholesale electricity market. Specifically, according to the current legal and regulatory framework of the Greek electricity market, RES Aggregators are allowed to participate in the Day-Ahead Market, Intra-Day Markets and Balancing Market, while DR Aggregators are allowed to participate only in the Balancing Market for the provision of balancing services. The everyday participation of DR Aggregators is now technically feasible only for the large (industrial and commercial) consumers, which are exclusively connected to the HV and MV levels. In addition, DR Aggregators currently participate only in the Balancing Market, since the related regulatory framework and detailed technical decisions pertaining various operational aspects regarding the participation of DR in the Day-Ahead Market are still under formulation and are expected to be finalized soon. The lack of appropriate IT infrastructure (e.g. smart meters), which would allow for real-time access to massive electricity consumption data, further aiming at the extended deployment of DR programs for end-consumers that are connected to both MV and, mostly, LV distribution networks is the main barrier for the large-scale implementation of DR to all end-consumers.

In Slovenia, it is necessary to provide a coherent normative framework in which the aggregator will be able to provide services to any potential customer and will ensure that all interested stakeholders are sufficiently informed and, if necessary, compensated for the aggregator's actions. The aggregator framework needs to be integrated with existing market mechanisms while introducing new markets if they are not already in place (eg local markets for congestion management and capacity management).

In Finland, there is no distinction between RES and DR aggregators. The aggregation of different resources is already permitted in all electricity marketplaces in Finland. At the moment, independent aggregators can provide frequency-controlled reserves (FCR-N, FCR-D and FFR) and a pilot project tests their participation in the balancing energy markets (mFRR) There is not yet a legal framework for the independent aggregation in place.

Finally, this section defines the integration of energy sectors from the perspective of the iFLEX project: Buildings have a large thermal mass that acts as natural energy storage that provides a cost-efficient solution for demand response. Sector integration between heating systems (district heating (DH) or heat pumps) and electricity is an interesting opportunity as it provides new possibilities for consumer empowerment and demand response. Moreover, district heating is typically generated with Combined Heat and Power (CHP) plants that produce electricity as a by-product. Therefore, demand-side flexibility in the DH network directly contributes also to the electricity sector as it influences the flexibility of CHP generation.

4 iFLEX business models and use cases

Business models are increasingly being used to describe the complex environment in which companies and organisations in the energy sector are operating; having to deal with new disruptive technologies, rapidly changing demand patterns, decreasing customer loyalty and constantly facing new entrants onto the market. In this environment, operators, companies, and prosumer organisations must constantly move and re-position themselves.

4.1 Business modelling methods

The basic questions to be answered in any business model are the fundamental questions of any business: What do we offer to the customer, who are they and how do we operate to deliver the product or service so that we can create a profitable and sustainable business? In other words, we need to identify and analyse the value proposition in the intended iFLEX Assistant service, to which customer group the service is targeted and how we organise ourselves to deliver the service in the most efficient way.

To do so in a structured way, mathematical simulation tools of ecosystem dynamics are developed with the aim to analyse economic and operational performance, identify alterative incentive schemes, and explore actor sensitivities to various market signals, to name a few. The result is often new and sustainable business models responding to emerging opportunities or threats to market dynamics. In iFLEX two approaches to business modelling were applied: process modelling and value modelling.

Process modelling refers to the exercise of grouping procedures of the same nature into a model. In this sense a process model is a description of a process at the type level; a real business process then becomes an instantiation of the process model. The same process model is used to describe the structure and development of many applications and thus, has many instantiations. A process model is useful to prescribe how things must/should/could be done in contrast to the process itself, which captures what really happens. A process model is roughly an anticipation of what the process will look like. What the process shall be will be determined during actual system development.

A value model captures decisions regarding who is offering and exchanging what with whom and expects what in return whereas a process model focuses on decisions with respect to how processes should be carried out, and by whom. A value model thus captures other stakeholder decisions, including hitherto unexplored use cases, than a process model does. A value model shows the essentials (the strategic intent) of the way of doing business in terms of actors creating and exchanging objects of value with each other, while a process model shows decisions regarding the way a business is put into operation. Value models are useful tools to investigate the impact of actors entering or leaving the ecosystem, secondary and tertiary utilization of key assets for improved profitability, and the effect of changing incentives/revenue models to explore system sensitivities.

4.2 Summary of work done in the initial business models

The first work in business models was initiated early in the project and the results were reported in M6 in *D5.1 Initial market analysis and iFLEX business models*.

Much of this early work still holds merit and has not been significantly changed. Consequently, we have decided to refer to deliverable D5.1 for the results of the initial business modelling work and rather focus on the work that has been done since then in the present deliverable.

To define, describe, select, and assess the most promising iFLEX-enabled business models (BM), the project decided to use different methods. The process and associated methods are outlined in Figure 28 below. Each step and its methods are described in deliverable D5.1 chapter 4 in detail.

Step 1: Define business roles and describe baseline business models
Step 2: Analyse and explore iFLEX business use cases
Step 3: Assess business use cases and models

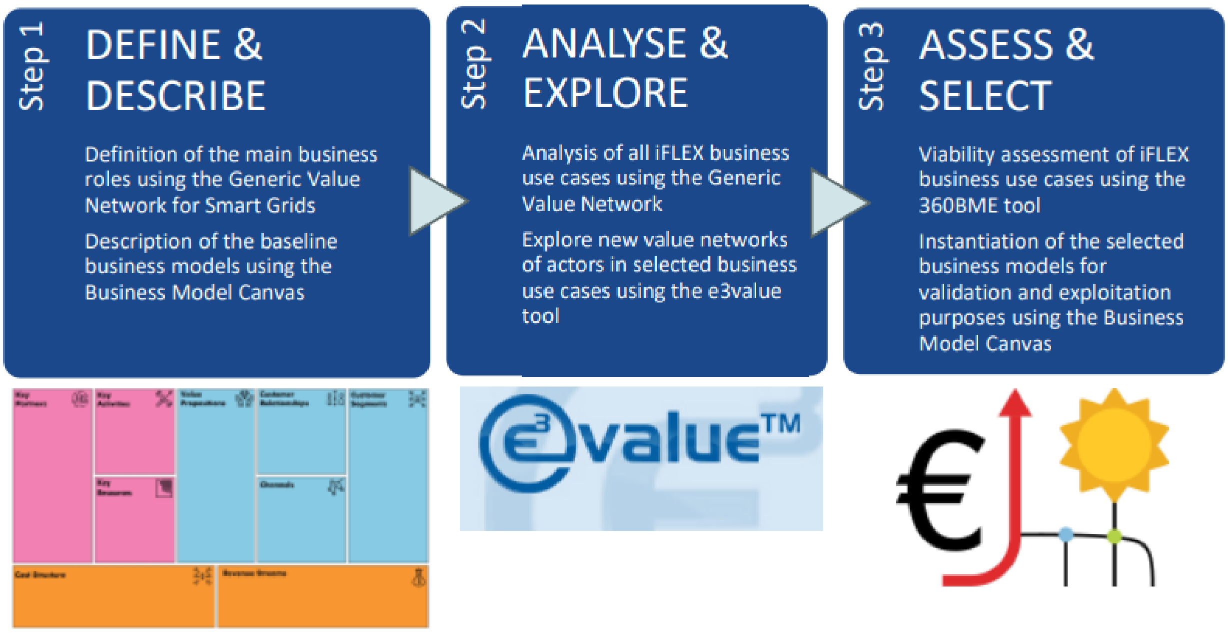

Figure 28: The business modelling steps and methods

Step 1: In step 1, the main business roles were defined, and the baseline business models were described using a "generic Value Network" for Smart Grids and the Business Model Canvas methodology. The value networks defined, and the business model canvasses developed are still valid and form the basis for the eight business model use cases defined in *D2.1 Use cases and requirements*: BUC-01 through BUC-08.

In terms of services/value exchanged by the various business roles, a high-level view of the value network in the relevant electricity markets (Figure 29) was summarized in D5.1.

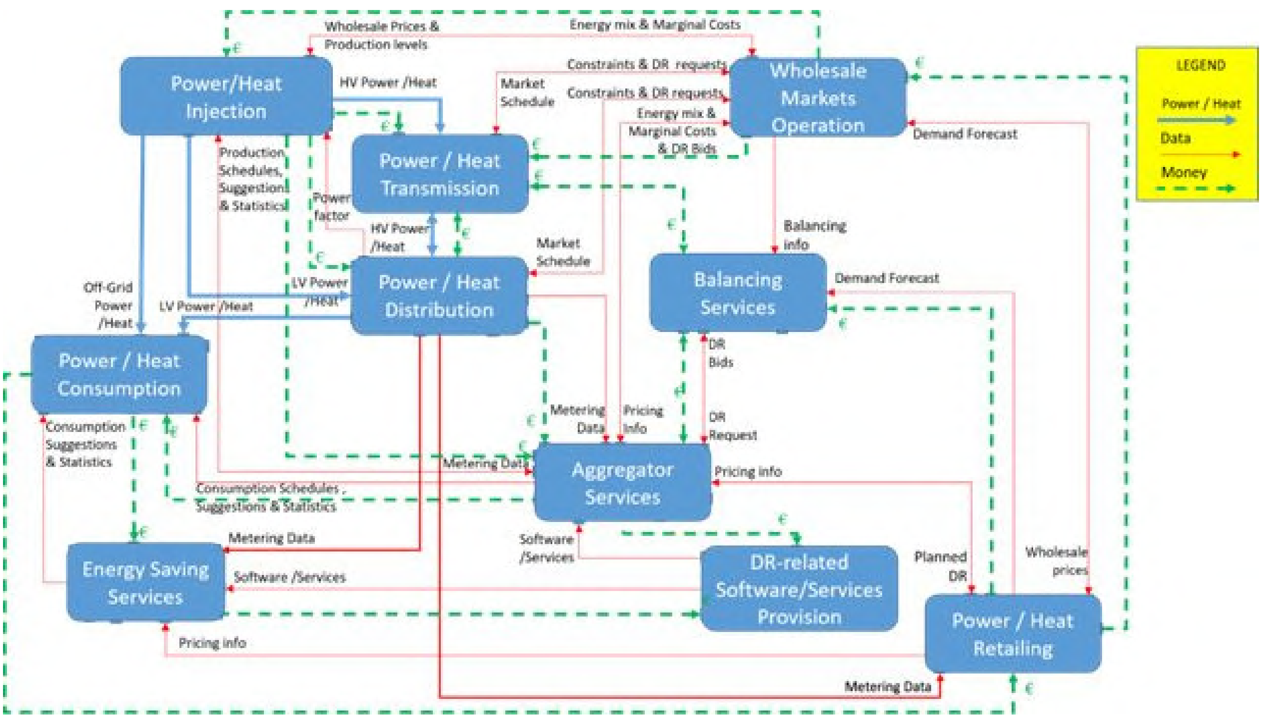

Figure 29: An overview of the Generic Value Network in energy markets

Step 2: In step 2, each iFLEX business use case defined in D2.1 was modelled focusing on the business roles and relationships that are most relevant to the iFLEX context.

Each of the BUCs were qualitatively modelled in the Generic Value Network notation and the value propositions offered with specific focus on new iFLEX enabled value propositions. Further work has been done in these aspects and reported in the following sections.

Furthermore, some aspects related to the BUCs were elaborated using the e3value modelling method with the aim to explore new value networks of actors. Initially, an “iFLEX energy and flexibility management with implicit DR” use case was developed to show the potential usefulness of this method. Further analysis of the business use cases from D2.1 and the pilots have been performed and will be reported in the following sections.

Step 3: The third and final step was to assess the viability and attractiveness of the iFLEX business use cases, using the 360 Business Model Evaluator (BME) tool. The objective of this tool is to assist the planning and deployment of new products, infrastructures, and services in diverse areas (telecoms, ICT, energy) by providing a techno-economic analysis and evaluation before and during the implementation and the deployment phases.

The work that has been performed mostly focus on relevant BUCs implemented in the pilots and will be reported in the following sections.

4.3 Value Network analysis and process models for iFLEX Use Cases

Most of the iFLEX business use cases have been subject to the process modelling approach and instantiated with realistic economic properties and revenue models with the aim to find an optimal business model that reflects the implementation of iFLEX Assistant services in an existing ecosystem. The process models represent an instantiation of the business use cases developed in D2.1 Use cases and requirements.

4.4 Value modelling analysis for iFLEX Use Cases

A limited number of business use cases has been subject to dynamic value modelling involving different scenarios with different actors and value propositions. Value modelling allows us to model and experiment with different combinations of service constellations and actors to calculate a first approximation of potential revenue streams to evaluate the sustainability of the model.

The e3value modelling method used for this work is based on the work “Analysis of economic value creation, distribution and consumption in a multi-actor network” originally developed by Jaap Gordijn (Gordijn, 2002) and used in several energy related business analysis case studies.

In a typical situation, the service proposition will be analysed together with pilots and other partners to arrive at a common understanding of the dynamics of the business ecosystem. Hence, the analysis must be performed quickly and often with an imperfect or partly unknown data foundation which is subject to frequent updates. To serve these needs, the e3value methodology provides a conceptual modelling tool with the following features:

- A lightweight approach to carrying out the value analysis in a limited timeframe
- An economic value aware approach to capturing and evaluating a value proposition
- A multi-viewpoint approach to dealing with a wide range of stakeholders
- A graphical conceptual modelling approach to create a common understanding and rapid evaluation and value analysis of the business idea with frequent updates to the underlying data foundation
- A scenario approach to creating a common understanding of a business idea, to capturing and presenting a value proposition, and to evaluating the usability of the business idea

4.4.1 Introducing perspectives

The many business use cases created at the beginning of the project provide an impossible high number of potential business models if we were to analyse all possible combinations of use cases.

Instead, we have organised the BUCs developed in D2.1 into three distinctive perspectives:

Perspective I: Consumer-driven flexibility

BUC-03: Offer the flexibility of a multi-vector energy system (building community) to the energy markets

BUC-04: Optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals

Perspective II: Aggregator-driven flexibility

BUC-01: Optimise BRP operation by leveraging flexibility from consumer/prosumer through DR

BUC-02: Optimise grid operation by leveraging flexibility from consumer/prosumer through DR

Perspective III: Virtual Energy Communities

BUC-05: Added value services: Customer load profile analysis and overview

BUC-06: Increase self-balancing through advanced monitoring and automation

BUC-07: Optimise end-user's energy consumption based on own preferences and market price signals

BUC-08: Offer flexibility through participation in explicit demand response programmes

This method allows us to analyse only three business models while still being able to analyse the effect of the relevant BUCs as well as utilising relevant feedback from the three validation pilots.

4.4.2 Perspective I: Consumer-driven flexibility

Perspective I: Consumer-driven flexibility focuses on the consumer and prosumer actors in buildings such as residential buildings, retail business and small industries. The purpose of the business modelling work was to explore how the optimal business models are performing as seen from the point of view of the building communities (and their prosumers and consumers) and to evaluate how such optimal business cases will reflect on their attractiveness and sustainability as seen from the point of view of the professional actors.

With increasing penetration of RES, demand-side flexibility becomes essential for the power system balance. Using both heating and electrical energy of buildings will markedly increase the amount of flexibility that can be offered to the electric power grid and in effect turn the buildings into massive batteries. Buildings' HVAC systems are a good source for demand flexibility because[11]:

- Residential heating is the most significant technology (106 GW flex estimated for 2030)
- 70-80% of residential sector energy demand is heating (includes DHW)
- Large thermal mass that can be used as energy storage
- Electrification of heating sector in EU
- 10 million new heat pumps by 2027
- District heating and sector integration
- Connection to the power grid via CHP power plants

The use cases in this perspective have mainly been demonstrated in the Finnish pilot and to a lesser extent in the Slovenian pilot. The Finnish pilot provides some data for the business model. The use cases in this perspective are:

- BUC-03: Offer the flexibility of a multi-vector energy system (building community) to the energy markets
- BUC-04: Optimal energy consumption for multi-vector energy system (building community) based on the behaviour of consumers and market price signals

Stakeholder perspective (actors)

The possible actors in this perspective are the following:

Primary actors: Building Communities, Building Managers and/or HVAC Operators, Consumer and Prosumers, Energy Service Companies

Secondary actors: Retailers, Aggregators, Balancing Responsible parties, Distribution System Operator (DSO), Transmission System Operator (TSO), District Heating Companies, Energy Market Place

Central actor: Building Communities

Value propositions

The iFLEX Assistant is a central component around which value activities can be deployed in this perspective.

[11] https://smarten.eu/demand-side-flexibility-quantification-of-benefits-in-the-eu/

In an explicit mode, the iFLEX Assistant used in the Building Community, Building Managers and/or HVAC Operators can manage the flexibility vis-à-vis the Aggregator. The building uses automated control, taking into consideration the preferences of the Community, and the Consumer and Prosumers and leveraging the modelling of the dynamic behaviour of the building to calculate the optimum control scenarios. It will further be able to learn the behaviour of the end users at the building level and adapt its control strategy accordingly. Hence, its operation will not hinder the comfort levels of the buildings.

In the implicit mode, the iFLEX Assistant can be used to optimise the aggregated energy consumption of the building based on market price signals. This optimisation will be based on market signals and can consider the consumption behaviour of the individual users and automatically achieve the desired flexibility without affecting the comfort levels of the residents.

Further view on the value proposition is found in the presentation at the iFLEX Webinar, 29th of February 2024: Automated flexibility management with hybrid modelling and model predictive control. In this webinar, a detailed overview of the functionality of the iFLEX Assistant was presented with details of the value proposition as shown in Figure 30.

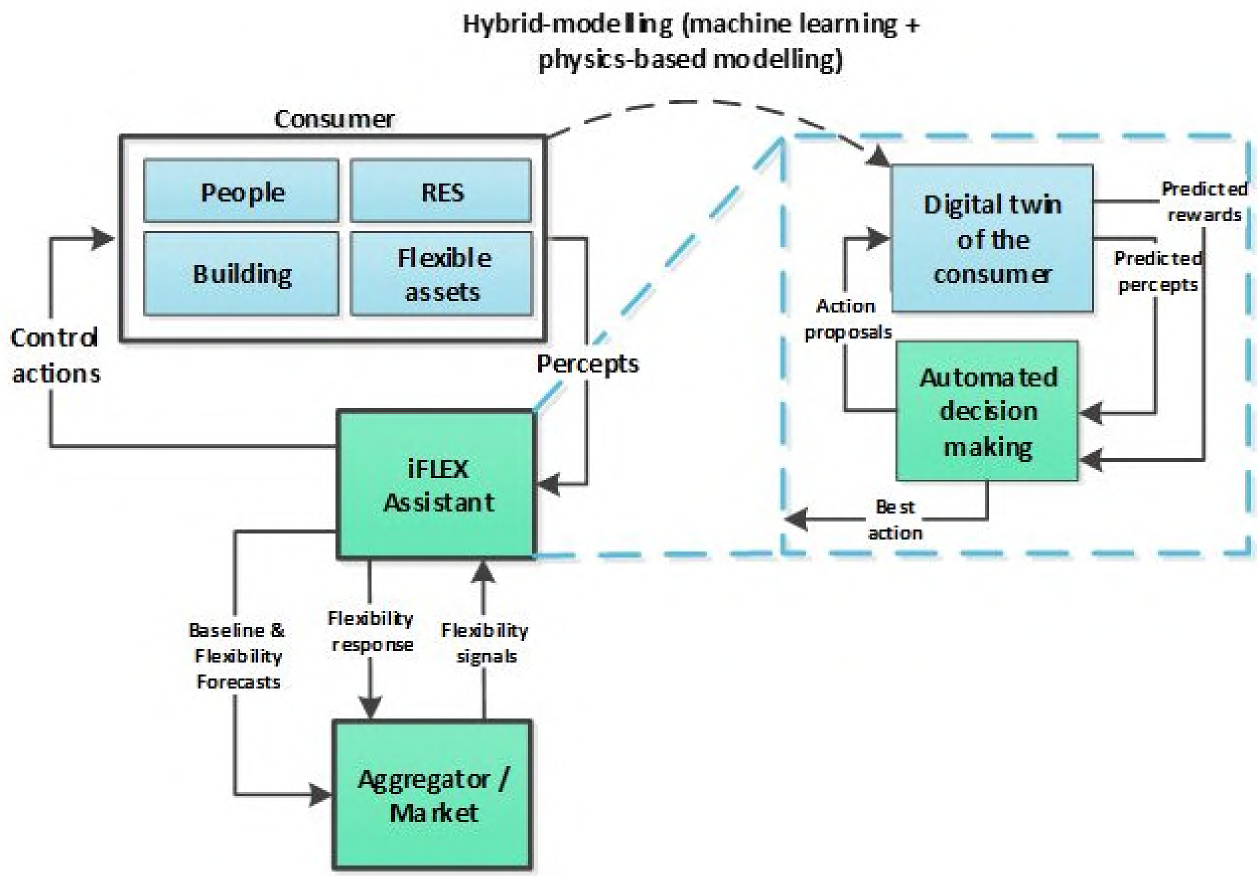

Figure 30: iFLEX Hybrid modelling used for flexibility predictions (iFLEX Webinar 2024)

The iFLEX Assistant creates a Digital Twin of the consumer (or consumers/prosumers) in which predicted flexibilities from both heat and RES generation as well as consumption predictions are modelled and used for creating automated decisions and associated control actions for the relevant systems such as building management and heating systems, heat pumps, EVs, solar panels, etc. Model predictive models make it possible to find optimal actions in a complex environment. The value activities are also easy to integrate with explicit DR using more deterministic response from consumers.

The iFLEX Assistant finally forecasts the potential overall flexibility and negotiates it to the Aggregator, the Balancing Responsible or other market players. Further, the iFLEX Assistant responds to the flexibility signals and performs the necessary action controls which provides the flexibility response to the market.

Business model framework

The e3value model is based on a visual representation of the actors involved, the value generating activities, and the resulting exchange of values between actors.

The template for the model is as shown in Figure 31

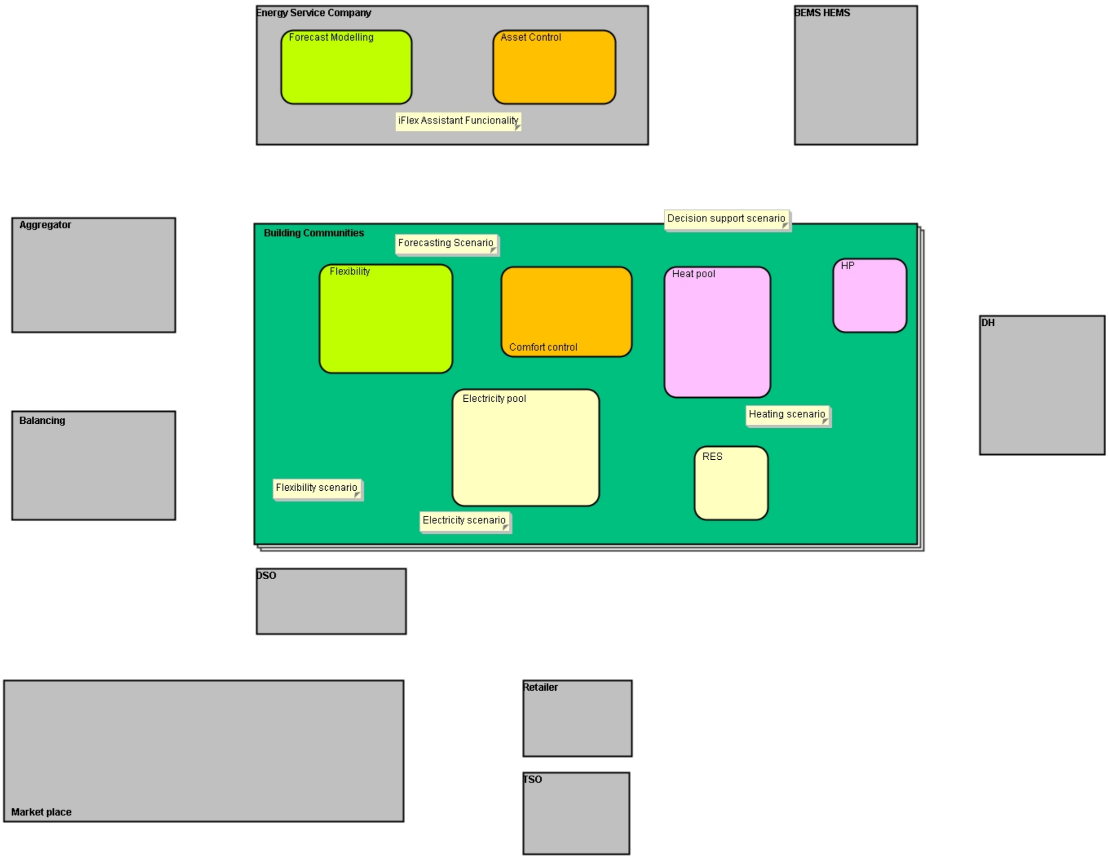

Figure 31: Template for e3value modelling in Perspective I: Consumer-driven flexibility

The square boxes represent the different actors involved in the value transactions. The green box represents the central actor: Building Communities. In effect, this is representing a wide group of similar building communities across the energy system (market segment). Inside some actors, we have identified key value activities, such as “providing flexibility” and “Electricity pool”. By doing so, we can calculate the net economic impact per specific activity within an actor.

In the next step, we will construct the value propositions and their exchanges around four scenarios. The value proposition is offered as a value object from on actor to another in return for another value object which typical is of monetary kind (MONEY) but can also be non-monetary (comfort, access to data, etc.). The full model is shown in Figure 32 below:

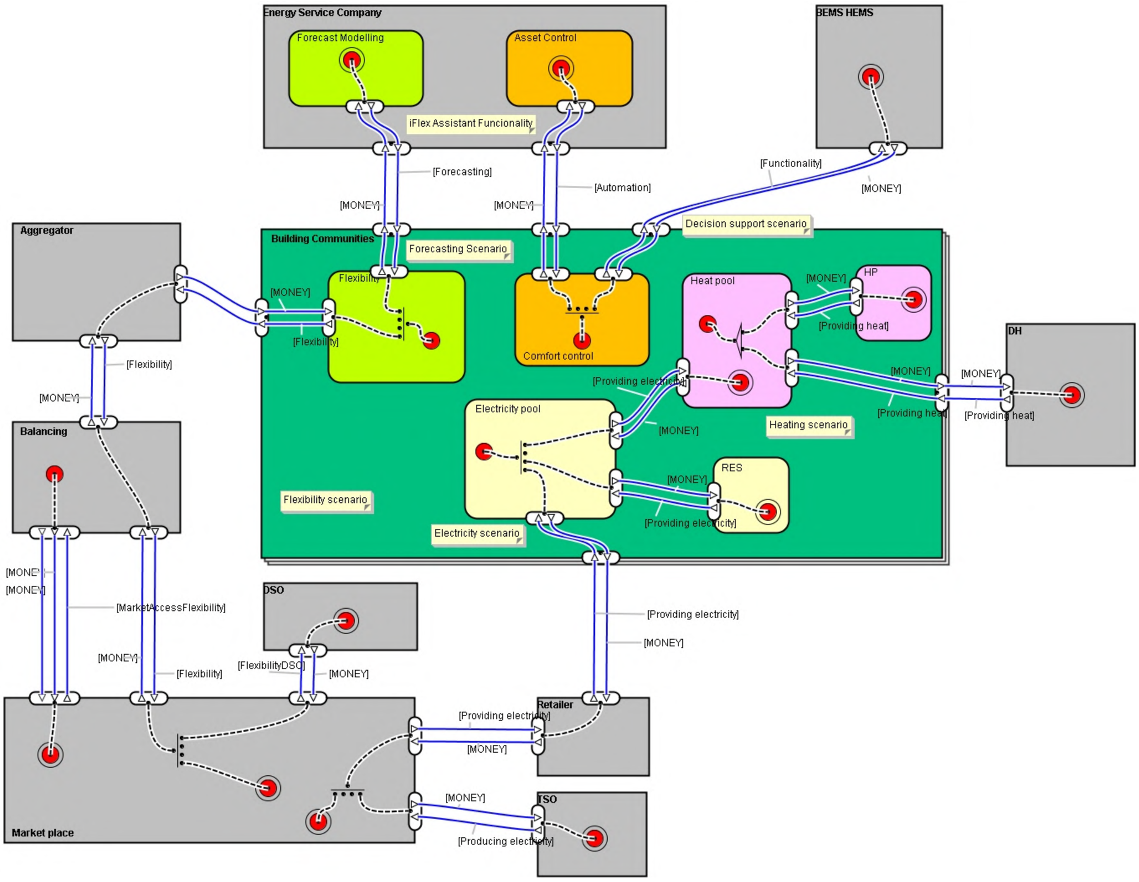

Figure 32: e3value modelling in Perspective I: Consumer-driven flexibility

The scenarios are shown as dotted lines connecting a start stimulus with one or more end stimuli. The scenario can transition across different actors in the value chain thus providing a calculation of the economic footprint on each actor. In this way, the full economic impact can be calculated on all actors in a single run. Parameters can then be changed, and new runs performed to see the potential impact on the entire ecosystem.

In Figure 32, the four scenarios are labelled with yellow textbox:

1. iFLEX Assistant Functionality with Decision support scenario and Forecasting scenario – involves all functionalities used by building communities for automatic control (implicit DR) and autonomous operation (explicit DR) using hybrid modelling forecasting tools combined with automatic controls (green and orange value activities)
2. Heating Pool scenario – involves the ability to shift heating sources from external district heating to locally produced heat from electrical heat pumps (purple value activities)
3. Electricity Pool scenario – registers the resulting electricity consumption considering locally produced RES electricity and using market and retailers for residual electricity needs (yellow value activities)
4. Flexibility scenario – predicts the potential flexibility that can offered and how this can be pushed through the value chains to the final beneficiaries such as DSO, TSO, Balancing partiers (green value activities)

Value transactions

We will provide a couple of comments on the many value transactions depicted in the model.

Starting with the iFLEX functionalities, these are offered by an Energy Service Company, which will provide the iFLEX Assistant to the Building Communities for a fee. There are presumable separate fees for the Assets control (used for both implicit and explicit DR) and for Forecast modelling (used for explicit DR and Flexibility). In order so show the re-use of value propositions, we have shown a supplier of BEMS / HEMS systems who will benefit from the API based Asset controls of the iFLEX Assistant and would be perceived to compensate monetarily in some form to the Energy Community to offset their cost.

In the Heat pool activities, the Building Communities have the choice to install several heat pumps and selective use the HP heat to replace district heating. This will reduce the cost of heating but will require substantial investments and costs in the form of depreciations. An optimum point can be found through simulations.

Clearly, the choices made in the Heat pool affect the Electricity pool as well. The electricity consumption changes with the number of heat pumps installed, but it is offset by the increased flexibility that can potentially be traded with the Aggregator and the Balancing Party. It can also potentially be offset by increasing RES.

Further, the amount of potential flexibility does not differentiate between promised and provided flexibility and the whole pricing structure of trading flexibility is not implemented in the model beyond a simple market fee for access to the flexibility market and imposed in the Balancing Party. When using the model for iterations and sensitivity analysis, these shortcomings are not so important because the model is aiming at showing the optimal business models as seen from the consumers' and prosumers' perspective. The Perspective II: Aggregator-driven flexibility will compensate for this with more detailed value activities for these actors.

Finally, the model does not include an activity related to energy savings from load shifting. Clearly, delivering flexibility will lead to time shift in load, which presumably will lead to lower tariffs and thus net savings. The model does not have a granularity that allows us to model these savings in an easy way.

Business model instantiation

The e3value tool is designed to provide a quick, visual, and easy-to-use tool for evaluating various business models under different boundary conditions. It is well known that very detailed modelling of all monetary value flows requires a similarly fine-grained business modelling tool such as the BME360 tool, which is used in other tasks in iFLEX.

Conversely, the e3value tool works on average value flows. We are using a calendar year as time frame and calculate all energy components in terms of "average consumption/average generation per year". Further, we use average values for estimates of energy and flexibility components such as "potential flexibility is 10% of total electricity consumption" and "Heat from heat pumps corresponds to 80% of total heating need". Again, the values are provided as annual averages.

Further, for the business model to provide correct answers, it must be supplied with a) correct formulas for computing the correct value transactions and b) realistic values for computing trustworthy business results. This is a crucial activity with quite enormous challenges, because reliable data for the many details are very hard to obtain in general (either because of proprietary or because of lack of public statistics) and never obtainable in single ecosystems (national and regional).

Finally, the model does not capture all value activities in secondary actors, but only those activities that are related to the primary actors and the scenarios described.

The lack of data and the use of annual averages inevitable makes the resulting business models hard to validate in a real environment. But they are very well suited for comparative studies where they capture the resulting impact on both primary and secondary actors from specific changes in one or more parameters.

This ability will be used in the next section to discuss sensitivity and optimisation of business models for the core actor, i.e. the Building Communities.

Business model data

The data for the business model has been collected from a wide variety of related and unrelated sources. As such, they should not be understood to represent a certain national or regional setting. However, the data made available from the Finnish and Slovenian pilot (including national data) have been used wherever possible. The source of most of the data is shown in the column "Source" in Table 2.

Table 2: Data used in Perspective I: Consumer-driven flexibility

Value property description	Value	Unit	Source
Building Communities			
Number of communities in the market	1		
Number of households with assets control	93		SF
Number of households with flexibiiity	93		SF
Number of households with consumption	93		SF

Number of producers with production	10		ESTIM.
Avg. total energy consumption per household	4.940	kWh/yr	SF
Activity: Heat pool			
Annual heat consumption per community (all households)	341	MWh/yr	SF pilot
Fraction HP to DP (with all HPs in use)	1:5	ratio	
Investment in one HP	4.966	€	
Number of HPs installed in	4		
Depreciation over 20 years per HP	248	€/yr	
Price of HP heating energy	16,55	€/MWh	
Max heat generated by one HP with 12000 BTU	15	MWh/yr	
Max electricity consumption by one HP with 48000 BTU	16	kWh/yr	
Activity: Electricity pool			
Annual electricity consumption per ms (for all households)	3.700	kWh/yr	DK
Average annual RES production	480	kWh/yr	ESTIM.
Cost of generating RES	0,017	€/kWh	US
Activity: Flexibility			
Percentage of consumption that can be used for balance	20%		F
Total energy available for balancing per household	848	kWh/yr	CALC.
Avg. energy savings with flexibility	5%	kWh/yr	DE
Aggregator			
Price paid for balancing (balancekraft)	0,110	€/kWh	DK
District Heating Provider (DH)			
Price of district heating energy	77	€/MWh	SF pilot
Energy Service Company			
Access to asset control per household	100	€/hh/yr	ESTIM.
Access to forecast models per household	60	€/hh/yr	ESTIM.
BEMS HEMS			
Support for Asset control interfaces per household	20	€/hh/yr	ESTIM.
Retailer			
Retailers add-on costs on all energy	0,100	€/kWh	ESTIM.

Wholesale Energy Market			
Spot price of energy on market	0,075	€/kWh	SF
Flat fee for accessing market	1.560	€/yr	DK
Availability fee for max volume of flexibility to sell	0,134	€/MWh/yr	DK
Market price for balance	0,307	€/kWh	DK
Balancing Company			
Market price for purchasing balance	0,120	€/kWh	PL

Business model results

Instantiated with the set of relevant data, the e3value model has calculated all the monetary flows in and out of actors and activities. The absolute numbers do not make a lot of sense, since they, for most actors, are incomplete and/or either show costs only or revenues only. What is important though, is the ability to do several runs of the model with incrementally changed parameters. Doing so with one parameter at a time will provide valuable insight into the sensitivity from this parameter for the entire ecosystem. This will be further illustrated in section 4.5.2.

The results of the model calculations using a few parameters for the Building Communities, which can be useful to study, are shown in Table 3: Baseline revenues in the Building Community. The full list of results is provided in Appendix I.

Table 3: Baseline revenues in the Building Community

Variables	Baseline	
Baseline electricity consumption per household	3.700	kWh/yr
Baseline heat consumption per household	341	MWh/yr
Number of heat pumps deployed (12.000 BTU)	4	
Investment in HP needed	19.866	€
Ratio DH:HP	1:5	
Number of households	93	
Flexibility potential	20%	

Overview of main results	Baseline	
Cost of heat	-2.779	11%
Cost of electricity	-30.541	124%
Revenues flexibility	8.683	-35%
External costs net for Building Community	-24.637	

The data shown are aggregated data for all 93 households in the building community. Given the main parameters shown, the annual cost of heat is 2.779€ using four 12000 BTU heat pumps and a ratio between district heating and HP generated heat of 1:5. The annual cost of electricity is 30.541€, but this is offset by revenues of 8.683€ from potential flexibility sold to the market. The scenario requires a onetime investment of around 20k€ for four heat pumps. It should be noted that the cost of obtaining the iFLEX Assistant services has not been considered at this stage and possible savings in energy tariffs are also not included.

4.4.3 Perspective II: Aggregator-driven flexibility

Perspective II Aggregator-driven flexibility focuses on professional actors such as grid operators and aggregators and aims to optimise their business models related to flexibility. The purpose of the business modelling work was to explore how the optimal business models are performing as seen from the side of the professional actors and to evaluate how such optimal business cases will reflect on their attractiveness and sustainability as seen from the viewpoint of the prosumers and consumers. The use cases in this perspective have been mainly demonstrated in the Greek pilot and to a lesser extent in the Slovenian pilot which will be providing validation data for the business model. The use cases in this perspective are:

- BUC-01: Optimise BRP operation by leveraging flexibility from consumer/prosumer through DR
- BUC-02: Optimise grid operation by leveraging flexibility from consumer/prosumer through DR

Stakeholder perspective (actors):
In most countries, all market entities active in the wholesale electricity markets must comply with certain requirements regarding their balance in day-ahead and intra-day wholesale markets. To facilitate balancing their portfolio, balance responsible parties, aggregators and retailers choosing to be responsible for their imbalances can make use of demand-side management techniques so that consumers and prosumers have incentives to adjust their demand and/or production decisions either when instructed to do so, or automatically according to long term contracts of preferences.

Moreover, a DSO is responsible for maintaining the Low/Medium Voltage distribution grid in a cost-effective way and providing secure and high-quality power to end users in terms of service continuity and stability of electrical parameters. Similarly, a TSO is responsible for installation and maintenance of the High-voltage transmission grid and for system stability. Both are thus actively engaged in promoting balancing activities in their parts of the power grids.

The possible actors in this perspective are thus the following:

Primary actors: Balance Responsible Party (BRP), Integrated aggregator (aggregator and BRP), Consumers and Producers.

Secondary actors: Distribution System Operator (DSO), Transmission System Operator (TSO), Day-ahead market (flexibility), Spot market (real-time electricity market), iFlex Service Provider

Central actor: Aggregator

Value propositions(s):
The iFLEX Assistant will enable the realisation of this business case by implementing automated control strategies based on:

- The explicit DR response of Consumers and Producers with respect to the preferences of the end user (i.e. Consumer, Producer), at the level of the individual user.
- DSO and TSO requests for flexibility with respect to the preferences of the Aggregator
- Internal balancing at the level of the Aggregator from massive aggregation of DR flexibility from Consumers and RES generation farms.

The iFLEX Assistant is a central component around which value activities can be deployed in this perspective.

An integrated DR/RES aggregator can solicit DR flexibility from consumers and producers. The group has ordinary household consumption of electricity and a small amount of RES generating units (5kW each). In addition, the Aggregator can draw on several industrial RES farms (order of magnitude of 10MW each).

Further view on the value proposition is found in the presentation at the iFLEX Webinar of 3rd April 2024: “Innovative win-win trading scheme for energy flexibility management”. In this webinar, a detailed overview of the RES Participation in the Wholesale Electricity Markets was provided. In the proposed solution, end-user Demand Side Response (DR) resources (represented by a DR Aggregator) can address and mitigate RES imbalances, before the RES Aggregator seeks to perform balancing in the relevant wholesale market. Using the iFLEX Assistant. the DR Aggregator informs eligible consumers to turn-on/off flexible loads to mitigate RES imbalances as outlined in Figure 33:

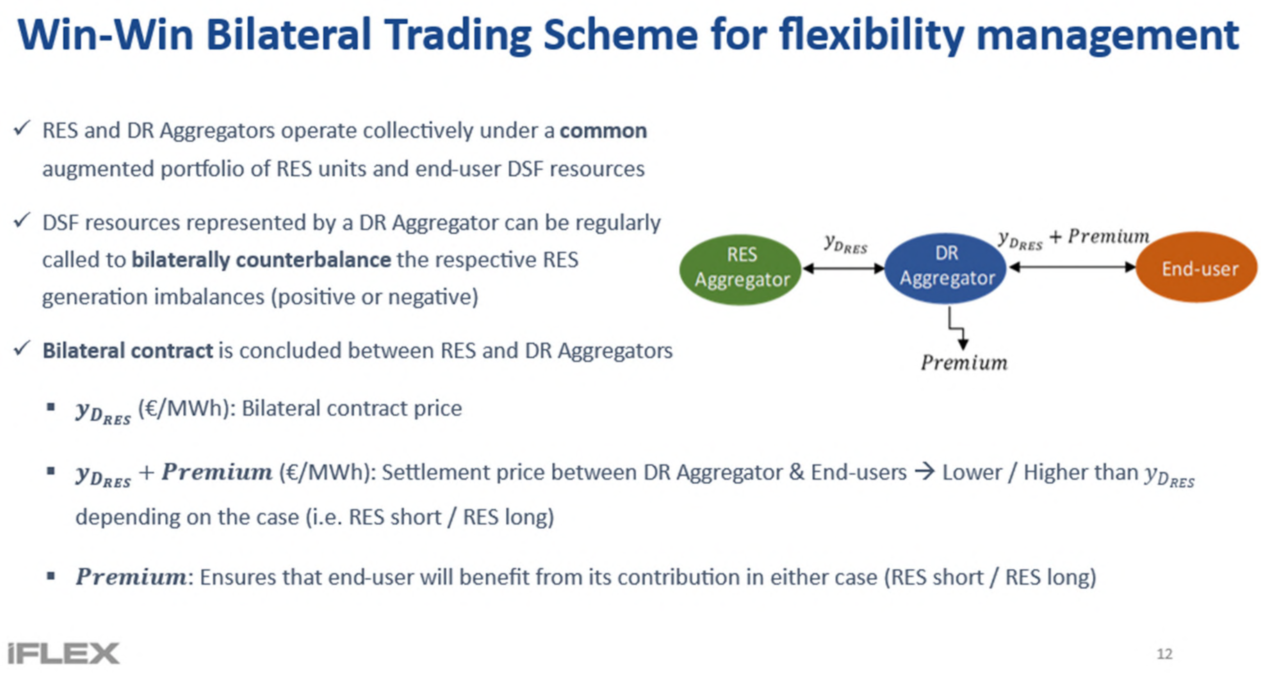

Figure 33: Bilateral Trading Scheme for flexibility management

With this business model, it was demonstrated that a DR/RES aggregator obtains more favourable prices for its imbalance settlement, irrespective of the direction of its own energy imbalances (negative/positive) and thus improves its overall financial position. Including RES in the internal balancing takes advantage of the coordinated operation and obtains benefits by engaging end-users to participate in DR programs for increasing/decreasing their load consumption. This will in turn lead to their actively participate in DR schemes and reap significant monetary benefits.

The iFLEX Assistant is used to optimise the aggregated energy consumption of the building that the Aggregator needs for flexibility. It is possible for consumers and prosumers to opt out of the autonomous DR scheme and perform manual control. However, it requires that they subscribe to a manual control component of the iFLEX Assistant and further receive a slightly lower compensation for their DR flexibility.

Business model framework

The e3value model is based on a visual representation of the actors involved, the value generating activities, and the resulting exchange of values between actors.

The template for the model is as shown in Figure 34:

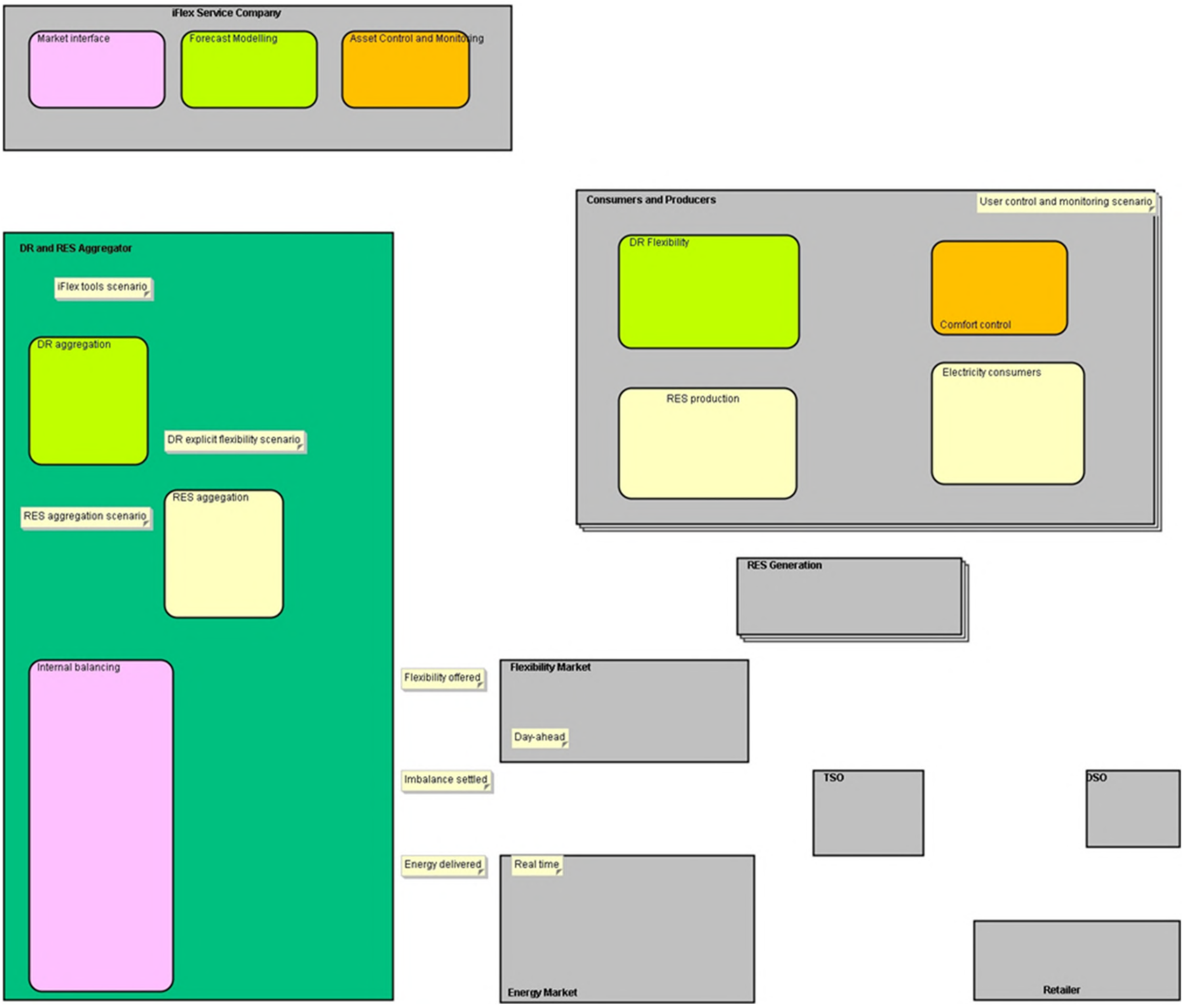

Figure 34:Template for e3value modelling in Perspective II Aggregator-driven flexibility

The square boxes represent the different actors involved in the value transactions. The green box represents the central actor: DR and RES Aggregator. Inside some actors, we have identified key value activities, such as “DR aggregation” and “Electricity consumers”. By doing so, we can calculate the net economic impact per specific activity within an actor.

In the next step, we will construct the value propositions and their exchanges around four scenarios. The value proposition is offered as a value object from on actor to another in return for another value object which typical is of monetary art (MONEY) but can also be non-monetary (comfort, access to data, etc.). The full model is shown in Figure 35 below:

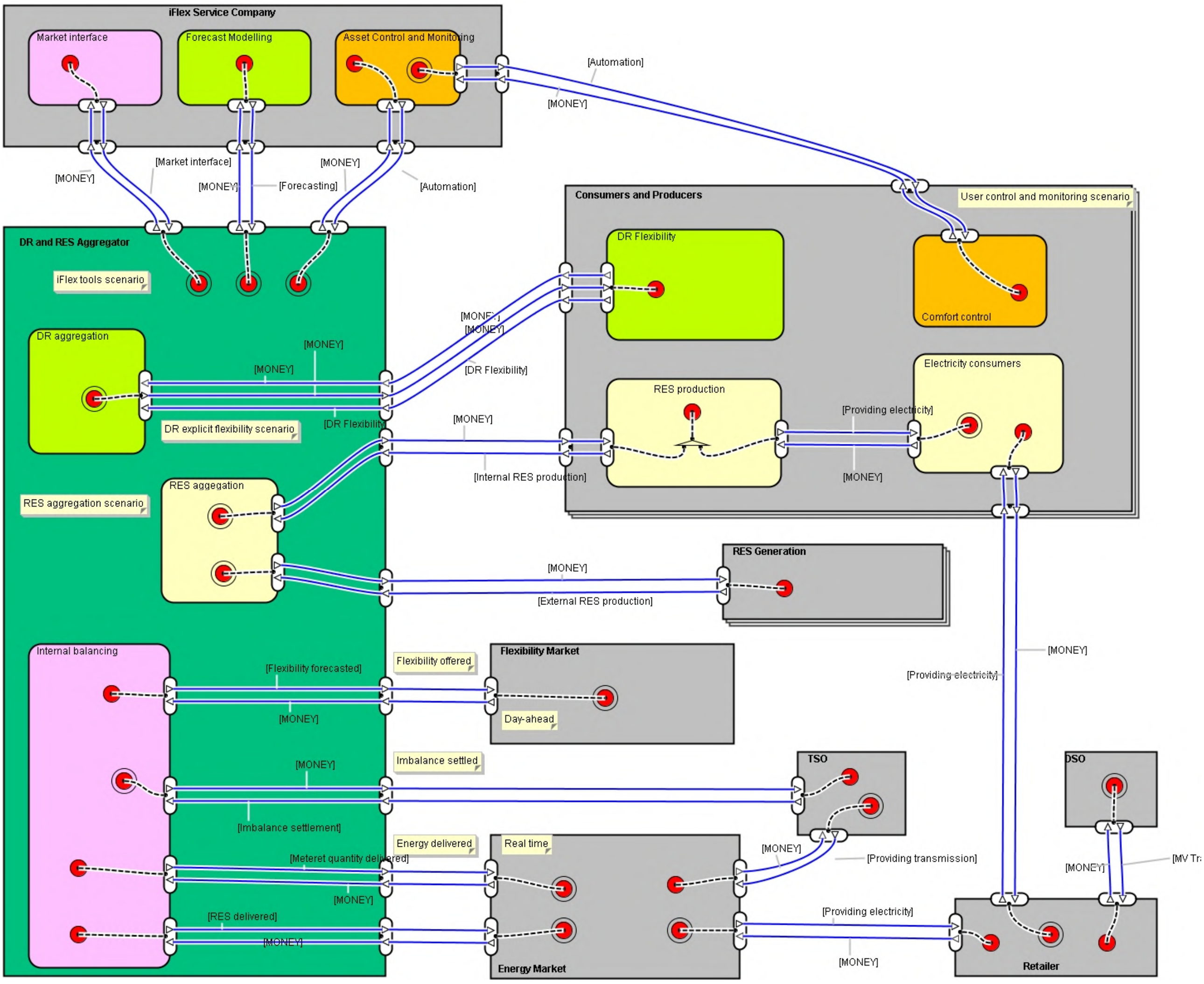

Figure 35: e3value modelling in Perspective II Aggregator-driven flexibility

The scenarios are shown as dotted lines connecting a start stimulus with one or more end stimuli. The scenario can transition across different actors in the value chain thus providing a calculation of the economic footprint on each actor. In this way, the full economic impact can be calculated on all actors in a single run. Parameters can then be changed, and new runs performed to see the potential impact on the entire ecosystem.

In Figure 35, the main scenarios are labelled with yellow textbox:

1. iFLEX tools scenario – involves all iFLEX functionalities related to forecasting of DR flexibility and subsequent execution the flexibility using iFLEX asset control functions. It also includes the iFLEX Market Interface. These tools are provided to Consumers and Producers and paid by the DR and RES Aggregator. Further, a manual control mode app can be requested by the consumers.
2. DR Explicit flexibility scenario – involves DR and RES aggregator to acquire DR flexibility from the Consumers.
3. RES aggregation scenario – involves the DR and RES aggregator to acquire RES flexibility from Producers and from large scale RES Generation units.
4. Flexibility (offered and delivered) scenarios – involves internally balanced DR a RES flexibility on the whole sale markets represented by the Day-ahead Market (DAM) for future flexibility and the Real-time (Spot) market for instantaneous DR a RES flexibility.
5. Imbalance settlement scenario – involves any imbalance (either positive or negative) realised to be settled financially with the TSO.

Value transactions

We will provide a couple of comments to the many value transactions depicted in the model.

Starting with the iFLEX functionalities, these are offered by an iFLEX Service Company, which will provide the iFLEX Assistant to the Aggregator for a fee. There are separate fees for the Market Interface, the Forecast modelling tools and the Assets control tools.

In the RES production activity, the producers RES generation is delivered both internally to the consumers and externally to the RES Aggregator. The consumer thus benefits from lower, internal RES generation costs relative to the more expensive market prices for electricity. All value transactions operate at annual averages and does not take time fluctuations into account. The ratio between RES electricity consumed internally and sold externally can be changes (between 1 and 99%) and thus used to simulate the sensitivity on the consumers total electricity bills as well as the Aggregators business. This will be further exported in section 4.5.2 below.

The Aggregator sells the DR and RES flexibility on the Flexibility market (DAM). Any imbalance is settled directly with the TSO. The model operates with average annual values and does not take time variations into account.

The model also calculates the energy cost to the consumers from the net electricity consumption delivered from the Energy Market including transmission costs for DSO and TSO.

Finally, the model does not include an activity related to energy savings from load shifting. Clearly, delivering flexibility will lead to time shift in load, which presumably will lead to lower tariffs and thus net savings. The model does not have a granularity that allows us to model these saving in an easy way.

Business model instantiation

The e3value tool is designed to provide a quick, visual, and easy to use tool for evaluating various business models under different boundary conditions. It is well known, that very detailed modelling of all monetary value flows requires a similarly fine-grained business modelling tool such as the BME360 tool, which is used in other tasks in iFLEX.

Conversely, the e3value tool is working on average value flows. We are using a calendar year as time frame and calculate all energy components in terms of “average consumption/average generation per year”. Further, we use average values for estimates of energy and flexibility components such as “potential flexibility is 10% of total electricity consumption”. Again, the values are provided as annual averages.

Further, for the business model to provide correct answers, it must be supplied with a) correct formulas for computing the correct value transactions and b) realistic values for computing trustworthy business results. This is a crucial activity with quite enormous challenges, because reliable data for the many details are very hard to obtain in general (either because of proprietary or because of lack of public statistics) and never obtainable in single ecosystems (national and regional).

Finally, the model does not capture all value activities in secondary actors, but only those activities that are related to the primary actors and the scenarios described.

The lack of data and the use of annual averages inevitable makes the resulting business models hard to validate in a real environment. But they are very well suited for comparative studies where they capture the resulting impact on both primary and secondary actors from specific changes in one or more parameters.

This ability will be used in the next section to discuss sensitivity and optimisation of business models for the core actor, i.e. the DR and RES Aggregator.

Business model data

The data for the business model has been collected from a wide variety of related and unrelated sources. As such, they should not be understood to represent a certain national or regional setting. However, the data made available from the Finnish and Greek pilot (including national data) have been used wherever possible. The source of most of the data are shown in the column “Source” in Table 4.

Table 4: Data used in Perspective II Aggregator-driven flexibility

Value property description	Value	Unit	Source
Consumers and produces			

Number of consumers in the market	250		ESTIM.
Number of producers in the market	250		ESTIM.
Share of manual control subscribers	15%		ESTIM.
Annual electricity consumption per ms (for all households)	14.000	kWh/yr	GR
Activity: DR Flexibility			
Percentage of consumption that can be used for balance	10%		F
Total energy available for balancing per consumer	1400	kWh/yr	Calc
Activity: RES production			
Average annual RES generation per producer	5.000	kWh/yr	ESTIM.
Average capacity per producer	5	kW	ESTIM.
Share of RES internally consumed	50%		ESTIM.
Aggregator			
Price paid for balancing (balancekraft)	0,110	€/kWh	DK
Price paid for RES from private producers	0,010	€/kWh	ESTIM.
Price paid for RES from external producers	0,029	€/kWh	US
Manual control premium (reduction in flexibility purchase)	50	$	ESTIM.
RES Generation farm			
Number of RES farms	4		ESTIM.
Average capacity per farm	10	MW	ESTIM.
Average generation per farm	10.000	MWh/yr	ESTIM.
iFlex Service Company			
Activity: Market interface			
Fixed license per aggregator	30.000	€/yr	ESTIM.
Activity: Forecast			
Licence for forecast per customer	500	€/user/yr	ESTIM.
Activity: Asset control and monitoring			
License for asset control per customer	250	€/user/yr	ESTIM.
License for manual control per user	150	€/user/yr	ESTIM.
Retailer			
Retailers' add-on costs on all energy	0,100	€/kWh	ESTIM.

Wholesale Energy Market			
Spot price of energy on market	0,079	€/kWh	GR
Flexibility DAM			
DAM price for flexibility	0,134	€/MWh/yr	DK
TSO			
Tarif for HV Transmission	0,005	€/kWh	SF
Imbalance percent of total flexibility	5%		ESTIM.
Imbalance settlement fee	1,150	€/MWh/yr	SF
DSO			
Tarif for HV, MV, LV transmission	0,037	€/kWh	SF

Business model results

Instantiated with the set of relevant data, the e3value model has calculated all the monetary flows in and out of actors and activities. The absolute numbers are not making a lot of sense, since they, for most actors, are incomplete and/or either shows costs only or revenues only. What is important though, is the ability to do several runs of the model with incrementally changed parameters. Doing so with one parameter at the time will provide valuable insight into the sensitivity from this parameter for the entire ecosystem. This will be further illustrated in section 4.5.2.

The results of the model calculations (using the ratio of 50% between internally consumed RES generated by the producers, and the balance being sold to the Aggregator for flexibility as a parameter) are shown in Table 5. The full list of results is provided in Appendix II.

Table 5: Baseline data for Consumers and Aggregator

Variables	**Baseline**	
Avg. total energy consumption per household	14.000	kWh/yr
Number of consumers and producers	250	
Ratio of RES generated internally and used internally	50%	
Overview of main results	**Baseline**	
Economic performance of Consumers and Producers	-598.125	€
Economic performance of DR and RES aggregator	2.052.907	€
Consumers total energy costs	646.000	€
DR and RES aggregator purchases for RES aggregation	1.166.250	€
Revenues from DR flexibility	38.500	€

The data shown are aggregated data for the entire 250 households in the Consumers segment. Given the main parameters shown, the annual cost of electricity is 646.000€ using a 50% ratio for RES generated by the Producers. The total RES purchases for the Aggregator amounts to 1.166.250 €.

4.4.4 Perspective III: Virtual Energy Communities

Perspective III: Virtual Energy Communities focuses on virtual communities built and managed by consumers and prosumers such as envisioned in the concepts of Citizens Energy Communities (CEC) and Renewable Energy Communities (REC).

High reverse power flow in distribution grids often results from RES production exceeding consumption in a local area. If the exceeding production is consumed or stored locally, it would not cause any technical challenges. In these circumstances, the power system can benefit from the advantages of distributed power generation in addition to having a clean energy source. To this effect, the EU in the “Clean Energy for all Europeans” package (EC, 2019), introduced new provisions on the energy market design and frameworks to engage EU citizens and activate the full benefit of distributed RES.

To encourage local RES production through Energy Communities and, at the same time, to prevent unnecessary parallel grids and guarantee the steady income for system operators, a new framework could allow Energy Communities to use the existing grids while they pay just the relevant part of the network service cost (cost-reflective charge). For this purpose, a Virtual Net Metering with one single metering point could be extended to multiple metering points to form a Virtual Energy Community (VEC) spreading across multiple physical locations.

Figure 36 shows a VEC described in a Finnish article published in 2020 (Divshali, 2020). The VEC is expanding over one LV grid with multiple metering points (MMP). This LV grid distributes the electricity to all end-users, no matter if they are part of VEC or are traditional customers. In this case, traditional customers can get energy from the wholesale market and pay the electricity, tax, and network service cost.

However, members of VEC can trade the energy internally and pay the appropriate network service cost (and tax) proportional to the cost they cause. In these circumstances, inside the VEC, buying energy from different productions could have different costs for each end user, due to grid involvement.

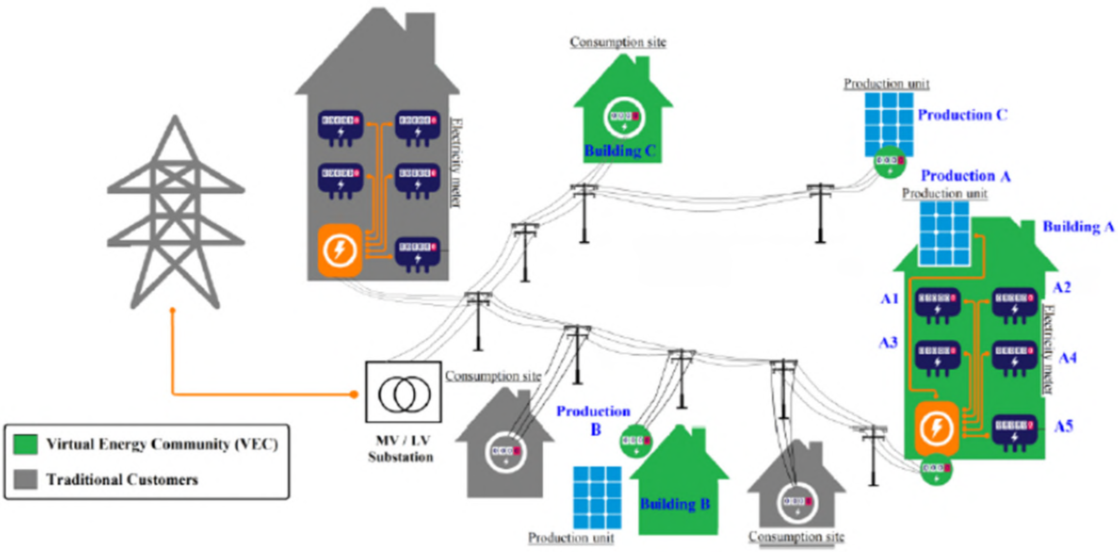

Figure 36: A VEC expanding over one LV grids with multiple metering points (MMP) (Divshali, 2020)

The VEC has as members three buildings (green) and three production points (blue). One member (A) is an apartment block with several tenants. It has a production unit behind the accredited meter and can share locally produced energy with the other tenants behind the meter. Another building (B) is a single dwelling with its own production unit behind the accredited meter. The third case (C) has two members. One is a single dwelling without production; the other is a single production unit without consumption. Each end-user of this VEC has four options to buy electricity (three production points + the wholesale market). The optimum source will be one located in the same building and the least optimal one will be the wholesale market.

The purpose of the business modelling work done here was to explore how the optimal business models are performing as seen from the point of view of the VEC (and their prosumers and consumers) and to evaluate how such business can be optimised to the benefit of VEC members as well as the grid operators. The use cases in this perspective are mostly related to the Finnish pilot and to a lesser extent in the Slovenian pilot. The use cases in this perspective are:

BUC-05: Added value services: Customer load profile analysis and overview

BUC-06: Increase self-balancing through advanced monitoring and automation

BUC-07: Optimise end-user's energy consumption based on own preferences and market price signals

BUC-08: Offer flexibility through participation in explicit demand response programmes

Stakeholder perspective (actors)

The possible actors in this perspective are thus the following:

Primary actors: Virtual Energy Communities (VEC), Consumer and Prosumers, Energy Service Companies, Distribution System Operator (DSO), Data Hubs

Secondary actors: Retailers, Aggregators, Balancing Responsible parties, Transmission System Operator (TSO), Energy Market Place

Central actor: Virtual Energy Communities (VEC)

The use cases playing out in the model include all relevant actors in the VEC energy system. We need to look at them individually to understand their relationships.

Virtual Energy Community: This actor is the core of the simulation model. By systematically changing the performance of this actor, we get an insight into the dynamics of the Virtual Energy Community. The actor has four value activities. Two of them are Consumers and Producers. Even though in the scenario, there are both producers, consumers, and prosumers, we have, in our value model, separated them in Consumers only and Prosumers only as we look at the two activities separately.

3rd party Energy Service Company: This actor is providing energy services to VECs and others. Its services (value activities) consist of managing Explicit Demand Contracts and VEC Operation Administration. Finally, the Energy Service Company gets the iFLEX Assistant and related products and services from an iFLEX Provider.

Retailers: This market segment consists of several legal energy suppliers that are engaged with the members of the VEC. Since there may be more than on retailer engaged in the geographically dispersed VEC, the actor is technically represented with a market segment. The purpose of the Provide Energy activity is to buy energy from the market and from the VEC Producers, arrange for the transmission to the Consumers, and bill them for the total cost of energy. The data for correct billing is obtained from the national Data Hub provided by the Agency Host (typically a TSO).

TSO: This actor is delivering energy to the market.

DSO: This actor is responsible for the distribution of energy on the MV and LV grids. The DSO also maintains a pool of locally produced energy in different parts of the MV and LV grids.

Wholesale Energy Market: This actor is the national or regional market place for wholesale energy.

Flexibility Market: This actor is the market for demand flexibility. Its only value transaction included in the model is the purchase of flexibility from the 3rd party Energy Service Company and we do not include penalties or other offsets in our model.

iFLEX Provider: This actor is an organisation providing the iFLEX Assistant and related products and services to the 3rd party Energy Service Company.

Agency Host: This actor is the host of the Data Hub. It is often a national entity, a TSO, which has this responsibility at the national level.

Value propositions

The following value propositions are used in the business models:

1. **Providing virtual metering and analysis**: The VEC members are offered load profiles and analyses of generation and consumption within the VEC based on virtual metering data supplied by a national Data Hub. The electricity consumption is summarised per hour/day/week/month, per device and/or per activity domain, so that the consumer can observe and verify the internal billing in the VEC and can

monitor efficient use of energy in the household. The service is offered by a 3rd party energy service company to the VEC as part of a VEC operation administration service (BUC-05).

2. **Providing forecasting and self-balancing capabilities:** Prosumers in the VEC can reduce their energy costs and/or increase their use of RES via leveraging energy forecasting and subsequently optimising the operation of the energy assets and devices. This value proposition is provided through several functionalities of the iFLEX Assistant which provides energy monitoring in the household, means for forecasting consumption and generation, as well as autonomous scheduling (BUC-06).
3. **Providing decision making capabilities**: Enabling implicit DR with automatic control of various energy assets based on price signals is offered via the iFLEX Assistant which executes the individual preferences for automatic control of energy assets (BUC-07).
4. **Providing flexibility to the market:** The VEC can offer aggregated flexibility (both positive and negative) to the market using the iFLEX Assistant which supports both the flexibility that can be promised and the execution of the individual preferences for autonomous control of energy assets. These functions are enabled through forecasting of baseline consumption and calculation of flexibility offerings (BUC-08).

Each value proposition extends across several actors according to the actual implementation and the corresponding value activities undertaken by the individual actors.

Business model framework

The e3value model is based on a visual representation of the actors involved, the value generating activities, and the resulting exchange of values between actors.

The template for the model is as shown in Figure 37.

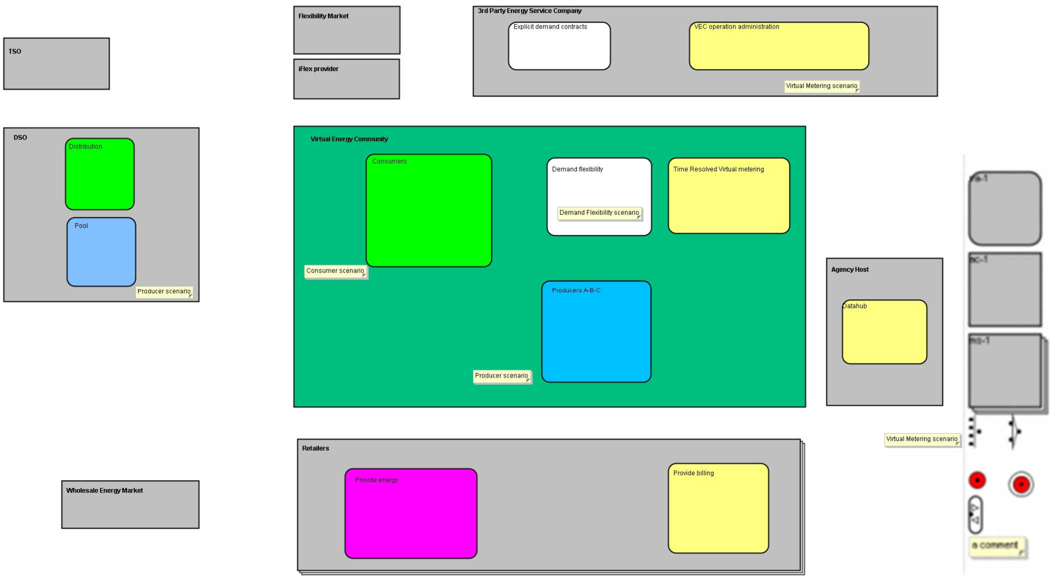

Figure 37: Template for e3value modelling in Perspective III Virtual Energy Communities

The square boxes represent the different actors involved in the value transactions. The green box represents the central actor: Virtual Energy Communities. In effect, this is representing a wide group of similar energy communities across the energy system (market segment). Inside some actors, we have identified key value activities, such as "Consumers" and "Producers". By doing so, we can calculate the net economic impact per specific activity within an actor.

In the next step, we will construct the value propositions and their exchanges around four scenarios. The value proposition is offered as a value object from on actor to another in return for another value object which typical is of monetary kind (MONEY) but can also be non-monetary (comfort, access to data, etc.). The full model is shown in Figure 38 below.

The scenarios are shown as dotted lines connecting a start stimulus with one or more end stimuli. The scenario can transition across different actors in the value chain thus providing a calculation of the economic footprint on each actor. In this way, the full economic impact can be calculated on all actors in a single run. Parameters can then be changed, and new runs performed to see the potential impact on the entire ecosystem.

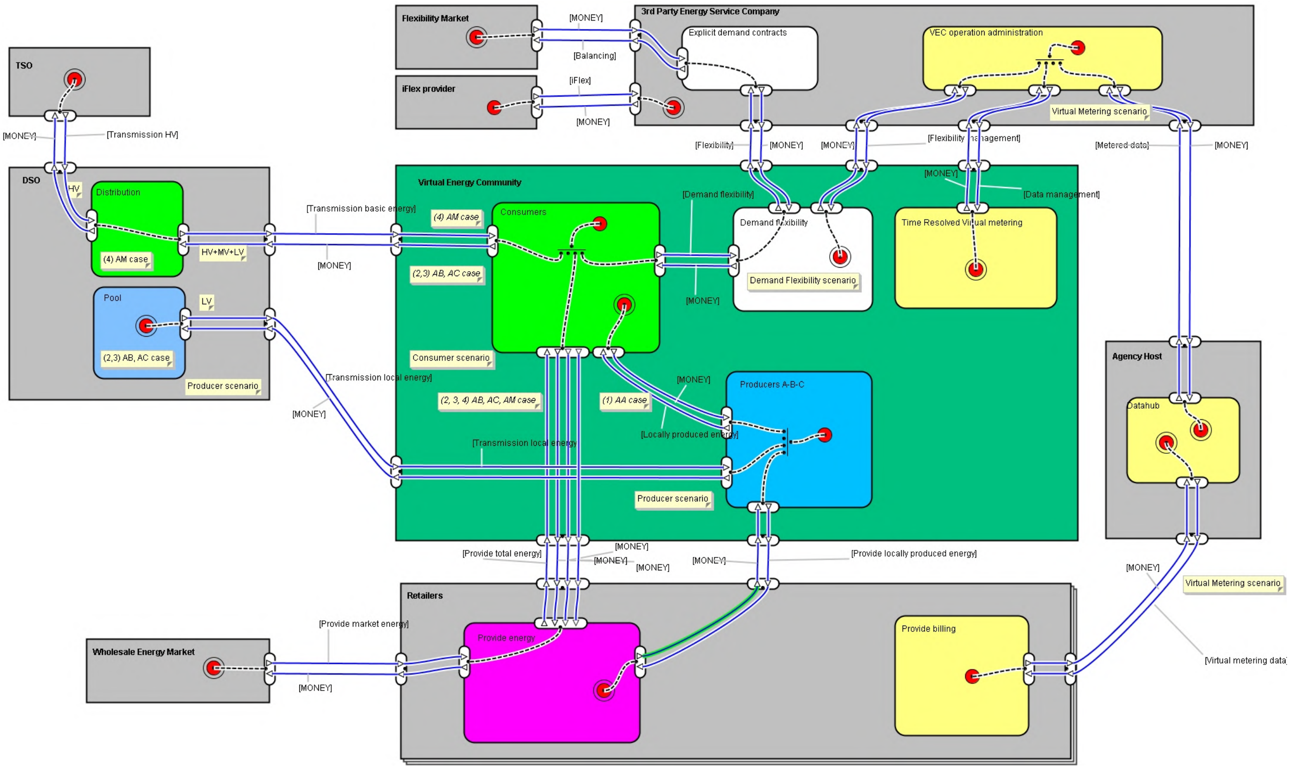

Figure 38: e3value modelling in Perspective III Virtual Energy Communities

In Figure 38, four scenarios are labelled with yellow tags as follows:

1. The Virtual Metering scenario – involves all functionalities used by the VEC for automatic control (implicit DR) and autonomous operation (explicit DR) using iFLEX Assistant with hybrid modelling forecasting tools. Further, it allows for time-resolved virtual metering allowing the VEC to correctly allocate revenues and costs on the individual members (yellow activities). The scenario interacts with 3rd Party Energy Service Company who supplies the iFLEX Assistant. The scenario further extends to the national Data Hub where data can be used for billing purposes by the Retailer.
2. The Demand Flexibility scenario – involves prediction of the potential flexibility that can offered and how this can be pushed through the value chains to the flexibility market. The scenario uses iFLEX Assistant functionalities to identify and deliver Demand Flexibility (white activities). The scenario interacts with 3rd Party Energy Service Company who supplies the iFLEX Assistant. The scenario further extends to the Flexibility Market.
3. The Consumer scenario – involves all VEC members acting as consumers only (green activities). It extends into the Retailer for delivery of energy from market and DSO pool, and with the DSO for transmission tariffs. It also extends internally into the Producer activity for obtaining the locally produced energy.
4. The Producer scenario – involves all VEC members acting as producers only (blue activities). Ot provides the locally produced RES electricity to the consumers and sells any surplus electricity to the market pool through the Retailer.

Value transactions

We will provide a couple of comments to the many value transactions depicted in the model.

In the VEC, one activity is to aggregate the demand flexibility from all its consumer members and to sell that flexibility for collective revenues. For this activity, the VEC uses the iFLEX Assistant as part of the infrastructure. The value transaction between the Consumer activity and the Demand Flexibility activity represents the distribution of flexibility revenues among the members and the value. The demand flexibility is managed through a 3rd party Energy Service Company and the revenues for demand flexibility offered constitute the value transaction with that partner.

Another activity is to establish a fully virtual, time-resolved metering system for the correct appropriation of revenues and costs among the members of the VEC. The service is provided by the 3rd party Energy Service Company and the payment is a value transaction with that actor.

The Consumers of the VEC have a value transaction with the DSO involving purchase of transmission and with the Retailer regarding purchase of energy (both from market and from the pool). Consumers also have a value transaction in purchasing local energy from the producers in the same VEC. The scenarios are playing out by branching out through all three transactions. By changing the number of Consumers and their energy consumption, we can simulate various performances of the VEC.

The Producers of the VEC have value transactions with Consumers for their locally produced energy, with the DSO for transmitting the surplus energy to the pool, and with the retailers for getting revenues from the sale of surplus energy from the pool.

The value transactions are entered into the model via a network of formulas, originally developed by (Divshali, 2020). As visualised in Figure 38 above, the VEC consists of buildings and production points. One member (A) is an apartment block with several tenants. It has a production unit behind the accredited meter and can share locally produced energy with the other tenants behind the meter. Another building (B) is a single dwelling with its own production unit behind the accredited meter. The third case (C) has two members. One is a single dwelling without production; the other is a single production unit without consumption. Each end-user of this VEC has four options to buy electricity (three production points + the wholesale market). The optimum source will be one located in the same building and the least optimal one will be the wholesale market.

Formulas can now be defined for all consumers A, B, C of the VEC buying energy from alle producers A, B, C, and wholesale market. These value transactions for member A are denoted respectively CAA, CAB, CAC, CAM and similarly for the other members B and C.

$$C_{AA} = \left(\pi_A + C_A + C_{Bi}\right)*1.24, \quad (1)$$

$$C_{AB} = \left(\pi_B + C_A + C_{Bi} + C_{LV} + \lambda_{LV}T_E\right)*1.24, \quad (2)$$

$$C_{AC} = \left(\pi_C + C_A + C_{Bi} + C_{LV} + \lambda_{LV}T_E\right)*1.24, \quad (3)$$

$$C_{AM} = \begin{pmatrix} C_M + C_{BA} + C_A \\ +C_{Bi} + C_{LV} + C_{MV} + C_{HV} + T_E \end{pmatrix}*1.24. \quad (4)$$

Where π_A, π_B, π_C, and π_M are respectively the energy price of production A, B, C, and market per kWh; C_A is ancillary service cost (Section II.C.2); C_{Bi} is billing cost (Section II.C.5); C_{LV} is LV network cost (Section II.C.4); C_{MV} is MV network cost (Section II.C.3); C_{HV} is HV network cost (Section II.C.1); T_E is the electricity tax (Section II.A); λ_{LV} is coefficient of proportional tax to network service, e.g. 1/3; and 1.24 is the VAT

Figure 39: Formulas for VEC accounting between energy sources (Divshali, 2020)

Finally, the VEC has a value exchange, which provides access to the Flexibility Market through the 3rd Party Energy Service Company. It should be noted that the amount of potential flexibility does not differentiate between promised and provided flexibility and the whole pricing structure of trading flexibility is not implemented in the model beyond a simple market value from the flexibility market. When using the model for iterations and sensitivity analysis, these shortcomings are not so important because the model is aiming at optimising certain parameters of the business models under all other conditions being equal.

3rd party Energy Service Company has two value activities. The Explicit Demand Contracts activity consist of providing technical means for aggregating demand flexibility including forecasting and smart automation functions using the iFLEX Assistant. The flexibility is sold on the Flexibility Market. Part of the revenues is passed on to the VEC as community renumeration. However, the real renumeration for Consumers is reflected in lower energy spot rates on the market, so some energy service companies do not share the profit for flexibility with the Consumers. In our model, we have separated it out in a specific value transaction to show it directly in the overall money flow of the VEC.

The other value activity of 3rd party Energy Service Company is to provide accurate billing information from virtual meters and deliver these readings to the Data Hub. For this service, the actor bills the VEC a monthly subscription fee and pays the Agency Host for data access to in the Data Hub.

For the Retailer, the value transaction with the Consumers has four elements. The value object delivered is the total energy. The money received are for 1) cost of market energy including ancillary costs for the Retailers, 2) cost of energy delivered from the DSO pool including ancillary costs for the Retailers, and 3) a monthly subscription service cost for each Consumer. A further value transaction reflects the payment of fees to the Agency Host for accessing the Data Hub.

The TSO's only value objected is to offer transmission of the energy through the High Voltage (HV) network against a HV transmission tariff.

The DSO has two value activities. One activity is to use its Low (LV) and Medium (MV) Voltage network to deliver market energy to the consumers. For this value object, the consumer pays a transmission tariff. It should be noted that the DSO delivers directly to the consumer (it owns the accredited meter at the consumer side) and it receives the transmission tariff (HV+MV+LV) from the consumer. This is the value transaction (for our model, it does not matter that the process flow for the payment is via the Retailer). The second value activity is to pool surplus energy generated from local producers. This energy is transmitted through the LV network and the DSO acts as a pool. The revenues are the LV transmission tariffs to be paid by the producers of the energy.

Business model instantiation

The e3value tool is designed to provide a quick, visual, and easy to use tool for evaluating various business models under different boundary conditions. It is well known, that very detailed modelling of all monetary value flows requires a similarly fine-grained business modelling tool such as the BME360 tool, which is used in other tasks in iFLEX.

Conversely, the e3value tool is working on average value flows. We are using a calendar year as time frame and calculate all energy components in terms of "average consumption/average generation per year". Further, we use average values for estimates of energy and flexibility components such as "potential flexibility is 10% of total electricity consumption". Again, the values are provided as annual averages.

Further, for the business model to provide correct answers, it must be supplied with a) correct formulas for computing the correct value transactions and b) realistic values for computing trustworthy business results. This is a crucial activity with quite enormous challenges, because reliable data for the many details are very hard to obtain in general (either because of proprietary or because of lack of public statistics) and never obtainable in single ecosystems (national and regional).

Finally, the model does not capture all value activities in secondary actors, but only those activities that are related to the primary actors and the scenarios described.

The lack of data and the use of annual averages inevitable makes the resulting business models hard to validate in a real environment. But they are very well suited for comparative studies where they capture the resulting impact on both primary and secondary actors from specific changes in one or more parameters.

This ability will be used in the next section to discuss sensitivity and optimisation of business models for the core actor, i.e. the Virtual Energy Communities.

Business model data

The data for the business model has been collected from a wide variety of related and unrelated sources. As such, they should not be understood to represent a certain national or regional setting. However, the data made available from the Finnish and Slovenian pilot (including national data) have been used wherever possible. The source of most of the data is shown in the column "Source" in Table 6.

Table 6: Data used in Perspective III Virtual Energy Communities

Value property description	Value	Unit	Source
Virtual Energy Communities			
Number of consumer households	100		
Number of producer households	40		

Avg. total energy consumption per household	4.940	kWh/yr	SF
Avg. energy delivered from market per household	2.660	kWh/yr	CALC.
Avg. energy surplus delivered from pool per household	1.800	kWh/yr	RO
Avg. energy production consumed internally per household	480	kWh/yr	ESTIM.
Cost of energy produced for own use	0,017	€/kWh	US
Cost of energy produced for VEC use excl. LV tariffs	0,019	€/kWh	ESTIM.
Data Hub Host			
Access for retailer per access point	1,00	€/yr	SF
Access for third party per access point	3,00	€/yr	SF
Access for DSO per access point	0,3	€/yr	SF
Retailer			
Retailers' add-on costs on all energy	0,010	€/kWh	ESTIM.
Retailers' subscription charges per household	3,81	€/md	DK
Wholesale Energy Market			
Spot price of energy on market	0,075	€/kWh	SF
3rd Party Energy Service Company			
Percentage of balance revenues passed on to consumers	50%	%/yr	ESTIM.
Charge by 3rd party for operating iFlex Assistant per user	5,00	€/month	ESTIM.
Charge by for operating Data Hub Assistant per user	1,00	€/month	ESTIM.
Balancing Company			
Market price for purchasing balance	0,120	€/kWh	PL
TSO			
Tarif for HV Transmission	0,005	€/kWh	SF
DSO			
Tarif for HV, MV, LV transmission	0,037	€/kWh	SF
Tarif for LV transmission	0,020	€/kWh	SF

Business model results

Instantiated with this set of data, the e3value model has calculated all the monetary flows in and out of actors and activities. The absolute numbers are not making a lot of sense, since they, for most actors, are incomplete and/or either shows costs only or revenues only. What is important though, is the ability to do several runs of the model with incrementally changed parameters. Doing so with one parameter at the time will provide valuable insight into the sensitivity from this parameter for the entire ecosystem. This will be further illustrated in section 4.5.2.

The results of the model calculations using a few parameters for the Virtual Energy Communities, which can be useful to study, are shown in Table 7. The full list of results is provided in Appendix III.

Table 7: Baseline revenues in the Virtual Energy Community

Variables	Baseline	
Avg. total energy consumption per household	4.940	kWh/yr
Avg. energy delivered from market per household	2.660	kWh/yr
Avg. energy surplus delivered from pool per household	1.800	kWh/yr
Avg. energy local delivered from pool per household	480	kWh/yr
Overview of main results	**Baseline**	
Economic performance of VEC	-41.758	€
Economic impact on Retailers	9.890	€
Economic impact on DSO	9.952	€
Economic impact on Wholesale Energy Market	19.950	€

4.5 Final assessment of business use cases and models

The third step is to assess the viability and attractiveness of the iFLEX business use cases.

4.5.1 Validation of business use cases using the 360 Business Model Evaluator

The overall validation will be using the 360 Business Model Evaluator (BME) tool[12]. The 360 Business Model Evaluator is a state-of-the-art "what-if" scenario and cost-benefit analyses. The objective of this tool is to assist the planning and deployment of new products, infrastructures, and services in various areas (telecoms, ICT, energy) by providing a techno-economic analysis and evaluation before and during the implementation and the deployment phases.

The selection of business use cases and models is compared with standard "business as usual" models by using as input several techno economic KPIs and assumptions on costs and revenues. It aims at identifying market bottlenecks and assessing the effectiveness of additional compensations and evaluates the Cost-Benefit of technologies for the society as a whole. It also performs sensitivity analysis by running Monte Carlo simulations.

Given that several options/instances per BUC may exist, e.g., different type of iFLEX Assistant delivery models (e.g., SW, SaaS) and certain types of DR campaigns, Furthermore, each BUC instance will be evaluated against a set of baseline assumptions on the costs and revenues involved for each business role.

[12] For those use cases that are being explored as part of the e3value modelling, a close cooperation will be called for in order to explore various view ports offered by the two solutions.

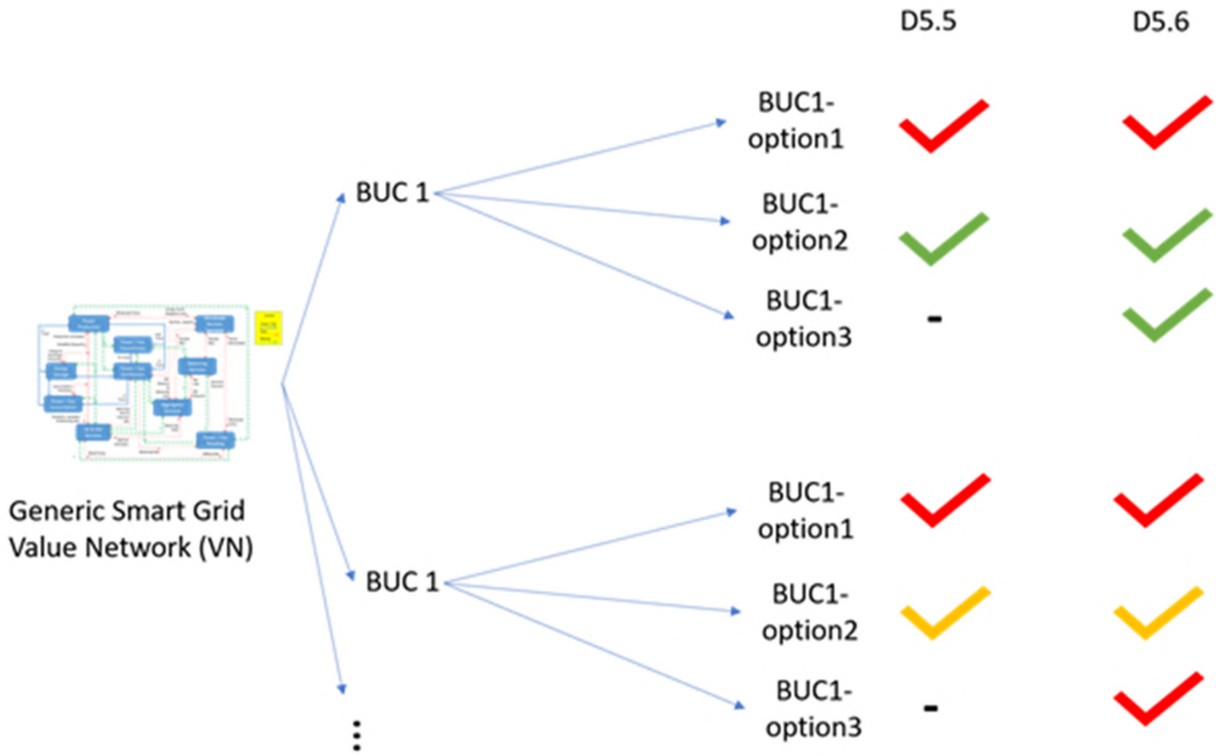

Figure 40 The phased methodology for assessing the attractiveness of each BUC

Furthermore, apart from analysing the profitability of each BUC independently, the profitability of selected combinations of BUC options will be analysed in D5.6 (e.g., combining some “orange” options with “green” options could be still profitable due to economies of scope). Besides, assumptions on cost and revenues may need to be revisited and sensitivity analysis will be performed. This is shown in the following figure.

Figure 41 Assessing the profitability of selected combinations of BUC options

In the final phase, the chosen iFLEX business models can also be instantiated using the Business Model Canvas with Real World Data, realistic revenue and cost models, and, if feasible, adopted to specific market segments. The full process model for each business model can be expressed in a business canvas, which again can be used in the user validation activities as well as a basis for the partners’ individual exploitation planning.

4.5.2 Validation of business use cases using e3value sensitivity analysis

The e3value modelling tool is a fast and easy way to perform iterations and sensitivity analysis of business models. Once the model has been created, it is very easy to incrementally change one parameter and observe the resulting impact on other parameter(s).

To do sensitivity analysis, it is necessary to have a certain relationship in mind. For example, the impact on overall energy costs in a Building Community from increasing the capacity of heat pumps and locally produced RES (perspective I) or the impact on balancing potential from varying the amount of locally produced RES energy in the case of the Virtual Energy Community (perspective III). The simulation would normally have to be actor driven so as the proper parameters are connected for the simulation. At this stage, we have only visualised the potential from sensitivity analysis performed with the e3value tool.

These are the first simulation results. They illustrate the potential in e3value for rapid analyses of the business ecosystem and the effect from changing operating parameters.

For example, various combinations of flexibility potential, pricing models and value exchanges could be investigated in another scenario. This work is best done with representatives from actors and other interested parties.

Perspective I: Consumer-driven flexibility

The analysis demonstrates how the model calculates overall energy costs in a Building Community as a function of heat pump capacity and RES generation:

Table 8: Perspective I sensitivities

Scenario	BM Perspective I v10 *Baseline*		BM Perspective I v10a *Increase RES*		BM Perspective I v10b *Increase heat pumps*		BM Perspective I v10c *Increase flexibility*	
Variables		**Case a**		**Case a**	**Case b**		**Case c**	
Baseline electricity consumption per household	3.700	kWh/yr	3.700	kWh/yr	3.700	kWh/yr	3.700	kWh/yr
Baseline heat consumption per household	341	MWh/yr	341	MWh/yr	341	MWh/yr	341	MWh/yr
Baseline RES generated	480	kWh/yr	960	kWh/yr	960	kWh/yr	960	kWh/yr
Number of heat pumps deployed (12.000 BTU)	4		4		8		8	
Investment in HP needed	19.866	€	19.866	€	39.732	€	39.732	€
Flexibility potential	10%		10%		10%		20%	
Resulting changes (€/yr)		**Base**	Δ	**Case a**	Δ	**Case b**	Δ	**Case c**
Cost of heat from district heating (DH)		3.606	0	3.606	-770	2.836	-770	2.836
Cost of electricity from retailers		30.541	-4.464	26.077	-3.869	26.672	-3.869	26.672
Revenues from flexibility		4.342	491	4.833	557	4.898	5.455	9.796
Total energy costs for Building Community		**29.806**	-4.955	**24.851**	-5.195	**24.610**	-10.093	**19.712**

Case a: By doubling RES, we obtain a significant saving in the cost of electricity, which was expected. The revenues from flexibility increases slightly but is capped at 10% of total energy consumption.

Case b: By doubling the number of heat pumps from 4 to 8, we achieve only a relatively small reduction in heat from district heating (27%). This can be attributed to the ratio between HP and ad DH energy which is fixed at 1:5. Further iterations of these parameter will explore the relationship between number of HP installed and the total cost of heating, particularly with a view to the cost of investments in further heat pumps.

Case c: By increasing the potential for flexibility from 10% to 20% of total electricity consumption, the revenues from flexibility increases significantly. This was expected but the amount is indeed significant. This calls for further analysis of the precise process of providing flexibility, the specifics of promised vs. delivered flexibility, and the behaviour of Building Community members towards DR. With the proper use of the iFLEX Assistant, the potential for significant reductions in total energy costs can be foreseen.

Perspective II: Aggregator-driven flexibility

The analysis demonstrates how the model calculates overall energy costs for Consumers as a function of % of Producers RES sold to the Aggregator:

Table 9: Perspective II sensitivities

Scenario	*BM Perspective II v10a Full internal RES*		*BM Perspective II v10b 50:50 internal RES*		*BM Perspective II v10c Full Aggregator RES*	
Variables	**Baseline**		**Baseline**		**Baseline**	
Avg. total energy consumption per household	14.000	kWh/yr	14.000	kWh/yr	14.000	kWh/yr
Number of consumers and producers	250		250		250	
Ratio of RES generated internally and used internally	1%		50%		99%	

Overview of main results (€/yr)	Base	Δ	**Case b**	Δ	**Case c**
Economic performance of Consumers Producers market	-727.363		-598.125		-468.888
Economic performance of DR and RES aggregator	2.046.786		2.052.907		2.059.027
Consumers total energy costs	770.950	-124.950	646.000	-249.900	521.050
DR and RES aggregator revenues from RES flexibility	1.172.375	-6.125	1.166.250	-12.250	1.160.125
DR and RES aggregator purchase from consumers prosumers	50.875	-6.125	44.750	-12.250	38.625
Revenues from DR flexibility	38.500		38.500		38.500

Case a: Dividing producer's generated RES with 1% internal consumption and 99% sold to Aggregator, the total cost of energy for Consumers amounts to 770.950€. At the same time, the total purchase of RES for the aggregator amounts to 50.875€. Consumers further claim revenues of 38.500€ for flexibility.

Case b: If the ratio is increased to 50%, the cost of energy for Consumers drops significantly with 124.950€ (16%) from 770.950 to 646.000€. This drop is of course due to the much lower tariff for locally generated RES compared to market tariffs plus, the savings in transmission tariffs. The impact on the Aggregator is much less pronounced (6.125€) because RES from Producers can be substituted with RES from RES Generation entities where the difference in tariffs is not so big.

Case c: This case represents the full internal utilisation (99%) of Producers RES by Consumers. In this case, the savings in Consumers total energy costs are 249.900€ (32%) whereas the Aggregator's purchase costs only increase with 12.250€.

The model builds a strong case for why Consumers and Producers should join the DR programme offered by the Aggregator. Not only are there direct revenues for providing DR flexibility to the Aggregator, but there is also a potential for massive savings on the electricity bill if the iFlex Assistant and the Aggregator flexibility programmes can optimise the customers use of internally generated RES.

Perspective III: Virtual Energy Communities

The analysis demonstrates how the model calculates overall energy costs in a Virtual Energy Community as a function of locally generated RES:

Table 10 Perspective III sensitivities

Scenario	BM perspective III v10 *Baseline*		BM perspective III v10a *No local use*		BM perspective III v10b *No surplus*		BM perspective III v10c *Storage included*	
Variables								
Avg. total energy consumption per household	4.940	kWh/yr	4.940	kWh/yr	4.940	kWh/yr	4.940	kWh/yr
Avg. energy delivered from market per household	2.660	kWh/yr	3.140	kWh/yr	4.940	kWh/yr	3.140	kWh/yr
Avg. energy surplus delivered from pool per household	1.800	kWh/yr	1.800	kWh/yr	0	kWh/yr	1.400	kWh/yr
Avg. energy local generated per household	480	kWh/yr	0	kWh/yr	0	kWh/yr	-400	kWh/yr
Number of users in VEC	100		100		100		100	
Overview of main results	**Baseline**		**Case a**		**Case b**		**Case c**	
Economic performance of VEC (cost of energy)	-41.758		-47.614		-64.282		-46.438	
Economic impact on Retailers	9.890		10.370		8.318		9.514	
Economic impact on DSO	9.952		11.488		15.808		11.168	
Economic impact on Wholesale Energy Market	19.950		23.550		37.050		23.550	

Baseline: The VEC operates with full performance and uses prioritized energy from 1) local production within a single member, 2) local production within the VEC, and 3) market energy.

Case a: In this case, there is no locally produced energy within members. The VEC uses prioritized energy from 1) local production within the VEC, and 2) market energy.

Case b: In this case there is no locally produced energy, neither from the within the members, nor from within the VEC. All energy used, is from the market.

The change in the energy mix obviously has an impact on the main actors' economic performance. Each case has been calculated with the above mix and the aggregated results are shown in the table.

Case c: In this case we introduce a storage facility rather than RES within the individual members. The surplus energy to pool is lowered correspondingly.

The storage changes the internal cost structures. The VEC has a slightly higher economic performance because transmission costs for surplus energy is lowered through the storage. Further details of this case need to be performed to fully understand the dynamics of the model.

The VEC has, as could be expected, by far the lowest energy costs when using all the available locally produced energy (42 k€ annually). By not using locally and VEC product energy, the total energy costs soar to 64 k€; an increase of 64%. The difference comes from increased energy over market costs, as well as more transmission through the DSO network. The DSO revenues for transmission increases correspondingly.

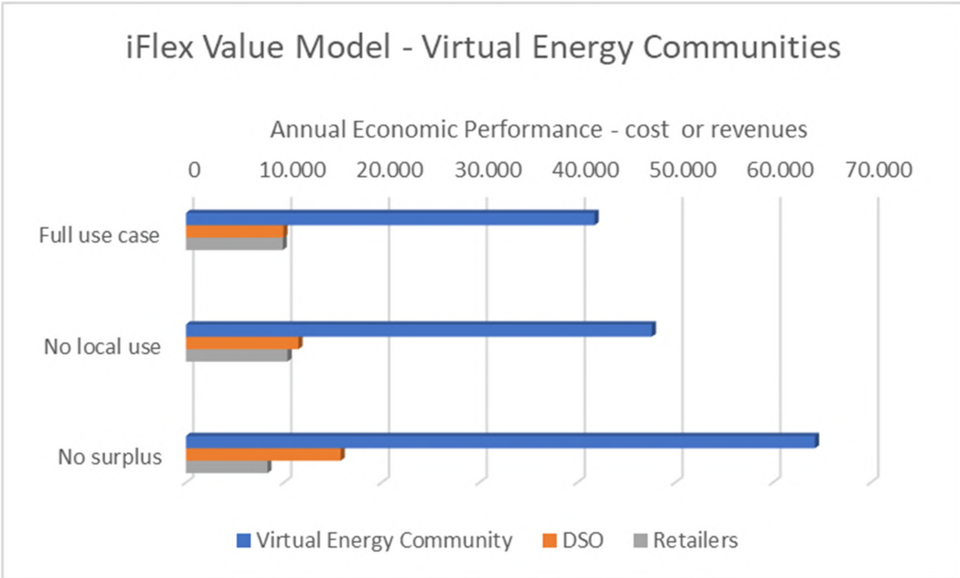

Figure 42. Result of calculations in cases

For the Retailers, the picture is mixed. The Retailers are not directly involved in the energy production between members, and is only affected when the surplus energy is substituted with market energy, in which case the price of purchased market energy becomes much higher thus lowering the Retailers' margin. The details of Retailers' revenues and costs are found in Appendix III.

5 Drivers, obstacles, and business opportunities

This Chapter presents drivers, obstacles and business opportunities. First, the drivers and obstacles are presented in target demonstration countries and then business opportunities are presented by different categories.

5.1 List of changes and updates in Chapter 5

Section 5.2 “Drivers” has been revised regarding Greece, accommodating all latest available data and trends regarding drivers that could enable the large-scale deployment of DR programs to end-consumers. Slovenian and Finnish sections have also been updated.

Section 5.3 “Obstacles” has been revised regarding Greece, accommodating all latest available data and trends regarding barriers that still hinder the large-scale deployment of DR programs to end-consumers. Slovenian and Finnish sections have also been updated.

5.2 Drivers

5.2.1 Greece

Greece has already set a fully functional wholesale market framework with four distinct markets, namely Forward Market, Day-ahead Market, Intra-day Market and Balancing Market in line with the provisions of the Target Model. In addition, Greece has also established recently a specific market framework for the direct participation of DR Aggregators in the wholesale electricity market. Specifically, the everyday participation of DR Aggregators is now technically feasible only for the large (industrial and commercial) consumers, which are exclusively connected to the HV and MV levels. Necessary regulatory provisions such as the baselining methodology are already in force, allowing for the unobstructed participation of either individual dispatchable loads or DR Aggregators representing a set of smaller dispatchable loads in the balancing market only. The related regulatory framework and detailed technical decisions pertaining various operational aspects regarding the participation of DR in the Day-Ahead Market is expected to be finalized soon, thus allowing (from the regulatory requirements’ perspective) for the full and active participation of DR resources in all wholesale electricity market segments.

5.2.2 Slovenia

By the end of 2023, all users in the distribution system were equipped with advanced measuring devices, which is an important building block of smart grids and enables more active customer participation. The Energy Agency has updated its policy with dedicated investment incentives in smart grids, research and development with a goal to enable more intensive introduction of new technologies and innovative approaches to network management and energy. The first set of public consultations on the introduction of a market with flexibility in Slovenia was conducted. Further development as regards the active participation of electricity consumers and the market will depend on: a) the effective elimination of regulatory and normative barriers, b) raising awareness of customers about the importance of their active role and c) the development of new business models.

5.2.3 Finland

As the amount of intermittent generation is increasing, there is also increasing need for flexibility and new flexibility service providers. In the regulatory environment there are drivers that enable the new market roles and opportunities.

The Ministry of Economic Affairs and Employment commissioned the Smart Grid Working Group (Pahkala et al, 2018) to review and present action for customer participation in the electricity market. In the conclusions of the final report, it is stated that demand response should be a competitive business and, thus, the load control performed nowadays by distribution network operators should be dismantled. This will enforce the role of retailers and aggregators in flexibility provision especially in the case of household customers.

Also, the role of energy communities and aggregators is welcome and first changes in electricity market legislation regarding the energy communities are now implemented in the Decree 66/2009 of the Council of

State concerning balance settlement and measurement in the form of local energy community and active customers definition and how their electricity generation is handled in balance settlement. (Finlex, 2009)

The rules on how the aggregated resources can be combined in larger units is under discussion. The goal is to enable new market participants access to electricity market on equal and market-based terms. It is also suggested to replace the fixed distribution charge with a power component to give customers better chances of influencing their distribution costs.

5.3 Obstacles

5.3.1 Greece

The status of the energy market in Greece and the corresponding legal and regulatory framework foresees the role of the DR Aggregator. However, although the necessary legal and regulatory framework is almost in place, the direct participation of large-scale DR resources in the wholesale electricity market is deemed practically infeasible at the current stage, since it requires a set of certain specifications and operational requirements that are still under design or in early implementation stages.

In particular, the areas of concern that have contributed to the tardy large-scale deployment of the DR schemes in the Greek energy market include, but are not limited to, the following:

- The current status of metering and telemetry infrastructure in Greece and, especially the lack of certified smart meters that shall be used to derive the settlement, performance and compliance of DR resources, especially as regards Low-Voltage end-consumers,
- The current status of IT infrastructure for enabling remote control at aggregator and/or consumer level, as well as enabling information exchange between the market actors for the DR quantities activated,
- Lack of installed DR-enabled devices,
- Lack of incentives for the different stakeholders and interested business actors (TSOs/DSOs, Aggregators, BRPs, Retailers) in DR schemes.

Currently, the metering infrastructure of the end-consumers connected at HV and MV levels support quarterly (15-min) measurements (with telemetering facility), so (given that remote control shall be also possible) the metering infrastructure shall not be a barrier for the participation of such customers in either (a) implicit DR programs (e.g. implementation of time-of-use rates and/or real-time tariffs) or (b) explicit DR programs (i.e. direct participation in the wholesale market). Especially in explicit DR programs, the assessment of the activated DR volume (i.e. difference between “what the consumer would normally consume” - namely, the baseline - and the actual measured consumption level following specific dispatch instructions sent by the TSO/DSO) is based on such appropriate metering infrastructure.

However, one of the major barriers for enabling the participation of LV consumers in implicit and explicit DR programs is that no official (certified) smart meters’ rollout has started yet in Greece for the provision of real-time measurements along with the lack of installed DR enabling devices. The regular energy metering infrastructure is placed outside of the buildings and is exclusively owned and operated by the DSO, i.e. no other party, including the owner of the house, has access to or can interact with the meter. The installation of smart meters by the DSO in all LV consumers is at very pre-mature stage and mainly concerns the installation of such devices for piloting purposes, thus without allowing any practical and commercial large-scale implementation.

Moreover, the current wholesale electricity market regulatory framework does not allow retailers to officially implement flexible tariffs. End-consumers are exclusively charged on the DSO-derived metering data and not on the basis of data collected by (additional) smart metering infrastructure that could have been provided by the retailers to the end-consumers. Due to the absence of smart meters installed by the DSO (which would be able to provide certified real-time consumption data on finest time resolution, e.g. hourly or 15-min intervals), any implementation of flexible tariff schemes is currently deemed as not applicable. The introduction of such flexible tariffs in Greece is expected to become feasible from the technical and regulatory point of view in the next few years, once the progress of the roll-out of the certified smart meters in all LV consumers is in advanced stage.

5.3.2 Slovenia

The analysis of the state of market development with flexibility at national and EU level confirms the great potential of flexibility on the demand side, which can only be exploited if all obstacles are removed in a timely and effective manner, open issues are resolved and the most appropriate market model is implemented effectively with flexibility, which will allow equal participation of all stakeholders and all sources of flexibility, including the smallest consumers.

Based on a comprehensive analysis of the market situation and the electricity system at the national level, the identified obstacles at the national level are discussed below and related recommendations are made by individual domain sets. The Agency's recommendations address perceived barriers at national level and include a proposal for appropriate action adapted to the situation in Slovenia. Therefore, the results of the analyses presented below represent a concrete proposal in the direction of providing conditions for the effective implementation of the market with flexibility in Slovenia. This takes into account both the existing normative regulation as well as the normative framework in the making or adoption, such as the package of the Directives related to the Clean Energy Package and associated network codes and the positions of the Energy Agency (market regulator) on further development of the electricity system and electricity market in terms of sector transformation. The findings are also based on the assumption that European legislation is properly and comprehensively implemented at national level.

The condition for the timely start of the implementation of the Clean Energy Package is the final, comprehensive and efficient operationalization of the functions of the electricity system and market model, and consequently the services arising from the implementation of the Third EU Energy Package. The following obstacles have been identified related to the implementation of tasks based on the implementation of the third package of EU directives and other applicable EU directives:

1. Unsatisfactory data services within the advanced measurement infrastructure;
2. Unsatisfactory availability of key data needed for a more efficient market;
3. The existence of other shortcomings in the implementation of the Third EU Energy Package, in the field of secondary legislation;
4. Incomplete implementation of the Directive on the establishment of infrastructure for alternative fuels.

To address the above obstacles, a set of measures is described below.

1. It is essential to provide the necessary data services within AMI based on the update of the AMI deployment plan. In addition to business services, special attention should be paid to the relevant services at the level of business to users. The users and indirectly the proxies must be provided with access to the measurement data as close as possible to real time, which is a condition for the creation of offers for participation in the flexibility market. The existence, integrity and quality of these services are key to running a campaign to raise consumer awareness of their new role in the energy market - the "active user".
2. It is necessary to start exploiting the available potential of digitalisation in order to ensure a higher level of transparency in the market and to provide appropriate signals to market participants. Based on the availability of detailed metering data, certain key market processes need to be optimized, in particular data exchange for a more efficient balancing process, which must be based on all available metering data (it must also include the smallest customers whose consumption is measured). Public disclosure of balance sheet deviation and balancing costs based on near real-time data must be ensured. This will ensure more accurate operational forecasts and more efficient self-balancing by balance groups.
3. There is urgent need to implement updates of key regulations with emphasis on system operating instructions of the distribution system operator, which is the basis for the definition of standard data services within AMI.
4. Inconsistencies in the implementation of EU directives need to be addressed.
5. If necessary, the possibility of storing mass measurement data for a period of 5 years should be provided in more optimal conditions for the use of statistical methods in network design.

5.3.3 Finland

There are multiple different types of obstacles and barriers for the demand response and active participation of the household consumers in the energy and flexibility markets. Obstacles are economical, technical and regulatory.

Even though the value of flexibility is more and more recognised, the economic benefits for the small consumers are still missing or are not big enough. Fixed priced and fixed-term contracts diminish the value of demand response actions. So far, end-customers haven't shown much interest on spot-prices and the share of customers changing retailer is relatively low. Since the household consumers are not able to participate in flexibility markets directly by themselves, intermediate parties are needed. This leads to sharing of the flexibility profits between multiple parties and thus to smaller economic benefit for the end-consumers.

Also, the control technology needed to participate in the flexibility markets is an obstacle for some of potential customers. Interoperability of the technical designs and lack of standards in data system interfaces create obstacles for scalable, cost-efficient solutions to be implement in large scale. (Honkapuro et al. 2015)

The use of AMI for demand response is at the moment limited to time-of-use tariff of the DSO in Finland. This situation should improve in the future with new legislation so that the retailer is the responsible party for any control actions. For the use of AMI-enabled demand response cost-effective aggregation, real-time status and validation measures are not yet in place and should be developed. The biggest potential in the households for demand response is in space heating or heating of hot water. This is in detached houses usually connected to a smart meter relay, which is a business opportunity. The nature of the load however poses some restrictions to the potential of these resources. (Honkapuro et al. 2015)

From the legislation perspective, in Finland there isn't yet regulation and rules for the independent aggregation. However, there are pilots already ongoing and this is under evaluation. It hasn't been announced when the legislation would be published. As described in previous sections, some aspects of the energy communities are implemented in the Finnish energy market legislation, but the principles for energy community across property boarders is not defined.

In the current energy market legislation, heavy security of supply demands for DSOs have led into massive network investments and DSOs at the moment don't have any incentives for the use of flexibility in their operations. This topic is also under review when the next regulation principles are designed.

When implementing demand response, there might be a conflict of interest among different parties and principles for the coordination or the renumeration should be agreed. If the aggregator performs demand response, it might cause imbalance costs for retailer (or the actual balance responsible party). In the case of end-customer demand response, the unusual behaviour of the end-customers might lead into new network situations at the DSO and create new network peaks, e.g if large-scale end-customers start to change their electricity consumption patterns based on spot-price. (Honkapuro et al. 2015)

5.4 Business opportunities

There are several potential uses of DR that could serve as business opportunities of its adoption in the shorter and in the longer term. For instance, assisting in grid operation management, expanding markets, adopting energy and climate policy, and even reducing energy cost could affect the deployment of DR in the coming years. Some potential opportunities are as follows:

- Presence of DR-related policy/regulation
    - Greece has already developed a specific market framework enabling the participation of DR in the Balancing Energy and Ancillary Services Markets at the individual unit level such as dispatchable load or through aggregation on a portfolio basis represented by a DR Aggregator. However, due to the lack of appropriate certified smart metering infrastructure in the LV level, the implementation of DR schemes are practically possible only in the HV and MV levels, which have already been equipped with metering infrastructure that provides detailed (15-min) telemeasurements to the DSO.
    - The introduction of a flexibility market in Slovenia is in its initial phase, while only certain themes have been addressed in a narrower sense. However, its comprehensive treatment shows that there are many obstacles that exist in the market. The introduction of a flexibility market calls for an integrated approach and the close cooperation of various stakeholders in the future.

    - In Finland there isn't yet regulation and rules for the independent aggregation.
    - Some aspects of the energy communities are implemented in the Finnish energy market legislation, but the principles for energy community across property boarders is not defined.

- Enhance infrastructure and reliability
    - Defer the need for potential investments in the generation sector as well as in the transmission and/or distribution grids by decreasing peak demand.
    - Potential of interoperability of the technical designs.
    - Reduction or shifting demand to smoothen load shape.
    - Assist in maintaining grid reliability during emergency and in congestion relief.
    - Act as a resource in operation planning and procurement activities.
- Manage and reduce energy costs
    - DR provides incentives to the customers to participate in such events by adjusting their energy usage according to dynamic tariffs that reflect the time-varying cost of electricity compared to the average retail prices of electricity.
    - Consumers will have the opportunity to gain control over their energy usage and take their own decisions to lower their electricity bills by participating in DR events.
    - Small customers need intermediate parties, which means smaller economic benefit.
    - Households' potential in demand response
        - Heating / cooling system of houses
        - RES production regulation
- Market reform
    - Evolution of interruptible power arrangements between utilities and HV consumers to an electricity market structure with design specifications for each market segment including DR participation,
    - Definition of the DR contractual relationships and settlements between the various market actors (consumers, suppliers/BRPs, aggregators, TSO and DSO).
    - Transparent remuneration models of DR representatives constitute a significant business opportunity for the involved players, especially for the consumers to express their interest in participating in such events. DR representatives are compensated through DR participation to the different market segments, whereas costs and benefits allocation and remuneration of DR should be fair for all involved players.
    - Clear and transparent participation rules in the wholesale electricity market and especially in the Balancing and Ancillary Services Market for DR resources.
- Minimize the environmental impact by reducing electricity usage
    - DR can reduce the electricity usage during peak hours and, thus, reduce the greenhouse gas and other emissions.
    - Reducing and shifting peak loads assists in integrating more RES generation during peak periods.
    - Greater awareness of participants will reduce EE consumption for end users.
    - Local consumption brings fewer losses in distribution / production.
- Partnerships between different stakeholders
    - Partnerships between public and private partners such as stakeholders and consumers represent a business opportunity for those partners collaborating in a mutual benefit and added value project. Appropriate business models should capture the different stakeholders

involved, together with the relationships and flows between stakeholders as well as the sources of value created along the value chain.

- Energy management companies offer energy services support for active consumers. If a supplier or a DSO uses implicit mechanisms of flexibility – tariffs, a company for energy services can optimise costs of active users according to the tariff. Unlike aggregators, companies for energy services are not active participants in the organised market but they can take over their role – an independent aggregator.
- Potential providers of flexibility services can all be consumers of the electro-energetic system. which disposes elements that make it possible to adjust flexibility (production sources, consumers, energy storage facilities),
- The changes in legislation will also be important, as it has to enable the participants to cooperate well and not allow the participants with the largest economic influence to dominate. The latter could bring about a deterioration in the quality of supply in the future.

6 Conclusions

This document describes the overview of the current and future energy market in target demonstration countries (Greece, Slovenia and Finland) as well as at the European level. In addition, the iFLEX business models and use cases have been analyzed. Moreover, at the end of the document, specific drivers, obstacles and business opportunities are presented for innovation in incentive design and consumer engagement.

In the description of the energy market context, the focus was first on the presentation of different stakeholders in the energy sector and then on the high-level description of the retail, wholesale, balancing, flexibility and DR markets. In addition, the energy sector integration was defined. Based on the energy market context description, differences were noted between the target countries.

Different iFLEX business models and use cases are assessed from three distinctive perspecitves: consumer-driven flexibility, aggregator-driven flexibility, and virtual energy communities. These use cases are validated by using the 360 Business Model Evaluator and the e3 value sensitivity analysis methods.

The deliverable observes economical, technical and regulatory obstacles that hinder the large-scale use of demand response, such as the lack of an appropriate baseline methodology, the lack of regulatory framework, the lack of technological status and interest between different parties and principles for the coordination. The status of these obstacles varies from country to country and for that reason in this deliverable they addressed by country.

Once the obstacles are presented by country, the document describes potential business opportunities. The potential uses of DR that could act as business opportunities for its adoption are identified in the shorter and longer term. These are divided into different categories, which are regulation, enhance infrastructure and reliability, managing and reducing energy cost, market reform, climate policy and partnerships between different stakeholders. Overall, if appropriate action is taken, then the business opportunities for DR are rather favorable, thus making the role of iFLEX as an enabler of DR more interesting and challenging.

7 List of figures and tables

7.1 Figures

7.2 Tables

8 References

(ACER and CEER, 2023)	Energy Retail and Consumer Protection 2023 Market Monitoring Report, Sep. 2023.
(A-D. Braimioti, 2019)	A-D. Braimioti (2019). “The Energy Services Company as business model for entrepreneurship – A case study of Greece”, M.Sc. Thesis, Greece, October 2019.
(Allee, 1999)	Allee, V. The art and practice of being a revolutionary. Journal of knowledge management, 3(2), 121-131, 1999
(Caruna, 2020)	Caruna. Fortumin ja Carunan akkuvarasto parantaa sähköjärjestelmän luotettavuutta. 2020.
(DEU, 2018)	“DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT on the promotion of the use of energy from renewable sources,” 2018.
(DEU, 2019)	“DIRECTIVE (EU) 2019/944 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCILon common rules for the internal market for electricity and amending Directive 2012/27/EU,” 2019.
(Chen et al, 2007)	Chen, Y.C., Liu, C.H., Wang, C.C., Hsieh, M.F. (2007). “RFID and IPv6-enabled Ubiquitous Medication Error and Compliance Monitoring System”, 9th International Conference on e-Health Networking, Application and Services, 2007, 19-22 June 2007 Page(s):105 - 108.
(Divshali, 2020)	P. Hasanpor Divshali; A. Kulmala; P. Järventausta, “Forming a Local Market using a Virtual Energy Community”, 17th International Conference on the European Energy Market (EEM), Stockholm, Sweden, 2020.
(Dorian Frieden et al, 2019)	A. Dorian Frieden, A. Tuerk, J. Josh Roberts, and Andrej Gubina, “Collective self-consumption and energy communities: Overview of emerging regulatory approaches in Europe,” 2019.
(EC, 2019)	European Commission, “Clean energy for all Europeans,” 2019.
(EC, 2007)	European Commission (2007). A lead market initiative for Europe. Brussels. COM(2007) 860 final.
(Energiateollisuus)	Energiateollisuus. https://energia.fi/uutishuone/materiaalipankki/energiavuosi_2020_-_sahko.html#material-view
(EnEx)	EnEx, Energy Exchange Group, Energy markets https://www.enexgroup.gr/energy-markets
(eSett, 2020)	eSett, “Nordic Imbalance Settlement Handbook Instructions and Rules for Market Participants”, 2020, [Online]. https://www.esett.com/wp-content/uploads/2020/12/nbs-handbook-v2.6.pdf [Accessed: 08-April-2021]
(ET,2017)	Energiateollisuus, “Finnish Energy’s position on the features of next-generation electricity meters” 2017, , [Online]. https://energia.fi/files/1697/Finnish_Energy_position_paper_features_of_next_generation_electricity_meters_final_20170810.pdf [Accessed: 06-April-2021]
(FCA GL)	https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ:L:2016:259:TOC&uri=uriserv:OJ.L_.2016.259.01.0042.01.ENG
(Gordijn 2002)	Gordijn, Jaap (2002): Value-based Requirements Engineering – Exploring Innovative e-Commerce Ideas, SIKS Dissertation Series No. 2002-8, Amsterdam

(MEEUS, 2020)	MEEUS, Leonardo, The evolution of electricity markets in Europe, Cheltenham : Edward Elgar Publishing, 2020[Florence School of Regulation], [Electricity]
(Fingrid,a)	Aggregation Pilot Project in the Balancing Energy Markets. https://www.fingrid.fi/en/electricity-market/market-integration/the-future-of-the-electricity-markets/aggregation-pilot-project-in-the-balancing-energy-markets/
(Fingrid,b)	Reserves and balancing power. https://www.fingrid.fi/en/electricity-market/reserves_and_balancing/#reserve-obligations-and-procurement-sources
(Fingrid, 2021)	Fingrid. Reserve products and reserve market places. https://www.fingrid.fi/globalassets/dokumentit/en/electricity-market/reserves/reserve-products-and-reserve-market-places2021.pdf 1.3.2021.
(Fingrid, c)	Independent aggregator pilot in the balancing energy market to start 21.7.2020. https://www.fingrid.fi/en/pages/news/news/2020/independent-aggregator-pilot-in-the-balancing-energy-market-to-start-21.7.2020/. 21.7.2020.
(Finlex, 2009)	5.2.2009/66. Valtioneuvoston asetus sähköntoimitusten selvityksestä ja mittauksesta. 2009
(Fortum, 2020)	Fortum. Fortum and Elenia's battery pack stores electricity for power outages and for maintaining electricity network balance. 2020.
(Gordijn, 2002)	Gordijn, J.: Value-based Requirements Engineering – Exploring Innovative e-Commerce Ideas. SIKS Dissertation Series No. 2002-8, Amsterdam, 2002
(HAEE, 2019)	Greek Energy Market report 2019 https://www.haee.gr/media/4858/haees-greek-energy-market-report-2019-upload-version.pdf
(Honkapuro et al, 2015)	Samuli Honkapuro et al. PRACTICAL IMPLEMENTATION OF DEMAND RESPONSE IN FINLAND. CIRED. 2015.
(IRENA, 2019)	TIME-OF-USE TARIFFS INNOVATION LANDSCAPE BRIEF https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Feb/IRENA_Innovation_ToU_tariffs_2019.pdf?la=en&hash=36658ADA8AA98677888DB2C184D1EE6A048C7470
(JAO)	JAO https://www.jao.eu
(JRC)	JRC: Demand Response status in EU Member States file:///C:/Users/anast/OneDrive/Desktop/iFlex/DR%20EU/ldna27998enn.pdf
(MEAEF, 2020)	Ministry of Economic Affairs and Employment of Finland, "Finnish electricity market development and implementation plan", 2020, [Online]. https://ec.europa.eu/energy/sites/default/files/implementing_plan_finland_final_10072020.pdf [Accessed: 06-April-2021]
(MEEUS, 2020)	MEEUS, Leonardo, The evolution of electricity markets in Europe, Cheltenham : Edward Elgar Publishing, 2020[Florence School of Regulation], [Electricity] Retrieved from Cadmus, European University Institute Research Repository, at: https://hdl.handle.net/1814/69266
(Milagro et al, 2008)	Milagro, F., Antolin, P., Kool, P., Rosengren, P., Ahlsén M. (2008). SOAP tunnel through a P2P network of physical devices, Internet of Things Workshop, Sophia Antopolis.

(MIT, 2016)	MIT (2016), The value of Aggregators in Electricity Systems, MIT Center for energy and Environmental Policy Research. Available online: http://energy.mit.edu/publication/the-value-of-aggregators-in-electricity-systems/
(Nordpool)	Flexi order. https://www.nordpoolgroup.com/trading/Day-ahead-trading/Order-types/Flexi-order/
(Nylund,2018)	Jere Nylund, “LOCAL ENERGY MARKETS: OPPORTUNITIES AND CHALLENGES Examiners: Professor Samuli Honkapuro,” Lappeenranta University of Technology, 2018.
(Ohrling, 2019)	Tiina Ohrling. THE EMERGING INDUSTRY OF AGGREGATION Novel business models and empowerment strategies for incentivebased demand response in Finland. Aalto University School of Business. 2019.
(Osterwalder & Pigneur, 2010)	Business Model Framework (Osterwalder & Pigneur, 2010) Osterwalder & Pigneur, 2010). Osterwalder, A., & Pigneur, Y. (2010). Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley & Sons.
(Pahkala et al, 2018)	T. Pahkala, H. Uimonen, and V. Väre, “Flexible and customer-centred electricity system- Final report of the Smart Grid Working Group,” Työ- ja elinkeinoministeriön julkaisuja 39/2018, 2018. [Online]. Available: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161147/TEM_39_2018.pdf?sequence=1&isAllowed=y. [Accessed: 07-April-2021].
(Porter, 1985)	Porter, “The Competitive Advantage: Creating and Sustaining Superior Performance”. New York, Free Press, 1985
(RAE)	RAE http://www.rae.gr/site/file/system/docs/ActionReports/national_2018
(SEDC, 2017)	Explicit Demand Response in Europe Mapping the Markets 2017. https://smarten.eu/wp-content/uploads/2017/04/SEDC-Explicit-Demand-Response-in-Europe-Mapping-the-Markets-2017.pdf
(SEDC, 2015)	Mapping Demand response in Europe Today Smart Energy Demand Coalition (SEDC) (http://www.smarten.eu/wp-content/uploads/2015/09/Mapping-Demand-Response-in-Europe-Today-2015.pdf)
(Tourlis, 2019)	Nikolaos Tourlis, Postgraduate Dissertation An initial study on the participation of demand response in the Greek electricity market. Patras, Greece, July 2019. https://www.apothesis.eap.gr/bitstream/repo/41813/1/103886_TOURLIS_NIKOLAOS.pdf
(Wisegrid, 2017)	“D1.1 WiseGRID Legislation business models and social aspects” technical report, available online at https://cdn.nimbu.io/s/76bdjzc/channelentries/1k3tosl/files/D1.1_WiseGRID_Legislation%20business%20models%20and%20social%20aspects.pdf?e7dezc7
(2018/2002, 2018)	Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 Amending Directive 2012/27/EU on Energy Efficiency (Text with EEA relevance.). OJL, 21 December 2018; pp. 210–230.
(2019/943, 2019)	Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the Internal Market for Electricity (Text with EEA Relevance.). OJL, 14 June 2019; pp. 54–124.
(2019/944, 2019)	Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on Common Rules for the Internal Market for Electricity and Amending Directive 2012/27/EU (Text with EEA Relevance.). OJL, 14 June 2019; pp. 125–199.

(2012/27/EU, 2012)	Directive 2012/27/EU, on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 25 October 2012

9 Appendix I Computed data for Perspective I Consumer-driven flexibility using the e3value model

Annual cash flows (€)

Building Communities

Decision support scenario	
Comfort control tools	-9.300
BEMS HEMS contribution	1.860
Net money flow of Decision support scenario	-7.440
Heating scenario	
Buying heat from District Heating	-3.606
Cost of taking heat from heat pumps	827
Net money flow of Heating scenario	-2.779
Electricity scenario	
Providing electricity to heat pumps	595
Cost of taking electricity from RES	-759
Cost of buying electricity from retailers	-30.541
Net money flow of Electricity scenario	-30.705
Flexibility scenario	
Forecast modelling tools	-5.580
Income from selling flexibility	4.342
Net money flow of Flexibility scenario	-1.238
Total economic performance for Building Communities	-42.162

Aggregator

Buying flexibility	-4.342
Selling flexibility to Balancing	4.736
Total economic performance for Aggregator	395

Balancing

Buying flexibility	-4.736
Selling flexibility	121
Paying flat fee for market access	-1.560
Paying fee for availability	-3

Total economic performance for Balancing	-6.178

Retailer	
Sale of electricity to customers	30.541
Purchase electricity on market	-22.906
Total economic performance for Retailer	7.635

Energy Service Company	
Revenues from forecast modelling tools	5.580
Revenues from asset control tools	9.300
Total economic performance for Energy Service Company	14.880

BEMS HEMS	
Contributions to service integrations	-1.860
Total economic performance for BEMS HEMS	-1.860

DH	
Heat deliveries revenues	3.606
Total economic performance for DH	3.606

Market place	
Selling electricity to retailer	22.906
Flat fee for balancing parties	1.560
Fee for balancing availability	3
Buying flexibility from balancing	-121
Buying electricity from producer	-22.906
Collecting balance revenues	121
Total economic performance for Market place	1.563

DSO	
Flexibility purchased from market	-121
Total economic performance for DSO	-121

TSO	
Supplying electricity to market	22.906
Total economic performance for TSO	22.906
Sum of all external value transactions	664
Sum of all internal value transactions	664

10 Appendix II Computed data for Perspective II Aggregator-driven flexibility using the e3value model

Annual cash flows (€)

Consumers and producers (per user in market segment)

Demand Flexibility scenario	
Flexibility revenues from aggregator	154
Premium for manual control	-8
Net money flow of Demand Flexibility scenario	147
Manual control scenario	
Cost of control tools	-23
Net money flow of Manual control scenario	-23
Electricity purchase scenario	
Cost of market electricity	-2.542
Cost of internal RES electricity	-43
Net money flow of Electricity purchase scenario	-2.584
Producers scenario	
Internally produced energy sold to aggregator	43
Internally produced energy sold to consumers	25
Net money flow of Producers scenario	68
Total economic performance for Consumers	-2.393
Total economic performance for Consumer Producer Market	-598.125

DR and RES Aggregator

Deploying iFlex tools scenario	
License for market interface	-30.000
License for forecasting	-125.000
License for asset control	-62.500
Net money flow of Deploying iFlex tools scenario	-217.500
DR explicit flexibility scenario	
Buying DR explicit flexibility	-38.500
Premium for manual control option	1.875
Net money flow of DR explicit flexibility scenario	-36.625

RES aggregation scenario	
Buying RES from producers	-6.250
Buying RES from external farms	-1.160.000
Net money flow of RES aggregation scenario	-1.166.250
Internal balancing scenario	
Offering flexibility to DAM	76.877
Selling consumer electricity to the energy market	294.000
Selling RES to the energy market	3.160.000
Paying balance settlement fees to TSO	-57.595
Net money flow of Internal balancing scenario	3.473.282
Total economic performance for DR and RES Aggregator	2.052.907

Retailers	
Provide energy scenario	
Revenues from providing market electricity to consumers	635.375
Cost of buying electricity from market	-294.000
LV Transmission costs	-129.500
Net money flow of Provide energy scenario	211.875
Total economic performance for Retailers	211.875

iFlex Service Company	
Activity: Market interface	
Fixed license per aggregator	30.000
Net money flow of Activity: Market interface	30.000
Activity: Forecast	
Licence for forecast per customer	125.000
Net money flow of Activity: Forecast	125.000
Activity: Asset control and monitoring	
License for asset control per customer	62.500
License for manual control per user	5.625
Net money flow of Activity: Asset control and monitoring	68.125
Total economic performance for iFlex Service Company	223.125

RES Generation (per user in market segment)	
Revenues from RES generation per farm	290.000
290.000	
Total economic performance for market segment with 4 farms	1.160.000
TSO	
HV transmission tariffs	17.500
Imbalance settlement	57.595
Total economic performance for TSO	75.095
DSO	
MV transmission revenues	129.500
Total economic performance for DSO	129.500
Energy Market	
Provide energy to retailers	294.000
Purchase energy for consumers	-294.000
Purchase RES energy	-3.160.000
Cost of HV transmission	-17.500
Total economic performance for Energy Market	-3.177.500
Flexibility Market (DAM)	
Purchase flexibility from Energy Service Company	-76.877
Total economic performance for Flexibility Market (DAM)	-76.877
Sum of all external value transactions	0

11 Appendix III Computed data for Perspective III Virtual Energy Communities using the e3value model

Annual cash flows (€)

Virtual Energy Community

Demand Flexibility scenario	
Flexibility revenues from market	2.964
Flexibility revenues reimbursed consumers	-2.783
Charges for flexibility automation	-1.200
Net money flow of Demand Flexibility scenario	-1.019
Virtual Metering scenario	
Cost of data administration	-1.200
Net money flow of Virtual Metering scenario	-1.200
Consumers scenario	
Market energy purchased from retailer	-22.610
Surplus energy purchased from pool	-5.220
Retailer subscription fees	-4.578
Transmission tariffs for market energy	-9.842
Internally produced energy costs	-326
Reimbursement for flexibility	2.783
Net money flow of Consumers scenario	-39.793
Producers scenario	
Internally produced energy revenues	326
Locally produced energy sold to market	1.368
Transmission tariffs for surplus energy	-1.440
Net money flow of Producers scenario	254
Total economic performance for Virtual Energy Community	-41.758

Retailers

Provide energy scenario	
Revenues from market energy to consumers	22.610
Revenues from surplus energy from pool to VEC consumers	5.220
Subscription charges from,consumers	4.578
Purchase energy from market	-19.950
Surplus energy from VEC producers	-1.368

Net money flow of Provide energy scenario	11.090
Provide billing scenario	
Acces to DataHub	-1.200
Net money flow of Provide billing scenario	-1.200
Total economic performance for Retailers	9.890
Energy Service Company	
Explicit Demand scenario	
Selling flexibility to market	5.928
Passing on flexibility revenues to VEC	-2.964
Net money flow of Explicit Demand scenario	2.964
VEC operation administration scenario	
Income from flexibility automation	1.200
Income from data management	1.200
Cost of Data Hub data	-2.400
Net money flow of VEC operation administration scenario	0
Cost of iFlex	-2.400
Total economic performance for Energy Service Company	564
TSO	
HV transmission tariffs	1.330
Total economic performance for TSO	1.330
DSO	
Market transmission revenues	9.842
Pool transmission revenues	1.440
HV transmission costs	-1.330
Total economic performance for DSO	9.952
Wholesale Energy Market	
Provide energy to retailers	19.950

Total economic performance for Wholesale Energy Market	19.950

Flexibility Market	
Purchase flexibility from Energy Service Company	-5.928
Total economic performance for Flexibility Market	-5.928

iFlex Provider	
Selling iFlex to Energy Service Company	2.400
Total economic performance for iFlex Provider	2.400

Agency Host	
Selling data to Energy Service Company	1.200
Selling data to Retailers	2.400
Total economic performance for Agency Host	3.600

Sum of all external value transactions	0
Sum of all internal value transactions	0