BEHAVIOUR OF ENERGY PROSUMERS

ROLE AND IMPACT ON THE FUTURE ENERGY SYSTEM OF THE EUROPEAN UNION

Melisa Vrapi – Men18014
Dr. Athanasios Dagoumas

TABLE OF CONTENTS

ACKNOWLEDGEMENT

I would first like to express my sincere gratitude to my thesis advisor Athanasios Dagoumas, Associate Professor of the Departments of International and European Studies of the School of Economics, Business and International Studies at the University of Piraeus for giving me the opportunity to do this research and for providing his continuous guidance advice effort. He steered me in the right direction whenever he thought I needed it and provided invaluable suggestion and comments throughout the process. It was a great privilege to work and study under his guidance.

My thanks are also delivered to all the lecturers of the Department of International and European Studies and my colleagues, who shared their excitement and passion throughout the lectures and discussions, and without their guidance and support this dissertation would not have been possible.

And finally, I would like to acknowledge, with gratitude, the support and understanding of my family and friends that kept me encouraged in every path.

EXECUTIVE SUMMARY

There is a growing trend that characterizes today's energy market in the EU: prosumption. An increasing number of consumers become actively engaged by self-generating energy from renewable sources and/or undertaking services of storage, demand response. As a result, the emergence of new actors has been challenging the existing energy landscape, leading to a more decentralized energy system with new actors undertaking new roles and old actors adapting to the new reality. This study attempts to offer a presentation of the force that prosumers embody in a more decentralized system. This means that along with benefits that come with prosumption, there are several challenges that need to be managed in an effective way. Especially in the case of the European Union, this article points out that prosumers are the rising stars of the EU market, directly connected with the goal for a more efficient and green energy market. The existing regulations and laws of the European Union and Greece as an example, are presented along with actual paradigms of prosumers and their remuneration method. The article concludes framing the future of prosumption in the EU though examining several observations-recommendations on different levels of policy making regarding energy prosumers in the future energy market.

ACRONYMS AND ABBREVIATIONS

PV	Photovoltaic
EU	European Union
VPP	Virtual power plant
RES	Renewable sources
SME	Small and Medium-Sized Enterprise
AC	Alternating current
DC	Direct current
P2P	Peer-to-peer
NOBEL	Neighborhood Oriented Brokerage Electricity and Monitoring System
TSO	Transmission System Operator
DSO	Distribution System Operator
DSR	Demand Side Response
CHP	Combined Heat and Power
FiTs	Feed-in tariffs
FiPs	Feed-in premiums

LIST OF TABLES

LIST OF FIGURES

LIST OF PICTURES

1. INTRODUCTION

The energy sector has been witnessing a new paradigm of bidirectional interaction with its stakeholders that leads to a new energy landscape. To be more specific, the role and the behavior of consumers have been evolving towards a more active approach, the one of "prosumers". Several factors are of vital importance for facilitating this shift: the fact that energy consumers want to cover their energy needs in a more efficient way, meaning that in the energy sector the focus has been put on the demand, not on supply.[1] Secondly the rise of prosumers has been possible due to the fall of the cost of renewable energy technologies e.g. solar panels.[2]

Until today, energy consumers have been following a passive stance, meaning that they are just the receivers of goods and services from the grid, but they do not contribute in any way to it.

With the new trend, consumers have started to produce and even store energy. Consumers have the option of generating on small scale their own power, for example at homes and businesses. Additionally, the on-site storage of energy is now an actual option for consumers. This way they can contribute to the energy grid and become a new type of participants in the energy sector. Consumers of energy are encouraged not only to reduce energy consumption, but also generate and use renewable energy and return the excess the grid.

This new type of behavior states a new challenge for the traditional energy sector paradigms, all of which are based on the division between "consumers" and "producers". Consequently, the boundaries between those two categories are not that distinct anymore, creating new challenges for the energy landscape. In this sense, the existing legal and political framework needs to adapt to the new energy landscape.

The main objective of this thesis is the presentation of the transition towards an energy market, with its main focus on energy prosumers. With this thesis we will show, through examination of energy prosumers' behavior and characteristics, how the energy system regarding the structure of the market, the relations between different stakeholders, and the regulation framework of the European Union, is being shaped and changed by prosumption. The latter will be unfolded in four parts. In the first part we will touch upon the term of "energy prosumers" through an insight into international literature. The goal is to present the most important aspects of this term and the typology of prosumers. Later, we will focus on the role of prosumers in a decentralized energy sector. What are challenges and opportunities that arise for the energy sector and prosumers? This question will be answered in the second part of the first chapter. The transition towards a more decentralized energy system with the existing stakeholders and actors being challenged by the emergence of prosumers is the focus of the three chapters that follow.

The European perspective and its role of encouraging the growth of the potential of the new energy actor are of vital importance. As a result, in the second part, the legal and financial

[1] (Jacobs, 2017)
[2] (European Parliament Think Tank, 2016)

framework is put under consideration, along with the different ways of payment of prosumers for their contribution to the grid.

The third part includes three different examples of small-scale producers in Greece using PV system. With these examples and the comparative method, we gain a greater insight into the way that prosumers can be remunerated for their electricity production.

Finally, the future perspective of presumption is presented. This part's focus is the presentation of several essential steps that could be considered by the European Union in order to support this new trend in the energy sector.

The Thesis concludes with several remarks upon the matter of analysis.

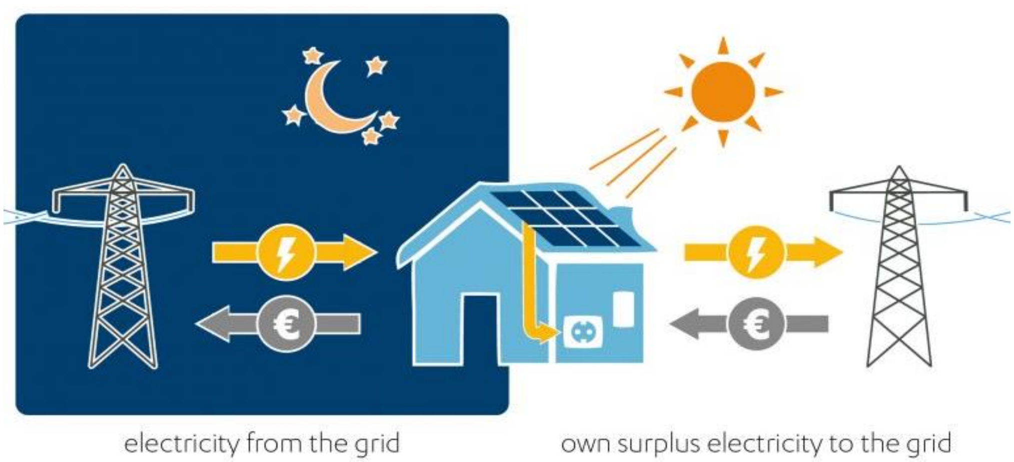
1.1. THE TERM "PROSUMERS" (THEORETICAL BACKGROUND)

The changing environment of the energy system with the introduction of new energy actors, prosumers, calls for a deeper understanding through examination of existing literature of what prosumers are. The term "prosumer" is relatively new in usage. It describes the new hybrid energy consumers-generators, which are energy prosumers.

Alvin Toffler presented the idea of prosumers, in general, in his book "Third Wave". He argues that the traditional consumers will gradually be replaced by prosumers, which constitute a new group of actors that will engage in consumption as well as in production. This means that the line between production and consumption will become more blurred as this transition process will be taking place. Since then the definition and the usage have broadened, to eventually include the energy sector as well.

When referring to the energy sector, prosumers are consumers that produce, sell, trade, and store energy.[3] These are the consumers that have started to embrace a more dynamic role in the energy sector. In other words, these are electricity producers, and consumers, that own a micro RES generating facility, are connected to the grid, and have the right to produce and consume self-generated electricity and deliver the excess to the grid.[4]

In addition to that general concept, the term can be approached from different "angles". One social approach puts focus on energy prosumers in the form of energy communities or virtual power plants (VPPs). Another approach gives attention to the technologies that energy prosumers have available (such as photovoltaics, wind, geothermal energy etc.) to become engaged participants in the energy market.



Picture 1: Consumers as byers and producers of electricity[5]

[3] (Kotilainen & Saari, 2018)
[4] (Haziri, n.d.)
[5] (BEUC, 2016)

The approaches are multiple, but at the center of all are two key features: autonomy and participation in the market. With more active engagement in the processes that form the energy market, prosumers have a more decisive role in their consumption decisions, by controlling the amount of energy in need and/or by becoming self-suppliers. Prosumers' activities expand towards the energy market, and include energy storage, demand response, disposal of excessive amount of produced energy.

The above two characteristics are common for the different types of energy prosumers. The "effect" of each of the above categories of prosumers on the energy market is different, mostly because of the "size" of prosumption. To be more specific, prosumers are categorized as follows:

- Residential prosumers: consumers that engage in microgeneration in households. The most popular means they use are solar PV panels.
- Commercial prosumers: refers to business establishments that produce energy as a way of cost reduction.
- Industrial prosumers: industrial operators that produce energy to cover to a different extent the onsite needs and sell the remaining energy to the grid.[6]

All in all, prosumer is an "umbrella term". This means that the term can be used for different actors, from households to energy communities, from small to large scale self-production.[7]

But what motivates the transition from traditional consumption to the more modern approach of energy prosumption? The first reason is the possibility of autonomy that presumption offers. The extent of autonomy can differ, reaching even the point of entirely self-supply. Through self-production and consumption of the produced energy, the energy actors can exert greater control over their consumption patterns, decide upon the energy source for energy production, and not just follow a reactive approach towards the energy market.

Another important incentive is the economical one: the price of energy. Self-generation from RES reduces the amount of energy purchased from the energy grid, and in case of surplus, allows even profits. Besides giving back to the grid the excess of energy production, consumers have the option to provide other services to the grid, such as storage, and gain profit from such activities. Additionally, generation response programs give economic incentives for participation.

The introduction of prosumption in the energy sector has been driven by several factors. First, the concept of prosumer has been inspirited by the increase and optimization of microgeneration technologies using renewable energy sources (wind, sun, biomass etc.), which have become more affordable and accessible even for small-scale consumers. Solar power has emerged as one of the most affordable sources, with its cost to be reducing over the next decade.[8]

---

[6] (United Nations Industrial Development Organisation, n.d.)
[7] (Leal-Arcas, Lesniewska, & Proedrou, 2018)
[8] (IRENA, 2012)

Other technological aspects include advances in information and communication technologies (smart metering, sensors etc.) that provide the necessary tools for consumers to manage their energy consumption and costs[9] and become more aware and informed over energy related issues.

Climate change is another factor that should be examined. As the European Union tries to find solutions to tackle with climate change, the gradual phasing-out of traditional energy sources (such as fossil fuels) that are one of the reasons for climate change is considered prerequisite for a cleaner and more sustainable energy future. For this purpose, renewable energy deployment comes forward as a straightforward solution for reducing CO_2 emissions.[10] The combination of prosumption and renewable energy creates the possibility for a greater exploitation of RES potential in the energy sector of the EU starting from small scale production. Following this direction, the European Union has as a priority the creation of energy citizens within the energy system by promoting self-generation from small to large scale.

A common issue that is introduced in the international literature is that the development of these new energy actors in the energy landscape creates new challenges and possibilities for the energy system and prosumers. What exactly would be the role of consumers-producers in the future energy market and how the emergence of energy prosumers will affect the energy system? These issues will be discussed in detail in the two chapter that follow.

[9] (Da Silva, Karnouskos, & Ilic, 2012)
[10] (Carbon Market Watch, 2019)

1.2. ROLE OF PROSUMERS: CHALLENGES AND OPPORTUNITIES

Energy prosumers have a new role in the energy market, being not only consumers but also participating in production activities. The creation of the new energy actor in the energy market creates new challenges to the existing complex energy landscape.

As we have mentioned above, the excess of energy produced by prosumers can be returned to the energy grid, contributing to the stabilization of the energy system. Particularly, by providing low cost energy during the peak demand periods, peak loads can be managed in a more effective way, avoiding unexpected destabilization of the energy market. Furthermore, energy surplus can be stored or transmitted further through the grid. Energy market needs of last resort solutions and back up capacity, so prosumption is a great way of ensuring the existence of sufficient amount of energy.

The new type of energy actors still needs to rely on the existing "structure" of the energy market. For now, it is possible for an energy consumer and producer to cover with its own production most of its energy needs (depending of course on energy profile), still will need access to conventional forms of energy, which are provided by the grid. Besides, in order to sell the excess of energy, prosumers need to use the existing infrastructure, again provided by the grid. As a result, the relation between energy prosumers and energy companies becomes more symbiotic, still necessary for the successful operation of energy system and market.

In addition to that, prosumers have the opportunity for an even more deciding role, by becoming "negotiators" and stakeholders in the energy market, by promoting their concerns over issues related for example to climate change, or societal issues. They do not just observe the changes, but they are able to contribute to the transformation of the energy landscape. Especially in the case of climate change, the role of prosumers has been recognized as vital for the mitigation of climate change.[11] They use and produce energy in smarter and more efficient way. The sources they use for energy production are the renewables (solar PV panels, wind energy etc.). Furthermore, they control the consumption of energy through monitoring systems. New digital technologies create the opportunity for better adjustments of their consumption to their needs and for better energy prices in the market.

In the context of the European Union, prosumption is related to energy sustainability that the EU aims at. To be more specific, energy sustainability can be achieved by decarbonizing the economy, democratizing the access to energy, digitalization, and diversification of supply.[12] Prosumption facilitates decarbonization of the economy, by producing energy from renewable sources, that don't produce environmental pollution as the traditional fossil fuels. Thus, the share of renewable sources in the energy mix is increasing, leading to a more diversified energy supply.

[11] (Kotilainen & Saari, 2018)

[12] (Leal-Arcas, Lesniewska, & Proedrou, 2018)

Prosumption is strongly related to energy democracy. It is a concept based on the idea of giving more space for public participation in the energy sector. The citizens though producing, consuming and storing energy are becoming empowered and break the monopoly of energy companies. The energy system is being transformed and redistributed on a more local level, where, what is produced is consumed. The use of renewable sources is one of the pillars of this transition. The European Union tries to support this change and recognizes the role of citizens as active market participants. In fact, for the first time, in the Renewable Energy Directive and the Electricity Directive, the European Union defines the “renewable energy communities” and “citizens energy communities” and provides framework that facilitates the development of these communities as part of its energy governance.[13] The European Union clearly gives priority to citizens, SMEs and local authorities, not the profit-oriented companies and large industries, and wants to ensure that they have equal treatment and access to the energy market.

The development of energy prosumers has impact on the existing energy landscape, and is considered as one of the factors, alongside the expansion of energy from renewable sources and the technological- digital transformation, that leads to more decentralized governance in the energy sector. The phenomenon of decentralization in the energy market will be analyzed in the following chapter.

[13] (Lowitzsch, Hoicka, & van Tulder, 2020)

1.3. DECENTRALISATION OF ENERGY SECTOR

The energy market is evolving towards a more decentralized scheme. Decentralization is not a new phenomenon for the energy sector. Before the introduction and the development of centralized sector, energy was produced on local level. With the introduction of the first power plant in 1882, it was possible to supply with electricity locations close to the production site. At the same time, local storage was used in order to cover energy demand in distanced areas.[14] Since the 19th century, with the development of larger power plants, the introduction of AC grids (that allow transport on longer distances) and the creation of economies of scale, production and supply of energy on large scale became possible. This transition was driven by desire for improved efficiency in electricity production and increased reliability of supply.[15]

The present scheme is based on large scale energy generation in centralized facilities. These facilities include fossil-fuel power plants, nuclear power plants, large solar plants or hydro power plants and are usually located far from the end-users.[16] End-users do not participate actively in the energy market; they are just the receivers of the final product. Energy is distributed through a network of high voltage power lines that reaches points that are far from the generation unit. This scheme suffers from certain problems that regard power generation and the grid, such as the loss of heat rejected during the production process, energy loss during transmission, and need for high concentration of capital for investments.

Decentralization is the transition from a highly centralized energy system towards a more distributed generation, energy storage and with an active participation of consumers in the energy system.[17] That means that the local level is getting increased attention. In a decentralized energy system, energy is generated by small-scale units, that can be connected to each other (distributed generation). Energy is delivered on local level, which means that production is sited near the locations where the electricity is used. The existence of network connections between different local generation units provides additional advantages, e.g. sharing of surplus. In this case, small-scale units generating energy can be households, businesses, and energy communities. Consequently, consumers can play a more active role in the energy system.

The transition described above is depicted on Figure 1 that follows. The development of small-scale generation is becoming a more feasible option, due to the fact that the set-up cost of certain technologies enabling small scale production has been declining and becomes competitive towards the "economies" of scale.

[14] (Belmans, D'haeseleer, Driesen, Haeseldonckx, & Pepermans, 2003)
[15] (Kelly, 2003)
[16] (United States Environmental Protection Agency, n.d.)
[17] (Directorate General for Internal Policies: Policy Department A: Economic and Scientific Policy: Industry, Research and Energy, 2010)

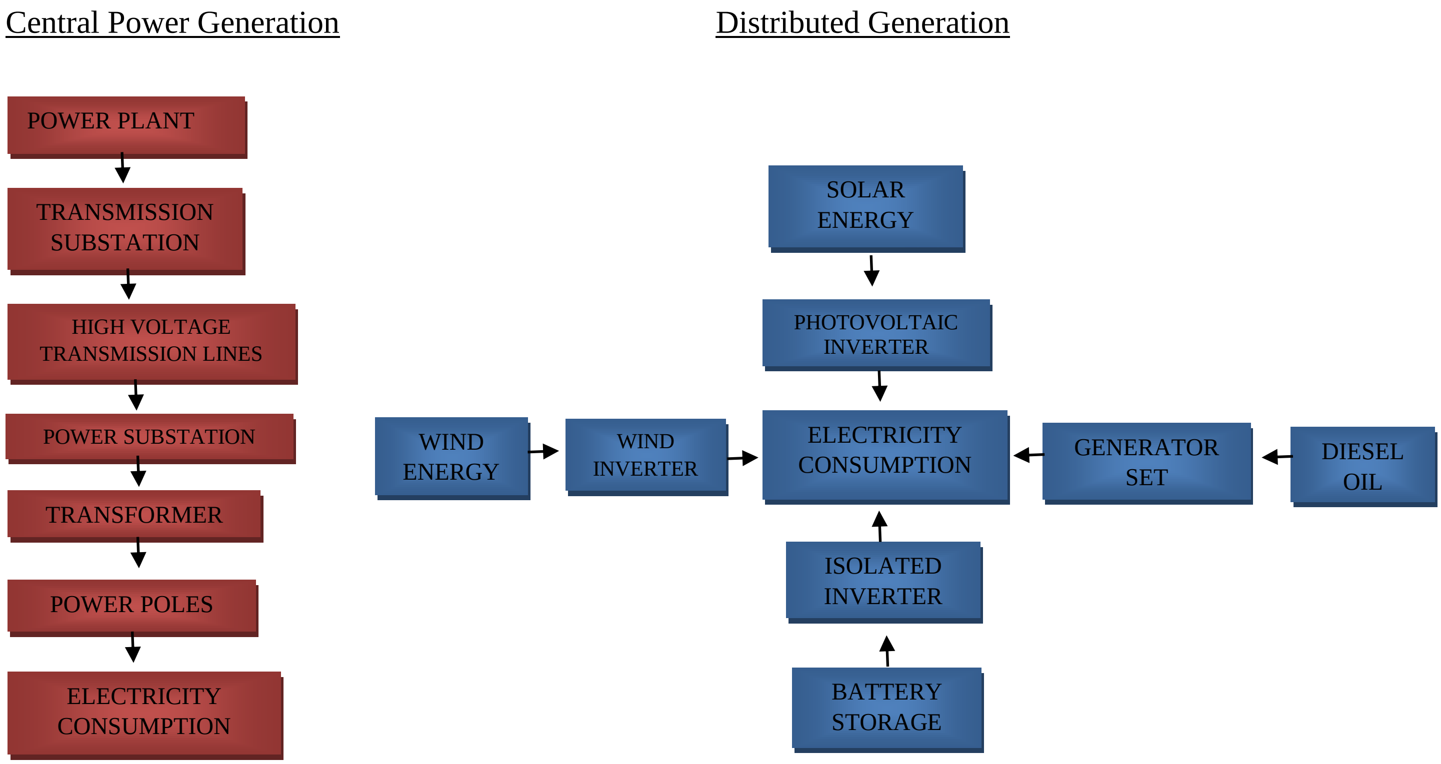


Figure 1.3: Types of Power Generation Structure: Central and Distributed[18]

Except from the structure of the energy system, another aspect of vital importance for the decentralization of the energy system is the energy source. The rise of renewable sources (RES) gives the means for consumers to become producers of energy on local level. In this case, the so called distributed generation concerns energy sources such as photovoltaic panels, small wind turbines, biomass generators, and even the combination of those sources into hybrid renewable energy systems (that include two or more energy sources in a supplementary way).[19] The most common source is solar energy generated from photovoltaic (PV) panels, especially due to the declining price of silicon photovoltaics.

The decentralization of the energy system is connected also to the distribution of energy storage. The growth of renewable energy, that is variable as source of energy, and the distributed energy generation increases the need for advanced and distributed energy storage. Today, several energy technologies for energy storage are available. With these technologies it is possible for the energy producer to retain an amount of energy and use it for own energy needs in a future time. Especially in the case of renewable sources, such as solar or wind power that are intermittent, generation of energy varies over time, energy storage is essential for the use of the full potential that RES provide.

[18] (Jaiswal, Kumar, & Samuel, 2015)
[19] (González, Riba, & Rius, 2015)

Besides dealing with the intermittency of RES, energy storage can be used as a response tool for rapid fluctuations in energy demand. Energy storage can reduce the need for back-up power plants. The production of energy from renewable sources is more unpredictable and less stable than that of the conventional sources, so the shortfall between energy demand and supply from RES is covered by back-up energy produced from fossil fuels mostly, that are responsible for CO_2 emissions. Storing energy produced from environmentally friendly sources enables the absorption of "surplus renewable energy output" and therefore "reducing the reliance on fossil fuel-based backup".[20] In addition to that, it makes the grid more effective[21], since it increases its flexibility and stability. Another important result of distributed energy storage is the price reduction on daily basis. Storage of energy that is distributed helps in reducing peaks in energy demand during the day[22], balancing supply and demand.

A distributed energy storage system will give greater attention to small scale storage systems used by end-users. The most widely in usage small–scale storage technology is battery storage (especially lithium-ion batteries), a technology that is constantly developing. Batteries represent an electro-chemical storage method that has the widest application, the best cost-benefit ratio.[23]

Distributed generation combined with local energy storage is often termed "distributed resources".[24]

Finally, consumers become a more active part of the energy system through demand response programs. These are "consumer-centered programs aiming at improving system efficiency and achieving the best economic/operational/technical fit between supply and demand by influencing the demand side".[25] Such programs include incentives for consumers to alter consumption patterns, considering time and level of consumption. For this purpose, several tools can be used such as monitoring programs that provide consumption information, remote control, or the dynamic rates of pricing which gives an economic incentive for consumers. For example, there are some activities that can be performed on different times during the day (e.g. using dish washers or washing machines), in order to balance demand and supply of energy.[26]

Demand response program are applicable in both wholesale and retail market. In the case of retail market, utilities can either charge higher prices at peak times (dynamic rates of pricing) or pay customers for reducing consumption at certain time during the day. On wholesale level, customers participate in demand response programs that the administrator offers, for example the on-call reduction of energy demand. In this case, consumers are participants in both demand and supply side of the energy system, growing into prosumers.[27]

---

[20] (Kelly, 2003)
[21] (Laporte, 2019)
[22] (Energy Storage World Foum, n.d.)
[23] (InnoEnergy, n.d.)
[24] (Kelly, 2003)
[25] (Parag, 2015)
[26] (Parag, 2015)
[27] (Jacobs, 2017)

1.4. ENERGY SYSTEM IMPACTS

The surge in technologies empowers consumers and gives them the opportunity to re-evaluate their traditional role as agents in the energy system. This transition is further supported by the favorable regulatory framework, as presented in the 2nd chapter. The changing regulations aim at increasing the number of prosumers in the EU in the upcoming decades and facilitate the integration of the new actors into the grid. As a result, the traditional market design is questioned and is likely to undergo changes that will comply with the new regulations and laws, leading to a new structure, roles, and relations between the participating agents. Future market will include a higher degree of complexity, since it will encompass wider variety of actors, services, roles.

In this section three potential models of the future structure of the market system will be closely examined. A common feature of those models is that they are designed to suit the requirements of a decentralized market system, elevating the importance of local markets.[28]

Prosumers Market Models

The three models of market design that are under consideration are:

<u>1. Peer-to-peer models</u>

Peer-to-peer (P2P) energy trading model is based on trading energy among prosumers and consumers in energy communities. The actors involved in the system are fewer than in the traditional model since the community members act as producers and suppliers. Energy is traded on local level. In the first place the excess of energy produced by prosumers is sold to other neighboring consumers, and later, if possible, is stored in batteries. In the traditional model, the excess of energy is transported to the grid, and between sellers and buyers, electricity retailers play the role of middle man. In P2P model prosumers consume the energy they produce and sell the excess to other members of the energy community. This way prosumers gain profit from the additional margin on their sale, since there is no middle man involved. At the same time, consumers can choose the source of electricity they want, gaining access to energy from renewable sources at better prices.[29] Additionally, the transmission loses and costs are reduced.[30]

Specifically, the P2P model is composed of prosumers, each one of them comprised loads and PV systems. The ability of energy storage with the form of batteries is not compulsory in this model. The photovoltaics system of each prosumer is connected to the load and AC system

[28] (Parag & Sovacool, 2016)
[29] (Sia partners, 2018)
[30] (Chao, Chaudhari, Gooi, & Paudel, 2018)

through a DC/AC converter (PV inverter). In case the prosumer has energy storage system, for the connection to the system can be used a DC coupled or an AC coupled topology: battery and PV system are connected at the DC or AC side of the PV inverter respectively.

On the above figure, the different possibilities of prosumers' connections are depicted. Prosumer 1 and 2 have batteries, while Prosumer 3 is directly connected to the load and the AC system.[31]

Each prosumer has smart meter technology installed, that tracks energy generation, consumption and transaction with other consumers or the grid. The data is transmitted to local workstations. All the communication is done through the smart meters.

In this model, another actor involved in the energy trading system will be a P2P Market System Operator that assists in energy trading.

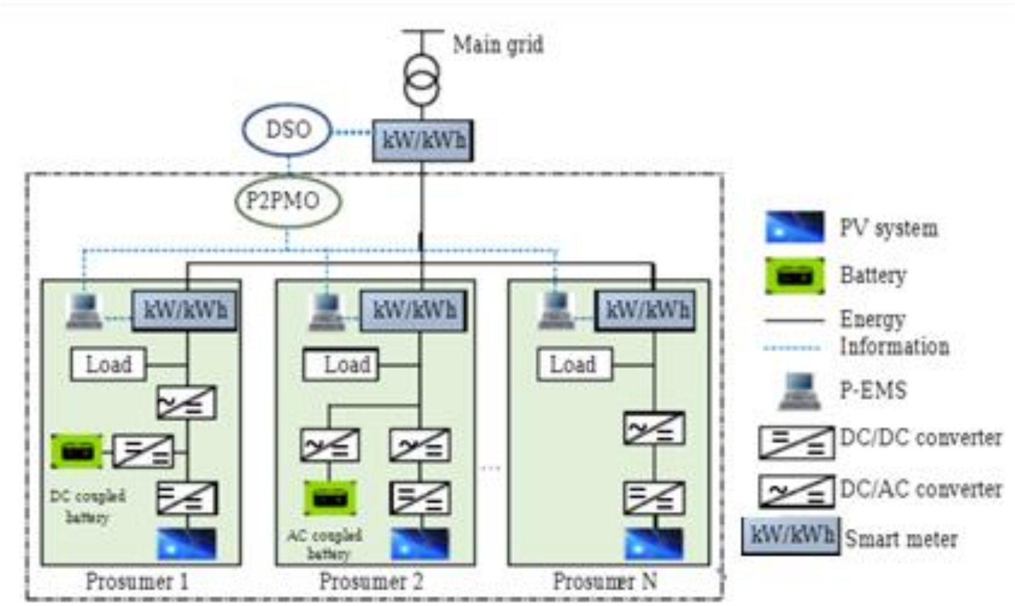


Figure 1.4: Peer-to-peer trading: possibilities of grid structure[32]

2. Prosumer-to-grid models

Another potential market structure is the one with connection between prosumers and the grid. Prosumers can be "organized" around a microgrid that is connected to the main grid or can operate separately.

To be more specific, if there is connection between micro grid and main grid, excess of produced energy is sold to the main grid. On the other hand, in case of autonomous micro grid,

[31] (Chao, Chaudhari, Gooi, & Paudel, 2018)
[32] (Chao, Chaudhari, Gooi, & Paudel, 2018)

optimization is necessary in order to balance local energy production and the ability for energy storage.

There are multiple expressions of this general model. One of these is the involvement of a brokerage system.

Consumers can communicate, through a brokerage agent, information regarding energy needs, to large- and small-scale producers. At the same time, by sharing their information on energy production, consumption and excess, prosumers help the system to track and adapt to energy needs of the network in real time, in order to meet the energy demand with energy production. The model is based on cooperative approach between different actors and entities increasing this way the energy efficiency. The excess of produced energy is monitored in order to be sold and used in other parts of the network (demand side). Essential aspect of this model is the use of energy monitoring tools. It is important for prosumers to have insight into their own consumption, energy wasting in near real time basis.[33]

Example of such a model is the Neighborhood Oriented Brokerage Electricity and Monitoring System (NOBEL), a project initiated by the European Union.[34]

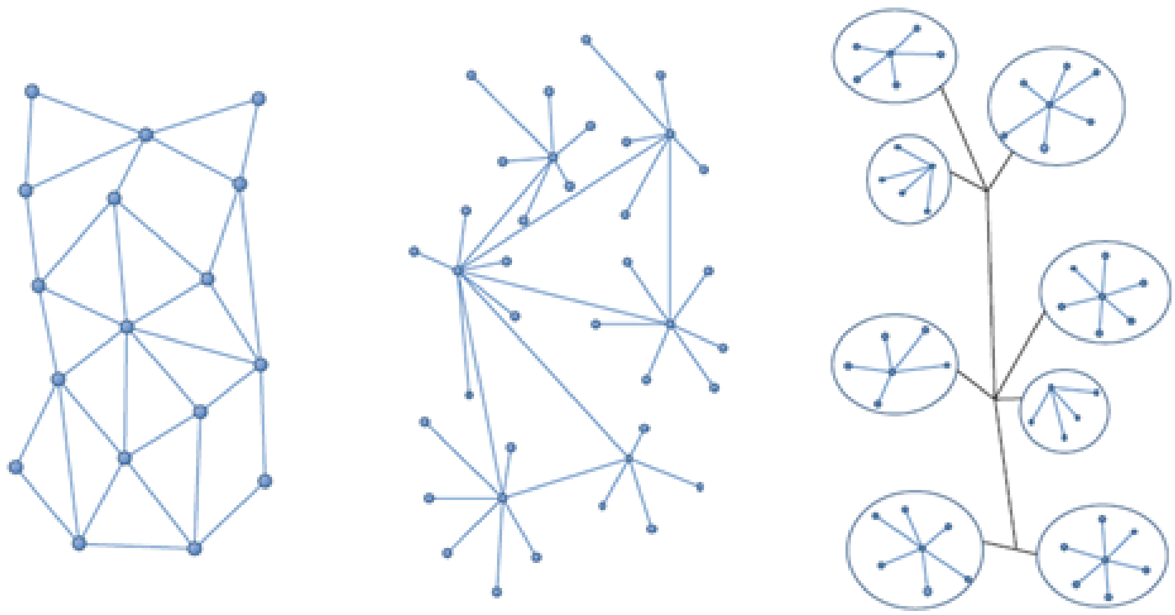
Another possibility is the introduction of market rules that financially encourage consumers to adapt their consumption or production schemes so that production and consumption are in balance.

3. Organized prosumer groups

The last potential scheme for energy market organization, which will be presented in the section that follows, is the market organized around communities of prosumers. In the first place, communities manage their own energy needs, balancing energy demand and supply. The structure of community is to serve the interests of its members. All members of energy communities are strongly involved in efficient production and use of energy.[35] Additionally, prosumers organized in energy communities can gain revenue through selling the excess energy they produce as community to the grid. This way they act as partners to the grid.

The above typologies of prosumers energy market organization are depicted on the picture above. Prosumers are depicted with dot, while the lines are the transaction relation.

[33] (Dimeas, Hatziargyriou, Tomtsi, & Weidlich, 2011)
[34] (Parag & Sovacool, 2016)
[35] (Guia & MacGill, 2017)



Picture 1.4: Typology of prosumers market organization[36]

The first one presents the model of peer-to-peer design, where all "transactions" are interconnected among individual prosumers.

The second diagram is a representation of structuring the market based on connection between prosumers and the grid via microgrids.

Lastly, prosumers can organize themselves in energy communities (circles) and interact with the grid.

[36] (Parag & Sovacool, 2016)

1.5. OLD AND NEW ACTORS IN THE EUROPEAN UNION

The energy market of the European Union, being under transition, is resulting in new engagement patterns of actors participating in it. The emergence of new actors, in particular prosumers, challenges and shapes the energy landscape. The existing, "**old actors**" will need to adapt to the changing environment.

EU regulation on the establishment of a fully liberalized energy market, has created separate roles for Transmission System Operators and Distribution System Operators.

Transmission System Operators (TSOs) are designated to secure system stability. Their responsibility is to control the operation of the transmission grid.[37] Distribution System Operators (DSOs) manage the network, where energy is transmitted from high-voltage transmission system to the distribution sites and then to end-consumer.

An active engagement of the side of demand in the energy market, either as prosumers or with demand side response (DSR), revises the role and the way TSOs and DSOs interact. First of all, both operators shall encourage and facilitate the dynamic participation of customers in all markets (energy, services etc., and at the same time maximize the profit for participating consumers. The amount of resources, especially renewable sources, available to the distribution system should be increased.[38] What is essential for the above transition is that the role of different stakeholders and other entities should be regulated.

The Paper "Energy Regulation: A Bridge to 2025: Recommendation of the Agency on the regulatory response to the future challenges emerging from developments in the internal energy market" outlines that importance. To be more specific, Distribution System Operators is the actor that is being mostly challenged by the increase of RES and small-scale generation. The new role that DSOs are called to play is that of the facilitator: making the penetration and connection to existing distribution system of smart grid and smart meter technologies easier and at lower cost. In parallel, developing this new aspect of their activities, DSOs shall at the same time ensure the modernization of the existing system, its security, increase resilience and management of threats that are accompanied by the increased digitalization, for example cyber threats and protection of consumers data.

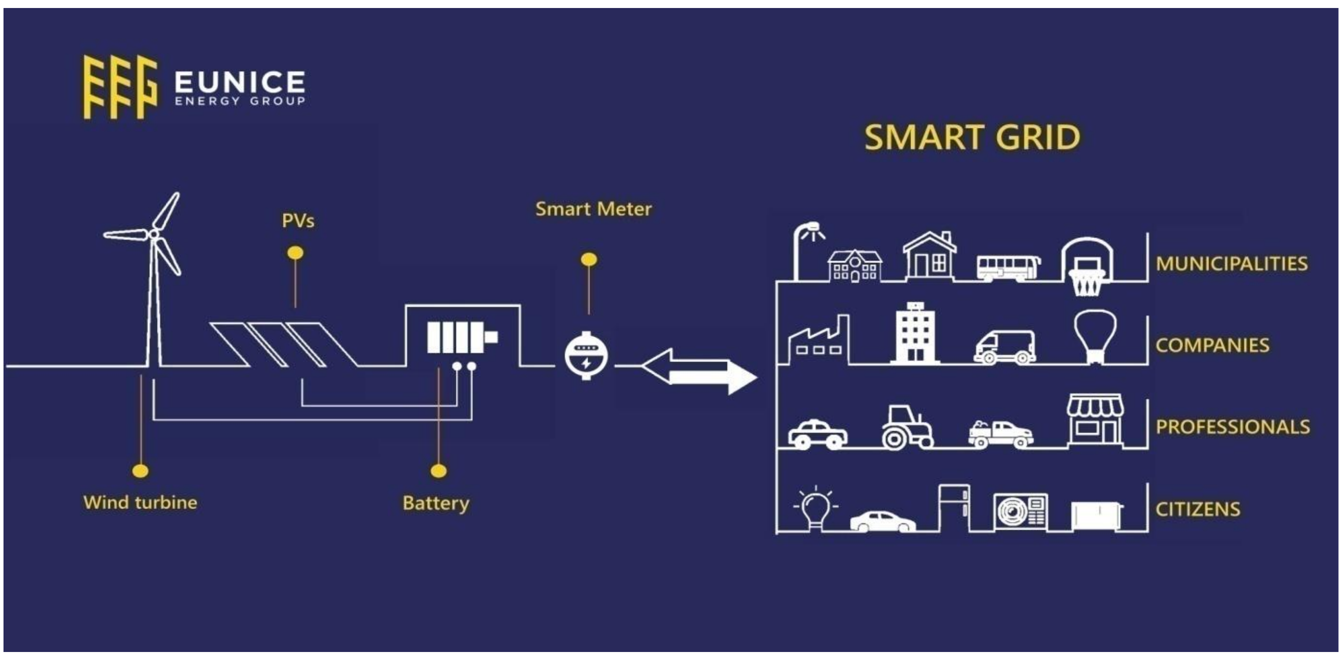
Better coordination and operational arrangements between TSOs and DSOs are of vital importance. As stated in objective 68, "Cooperation between the DSOs and the TSO must be effective as the requirement for active network management by DSOs increases as a result of greater distributed generation and DSR." Deeper cooperation means for example greater exchange of data (forecasts of demand, network conditions etc.)[39] between the two operators.[40]

[37] (Koch, 2015)
[38] (ENTSOE, n.d.)
[39] (ENTSOE, n.d.)
[40] (Agency for the Cooperation of Energy Regulators, 2014)

TSOs will need to undertake a more active role and to continue to balance, control and restore the energy system, as decentralized energy structure is being developed, with the changing nature of electricity production.

The new energy landscape is linked with the appearance of **new energy actors**, the *prosumers*. Individuals, households, businesses become active part of the energy system and energy trade through self-generation of electricity from renewable sources, energy storage and demand response. Consumers are becoming the center of the energy system, taking the responsibility for the long scale transition towards a more flexible and green energy system and economy. This way they become "energy citizens", promote the system's flexibility and efficiency. They provide additional sources of energy that help in stabilization of energy supply, especially via storage.

Energy prosumerism can be either individual, as presented above, or collective. Most notable example of collective prosumerism is "*energy communities*". Energy communities are legal entities that are formed from consumers, energy companies, local authorities, small and medium scale businesses, and have the ability to function collectively in the energy market, by producing, consuming and sharing energy from renewable sources in local, regional level. Energy communities are considered as part and driving force of the decentralization of the energy system and contribute to social and economic progress not only on regional level but also broader to the rest of the community.[41]



Picture 1.5.1: Energy communities[42]

[41] (Eunice Energy Group, n.d.)
[42] (Eunice Energy Group, n.d.)

The legal framework of the European Union has recognized the role of the energy communities. The "Clean Energy for all" Package is the legal framework that sets the basis for including energy communities in the energy system. To be more specific, the revised Renewable Energy Directive 2018/2001[43] and the revised Internal Electricity Market Directive 2019/944 mention the role and responsibilities of renewable and citizens energy communities. Energy communities have as priority affordable energy for their members-stakeholders rather than profit making, which characterizes traditional energy companies. It is acknowledged that the European Union should not only recognize these entities but also should protect and ensure fair access to the energy sector, based on market principles and without distorting competition.[44]

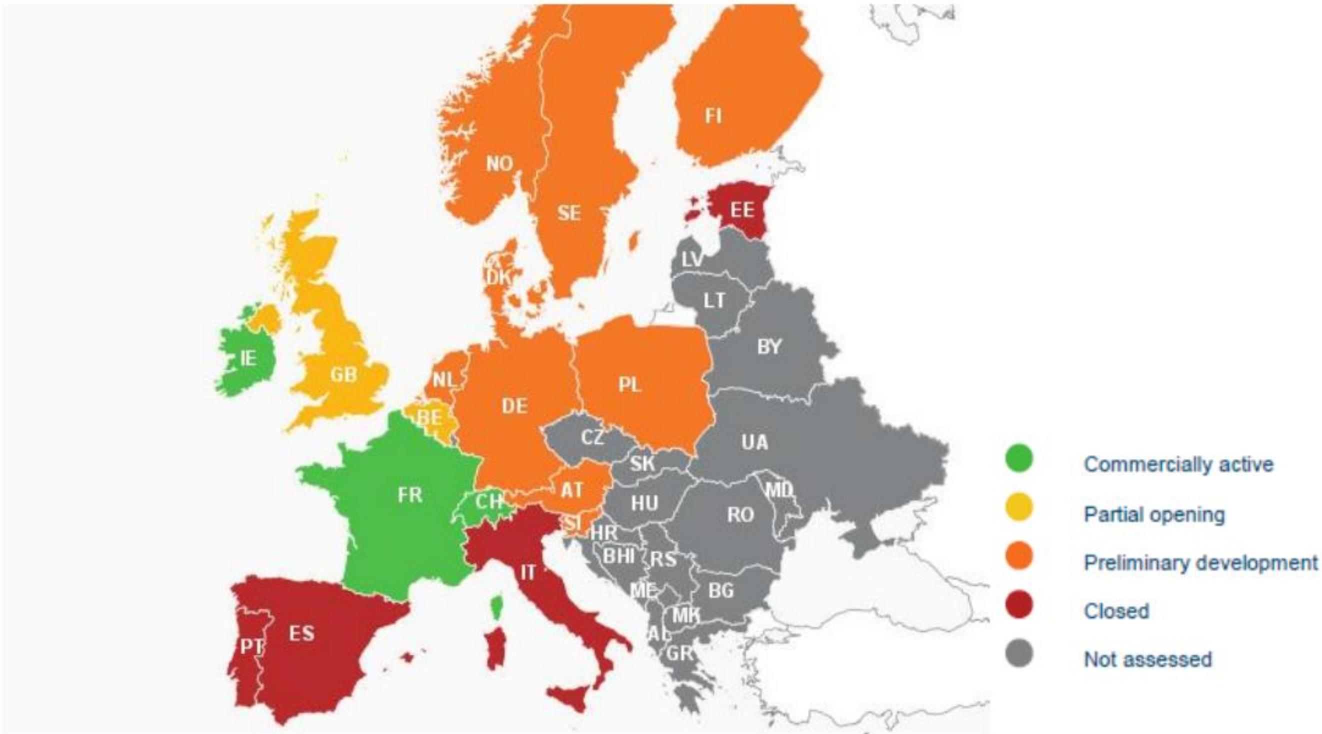
Because of the fact that consumers can engage in energy trading in the energy system, there is another important actor that should be considered too. Prosumers can either trade electricity directly with the energy utilities or with energy aggregators. Energy aggregator is a new type of energy service provider, which forms an agreement with a group of consumers in order to optimize their operation. They can increase or decrease energy consumption of a group of consumers in accordance with energy demand on the grid, so that the consumers are favored by better energy prices. This is achieved through real time tracking of consumption and transmission system operators' requirements.[45] Additionally, aggregators can sell the excess of energy produced by consumers to the grid, on their behalf. Independent aggregators should cooperate not only with industrial and commercial actors, but with residential actors too. Communication and tracking interface for households and businesses is expanding rapidly, providing opportunities for aggregation services.[46]

The European Union, within the "Clean Energy for All" Package expresses its intention to ease the entry and activity of energy aggregators in the energy system. This is achieved by making entering of independent aggregators to the market possible without the need for energy suppliers' consent.

The access that energy aggregators varies among member states of the European Union, as depicted on the above map, with some being under development and even closed for this type of service providers.

---

[43] (DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources , 2018)
[44] (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. , 2019)
[45] (What role does the aggregator paly in balancing the grid?, 2017)
[46] (BUREAU EUROPÉEN DES UNIONS DE CONSOMMATEURS AISBL , 2018)



Picture 1.5.2: Aggregators' access to markets[47]

The right of consumers, including prosumers, to engage and sign separate contracts with energy supplier and aggregator should be protected, in order to fully support the activation of energy citizens in the energy market.

The concept of "energy citizens" attracts finest attention, becoming a game changer in the future structure of the energy system and the relations between different stakeholders. The emergence and the blooming of prosumers is being conducted along with the creation of an environment of laws and regulations with the purpose of defining prosumption and the promotion of an incentive strategy. Consequently, there is a growing need for an in-depth look at the regulatory framework of the European Union surrounding this concept. This is the main focus of the section that follows. Additionally, the example of Greece and the country's law regarding self-consumption will be presented.

[47] (BUREAU EUROPÉEN DES UNIONS DE CONSOMMATEURS AISBL , 2018)

2. EUROPEAN POLICY

2.1. EUROPEAN POLICY: CREATION OF ENERGY CITIZENS

Energy systems on global scale are under transition, which is driven and affected by several co-existing factors. First, the global demand for energy follows and upward trend. In order to avoid energy shortages additional sources of energy need to be used. Besides the increased energy demand, another important factor is climate change and the need for decarbonizing the energy system. The answer for the above challenges is the renewable sources.

With the development of solar, wind energy, smart grid technologies traditional energy consumers also become producers. Self-consumption is among RES policies. This way, the traditional paradigm is being challenged and redesigned towards a more flexible energy ecosystem.

Regarding the European Union, the growth of renewable sources and prosumption reflects the EU policy of combating climate change and achieving renewable energy targets.

The European Union has adopted several directive, protocols and international agreements aiming at adopting and making the transformation of the energy system smoother. The Renewable Energy Directive (2009/28/EC) sets the direction towards promotion energy production from renewable sources. According to the 2009 Directive, 20% of total energy needs of the EU should be covered by energy from renewable sources by 2020.

The revised Renewable Energy Directive 2018/2001/EU, part of the “Clean energy for all Europeans package”, sees the European Union as the leader globally in renewable energy. The new binding target for the EU, in order to meet the commitments agreed under the Paris Agreement, is 32% of total energy needs to be met from renewables, by 2030, with the possibility of a revision, by 2023.[48] In addition, the EU commits to decrease the CO_2 emissions by 40 by 2030 as part of the plan that EU has in order to combat climate change.

Attention towards the side of consumers is given in the “Clean Energy for all Europeans package”. The winter package, as it is often called, acknowledges more rights in favor of prosumers in order to facilitate energy production and storage, and sale of energy.[49] The European Union aims at achieving the renewable energy targets partly with the active participation of citizens and communities. Consumers’ participation is considered as prerequisite in order to transform the existing energy system in a cost-effective way.[50] The citizen is at the heart of this transition. With consumers undertaking services and activities of producers, investing in renewable energy technologies, the energy transition is accelerated and facilitated.

[48] (European Commission, 2014)
[49] (European Commission, 2019)
[50] (European Commission, 2018)

In a research conducted by CE Delft, the estimated number of households that will be involved in renewable energy production, storage and demand response, by 2050, will be around 187 million (83% of total households in the European Union).[51]

That is why the European Union wants to create the conditions that will enable the flourishing of prosumption within its member states, where consumers will not only be producers but will become "energy citizens". As its main priorities, the European Union has recognized several suggestions on policy and regulatory framework. The goal is to ensure not only the conditions that encourage consumers to be a part of the energy system, but also that the incentives for active consumers are strong and widespread. Among the priorities are:

Retail market:

- Creation of bills which are customer-friendly, clear in giving information on energy costs, taxes, etc.
- Ensuring that the conditions for switching between energy suppliers is easy and free of charges (except the charge for early termination of a fixed contract)
- Developing smart meter technology and providing every consumer with this technology, as well as the information on available smart technology. This way, consumers will get familiar with controlling their own consumption, managing and decreasing their electricity bills. Under Directives 2009/72/EC of the Directive 2009/73/EC of the European Parliament and the Council member states have the obligation to facilitate the participation of consumers in the energy market, and the adoption of smart metering technologies.[52]
- Promotion of energy demand management with smart technology
- Giving incentives to customers to become active participants in the energy system, for example the dynamic price of contract with electricity supplying companies.
- The legislation and regulations vary among the member countries of the European Union, which makes it more difficult to safeguard consumers' equal participation.[53]

Wholesale market:

- With the rise of electricity generation from renewable sources, more flexible and responsive short-term market is needed.
- Market prices to reflect real electricity price by removing wholesale price caps.
- Dispatch rules should prioritize electricity generated from renewable sources.[54]
- Better economic incentives and remuneration for demand response and self-generation.[55]

[51] (Blommerde & Kampman, 2016)
[52] (Leal-Arcas, Lesniewska, & Proedrou, 2018)
[53] (European Commission, 2019)
[54] (European Union Emissions Trading Scheme, n.d.)
[55] (European Commission, n.d.)

In addition, the law reform that the European Union is performing aims at creating a new energy landscape that will ensure more democratic access to energy and will prioritize green economy and low carbon energy production. In this context the EU, along with the 2020 and 2030 energy targets, has expressed its goal to create an Energy Union. The European Commission underlined the key role of consumers in the Energy Union.

Besides the priorities, as listed above, the European Union, promotes demand response programs, which, as mentioned in previous part, gives incentives to end-consumers to alter their consumption pattern. Demand response is established in the 2012 Energy Efficiency Directive. Member countries of the European Union, with agreement to the directive, need to encourage public engagement in demand response, especially small final consumers, and deal with different types of barriers to demand response. These barriers include the inability of consumers to react to price changes due to non-dynamic pricing contracts (with dynamic pricing contracts the consumer gets price signals closer to real-time), or lack of smart metering technologies. These two barriers are characterized as implicit. As for, explicit obstacles to demand response are some legal barriers, such as exclusion of demand response in certain markets, and logistical, such as market requirements.[56]

Regarding demand response, for the European Union, to enable consumers to make use of this mechanism, regulation that will allocate roles and responsibilities, needs to be adopted by member states of the European Union. The progress of each of the EU members is different. One of the best examples of successful adoption and spread of smart metering technologies is Italy, where the installation of smart metering was mandatory already in 2006. Italy has replaced 99% of electricity meters with smart meters and has launched strategy in order to use new generation of smart meters,[57] where the overall target for the European Union is 80% of penetration in electricity market.[58]

That difference is associated with the hybrid strategy that the European Union follows. Particularly, the European Union sets policy goals on top-down level, but the implementation of those and the steps that each country will follow is determined on lower levels.[59]

A greater insight into the Greek energy framework is of increased interest. Greece is an example of country that has developed separate regulatory framework regarding self-production. The first Greek law that defined self-producers as producers who generate power mainly for his own use and channels the surplus to the grid was the Law 3468/2006, that was supplemented with the Law 4001/2011.[60]

The fundaments for the development of photovoltaic stations and self-production were set with the Ministerial Decision of 2014 3583B / 31.12.2014.The maximum power of the PV system was

[56] (Leal-Arcas, Lesniewska, & Proedrou, 2018)
[57] (Rahul, 2019)
[58] (European Commission, 2014)
[59] (Leal-Arcas, Lesniewska, & Proedrou, 2018)
[60] (ECRB, 2020)

defined at 20kwp or up to 50% of agreed capacity consumption (Article 1).[61] Additionally, it was decided that the payment method for self-producers will be the energy off-setting (the energy consumed and produced via PV system are calculated together on an annual basis (Article 6.1))[62]. The offsetting method regarding the greek energy suppliers will be presented with further details with actual examples in the 3rd chapter of this thesis.

The above law was replaced by the Ministerial decisions: 1547B/5.5.2017 and 759B/5.3.2019. With the Law N.4414/2016 the off-setting was expanded in order to include additional technologies for self-production besides PV systems (small wind turbines, biomass-biogas-biofluid stations, small hydroelectric stations, electric heat cogeneration stations.)[63] On the above table each of these technologies along with deployment requirements are presented. It should be noted that the Greek energy market is divided into two “regions: the interconnected system that includes the mainland and is connected to the electricity grid, and the island of Crete, and the non-interconnected system that includes the rest of the Greek islands. Due to technological and technical difficulties in interconnecting islands to the mainland’s electricity grid, and due to high capital demand, these areas remain not connected until date. The non-interconnected system is powered mostly by local power plants and RES plants.[64] Another step further took the Ministerial Decision 759B/5.3.2019. Specifically, the possibility of installation of storage units (for excess of electricity produced to be stored) was introduced.

Table 1: Requirements for self—production according to Greek law[65]

TECHNOLOGY	REQUIREMENTS
SOLAR ENERGY	**INTERCONNECTED SYSTEM:** -PV plants <20kW or 50% of the agreed capacity consumption. -For non-profit legal person this could reach up to 100%. -Maximum capacity limit: 500kWp **NON-INTERCONNECTED ISLANDS:** - PV plants <10kW or 50% of the agreed capacity consumption

[61] (TAXHEAVEN, 2015)
[62] (TAXHEAVEN, 2015)
[63] (Σύνδεσμος Εταιριών Φωτοβολταϊκών , 2020)
[64] (Regulatory Authority for Energy, n.d.)
[65] (RES Legal, n.d.)

	-For non-profit legal person this could reach up to 100%. -Maximum capacity limit: 20kWp (50kWp for non-profit legal person) **ISLAND OF CRETE:** -PV plants <20kW or 50% of the agreed capacity consumption -For non-profit legal person this could reach up to 100%. -Maximum capacity limit: 100kWp (300kWp for non-profit legal person).
WIND ENERGY	**INTERCONNECTED SYSTEM:** up to 50 kW
BIOGAS	Biogas power plants are eligible
BIOMASS	Small scale hydro power is eligible
HYDRO-POWER	Biomass and CHP is eligible

The regulatory framework is under constant development in order to address issues related to prosumption but there is room for development. Another important aspect to focus on is the issue of remuneration of prosumers as follows.

2.2. PAYMENT OF PROSUMERS

The European Union has not one common policy for all member states regarding the methodology of remunerating of prosumers for the electricity they produce. Each member state applies different strategy that is formed on national level.

There are different models in the energy system that can be applied to pay the prosumers for the services they provide to the grid and the market. For the remuneration of prosumers it is of vital importance to track consumption and production in real-time.[66] In this part of the thesis we will put under consideration: net-metering and net billing, feed-in tariffs (Fits), feed-in premiums (FiPs), competitive auctions and requests for tenders.

<u>Net-metering</u>

Net metering is a method of offsetting between electricity produced and consumed with the use or renewable sources, mostly PV photovoltaics.[67] With net metering, the surplus of energy produced by consumers is returned to the grid, which is used as storage, and in exchange for that service, that excess of energy is credited to these consumers for future use. This means compensation is based on energy scheme. The period ("called the netting period or rolling credit time frame") in which that amount of energy can be consumed varies from an hour to a year.[68] For example, the excess of electricity can be produced during day and consumed to cover night needs. Production and consumption have the same value, there is no difference in price of energy at peak and non-peak period. Customers are charged at the end of billing cycle on the basis of net usage of kWh, if it is positive.[69]

Additional benefits that come from net metering is the significant reduction and even nullification of competitive tariff charges and decrease of regulated charges.

This method of payment will be presented in the next chapter thought three different examples of self-producers in Greece In Greece the prosumer is compensated thought offsetting in cleaning bills.[70]

<u>Net-billing</u>

In this model, electricity production and consumption are monitored and valued separately, meaning that customers will be billed for the full retail rate per kWh when using energy directly from the grid, and at the same time will get compensation when they feed the grid with excess of

---

[66] (Open, 2019)
[67] (Kiefer, n.d.)
[68] (Šajn, 2019)
[69] (Šajn, 2019)
[70] (ECRB, 2020)

generated electricity. In net-billing the compensation of the credited electricity units produced by prosumers is a monetary one. Each unit of energy is sold to the utility company at pre-determined wholesale prices.[71]

Feed-in tariffs

Another alternative method of supporting the development of energy prosumers in the energy system is the mechanism of feed-in tariffs (FiTs). This model is widely used in Germany.[72] With this mechanism prosumers are offered long term purchase agreement for the electricity they sale at a fixed price. The payment of these tariffs is made through RES levies that are included and increase the price of electricity in the bill. The mechanism of Feed-in tariffs can be considered as attractive method not only for the investors (by securing the investment and predictability) but also to prosumers, since they can gain huge profit.[73] These agreements can last 10 to 25 years and are set at an above-the market price.[74] The price is subject to the size and the location of the project, the technology that is used, the quality of the resource, and can be adjusted in subsequent years as the technology used in the project becomes more mature.[75] For the electricity that prosumers consume from the grid, they are billed with the retail price.

Feed-in premiums

In the model, the remuneration of electricity produced by prosumers is done by offering long term contracts that take into account the same specifications as feed-in tariffs regarding technology, location etc. The main difference between those two types of tariffs is that with feed-in premiums is a bonus that is added to the current market price. The bonus can be fixed, meaning that the compensation can be either too low if the market price is low, or too high, if the market price is too high, or sliding, closing this way the gap between feed-in tariff and the market price.

Competitive auctions

For the distribution and the level of FiTs and FiPs the system of auctions can be used. Small-scale producers bid for compensation of certain amount of electricity. This model, which has been used in the past by several countries, is not as effective as FiTs or FiPs regarding the transition to a decentralized energy market, and has high administrative costs.[76]

[71] (IRENA, 2017)
[72] (Schneidewindt, 2017)
[73] (Šajn, 2019)
[74] (Šajn, 2019)
[75] (Cory, Couture, & Kreycik, 2010)
[76] (Šajn, 2019)

3. PARADIGM

In this section of the thesis an actual example of prosumers with installed PV systems will be presented. The example includes three different businesses, with different working hours, different consumption and different installed capacities of their PV systems. Each one the businesses will be provided with description along with actual readings of their consumption. This way we will understand in practice how the retaliation of prosumers works,

But before we move on further, some remarks regarding the Greek energy market need to be made. In particular, the methodology of billing by energy companies in Greece of customers with net metering is essential for this matter.

With the Ministerial Decision ΦΕΚ Β' 3583/31.12.2014, consumers are entitled to produce quantities of energy in order to partially cover their needs for electricity. The system used is the energy setoff of the electricity produced by the PV system and the total consumed by the prosumers electricity. The setoff is conducted on annual basis.

The methodology of billing, in case of existing PV system, considers three measurements (kWh):

1. **Absorbed energy**: the amount of electricity that has been absorbed from the grid and has been consumed by the customer

2. **Produced energy** directly from the PV system. It accounts the total of produced electricity, regardless of whether it was self-consumed or injected into the grid.

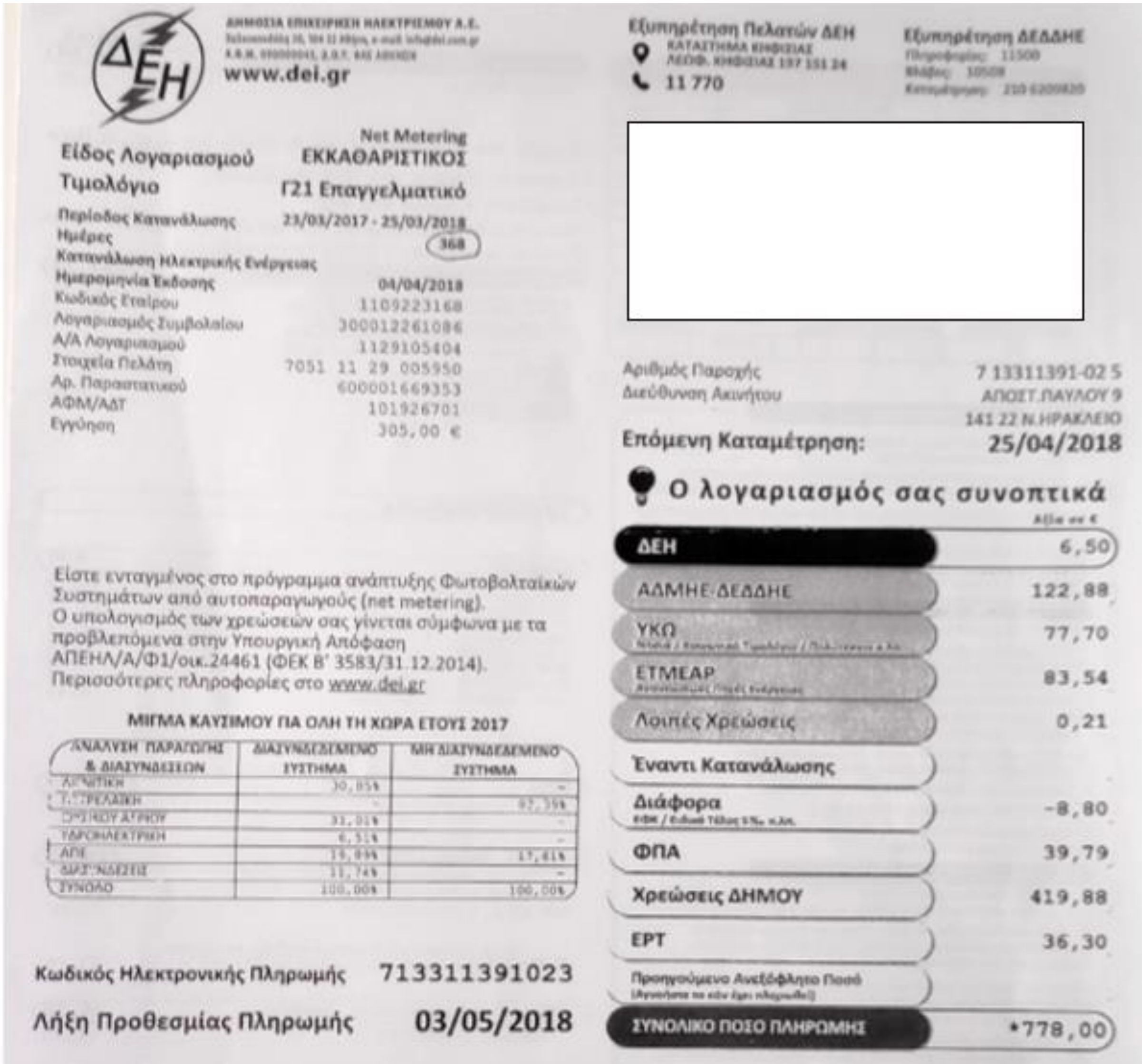
3. **Injected energy:** total of electricity generated by the PV system and injected into the energy grid.[77]

The energy supply charge is calculated from the difference between the Absorbed energy and the Injected energy (1-3). In case of positive result, the difference is charged. With zero difference, there is no charge for the customer. If the energy that has been injected to the grid surpasses the consumed energy, then the excess of energy is credited to the next actual reading as additional injected energy.

[77] (PPC, n.d.)

3.1.

1st scenario: office with working hours: Monday to Friday, 9 am to 6 pm.


ΔΕΗ

www.dei.gr

Εξυπηρέτηση Πελατών ΔΕΗ

11 770

Εξυπηρέτηση ΔΕΔΔΗΕ

Είδος Λογαριασμού	Net Metering ΕΚΚΑΘΑΡΙΣΤΙΚΟΣ
Τιμολόγιο	Γ21 Επαγγελματικό
Περίοδος Κατανάλωσης	23/03/2017 - 25/03/2018
Ημέρες	368
Κατανάλωση Ηλεκτρικής Ενέργειας	
Ημερομηνία Έκδοσης	04/04/2018
Κωδικός Εταίρου	1109223168
Λογαριασμός Συμβολαίου	300012261086
Α/Α Λογαριασμού	1129105404
Στοιχεία Πελάτη	7051 11 29 005950
Αρ. Παραστατικού	600001669353
ΑΦΜ/ΑΔΤ	101926701
Εγγύηση	305,00 €

Αριθμός Παροχής	7 13311391-02 5
Διεύθυνση Ακινήτου	ΑΠΟΣΤ.ΠΑΥΛΟΥ 9 141 22 Ν.ΗΡΑΚΛΕΙΟ
Επόμενη Καταμέτρηση:	25/04/2018

Είστε ενταγμένος στο πρόγραμμα ανάπτυξης Φωτοβολταϊκών Συστημάτων από αυτοπαραγωγούς (net metering). Ο υπολογισμός των χρεώσεων σας γίνεται σύμφωνα με τα προβλεπόμενα στην Υπουργική Απόφαση ΑΠΕΗΛ/Α/Φ1/οικ.24461 (ΦΕΚ Β' 3583/31.12.2014). Περισσότερες πληροφορίες στο www.dei.gr

ΜΙΓΜΑ ΚΑΥΣΙΜΟΥ ΓΙΑ ΟΛΗ ΤΗ ΧΩΡΑ ΕΤΟΥΣ 2017

ΑΝΑΛΥΣΗ ΠΑΡΑΓΩΓΗΣ & ΔΙΑΣΥΝΔΕΣΕΩΝ	ΔΙΑΣΥΝΔΕΔΕΜΕΝΟ ΣΥΣΤΗΜΑ	ΜΗ ΔΙΑΣΥΝΔΕΔΕΜΕΝΟ ΣΥΣΤΗΜΑ
ΛΙΓΝΙΤΙΚΗ	30,05%	-
ΠΕΤΡΕΛΑΪΚΗ	-	97,39%
ΦΥΣΙΚΟΥ ΑΕΡΙΟΥ	31,01%	-
ΥΔΡΟΗΛΕΚΤΡΙΚΗ	6,51%	-
ΑΠΕ	19,09%	17,61%
ΔΙΑΣΥΝΔΕΣΕΙΣ	11,74%	-
ΣΥΝΟΛΟ	100,00%	100,00%

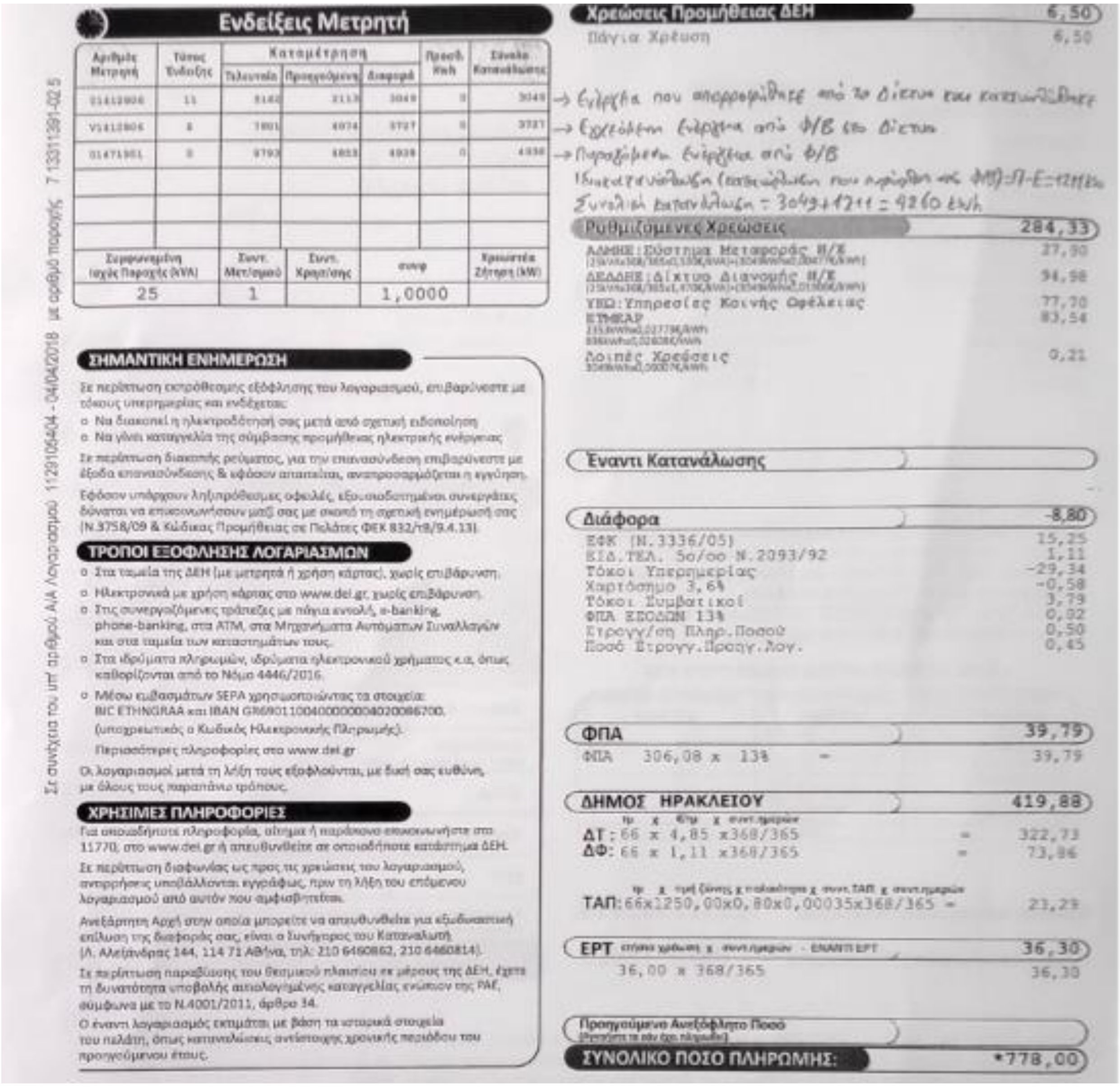
Ο λογαριασμός σας συνοπτικά

	Αξία σε €
ΔΕΗ	6,50
ΑΔΜΗΕ-ΔΕΔΔΗΕ	122,88
ΥΚΩ	77,70
ΕΤΜΕΑΡ	83,54
Λοιπές Χρεώσεις	0,21
Έναντι Κατανάλωσης	
Διάφορα	-8,80
ΦΠΑ	39,79
Χρεώσεις ΔΗΜΟΥ	419,88
ΕΡΤ	36,30
Προηγούμενο Ανεξόφλητο Ποσό	
ΣΥΝΟΛΙΚΟ ΠΟΣΟ ΠΛΗΡΩΜΗΣ	*778,00

Κωδικός Ηλεκτρονικής Πληρωμής 713311391023

Λήξη Προθεσμίας Πληρωμής 03/05/2018

Picture 3.1.1: 1st scenario



Ενδείξεις Μετρητή

Αριθμός Μετρητή	Τύπος Ένδειξης	Καταμέτρηση Τελευταία	Καταμέτρηση Προηγούμενη	Καταμέτρηση Διαφορά	Προσθ. Kwh	Σύνολο Κατανάλωσης
01412806	11	8162	2113	3049	0	3049
V1412806	8	7801	4074	3727	0	3727
01471501	8	8793	4853	4938	0	4938

Συμφωνημένη Ισχύς Παροχής (kVA)	Συντ. Μετ/σμού	Συντ. Χρησ/σης	συνφ	Χρεωστέα Ζήτηση (kW)
25	1		1,0000	

→ Ενέργεια που απορροφήθηκε από το Δίκτυο και καταναλώθηκε
→ Εγχεόμενη ενέργεια από Φ/Β στο Δίκτυο
→ Παραγόμενη ενέργεια από Φ/Β
Ιδιοκατανάλωση (καταναλώθηκε που παράχθηκε ως ΦΒ)=Π-Ε=1211 kWh
Συνολική κατανάλωση = 3049+1211 = 4260 kWh

ΣΗΜΑΝΤΙΚΗ ΕΝΗΜΕΡΩΣΗ

Σε περίπτωση εκπρόθεσμης εξόφλησης του λογαριασμού, επιβαρύνεστε με τόκους υπερημερίας και ενδέχεται:
- Να διακοπεί η ηλεκτροδότησή σας μετά από σχετική ειδοποίηση
- Να γίνει καταγγελία της σύμβασης προμήθειας ηλεκτρικής ενέργειας

Σε περίπτωση διακοπής ρεύματος, για την επανασύνδεση επιβαρύνεστε με έξοδα επανασύνδεσης & εφόσον απαιτείται, αναπροσαρμόζεται η εγγύηση.

Εφόσον υπάρχουν ληξιπρόθεσμες οφειλές, εξουσιοδοτημένοι συνεργάτες δύνανται να επικοινωνήσουν μαζί σας με σκοπό τη σχετική ενημέρωσή σας (Ν.3758/09 & Κώδικας Προμήθειας σε Πελάτες ΦΕΚ 832/τΒ/9.4.13).

ΤΡΟΠΟΙ ΕΞΟΦΛΗΣΗΣ ΛΟΓΑΡΙΑΣΜΩΝ

- Στα ταμεία της ΔΕΗ (με μετρητά ή χρήση κάρτας), χωρίς επιβάρυνση.
- Ηλεκτρονικά με χρήση κάρτας στο www.dei.gr, χωρίς επιβάρυνση.
- Στις συνεργαζόμενες τράπεζες με πάγια εντολή, e-banking, phone-banking, στα ATM, στα Μηχανήματα Αυτόματων Συναλλαγών και στα ταμεία των καταστημάτων τους.
- Στα ιδρύματα πληρωμών, ιδρύματα ηλεκτρονικού χρήματος κ.α. όπως καθορίζονται από το Νόμο 4446/2016.
- Μέσω εμβασμάτων SEPA χρησιμοποιώντας τα στοιχεία: BIC ETHNGRAA και IBAN GR6901100400000004020086700 (υποχρεωτικός ο Κωδικός Ηλεκτρονικής Πληρωμής).

Περισσότερες πληροφορίες στο www.dei.gr

Οι λογαριασμοί μετά τη λήξη τους εξοφλούνται, με δική σας ευθύνη, με όλους τους παραπάνω τρόπους.

ΧΡΗΣΙΜΕΣ ΠΛΗΡΟΦΟΡΙΕΣ

Για οποιαδήποτε πληροφορία, αίτημα ή παράπονο επικοινωνήστε στο 11770, στο www.dei.gr ή απευθυνθείτε σε οποιοδήποτε κατάστημα ΔΕΗ.

Σε περίπτωση διαφωνίας ως προς τις χρεώσεις του λογαριασμού, αντιρρήσεις υποβάλλονται εγγράφως, πριν τη λήξη του επόμενου λογαριασμού από αυτόν που αμφισβητείται.

Ανεξάρτητη Αρχή στην οποία μπορείτε να απευθυνθείτε για εξωδικαστική επίλυση της διαφοράς σας, είναι ο Συνήγορος του Καταναλωτή (Λ. Αλεξάνδρας 144, 114 71 Αθήνα, τηλ: 210 6460862, 210 6460814).

Σε περίπτωση παραβίασης του θεσμικού πλαισίου εκ μέρους της ΔΕΗ, έχετε τη δυνατότητα υποβολής αιτιολογημένης καταγγελίας ενώπιον της ΡΑΕ, σύμφωνα με το Ν.4001/2011, άρθρο 34.

Ο έναντι λογαριασμός εκτιμάται με βάση τα ιστορικά στοιχεία του πελάτη, όπως καταναλώσεις αντίστοιχης χρονικής περιόδου του προηγούμενου έτους.

Χρεώσεις Προμήθειας ΔΕΗ	6,50
Πάγια Χρέωση	6,50
Ρυθμιζόμενες Χρεώσεις	284,33
ΑΔΜΗΕ: Σύστημα Μεταφοράς Η/Ε	27,90
ΔΕΔΔΗΕ: Δίκτυο Διανομής Η/Ε	94,98
ΥΚΩ: Υπηρεσίες Κοινής Ωφέλειας	77,70
ΕΤΜΕΑΡ	83,54
Λοιπές Χρεώσεις	0,21
Έναντι Κατανάλωσης	
Διάφορα	-8,80
ΕΦΚ (Ν.3336/05)	15,25
ΕΙΔ.ΤΕΛ. 5ο/οο Ν.2093/92	1,11
Τόκοι Υπερημερίας	-29,34
Χαρτόσημο 3,6%	-0,58
Τόκοι Συμβατικοί	3,79
ΦΠΑ ΕΣΟΔΩΝ 13%	0,02
Εισπρ/ση Πληρ.Ποσού	0,50
Ποσό Εισπραχ.Προηγ.Λογ.	0,45
ΦΠΑ	39,79
ΦΠΑ 306,08 x 13% =	39,79
ΔΗΜΟΣ ΗΡΑΚΛΕΙΟΥ	419,88
ΔΤ: 66 x 4,85 x368/365 =	322,73
ΔΦ: 66 x 1,11 x368/365 =	73,86
ΤΑΠ: 66x1250,00x0,80x0,00035x368/365 =	23,29
ΕΡΤ	36,30
36,00 x 368/365	36,30
Προηγούμενο Ανεξόφλητο Ποσό	
ΣΥΝΟΛΙΚΟ ΠΟΣΟ ΠΛΗΡΩΜΗΣ:	*778,00

Picture 3.1.2: 1st scenario

Ενδείξεις Μετρητή

Αριθμός Μετρητή	Τύπος Ένδειξης	Καταμέτρηση			Προσθ. Kwh	Σύνολο Κατανάλωσης
		Τελευταία	Προηγούμενη	Διαφορά		
01412806	11	5162	2113	3049	0	3049
V1412806	E	7801	4074	3727	0	3727
01471951	Π	9793	4055	4938	0	4938

Συμφωνημένη Ισχύς Παροχής (kVA)	Συντ. Μετ/σμού	Συντ. Χρησ/σης	συνφ	Χρεωστέα Ζήτηση (kW)
25	1		1,0000	

➔ Absorbed energy
➔ Injected energy
➔ Produced energy

Picture 3.1.3: 1st scenario

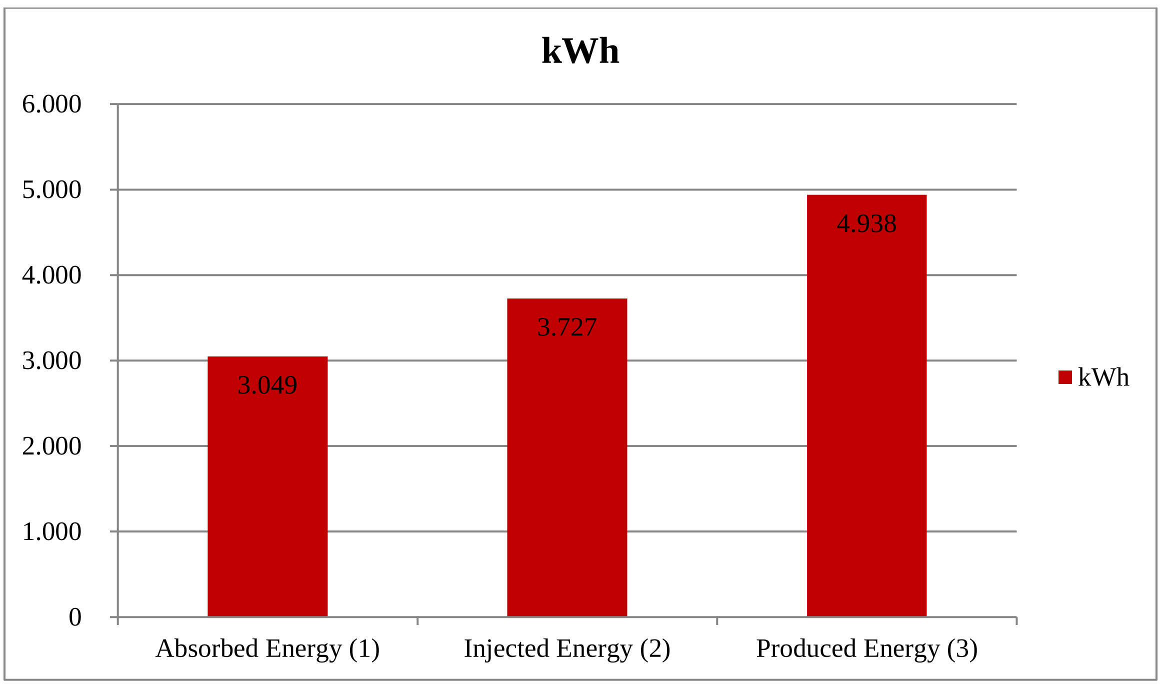


Figure 3.1.1: Net metering: measurements

Having distinguished each one of the three measurements (absorbed, injected and produced energy), first of all the total actual consumption of the customer can be calculated:

Produced Energy – Injected Energy= Self- consumption

4.938 – 3.727 = 1.211 kWh

The **total actual consumption** is given by:

Self-consumption + Absorbed Energy:

1.211+ 3.049 = 4.260 kWh

Lastly, the amount of energy that the customer will be billed is (as explained above):

Absorbed Energy – Injected Energy:

3049 – 3727 = -678 kWh

The negative result means: that the consumer produced and returned to the grid more energy than he received from the grid and consumed and will be credited for this amount of electricity produced in the next actual reading.

The above calculations are depicted on the above graph.

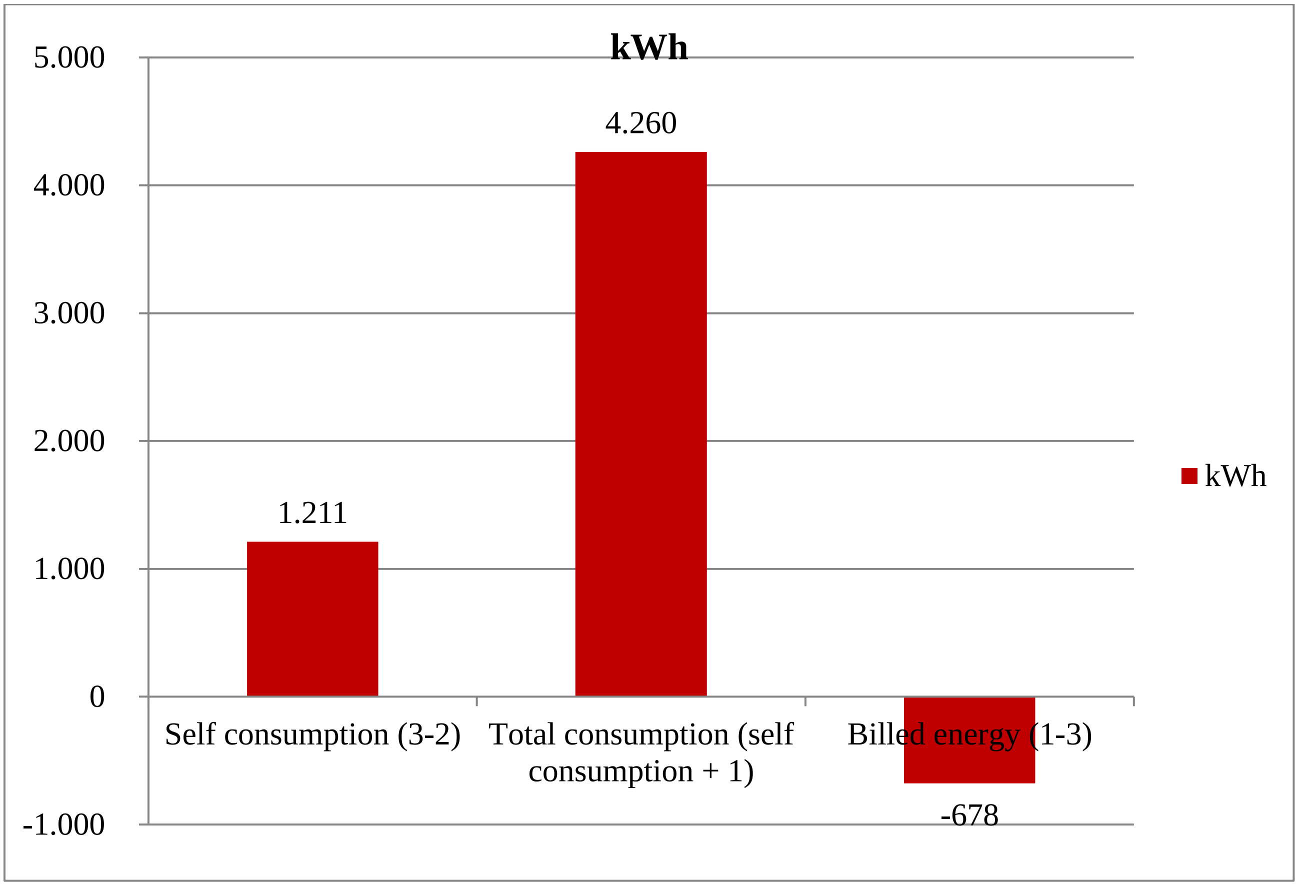


Figure 3.1.2: Net metering: billing

3.2.

2nd scenario: store of gambling company, with opening hours 10 am to 10 pm from Monday to Sunday.

ΔΕΗ
ΔΗΜΟΣΙΑ ΕΠΙΧΕΙΡΗΣΗ ΗΛΕΚΤΡΙΣΜΟΥ Α.Ε.
www.dei.gr

Εξυπηρέτηση Πελατών ΔΕΗ
ΚΑΤΑΣΤΗΜΑ ΚΗΦΙΣΙΑΣ
ΛΕΩΦ. ΚΗΦΙΣΙΑΣ 197 151 24
11 770

Εξυπηρέτηση ΔΕΔΔΗΕ
Πληροφορίες/Βλάβες/Καταμέτρηση:
11500 ή 2111900500 ή www.deddie.gr

015 600377

		Net Metering
Είδος Λογαριασμού		ΕΚΚΑΘΑΡΙΣΤΙΚΟΣ
Τιμολόγιο		Γ21 Επαγγελματικό
Περίοδος Κατανάλωσης		23/03/2018 - 25/03/2019
Ημέρες		368
Κατανάλωση Ηλεκτρικής Ενέργειας		
Ημερομηνία Έκδοσης		15/01/2020
Κωδικός Εταίρου		1112340466
Λογαριασμός Συμβολαίου		300012415032
Α/Α Λογαριασμού		1203760055
Στοιχεία Πελάτη		7051 05 13 020200
Αρ. Παραστατικού		600002587862
ΑΦΜ/ΑΔΤ		145584884
Εγγύηση		505,00 €

Αριθμός Παροχής	7 03093066-05 9
Διεύθυνση Ακινήτου	ΑΓ.ΝΕΚΤΑΡΙΟΥ 57 141 22 Ν.ΗΡΑΚΛΕΙΟ
Επόμενη Καταμέτρηση:	22/04/2019

Ο λογαριασμός σας συνοπτικά

	Αξία σε €
ΔΕΗ	1713,02
ΑΔΜΗΕ- ΔΕΔΔΗΕ	613,02
ΥΚΩ	632,07
ΕΤΜΕΑΡ	568,23
Λοιπές Χρεώσεις	1,66
Έναντι Κατανάλωσης	
Διάφορα	172,99
ΦΠΑ	223,71
Χρεώσεις ΔΗΜΟΥ	586,00
ΕΡΤ	36,30
Προηγούμενο Ανεξόφλητο Ποσό	
ΣΥΝΟΛΙΚΟ ΠΟΣΟ ΠΛΗΡΩΜΗΣ	*4.547,00

Είστε ενταγμένος στο πρόγραμμα ανάπτυξης Φωτοβολταϊκών Συστημάτων από αυτοπαραγωγούς (net metering).
Ο υπολογισμός των χρεώσεών σας γίνεται σύμφωνα με τα προβλεπόμενα στην Υπουργική Απόφαση ΑΠΕΗΛ/Α/Φ1/οικ.24461 (ΦΕΚ Β' 3583/31.12.2014).
Περισσότερες πληροφορίες στο www.dei.gr

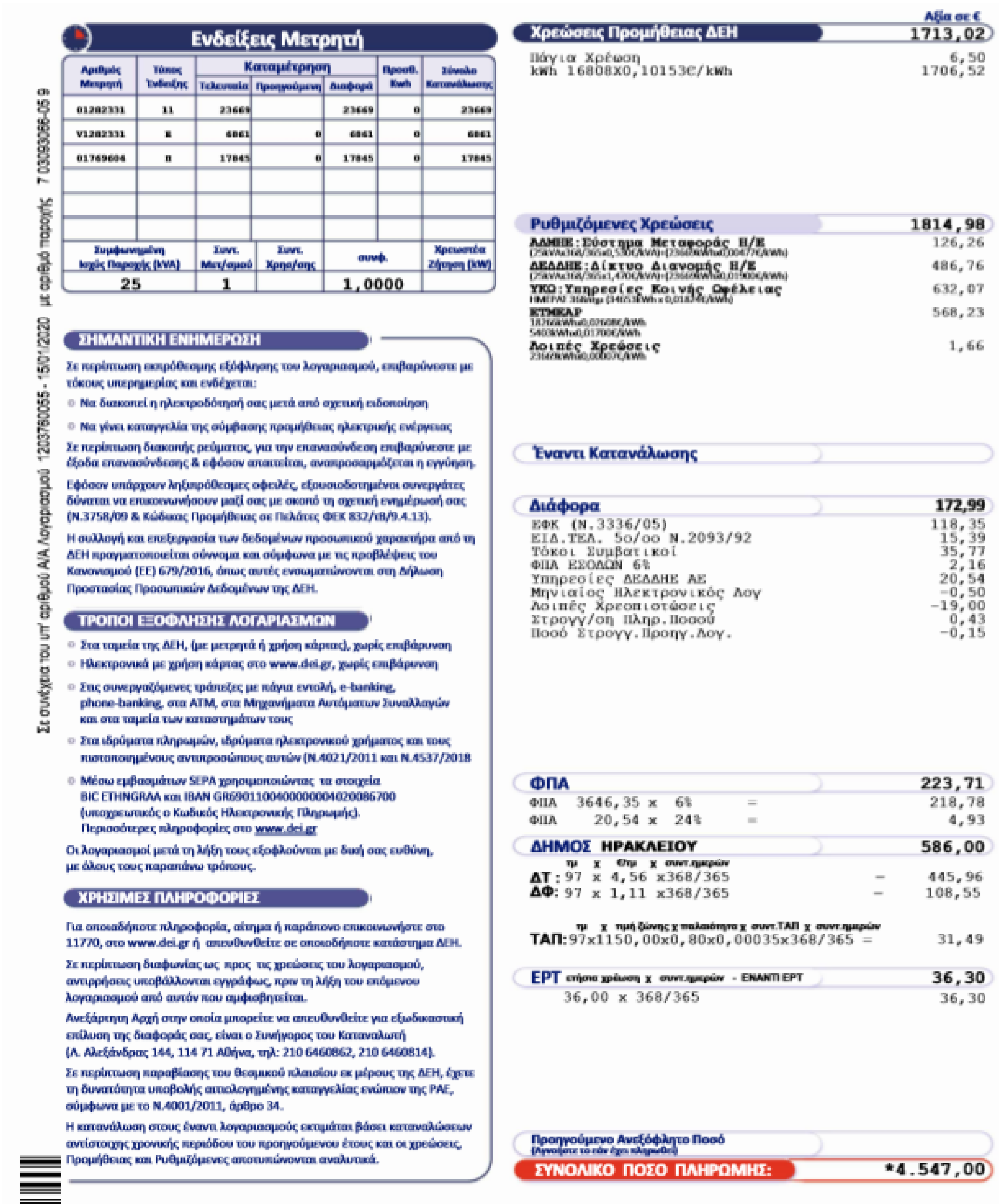
Σας ενημερώνουμε ότι α) από 01.09.2019 τροποποιούνται οι Χρεώσεις Προμήθειας σε όλα τα τιμολόγια και β) από 01.11.2019 ενεργοποιείται ο μηχανισμός αναπροσαρμογής του CO2 με διακριτή χρέωση στο λογαριασμό.
Επιπλέον, από 01.09.2019 μειώνεται η χρέωση ΕΤΜΕΑΡ (ΦΕΚ Β' 3373/31.08.2019) με αναδρομική ισχύ από 01.01.2019, για όλα τα τιμολόγια πλην του αγροτικού.
Για περισσότερες πληροφορίες καλέστε στο 11770 ή επισκεφτείτε το www.dei.gr.

Κωδικός Ηλεκτρονικής Πληρωμής
RF97907738000300012415032

Λήξη Προθεσμίας Πληρωμής 05/02/2020

Εξοφλήστε ηλεκτρονικά τον λογαριασμό σας χωρίς χρέωση, στο www.dei.gr, με χρήση καρτών VISA, MasterCard, Maestro καθώς και καρτών Diners Club έκδοσης της Alpha Bank.

Picture 3.2.1: 2nd scenario



Σε συνέχεια του υπ' αριθμού Α/Α Λογαριασμού 1203760065 - 15/01/2020 με αριθμό παροχής 7 03093066-05 9

Ενδείξεις Μετρητή

Αριθμός Μετρητή	Τύπος Ένδειξης	Καταμέτρηση			Προσθ. Kwh	Σύνολο Κατανάλωσης
		Τελευταία	Προηγούμενη	Διαφορά		
01282331	11	23669		23669	0	23669
V1282331	K	6861	0	6861	0	6861
01769604	8	17845	0	17845	0	17845

Συμφωνημένη Ισχύς Παροχής (kVA)	Συντ. Μετ/σμού	Συντ. Χρησ/σης	συνφ.	Χρεωστέα Ζήτηση (kW)
25	1		1,0000	

ΣΗΜΑΝΤΙΚΗ ΕΝΗΜΕΡΩΣΗ

Σε περίπτωση εκπρόθεσμης εξόφλησης του λογαριασμού, επιβαρύνεστε με τόκους υπερημερίας και ενδέχεται:

- Να διακοπεί η ηλεκτροδότησή σας μετά από σχετική ειδοποίηση
- Να γίνει καταγγελία της σύμβασης προμήθειας ηλεκτρικής ενέργειας

Σε περίπτωση διακοπής ρεύματος, για την επανασύνδεση επιβαρύνεστε με έξοδα επανασύνδεσης & εφόσον απαιτείται, αναπροσαρμόζεται η εγγύηση.

Εφόσον υπάρχουν ληξιπρόθεσμες οφειλές, εξουσιοδοτημένοι συνεργάτες δύναται να επικοινωνήσουν μαζί σας με σκοπό τη σχετική ενημέρωσή σας (Ν.3758/09 & Κώδικας Προμήθειας σε Πελάτες ΦΕΚ 832/τΒ/9.4.13).

Η συλλογή και επεξεργασία των δεδομένων προσωπικού χαρακτήρα από τη ΔΕΗ πραγματοποιείται σύννομα και σύμφωνα με τις προβλέψεις του Κανονισμού (ΕΕ) 679/2016, όπως αυτές ενσωματώνονται στη Δήλωση Προστασίας Προσωπικών Δεδομένων της ΔΕΗ.

ΤΡΟΠΟΙ ΕΞΟΦΛΗΣΗΣ ΛΟΓΑΡΙΑΣΜΩΝ

- Στα ταμεία της ΔΕΗ, (με μετρητά ή χρήση κάρτας), χωρίς επιβάρυνση
- Ηλεκτρονικά με χρήση κάρτας στο www.dei.gr, χωρίς επιβάρυνση
- Στις συνεργαζόμενες τράπεζες με πάγια εντολή, e-banking, phone-banking, στα ATM, στα Μηχανήματα Αυτόματων Συναλλαγών και στα ταμεία των καταστημάτων τους
- Στα ιδρύματα πληρωμών, ιδρύματα ηλεκτρονικού χρήματος και τους πιστοποιημένους αντιπροσώπους αυτών (Ν.4021/2011 και Ν.4537/2018
- Μέσω εμβασμάτων SEPA χρησιμοποιώντας τα στοιχεία BIC ETHNGRAA και IBAN GR6901100400000004020086700 (υποχρεωτικός ο Κωδικός Ηλεκτρονικής Πληρωμής). Περισσότερες πληροφορίες στο www.dei.gr

Οι λογαριασμοί μετά τη λήξη τους εξοφλούνται με δική σας ευθύνη, με όλους τους παραπάνω τρόπους.

ΧΡΗΣΙΜΕΣ ΠΛΗΡΟΦΟΡΙΕΣ

Για οποιαδήποτε πληροφορία, αίτημα ή παράπονο επικοινωνήστε στο 11770, στο www.dei.gr ή απευθυνθείτε σε οποιοδήποτε κατάστημα ΔΕΗ.

Σε περίπτωση διαφωνίας ως προς τις χρεώσεις του λογαριασμού, αντιρρήσεις υποβάλλονται εγγράφως, πριν τη λήξη του επόμενου λογαριασμού από αυτόν που αμφισβητείται.

Ανεξάρτητη Αρχή στην οποία μπορείτε να απευθυνθείτε για εξωδικαστική επίλυση της διαφοράς σας, είναι ο Συνήγορος του Καταναλωτή (Λ. Αλεξάνδρας 144, 114 71 Αθήνα, τηλ: 210 6460862, 210 6460814).

Σε περίπτωση παραβίασης του θεσμικού πλαισίου εκ μέρους της ΔΕΗ, έχετε τη δυνατότητα υποβολής αιτιολογημένης καταγγελίας ενώπιον της ΡΑΕ, σύμφωνα με το Ν.4001/2011, άρθρο 34.

Η κατανάλωση στους έναντι λογαριασμούς εκτιμάται βάσει καταναλώσεων αντίστοιχης χρονικής περιόδου του προηγούμενου έτους και οι χρεώσεις, Προμήθειας και Ρυθμιζόμενες αποτυπώνονται αναλυτικά.

	Αξία σε €
Χρεώσεις Προμήθειας ΔΕΗ	**1713,02**
Πάγια Χρέωση	6,50
kWh 16808X0,10153€/kWh	1706,52
Ρυθμιζόμενες Χρεώσεις	**1814,98**
ΑΔΜΗΕ: Σύστημα Μεταφοράς Η/Ε	126,26
ΔΕΔΔΗΕ: Δίκτυο Διανομής Η/Ε	486,76
ΥΚΩ: Υπηρεσίες Κοινής Ωφέλειας	632,07
ΕΤΜΕΑΡ	568,23
Λοιπές Χρεώσεις	1,66
Έναντι Κατανάλωσης	
Διάφορα	**172,99**
ΕΦΚ (Ν.3336/05)	118,35
ΕΙΔ.ΤΕΛ. 5ο/οο Ν.2093/92	15,39
Τόκοι Συμβατικοί	35,77
ΦΠΑ ΕΞΟΔΩΝ 6%	2,16
Υπηρεσίες ΔΕΔΔΗΕ ΑΕ	20,54
Μηνιαίος Ηλεκτρονικός Λογ	-0,50
Λοιπές Χρεοπιστώσεις	-19,00
Στρογγ/ση Πληρ.Ποσού	0,43
Ποσό Στρογγ.Προηγ.Λογ.	-0,15
ΦΠΑ	**223,71**
ΦΠΑ 3646,35 x 6% =	218,78
ΦΠΑ 20,54 x 24% =	4,93
ΔΗΜΟΣ ΗΡΑΚΛΕΙΟΥ	**586,00**
τμ x Ετμ x συντ.ημερών	
ΔΤ: 97 x 4,56 x368/365 =	445,96
ΔΦ: 97 x 1,11 x368/365 =	108,55
τμ x τιμή ζώνης x παλαιότητα x συντ.ΤΑΠ x συντ.ημερών	
ΤΑΠ: 97x1150,00x0,80x0,00035x368/365 =	31,49
ΕΡΤ ετήσια χρέωση x συντ.ημερών - ΕΝΑΝΤΙ ΕΡΤ	**36,30**
36,00 x 368/365	36,30
Προηγούμενο Ανεξόφλητο Ποσό	
ΣΥΝΟΛΙΚΟ ΠΟΣΟ ΠΛΗΡΩΜΗΣ:	***4.547,00**

Picture 3.2.2: 2nd scenario

Ενδείξεις Μετρητή

Αριθμός Μετρητή	Τύπος Ένδειξης	Καταμέτρηση			Προσθ. Kwh	Σύνολο Κατανάλωσης
		Τελευταία	Προηγούμενη	Διαφορά		
01282331	11	23669		23669	0	23669
V1282331	Ε	6861	0	6861	0	6861
01769604	Π	17845	0	17845	0	17845

Συμφωνημένη Ισχύς Παροχής (kVA)	Συντ. Μετ/σμού	Συντ. Χρησ/σης	συνφ.	Χρεωστέα Ζήτηση (kW)
25	1		1,0000	

Picture 3.2.3: 2nd scenario

The first observation is that the consumption of the store is much larger than the consumption of the office of the previous example. The working hours of the store on a weekly basis are 84 in comparison to 45 hours of the office.

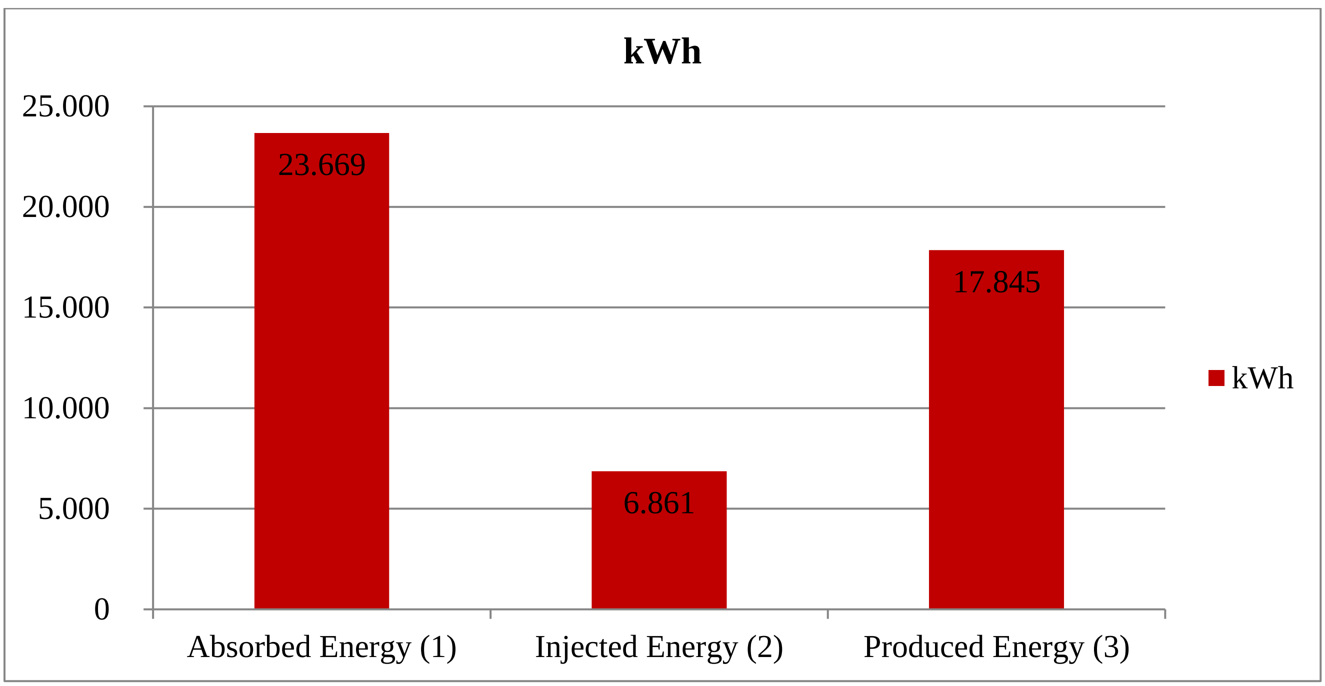


Figure 3.2.1: Net metering: measurements

Having distinguished each one of the three measurements (absorbed, injected and produced energy), first of all the total actual consumption of the customer can be calculated:

Produced Energy – Injected Energy= Self- consumption

17.845 – 6.861= 10.984 kWh

The **total actual consumption** is given by:

Self-consumption + Absorbed Energy:

10.984 + 23.669 = 34.653 kWh

Lastly, the amount of energy that the customer will be billed is (as explained above):

Absorbed Energy – Injected Energy:

23.669 – 6.861 = 16.808 kWh

The above calculations are depicted on the above graph.

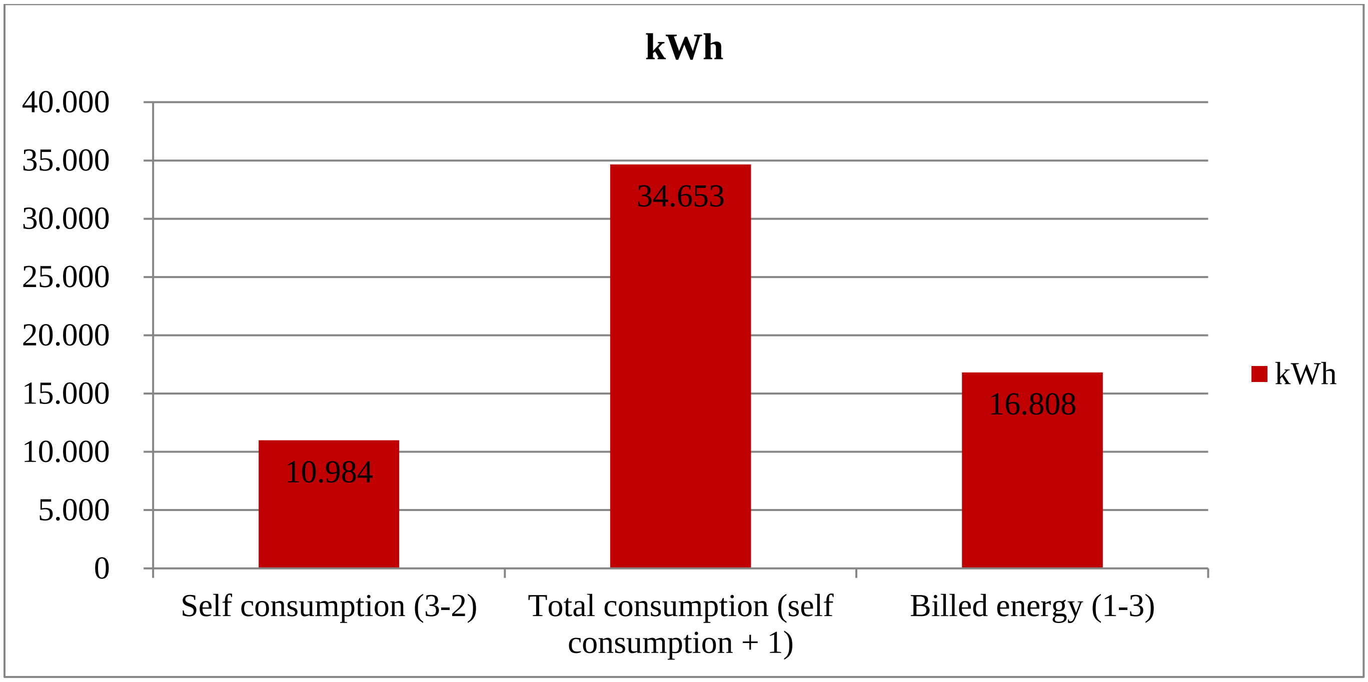


Figure 3.2.2: Net metering: billing

In this example, the energy needs exceeded the energy produced directly from the PV system installed in the store. In other words, the second customer will be billed for the remainder of electricity that he absorbed from the grid.

3.3.

3rd scenario: furniture factory, with working hours 7 am to 3 pm from Monday to Friday.


ΔΗΜΟΣΙΑ ΕΠΙΧΕΙΡΗΣΗ ΗΛΕΚΤΡΙΣΜΟΥ Α.Ε.
www.dei.gr

Εξυπηρέτηση Πελατών ΔΕΗ
ΚΑΤΑΣΤΗΜΑ ΚΟΡΩΠΙΟΥ
Β.ΚΩΝ/ΝΟΥ 250-Γ.ΚΟΥΛΟΧΕΡΗ 194
11 770

Εξυπηρέτηση ΔΕΔΔΗΕ
Πληροφορίες: 11500
Βλάβες: 10506
Καταμέτρηση: 22990 40875

145 600749

Είδος Λογαριασμού	Net Metering ΕΚΚΑΘΑΡΙΣΤΙΚΟΣ
Τιμολόγιο	Γ22 Επαγγελματικό
Περίοδος Κατανάλωσης	01/04/2016 - 25/04/2017
Ημέρες	390
Κατανάλωση Ηλεκτρικής Ενέργειας	
Ημερομηνία Έκδοσης	23/05/2017
Κωδικός Εταίρου	1112332216
Λογαριασμός Συμβολαίου	300012398468
Α/Α Λογαριασμού	1090499526
Στοιχεία Πελάτη	7070 20 Σ1 001412
Αρ. Παραστατικού	600001180747
ΑΦΜ/ΑΔΤ	082384522
Εγγύηση	755,00 €

Αριθμός Παροχής: 7 16008361-02 6
Διεύθυνση Ακινήτου: 2°ΧΙΛ Λ.ΚΟΡΩΠΙΟΥ ΒΑΡ 194 00 ΚΟΡΩΠΙ

Επόμενη Καταμέτρηση:

Ο λογαριασμός σας συνοπτικά

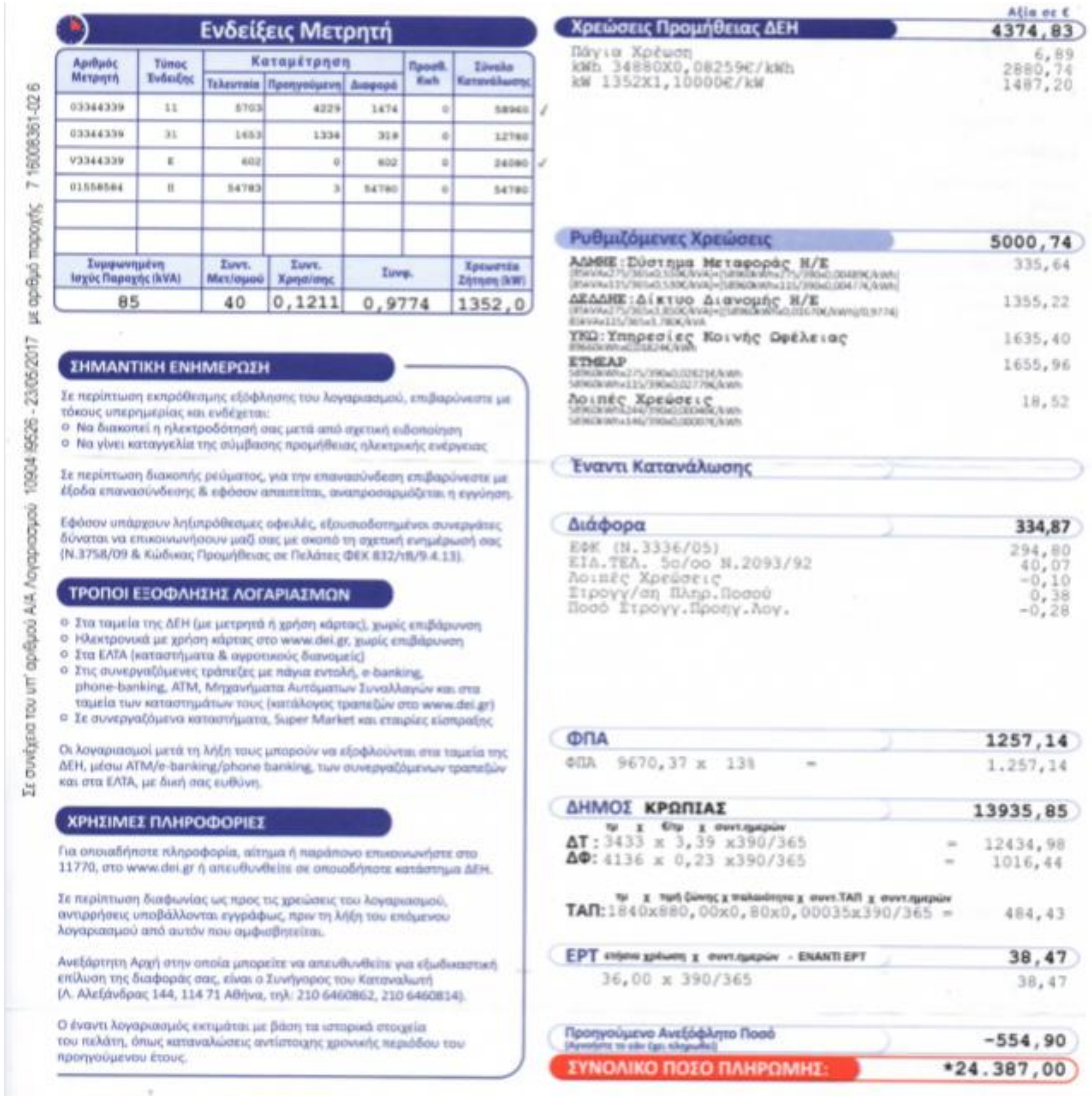
	Αξία σε €
ΔΕΗ	4374,83
ΑΔΜΗΕ-ΔΕΔΔΗΕ	1690,86
ΥΚΩ	1635,40
ΕΤΜΕΑΡ	1655,96
Λοιπές Χρεώσεις	18,52
Έναντι Κατανάλωσης	
Διάφορα (ΕΦΚ / Ειδικό Τέλος 5‰ κ.λπ.)	334,87
ΦΠΑ	1257,14
Χρεώσεις ΔΗΜΟΥ	13935,85
ΕΡΤ	38,47
Προηγούμενο Ανεξόφλητο Ποσό	-554,90
ΣΥΝΟΛΙΚΟ ΠΟΣΟ ΠΛΗΡΩΜΗΣ	*24.387,00

Είστε ενταγμένος στο πρόγραμμα ανάπτυξης Φωτοβολταϊκών Συστημάτων από αυτοπαραγωγούς (net metering).
Ο υπολογισμός των χρεώσεών σας γίνεται σύμφωνα με τα προβλεπόμενα στην Υπουργική Απόφαση ΑΠΕΗΛ/Α/Φ1/οικ.24461 (ΦΕΚ Β' 3583/31.12.2014).
Περισσότερες πληροφορίες στο www.dei.gr

Ενημερωθείτε για θέματα εξοικονόμησης ενέργειας στο https://energy-saving.dei.gr

Κωδικός Ηλεκτρονικής Πληρωμής 716008361024
Λήξη Προθεσμίας Πληρωμής 14/06/2017

Picture 3.3.1: 3rd scenario



Ενδείξεις Μετρητή

Αριθμός Μετρητή	Τύπος Ενδείξης	Καταμέτρηση Τελευταία	Καταμέτρηση Προηγούμενη	Καταμέτρηση Διαφορά	Προσθ. Kwh	Σύνολο Κατανάλωσης
03344339	11	5703	4229	1474	0	58960
03344339	31	1653	1334	319	0	12760
V3344339	E	602	0	602	0	24080
01558584	ll	54783	3	54780	0	54780

Συμφωνημένη Ισχύς Παροχής (kVA)	Συντ. Μετ/σμού	Συντ. Χρησ/σης	Συνφ.	Χρεωστέα Ζήτηση (kW)
85	40	0,1211	0,9774	1352,0

ΣΗΜΑΝΤΙΚΗ ΕΝΗΜΕΡΩΣΗ

Σε περίπτωση εκπρόθεσμης εξόφλησης του λογαριασμού, επιβαρύνεστε με τόκους υπερημερίας και ενδέχεται:
- Να διακοπεί η ηλεκτροδότησή σας μετά από σχετική ειδοποίηση
- Να γίνει καταγγελία της σύμβασης προμήθειας ηλεκτρικής ενέργειας

Σε περίπτωση διακοπής ρεύματος, για την επανασύνδεση επιβαρύνεστε με έξοδα επανασύνδεσης & εφόσον απαιτείται, αναπροσαρμόζεται η εγγύηση.

Εφόσον υπάρχουν ληξιπρόθεσμες οφειλές, εξουσιοδοτημένοι συνεργάτες δύνανται να επικοινωνήσουν μαζί σας με σκοπό τη σχετική ενημέρωσή σας (Ν.3758/09 & Κώδικας Προμήθειας σε Πελάτες ΦΕΚ 832/τΒ/9.4.13).

ΤΡΟΠΟΙ ΕΞΟΦΛΗΣΗΣ ΛΟΓΑΡΙΑΣΜΩΝ

- Στα ταμεία της ΔΕΗ (με μετρητά ή χρήση κάρτας), χωρίς επιβάρυνση
- Ηλεκτρονικά με χρήση κάρτας στο www.dei.gr, χωρίς επιβάρυνση
- Στα ΕΛΤΑ (καταστήματα & αγροτικούς διανομείς)
- Στις συνεργαζόμενες τράπεζες με πάγια εντολή, e-banking, phone-banking, ATM, Μηχανήματα Αυτόματων Συναλλαγών και στα ταμεία των καταστημάτων τους (κατάλογος τραπεζών στο www.dei.gr)
- Σε συνεργαζόμενα καταστήματα, Super Market και εταιρίες είσπραξης

Οι λογαριασμοί μετά τη λήξη τους μπορούν να εξοφλούνται στα ταμεία της ΔΕΗ, μέσω ATM/e-banking/phone banking, των συνεργαζόμενων τραπεζών και στα ΕΛΤΑ, με δική σας ευθύνη.

ΧΡΗΣΙΜΕΣ ΠΛΗΡΟΦΟΡΙΕΣ

Για οποιαδήποτε πληροφορία, αίτημα ή παράπονο επικοινωνήστε στο 11770, στο www.dei.gr ή απευθυνθείτε σε οποιοδήποτε κατάστημα ΔΕΗ.

Σε περίπτωση διαφωνίας ως προς τις χρεώσεις του λογαριασμού, αντιρρήσεις υποβάλλονται εγγράφως, πριν τη λήξη του επόμενου λογαριασμού από αυτόν που αμφισβητείται.

Ανεξάρτητη Αρχή στην οποία μπορείτε να απευθυνθείτε για εξωδικαστική επίλυση της διαφοράς σας, είναι ο Συνήγορος του Καταναλωτή (Λ. Αλεξάνδρας 144, 114 71 Αθήνα, τηλ: 210 6460862, 210 6460814).

Ο έναντι λογαριασμός εκτιμάται με βάση τα ιστορικά στοιχεία του πελάτη, όπως καταναλώσεις αντίστοιχης χρονικής περιόδου του προηγούμενου έτους.

	Αξία σε €
Χρεώσεις Προμήθειας ΔΕΗ	**4374,83**
Πάγια Χρέωση	6,89
kWh 34880X0,08259€/kWh	2880,74
kW 1352X1,10000€/kW	1487,20
Ρυθμιζόμενες Χρεώσεις	**5000,74**
ΑΔΜΗΕ: Σύστημα Μεταφοράς Η/Ε	335,64
ΔΕΔΔΗΕ: Δίκτυο Διανομής Η/Ε	1355,22
ΥΚΩ: Υπηρεσίες Κοινής Ωφέλειας	1635,40
ΕΤΜΕΑΡ	1655,96
Λοιπές Χρεώσεις	18,52
Έναντι Κατανάλωσης	
Διάφορα	**334,87**
ΕΦΚ (Ν.3336/05)	294,80
ΕΙΔ.ΤΕΛ. 5ο/οο Ν.2093/92	40,07
Λοιπές Χρεώσεις	-0,10
Στρογγ/ση Πληρ.Ποσού	0,38
Ποσό Στρογγ.Προηγ.Λογ.	-0,28
ΦΠΑ	**1257,14**
ΦΠΑ 9670,37 x 13% =	1.257,14
ΔΗΜΟΣ ΚΡΩΠΙΑΣ	**13935,85**
ΔΤ: 3433 x 3,39 x390/365 =	12434,98
ΔΦ: 4136 x 0,23 x390/365 =	1016,44
ΤΑΠ: 1840x880,00x0,80x0,00035x390/365 =	484,43
ΕΡΤ	**38,47**
36,00 x 390/365	38,47
Προηγούμενο Ανεξόφλητο Ποσό	-554,90
ΣΥΝΟΛΙΚΟ ΠΟΣΟ ΠΛΗΡΩΜΗΣ:	***24.387,00**

Picture 3.3.2: 3rd scenario

Ενδείξεις Μετρητή

Αριθμός Μετρητή	Τύπος Ένδειξης	Καταμέτρηση			Προσθ. Kwh	Σύνολο Κατανάλωσης
		Τελευταία	Προηγούμενη	Διαφορά		
03344339	11	5703	4229	1474	0	58960
03344339	31	1653	1334	319	0	12760
V3344339	E	602	0	602	0	24080
01558584	Π	54783	3	54780	0	54780

Συμφωνημένη Ισχύς Παροχής (kVA)	Συντ. Μετ/σμού	Συντ. Χρησ/σης	Συνφ.	Χρεωστέα Ζήτηση (kW)
85	40	0,1211	0,9774	1352,0

Picture 3.3.3: 3rd scenario

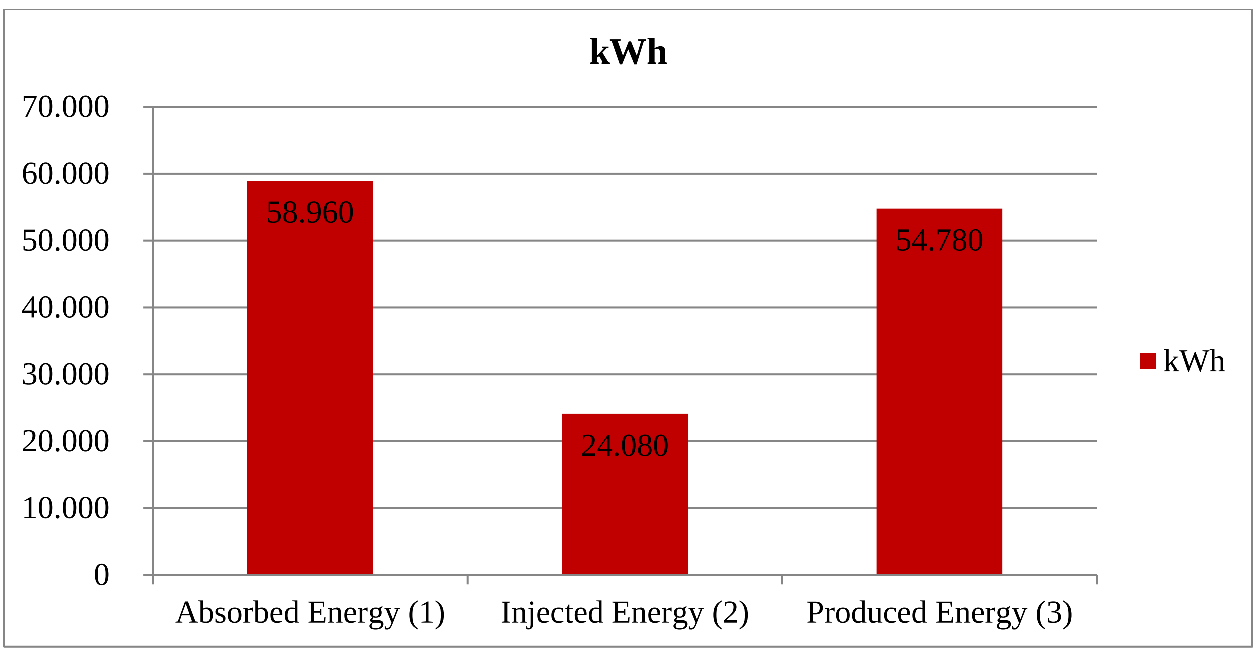


Figure 3.3.1: Net metering: measurements

As in the previous examples, based on the three measurements we calculate:

Produced Energy – Injected Energy= Self-consumption

54.780 –24.080 = 30.700kWh

Self-consumption + Absorbed Energy = Total actual consumption

30.700+ 58.960 = 89.660 kWh

Lastly, the amount of energy that the customer will be billed is (as explained above):

Absorbed Energy – Injected Energy:

58.960 – 24.080 = 34.880 kWh

The above calculations are depicted on the above graph.

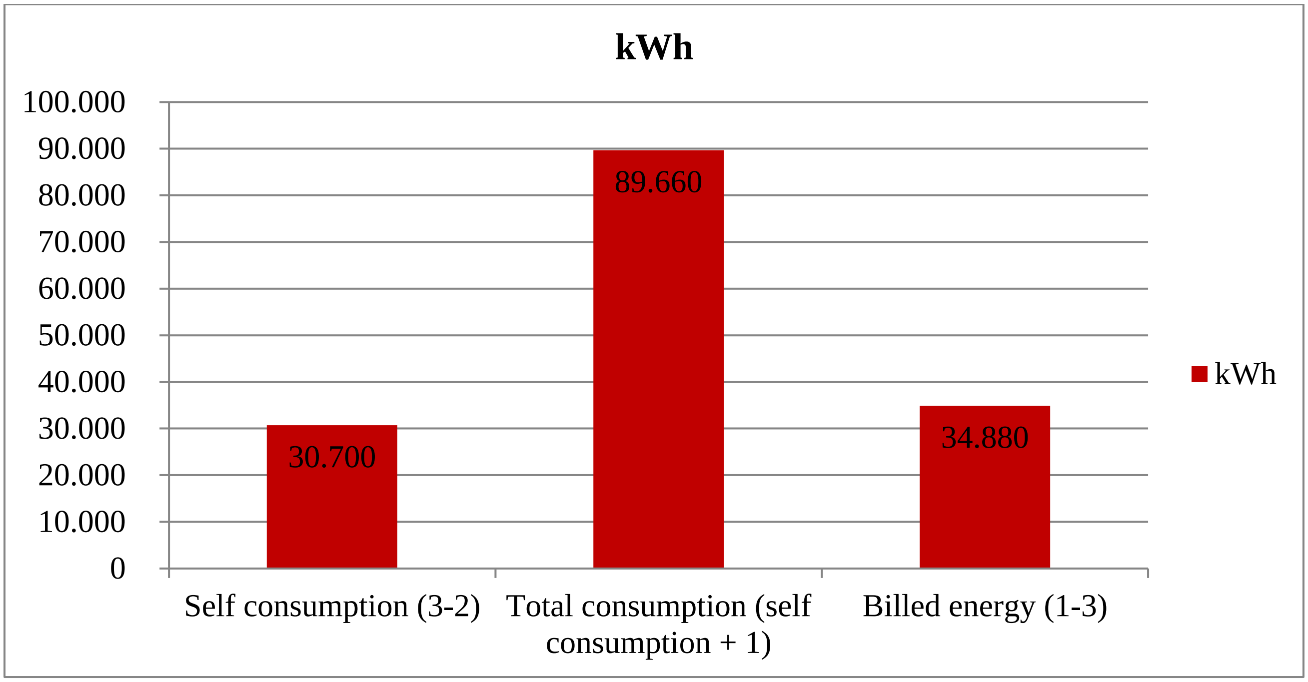


Figure 3.3.2: Net metering: billing

Once more, the amount of produced energy does not cover fully the energy needs of the consumer; it covers around 34% of total energy needs. That means that the remaining amount of energy need must be covered from the grid, and for this amount of energy the consumer will eventually be billed.

In numbers it is translated in 1.988,77€ of profit in scale of the year.

4. FUTURE OF ENERGY SYSTEM AND PROSUMPTION IN THE EU

The energy sector is undergoing a transformation driven by climate, economic and technological aspects. The European Union is facing several challenges. First and foremost, while the energy consumption and demand are rising, the consequent increase in pollution and the effects of climate change call for limiting of the use of conventional energy sources. Another important aspect that the European Union aims at is securing an acceptable cost and price of energy for the end user, and at the same time protecting economic growth. Finally, the introduction and development of new technologies that enable the transition towards new sustainable energy system models are becoming more and more available for wider use. The key for this transition is the renewable sources, along with smart technologies (storage, monitoring etc.) and digitalization. As the International Renewable Energy Agency has stated: "In an era of accelerating change, the imperative to limit climate change and achieve sustainable growth is strengthening the momentum of the global energy transformation. The rapid decline in renewable energy costs, improving energy efficiency, widespread electrification, increasingly "smart" technologies, continual technological breakthroughs and well-informed policy making all drive this shift, bringing a sustainable energy future within reach".[78] This means that, while the side of consumption and demand cannot be drastically changed, despite efforts for more energy efficiency, the future of the energy system will be most probably defined by the supply side.

In this new setting the emergence of new actors, prosumers to be specific, has showed the way that individuals can claim an active role in the energy system, contributing directly to the energy supply. The European Economic and Social Committee has briefly pointed out in its "Opinion of the European Economic and Social Committee on 'Prosumer Energy and Prosumer Power Cooperatives: opportunities and challenges in the EU countries" that "general development of distributed prosumer energy should form an important and sustainable part of the European Union's energy policy. Such an approach would be beneficial and might even be necessary from the point of view of energy security and in light of environmental and social concerns."[79]

But prosumption's contribution to the energy sector should not be taken for granted. So, what is the future of prosumption in the EU? What steps should be taken by the countries in order to ensure that the energy market develops into a promising environment for prosumers?

In the first place, the European Union should focus on creating legal regulation. It is essential to point out that the term "prosumers" is not used in newly adopted directives of The European Union and is replaced by broader terms such "active consumer" or "renewable self-consumer". "Prosumers" should be legally defined in a broad way to cover a wide spectrum of individuals

---

[78] (IRENA, 2018)

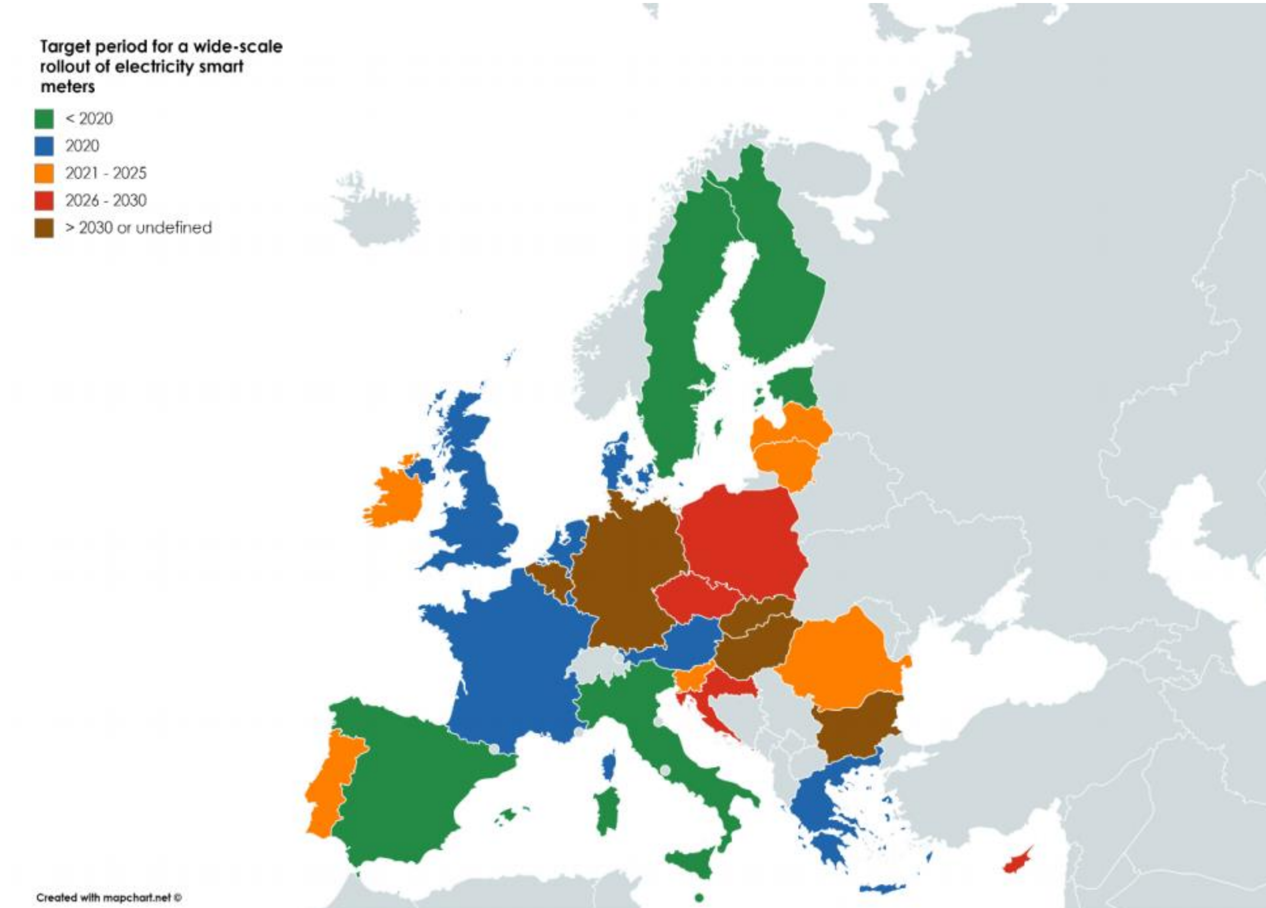
[79] (Opinion of the European Economic and Social Committee on "Prosumer Power Cooperatives: opportunities and challenges in the EU countries", 2017)

and communities' forms of self-consumption, and at the same time the definition should be clear and specific enough and a set of principles for prosumption. For example, features of prosumers that should be specifically determined should at least include: the size and the type of installation, regulations over collective vs individual energy generation, ownership of installation.

Besides the lack of a common definition of prosumer, another week spot is the lack of a common policy and regulation for energy prosumers among all of EU member states. This means that among member states, the legal aspects vary, and in some cases do not support growth of prosumers. It is important to create one common prosumer policy so that all EU countries are attuned to it, and the European Union will be able to follow one united direction towards supporting the growth of self – consumption within the territory of the European Union.

Additionally, it is essential to secure such an environment for consumers that will enable the rise of self-production and self-consumption. This means that, from market perspective, no market limitations imposed against prosumers should be allowed. Simultaneously, any support measures should not distort competition on the energy market. The goal is to create partnership relations between different stakeholders. When analyzing the changes that the energy market can sustain due to the rise of prosumers, it was pointed out that existing players, "old actors" in the market will interact differently in the new energy market structure. Energy producers, transmission and distribution companies and prosumers should establish such relations so that they could benefit to the fullest from the inclusion of prosumers to the equation of the market.

Besides the legal aspects of facilitating the penetration of prosumers into the market, there are some issues essential to dealt with. First of all, financial and other rights of prosumers must be protected. Despite undertaking production activities, prosumers' rights as consumers should remain undeniable. Additionally, new rights especially on financial level, established in the EU, for example with directives such as Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, should be promoted.



Picture 4: Target period for wide-scale rollout of electricity smart meters (with at least 80% of all consumers for each member state)[80]

In addition, the innovative smart meter technology should be fully supported by all member states of European Union. It must be noted that not all countries, such as Bulgaria or Latvia, have adopted national laws and strategies for smart metering in accordance with the Third Energy Package.[81] The spread of installation of smart meter technology across the EU must be done in tight partnership with network operators in each country. This means that there is a strong need for TSOs and DSOs to support the new market scheme. Smart local networks must be developed as part of the existing network infrastructure and services (data management[82]). The goal is to develop a prosumer-oriented energy market.

[80] (European Commission, 2019)
[81] (European Commission, 2019)
[82] (European Distribution System Operators for Smart Grids, 2014)

Furthermore, the direct financial support with financing smart metering from different sources is essential for wider spread and deployment of smart metering technologies. The finance of smart metering deployment comes from national authorities that have the obligation, according to the Third Energy Package, in the case of electricity, to roll out at least 80% by 2020.[83] On the Picture 4 there is presented the target period that the above goal is estimated to be completed in EU members states, based on the so-far countries' process.

Member states of the EU should also consider the different technical aspects behind smart metering. With the Directive (EU) 2019/944 on common rules for the internal market for electricity (Article 20) the European Union sets the minimum set of functionalities of smart meters[84], so that member states and consumers get the most out of smart metering technologies. Additional parameters that must be considered and addressed include standards and protocols that will facilitate the interconnection, risk of single manufacturer and/or technology lock-in, data management and security.[85]

To conclude, the European Union along with the member states have pursued the growth of renewable and sustainable energy market, shifting towards a more decentralized structure of the market with prosumption being at the heart of this transition. The development of prosumers as the new pillar of the future energy system requires the synergy on national and European level so that this attempt will be coordinated and optimized leading to the intended results.

[83] (European Commission, 2019)
[84] (DIRECTIVE (EU) 2019/944, 2019)
[85] (European Commission, 2019)

5. CONCLUSION

5.1. MAIN FINDINGS

Prosumers can be considered as the rising stars of the European Union. Their role and impact are being gradually recognized on legal documents of the EU and its member countries. Literature has shown that the prosumer phenomenon is the main dynamic that leads to a transition of the current energy market to a more decentralized energy system where an important role will be played by those consumers that will engage actively in production, self-consumption and storage activities. Most important factors that created the potential for the development of prosumption are environmental concerns especially for the European Union, technological innovation and economic incentives.

On one hand, the rise of prosumers creates opportunities and positive changes. Traditional consumers are no longer passive end-users but become more aware “energy citizens” that contribute to the change of the energy landscape. On large scale, prosumption supports greener energy system and economy, since it is based on renewable sources, promoting the gradual abandonment of fossil fuels, which is a priority for the European Union. In addition, an energy market with excess of overall electricity produced is an energy market that is more flexible, reliable and sustainable, providing that there are mechanisms for handling the excess of electricity in a smart way.

On the other hand, prosumption shakes the existing status quo of the energy market and system. The structure of the energy market and system are being not only questioned but also shaped by the rise and the penetration of prosumption. The market needs to adapt, becoming more decentralized, in order to perform better under the changing environment. This of course means that different scenarios are applicable, all of them having one common feature: decentralization. The new actors that are prosumers, besides challenging the roles and responsibilities of the old actors, who are provoked to adapt to the new landscape, they also alter the network of relations between new and old market players. Another challenge comes on regulation level since prosumers have not been defined as such. On technical-technological level, parameters such as data management and data sharing, operational issues, optimal functionalities of technologies used, should be considered so that to achieve the highest possible level of self-generation. All these challenges must be taken into consideration by policy makers to safeguard such an environment that will promote partnership relations between different stakeholders, including prosumers.

5.2. CONCLUDING REMARKS AND RECOMMENDATIONS

Within this paper we included a wide range of research from different studies, giving a broad picture of the prosumption landscape in the European Union. These findings add to a growing body of literature and support the idea that the future of the EU is strongly attached to prosumption. Our research has highlighted several burning issues that should be considered by policy makers to fully support the transition towards a more consumer-centered energy system,

Recommendations:

- There is great need for the European Union to form a common and inclusive policy and strategy for the promotion of prosumption within its member states. The necessity for this measure is increasing by the fact that, as for now, the member states follow different, even conflicting policies regarding self-production and RES, while the European Union wants a more green and sustainable future.
- The existing legislation does not provide the necessary foundation for the establishment and growth of prosumers in the EU. Thus, new legislative framework for the EU should be created. Aspects that should be included are technical and technological, economical and social.
- The growth of prosumers should be pursued in a “harmonious” way towards the energy market and its existing actors in all member states. At the same time, the existing actors shall accept cooperation and undertake new responsibilities for the operation of the future energy market.

This study has gone some way towards enhancing our understating of the phenomenon of prosumers. For future research it would be interesting to consider a more technical – economic analysis of the potential benefits of the prosumption for the European Union and its member states.

REFERENCES

Agency for the Cooperation of Energy Regulators. (2014, September 19). *Energy Regulation: A Bridge to 2025 Conclusions Paper*. Retrieved from: https://www.acer.europa.eu/official_documents/acts_of_the_agency/sd052005/supporting%20document%20to%20acer%20recommendation%2005-2014%20-%20%20energy%20regulation%20a%20bridge%20to%202025%20conclusions%20paper.pdf

Arora, R. (2019, November 11). Smart meters the Italian way. *Utility Week* Retrieved from: https://utilityweek.co.uk/smart-meters-italian-way/

Belmans, R., D'haeseleer, W. ,Driesen, J. , Haeseldonckx, D. &Pepermans, G. (2003). Distributed generation: definition, benefits and issues, p. 2. Faculty of Economics and Applied Economic Sciences. Center for Economic Studies Energy, Transport & Environment. *Katholiekie Universiteit Leuven.* Retrieved from: https://www.researchgate.net/publication/222561651_Distributed_generation_definition_benefits_and_issues

BEUC. (2016, June 13). *Can consumers easily produce their own electricity?*. Retrieved from: https://www.beuc.eu/blog/can-consumers-easily-produce-their-own-electricity/

Blommerde, J. &Kampman, B. (2016, September). The potential of energy citizens in the European Union, *CE Delfte*, p. 20. Retrieved from: https://www.cedelft.eu/publicatie/the_potential_of_energy_citizens_in_the_european_union/1845

BUREAU EUROPÉEN DES UNIONS DE CONSOMMATEURS AISBL. (2018, February 15). *ELECTRICITY AGGREGATORS: STARTING OFF ON THE RIGHT FOOT WITH CONSUMERS*, p. 3-4. Retrieved from: https://www.beuc.eu/publications/beuc-x-2018-010_electricity_aggregators_starting_off_on_the_right_foot_with_consumers.pdf

Caramizaru, A &Uihlein, A. (2020).*Energy communities: an overview of energy and social innovation*, Joint Research Center, p. 5 Retrieved from: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC119433/energy_communities_report_final.pdf

Carbon Market Watch. (2019, April). *CRACKING EUROPE'S HARDEST CLIMATE NUT,* p. 7.

Chao, L., Chaudhari, K., Gooi, H. B. &Paudel, A. (2018, October). Peer-to-Peer Energy Trading in a Prosumer Based Community Microgrid: A Game-Theoretic Model, p. 2-3. *IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS.* Retrieved from: https://www.researchgate.net/publication/328021777_Peer-to-Peer_Energy_Trading_in_a_Prosumer_Based_Community_Microgrid_A_Game-Theoretic_Model

Cory, K. , Couture, T.D. , Kreycik, C. & Williams, E. (2010, July). *A Policymaker's Guide to Feed-in Tariff Policy Design*, p. 6. National Renewable Energy Laboratory. Retrieved from: https://www.nrel.gov/docs/fy10osti/44849.pdf

Da Silva, P. G. , Ilic, D. & Karnouskos, S. (2012). *A Survey Towards Understanding Residential Prosumers in Smart Grid Neighbourhoods*, p. 3-4. Retrieved from: https://ieeexplore.ieee.org/document/6465864

Dimeas A., Hatziargyriou, N., Tomtsi, T. &Weidlich A. (2011, March 7). *Energy-Efficient Computing and Networking*, p. 187-194. Retrieved from: https://books.google.gr/books?id=PxKms-yBaB8C&pg=PA187&lpg=PA187&dq=brokerage+system+energy+prosumers&source=bl&ots=7eRs_-0eG2&sig=ACfU3U0WX3w4L_7t2admMdk8wLp0ZIynQQ&hl=el&sa=X&ved=2ahUKEwibjqrwzbrpAhU08uAKHY-rApUQ6AEwAXoECAsQAQ#v=onepage&q=brokerage%20system%20energy%20prosumers&f=false

DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources. (2018, December 12). *Official Journal of the European Union.* Retrieved from:https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN

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. (2019, June 14). *Official Journal of the European Union*, p.130-131. Retrieved from:https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0944&from=EN

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. (2019, June 14th). *Official Journal of the European Union.* Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L0944

Directorate General for Internal Policies: Policy Department A: Economic and Scientific Policy: Industry, Research and Energy. (2010). *Decentralized Energy Systems*,pp.3. Retrieved from: https://www.europarl.europa.eu/document/activities/cont/201106/20110629ATT22897/20110629ATT22897EN.pdf

ECRB. (2020, March). *Prosumers in the Energy Community*, p. 8, 35. Retrieved from: https://energy-community.org/dam/jcr:abacd12d-283c-492a-8aa4-6da5797d044a/ECRB_prosumers_regulatory_framework_032020.pdf

Energy Storage World Forum. (n.d.). *WHY DISTRIBUTED ENERGY STORAGE?*. Retrieved from: https://energystorageforum.com/news/why-distributed-energy-storage

ENTSOE. (n.d.). *Towards smarter grids: Developing TSO and DSO roles and interactions for the benefit of consumers*, p. 2-3,6. Retrieved from: https://www.energie-finder.ch/fileadmin/dateien/PDF/news/Towards_smarter_grid.pdf

ENVISOL. (n.d.). *Photovoltaic.* Retrieved from: http://envisol.gr/index.php/en/photovoltaic?amp;view=article&id=41&catid=16&lang=en-EN%22_hreflang=%22el=%22=

Eunice Energy Group. (n.d.). *Energy Communities*. Retrieved from: http://eunice-group.com/projects/energy-communities/

European Commission. (2014, July 16). *Renewable energy directive.* Retrieved from: https://ec.europa.eu/energy/topics/renewable-energy/renewable-energy-directive/overview_en

European Commission. (2014, July 31). *Smart grids and meters*. Retrieved from: https://ec.europa.eu/energy/topics/markets-and-consumers/smart-grids-and-meters/overview_en

European Commission. (2018). *SIMP - Subjective Individual Model of Prosumer*. Luxembourg: Publications Office of the European Union. Retrieved from: https://ec.europa.eu/jrc/en/publication/simp-subjective-individual-model-prosumer

European Commission. (2019, December*). Benchmarking smart metering deployment in the EU-28,* p. 17, 21, 36, 134. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/b397ef73-698f-11ea-b735-01aa75ed71a1/language-en

European Commission. (2019, May 22). *Clean energy for all Europeans package completed: good for consumers, good for growth and jobs, and good for the plane*. Retrieved from: https://ec.europa.eu/info/news/clean-energy-all-europeans-package-completed-good-consumers-good-growth-and-jobs-and-good-planet-2019-may-22_en

European Commission. (2019, October 10). *Protecting energy consumers.* Retrieved from: https://ec.europa.eu/energy/topics/markets-and-consumers/energy-consumer-rights/protecting-energy-consumers_en

European Commission. (n.d.). *New electricity market design: a fair deal for consumers*, p. 1-2. Retrieved from: https://ec.europa.eu/energy/sites/ener/files/documents/technical_memo_marketsconsumers.pdf

European Distribution System Operators for Smart Grids. (2014, June). *Data Management: The role of Distribution System Operators in managing data,* p. 5 Retrieved from: https://www.edsoforsmartgrids.eu/wp-content/uploads/public/EDSO-views-on-Data-Management-June-2014.pdf

European Parliament Think Tank. (2016). Electricity "Prosumers". Retrieved from: https://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI(2016)593518

European Union Emissions Trading Scheme. (n.d.). *Priority dispatch of electricity*. Glowacki Law Firm. Retrieved from: https://www.emissions-euets.com/internal-electricity-market-glossary/1818-priority-dispatching-of-electricity-from-renewable-energy-sources

González, A., Riba J.R & Rius A. (2015).Optimal Sizing of a Hybrid Grid-Connected Photovoltaic–Wind–Biomass Power System, p. 2. *Sustainability*, *7*.Retrieved from:www.mdpi.com/journal/sustainability

Guia, E. M. &MacGill, I. (2017, October). *Typology of future clean energy communities: An exploratory structure, opportunities, and challenges*, p. 95. Retrieved from: https://www.researchgate.net/publication/320635015_Typology_of_future_clean_energy_communities_An_exploratory_structure_opportunities_and_challenges

Haziri, P. (n.d.). *Regulatory framework on Prosumers in Contracting Parties*, p. 4. Retrieved from: https://www.energy-community.org/dam/jcr:1640e1b4-10d0-4ed8-8baf-22bfba4e4c93/ECRB_framework_Gas_Ring.pdf

Hoicka, C.E., Lowitzsch J. & van TulderF.J.(2020 January 3). Renewable energy communities under the 2019 European Clean Energy Package – Governance model for the energy clusters of the future?.*Renewable and Sustainable Energy Reviews*, *122.* Retrieved from: https://www.sciencedirect.com/science/article/pii/S1364032119306975

InnoEnergy. (n.d.). *The potential for local energy storage in distribution network*, p. 3. Retrieved from: https://www.innoenergy.com/media/1308/1702-potential_for_local_energy_storage_final.pdf

IRENA. (2012, November). *Renewable Power Generation Costs*, p. 8. Retrieved from: https://www.irena.org/documentdownloads/publications/renewable_power_generation_costs.pdf

IRENA.(2017). *ADAPTING MARKET DESIGN TO HIGH SHARES OF VARIABLE RENEWABLE ENERGY*, p.115-118. Retrieved from: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/May/IRENA_Adapting_Market_Design_VRE_2017.

Jacobs, S. B., (2017, January 2). The Energy Prosumer. *Ecology Law Quarterly*, *43*, 3, 521, 532-533. Retrieved from: https://scholar.law.colorado.edu/cgi/viewcontent.cgi?article=1749&context=articles

Jaiswal, A., Kumar, M. & Samuel, Ch. & (2015). AN OVERVIEW OF DISTRIBUTED GENERATION IN POWER SECTOR. *International Journal of Science, Technology & Management*, 4,1409. Retrieved from: https://www.researchgate.net/publication/293332086_AN_OVERVIEW_OF_DISTRIBUTED_GENERATION_IN_POWER_SECTOR

Kelly, N. (2003).*SMALL SCALE ENERGY STORAGE IN A DISTRIBUTED FUTURE*, p. 1-3. University of Strathclyde. Retrieved from: https://strathprints.strath.ac.uk/6628/1/small_scale_storage.pdf

Kiefer. (n.d.). *Net metering*. Retrieved from: https://kiefer.gr/services/%CE%BDet-metering/

Koch, S. (2015). Assessment of Revenue Potentials of Ancillary Service Provision by Flexible Unit Portfolios. *In Energy Storage for Smart Grids*, p. 35-66. Retrieved from: https://www.sciencedirect.com/topics/engineering/transmission-system-operator

Kotilainen K. &Saari U. A. (2018, January 13). Policy Influence on Consumers' Evolution into Prosumers—Empirical Findings from an Exploratory Survey in Europe. Sustainability, 10,186, p. 3,22. *MDPI* Retrieved from: https://www.mdpi.com/2071-1050/10/1/186

Laporte, A. (2019, February 22). *Energy Storage*. Environmental and Energy Study Institute. Retrieved from: https://www.eesi.org/papers/view/energy-storage-2019

Leal-Arcas R., Lesniewska F., Proedrou F. (2018) *Prosumers as New Energy Actors*, p.139-151. Africa-EU Renewable Energy Research and Innovation Symposium 2018 (RERIS 2018). Retrieved from: https://link.springer.com/chapter/10.1007/978-3-319-93438-9_12

Open. (2019, August). *Reinventing billing for prosumers through net metering and net billing*. Retrieved from: https://www.openintl.com/net-metering-and-net-billing-reinventing-billing-for-prosumers/

Parag , Y. & Sovacool, B. K. (2016, March 21). Electricity market design for the prosumer era, *Nature Energy*, 1, pp2-3. Retrieved from: https://www.nature.com/articles/nenergy201632

Parag, T. (2015). *Beyond energy efficiency: A 'prosumer market' as an integrated platform for consumer engagement with the energy system*, p. 17. ECEEE 2015 Summer Study on Energy Efficiency. Retrieved from: https://www.researchgate.net/publication/277551805_Beyond_energy_efficiency_A_'prosumer_market'_as_an_integrated_platform_for_consumer_engagement_with_the_energy_system

PPC. (n.d.). *Πώς γίνεται ο συμψηφισμός της καταναλισκόμενης ενέργειας με την παραγόμενη από το Φ/Β σύστημα ενέργεια και πώς υπολογίζονται οι Χρεώσεις Προμήθειας & οι Ρυθμιζόμενες Χρεώσεις;*. Retrieved from: https://www.dei.gr/el/oikiakoi-pelates/xrisimes-plirofories-gia-to-logariasmo-sas/net-metering/pws-ginetai-o-sumpsifismos-tis-katanaliskomenis

Regulatory Authority for Energy. (n.d.). *Not interconnected islands*. Retrieved from: http://www.rae.gr/site/categories_new/electricity/market/mdn.csp

RES Legal. (n.d.). *Net metering*. Retrieved from: http://www.res-legal.eu/search-by-country/greece/single/s/res-e/t/promotion/aid/net-metering-law-no34682006-amended-by-law-no42032013/lastp/139

Šajn, N. (2016, November 11). *Electricity Prosumers*, p. 6-7. Members' Research Service Retrieved from: https://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI(2016)593518

Schneidewindt, H. (2017, October 25). Germany: Prosumers (Still) Welcome!. *Energy Democracy*. Retrieved from: https://energy-democracy.org/germany-still-fair/

Sia partners. (2018, September 9). Peer-to-peer (P2P) energy: A threat or an opportunity for traditional suppliers?. Retrieved from: https://energy.sia-partners.com/20180911/peer-peer-p2p-energy-threat-or-opportunity-traditional-suppliers

Taxheaven. (2015, January 5). *Αριθμ. ΑΠΕΗΛ/Α/Φ1/οικ. 24461/30.12.2014 Εγκατάσταση μονάδων ΑΠΕ από αυτοπαραγωγούς με συμψηφισμό ενέργειας κατ' εφαρμογή του άρθρου 14Α του Ν. 3468/2006*. Retrieved from: https://www.taxheaven.gr/circulars/20139/ariom-apehl-a-f1-oik-24461-30-12-2014

United Nations Industrial Development Organisation. (n.d.). *Industrial Prosumers of Renewable Energy Contribution to Inclusive and Sustainable Industrial Development*, p. 8 Retrieved from: https://www.unido.org/sites/default/files/2015-04/PROSUMERS_Energy_0.pdf

United States Environmental Protection Agency. (n.d.) *Centralized Generation of Electricity and its Impacts on the Environment.* Retrieved from: https://www.epa.gov/energy/centralized-generation-electricity-and-its-impacts-environment

What role does he aggregator play in balancing the grid?. (2017, September 15). *The Agility effect*. Retrieved from: https://www.theagilityeffect.com/en/article/role-aggregator-play-balancing-grid/

Σύνδεσμος Εταιριών Φωτοβολταϊκών. (2020, April 17). *Net metering*, p. 2. Retrieved from: https://helapco.gr/pdf/HELAPCO_Net_Metering.pdf