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The Role of Solar Power Prosumers in the Transition towards a Decentralized Energy System. Comparative Study between Lithuania and the Netherlands

Neringa STROPUTE

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Neringa STROPUTE

CENTRAL EUROPEAN UNIVERSITY

ABSTRACT OF THESIS submitted by:
Neringa STROPUTE
for the degree of Master of Science and entitled: *The Role of Solar Power Prosumers in the Transition towards a Decentralized Energy System. Comparative Study between Lithuania and the Netherlands.*

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The thesis analyses two countries, Netherlands and Lithuania, which have chosen energy policy strategies of transitioning to prosumers that enables essential changes to regulatory and policy structures to urge prosumer expansion. In Lithuania the decision to have more prosumers in the electricity system was influenced by the closure of Ignalina Nuclear Power Plant in 2009, while the Netherlands encounters a fast decline of local gas production of Groningen field and obscure prospects for unconventional gas.

This thesis aims to determine the measures needed to assure a smooth transition from centralized to decentralized energy generation by prosumers in Lithuania, while taking Netherlands as an example, where successful growth of prosumers is taking place. The thesis is a qualitative study explaining the energy transition from centralized to decentralized energy generation by prosumers in both countries. It focuses on policies, financial and other measures encouraging prosumers. Findings reveal that Lithuania has clear guidelines how to boost a number of prosumers in a country, however, some further steps could be taken following the example of the Netherlands. First, local government should have a more significant role in encouraging prosumers in Lithuania. Second, the communication is essential in urging prosumers as well, hence consultancy centers are key in disseminating information about opportunities of solar power in the regions. Third, to geographically separate electricity production and consumption places, system like Dutch *postcoderoos* should be implemented in Lithuania. The further recommendations how to meet the ambitious targets of prosumer development are discussed in the last chapter.

Keywords: prosumers, renewable energy policy, decentralization, solar power, electricity

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1. Introduction

The times of fossil fuels comes to an end since it is a scarce and polluting source of energy. With regard to nuclear energy, in the time of international terrorism worries about nuclear proliferation are growing. Hence, the future belongs to renewables, not only from an environmental but also from a security perspective. In addition, the remaining oil and gas reserves are found mainly in the Persian Gulf, in central Asia and in Russia. Thus, Europe encounters the risk of becoming dependant on politically unstable countries with undemocratic regimes. Nevertheless, if Europe succeeds in using renewable energies, the power balance could once again shift in its favour. Therefore, recently Members of the European Parliament (MEPs) called for a renewable energy target of 35% for 2030 – rather than the 27% which the European Commission proposed in 2016 (EP 2018).

As the main requirement for the accession to the EU, Lithuania had to close Ignalina Nuclear Power Plant by 2009, since the Chernobyl type reactors were considered unsafe. Therefore, to assure energy security, the current project of Lithuanian energy strategy (that is now waiting for approval in the Parliament) sets yet more ambitious targets for the development of renewable energy: to raise the share of the RES by 30 % in 2020, 45 % in 2030, and 80 % in 2050. The significant attention is given to the decentralized electricity generation as there is a planned gradual increase of consumers, who can produce electricity for their own needs. Such producers, who both produce and consume energy, are called – *prosumers*. Until 2020 it is planned to have approx. 34.000 prosumers (now there are approx. 350).

The Netherlands also faces energy security issues. Even though the country remains Europe's second-largest producer of natural gas, it encounters a fast decline of local gas production of Groningen field and obscure prospects for unconventional gas. Also, the Netherlands is one of the most fossil fuel and CO2-intensive economies in the EU, with the share of fossil fuels in the energy mix above 90 %. In addition, the country is behind its national target for renewable energy. Since 2005, the share of renewables in final energy consumption has increased from 2,3 % to 6 % in 2017, which is still far from a relatively ambitious target of 14 % by 2020 and 16 % by 2023. This is a significant encouragement to make a transition towards renewable energy sources faster and urge energy generation by prosumers. Therefore, the share of electricity generated locally is rising, especially due to the growth in solar power. Net-metering legislation and the sharp fall in the costs of solar panels induced this development.

The total amount of electricity generated by decentralized PV systems has grown tenfold between 2000 and 2014, and now between 400.000 to 450.000 households have solar systems installed on their roofs. If the sector continues to grow 40 % per year, 6 % of electricity in the Netherlands will be generated by solar power in 2020.

The implementation of RES development strategy thus implies a transition away from centralized energy production and top-down energy policy to rather decentralized RES system with a more democratized bottom-up governance approach. However, there is a number of issues related to the decentralization of energy system. First, increasing number of prosumers lower investments in the grid and can affect electricity bills for those who do not produce their own energy. Second, there is a need for substantial investments in transmission grid extensions and upgrades to include variable RES in the outdated energy systems. To solve those problems, on the one hand there is a need to include local stakeholders, especially municipalities as key actors implementing the policies of future energy systems; on the other hand, there is still a need for the central government to support local energy planning as well as maintain grid stability and overall balance in production and infrastructure. Therefore, there is a need to strike the balance between central and local government power in the strategic energy planning heading towards increasing share of RES generated by prosumers.

Aims and Objectives

This thesis aims to determine the measures needed to assure a smooth transition from centralized to decentralized energy generation by solar power prosumers in Lithuania, while taking Netherlands as an example, where successful growth of prosumers is taking place. It is also essential to identify any potential areas of improvement in the transition towards decentralized renewable energy generation by prosumers in Lithuania. Hence, the objectives of the thesis are:

1. To analyse the energy transition from centralized to decentralized electricity generation by prosumers.
2. To compare policies how prosumers have been encouraged (or discouraged) by RES policies in Lithuania and in the Netherlands.
3. To look what is the role of local authorities in encouraging decentralized energy generation in Lithuania and in the Netherlands.

The study is based on analytical examination of scientific renewable energy journals, news articles, policy analysis and interviews. The thesis is a qualitative study analysing the energy

transition from centralized to decentralized energy generation by prosumers in Lithuania and the Netherlands. It examines policies, financial and other measures encouraging prosumers in two countries. There is no research in the field of solar power prosumers done in Lithuania as it is a very new topic in the country and little research exists in the field of solar power in general. There is some research done on solar power development in the Netherlands with little research regarding prosumers. Therefore, this study will broaden the perspective on solar power prosumers in both countries and show what encouraged the transition from centralized to decentralized generation and what are the measures urging the development in this sector.

First, electricity transition to decentralized generation by prosumers in Lithuania is discussed. The attention is drawn to the economic impact of the closure of Ignalina nuclear power plant (INPP), a decision taken due to the accession requirements to the European Union. Prosumers' policy is analysed as a measure that helped to overcome the technological lock-in of nuclear power. Second, challenges and opportunities for prosumers' development in Lithuania are examined. Third, electricity transition to decentralized generation by prosumers in the Netherlands is scrutinized. It is stressed that the country heavily depends on fossil fuels. However, from the political perspective, there is a shift to a low-carbon economy. Hence, prosumption in the Netherlands gains ground and measures encouraging prosumers are analysed. Lastly, as the local government in the Netherlands is actively promoting renewables and prosumption, the case of Leeuwarden municipality is introduced.

2. Literature review

2.1. The concept of prosumer

First of all, it is important to point out that the definition of prosumer has emerged in 1980s and has been regarded in many contexts since then. It was first mentioned by Alvin Toffler in his book "The Third Wave" (Gerhardt 2008). Ritzer et. al (2012) claims that the definition of prosumer, someone that is both producer and consumer, is certainly not new, but rather primordial. For instance, humans are by the very nature prosumers since the hunting and gathering societies. The authors claim that presumption has always been a part of production and consumption. Therefore, Toffler (1980) defines the prosumer as someone who has blurred the lines between "producer" and "consumer".

The prosumer usually is involved in activities of either sphere, despite the location and time. Therefore, prosumer is usually an adopter of "connected lifestyle" (Gerhardt 2008). As there now is increasingly more immaterial production, consumers have been enquired to give ideas for advertisements, and some are being applied by producers. Thus, in reality, prosumers produce the sense that surrounds brands like Nike or McDonald's. Also, the ultimate social factories are the websites where prosumers both consume and produce ideas on, for instance, wikis, blogs or social network sites. Eventually, the authors highlight that even the workers with the lowest wages are paid something, while many prosumers work without remuneration (Ritzer et. al 2012.).

However, energy prosumers are encouraged by material remuneration. According to Ford et. al (2016), prosumer is "a consumer of energy who also produces energy to provide for their needs, and who in the instance of their production exceeding their requirements, will sell, store or trade the surplus energy" (p. 1).

The definition of energy prosumer is yet more complex. The European Parliament (EP) differentiates between four kinds of prosumers: 1) *residential* – residents who produce electricity on their property, usually by solar PV panels; 2) *community/cooperative energy* – citizen-led RES cooperatives, housing associations, foundations, charities that are non-commercial subjects but produce energy in order to self-consume, mostly by wind turbines and solar PVs; 3) *commercial prosumers* – SMEs, department stores, offices and other business entities whose major business activity isn't production of electricity, but which self-consume the produced electricity, usually by solar PV panels and CHP; 4) *public prosumers* – hospitals, schools and other public organizations which self-consume electricity (EP 2016, 2).

Different scholars analyse prosumers from a variety of perspectives. Delgado et. al. (2018) considers prosumers in the context of a net-zero energy buildings where the annual electricity consumption is equal to the annual electricity generation. It is also highlighted that buildings usually do not rely on one form of energy, hence heat prosumers are regarded too as buildings that generate surplus heat and export it beyond the system boundaries (Delgado et. al 2018, p. 495). Picciarello et. al (2015) regards prosumers from the perspective of inceasing volumes of distributed generation (DG) that can result in decrease or increase of distribution network costs. The authors point out that utilities must increase tariffs in order to meet the revenue needs. Users without self-generation will be more likely to face network price increases that can be considered as a cross-subsidy for prosumers (Picciarello et. al 2015, 24).

However, the EU has neither legislation, nor a common definition of prosumers. Nevertheless, current energy legislation includes certain provisions applicable to the issue at hand. The 2009 Renewable Energy Directive requests Member States (MSs) to grant priority access to the grid system for all renewable electricity production (2009/28/EC). The 2012 Energy Efficiency Directive enforces a similar requirement for small scale and combined heat and power (CHP) (2012/27/EU). Also, it requests MSs to urge participation and demand response in wholesale and retail markets as well as, when needed, to include aggregators. The 2010 Energy Performance of Buildings Directive does not have particular provisions on prosumers, however, it creates a need for self-consumption (2010/31/EU). It imposes the concept of "nearly zero-energy buildings" (nZEB), which will be a requirement for all new buildings from 2021, and from 2019 for new public buildings. The nZEB must redeem the little energy they require from RES "including energy from renewable sources produced on-site or nearby". The EC's 2015 communication on Delivering a New Deal for Energy Consumers perceives the combination of decentralized generation and storage options as well as demand-side response as the most suitable way of energy sector development (2015/2323(INI)). It draws attention to the fact that consumers are now not adequately remunerated for active participation in the energy market, and are at times even discouraged from self-generation. Collective self-generation is pointed out as entitling better energy deals for consumers.

2.2. The drivers of prosumer development

The focus of the literature on the emergence of solar PV prosumers are characterized by three major trends. First, sustainable increase in PV deployment that has showed how quickly the solar PV can be scaled up; PV markets have increased at an approximate of 40 % every year

since 2000. The cumulative amount of PV capacity has gone up from 20 GW in 2009 to more than 150 GW in 2014. Second, the quick drop in the costs of solar PVs that makes PV increasingly competitive as compared to retail market prices of electricity. PV module prices have gone through a significant decline from $1.90 watt in 2009 to $0.70/watt in 20013 (Jones 2013). Besides, the costs of inverter have also plummeted from $0.60-1.00/watt in 2005 to less than $0.20/watt in 2013 (Clover 2013). Third, the essentially decentralized nature of PV systems that makes it possible for residential houses and enterprises to directly invest in rooftop systems following the economical and other reasons, such as independence and self-sufficiency. Approx. 20 % of PV capacity was installed in Europe and US in 2013. All in all, about 25%-35 % of global PV capacity is being installed on the residential level (IEA-RETD 2014).

Due to such trends, PVs can be considered as a "disruptive" technology that could have a revolutionary impact on utility sector. Nevertheless, the report (IEA-RETD 2014) claims that a prosumer "revolution" in which consumers install distributed PVs without favourable policy has not yet occurred. Despite the fact that installation of solar PV is a growing global trend, still it's mass expansion is in the hands of policy makers. Hence, the increase of prosumers demands policies such as feed-in tariffs and net-metering. They are particularly essential due to the fact that the timing when the PV produces electricity usually does not match the time when power is consumed. Only consumers that totally detach from the grid (usually with the energy storage) can produce electricity without grid-related policies. However, taking the cost of storage into account, the widespread detachment from the grid at the residential level is not considered to be cost-effective in the near future. Nevertheless, lithium-ion and lead-acid batteries are the essential technologies that will likely be prevailing in the upcoming decade. For instance, the cost of lithium-ion batteries is expected to decrease from $700/kWh in 2013 to $300/kWh in 2020-2025 (Bronski et al. 2014).

However, the four major factors that can have positive or negative impact on the growth of prosumers are as follows:

1) economic factor is the price of solar PV, electricity prices, the ratio of self-consumption;

2) behavioural factor is the wish to have more energy autonomy, preserve the environment, social status' demonstration;

3) technological drivers are the trends of technology which can affect the prosumer increase like novel PV technologies, electric cars, energy storage, demand-side response, energy efficiency;

4) national conditions are factors such as entire rooftop space available for solar PV, the share of building renters versus owners, trends of electricity demand, conditions of electric grid (IEA-RETD 2014).

Still, Kotilainen and Saari (2018) would add that policy support is crucial influencer of sustainability transformations. Besides, policy makers and business experts claim that macro-level policies, such as incentives, tax schemes, as well as legislative enablers are required to encourage consumers' adoption of early environmental innovations. Hence, environmental policy instruments (EPI) have been introduced to attain environmental aims. EPIs are classified into "market-based" and "command and control" (Kotilainen and Saari 2018).

The policy strategies of the country can be separated into three major groups. First, constraining prosumers – when the government works to prevent the development of prosumers because they are considered as a threat to a grid stability as as well as incumbent utility sector business models. Second, enabling prosumers – means the creation of basic policies to encourage the growth of prosumers, such as self-consumption policies. Third, transitioning to prosumers enables pivotal changes to regulatory and policy structures to urge prosumer expansion (IEA-RETD 2014).

One of the major concepts inflicting the discussion about PV competiveness is the socket parity. It is commonly considered "as the point at which the cost of self-generated PV falls below the retail price of electricity" (IEA-RETD 2014, 15). However, even though the socket parity has arrived in few countries, it is argued that it does not in itself make up an attractive return on investment. The price of PV generation must drop below retail electricity cost before the system payback and return on investment becomes appealing.

2.3. Measures and policies encouraging solar power development

There is a number of policies that encourage solar power development. First of all, *renewable electricity standards (RESs)* are regulatory mandates, which demand that a particular amount of electricity produced in a given area come from desirable renewable resources. Few states have set goals to particularly support solar deployment and following those goals countries are increasingly planning solar *set-asides* within their RESs to provide targeted support of solar technologies. With no solar set-asides, the least pricy RES technology would normally be privileged, hence, set-asides are essential to encourage solar investments, especially when solar costs are higher that other accessible RES options. Additionally, set-asides can be particularly

favourable for distributed solar projects. In all, RESs that incorporate a solar set-aside provide a market signal that solar development is a priority for the country (Booth 2015).

Second, *feed-in tariffs (FITs)* are created to increase development of RES technologies by proposing long-term purchase agreements for electricity generation at set prices, consequently, granting market certainty for developers (Couture et al. 2010). Good practices of FITs use include linking solar FITs to high-level solar targets and a strong policy framework. Besides, foreseeably and gradually decreasing solar FIT prices – as solar costs continue to drop, setting a FIT price that predictably decreases over time can encourage stable market growth, improve investor confidence, and assist movement of solar prices towards a grid parity. In addition, considering the benefits and value of solar means policymakers should regard wider environmental, development, and social benefits that can compensate for associated costs and probable electricity price increases. Lastly, regarding linkages with other policies, in some countries, policymakers are regarding links between solar FITs and other encouragement policies, like auction processes, net-metering and tender. In some instances, auction processes are leveraged to support price setting for FITs of solar PVs. Following this method, a utility or government can require bids for solar projects and pick numerous winning bids until total capacity amounts determined tender capacity goal (Booth 2015).

Net-metering is a policy based on tariffs that sets the value of surplus electricity given back to the utility grid by a consumer that utilizes electricity from an onsite renewable energy system. Net-metering usually allows a consumer's electricity production to be subtracted from the electricity usage with the remaining amount setting the "net" kilowatt hours (kWh) for which the utility makes the customer pay, despite the fact when the electricity was produced or consumed (NREL n.d.). If customer generate more electricity that was used in a billing cycle, the surplus kWh generated can be "rolled over" like a credit for the upcoming cycle of billing or the utility can pay for the surplus electricity at a set rate (Booth 2015).

Well-suited net-metering policy can be operative in encouraging decentralized solar electricity markets. Together with simplified interconnection standards, net-metering can ensure that utility customers that lease or have small scale decentralized RES technologies get the appropriate value for electricity they generate and feed to the grid (Booth 2015).

A few good practices are considered from countries' experience applying net-metering policies. First, *setting appropriate capacity limits* – policymakers usually determine limits on the individual systems' size as well as on the overall capacity permitted for net-metering on the grid. Second, *designing proper billing approaches* – an effectively formed net metering policy will allow customers with a RES electricity system to consume electricity from the grid as

demanded to fulfil their load and to send electricity back to the grid when it is generated more electricity than needed (IREC 2009). Under such terms, the customer is charged only for the "net" electricity which is consumed within the billing cycle. Third, regarding aggregate net-metering approaches – aggregate net-metering permits aggregation of metering across different separate PV systems or across different customers for the one system. Permitting some flexibility in setting the location of generation and which customers it serves has the potential to use solar resources more efficiently. Following this method, community members and businesses can buy a particular amount of the electricity generated by PV system in the community and consequently get credits on the utility bills for electricity produced. These "community solar gardens" award communities and local governments with a novel approach to sustain more efficient system level results (Booth 2015).

Interconnection standards explain the conditions under which electricity generation by non-utility entities are allowed to join the utility grid. They should give easy rules to assure grid reliability while reducing the price and suspension for generation projects (NREL n.d). Interconnection standards are a precondition for a success of the solar development and are especially important for decentralized generation, as they assure that all renewable electricity projects are linked to the grid, provided they meet specific technical safety requirements (Booth 2015).

Investment tax credits (ITCs) diminish the tax liability for owners of solar projects relying on a capital investment in the project. ITCs have rather low transaction price and are especially effective when facing risks related with early deployment technologies which have rather high advance costs. Considering production tax credits (PTCs), the overall tax incentive obtained is set by multiplying the incentive level (per kilowatt hour) by the electricity amount produced by the appropriate project rather than by an investment in the project as in the case of ITC (Philibert 2011). The advantage of PTC is that it encourages optimal performance from solar plants, urging solar PV owners to invest in a good quality technology and assure good maintenance of the facility (Booth 2015).

Also, there is a number of key barriers to solar energy diffusion, such as customer inertia, high up-front investments, long redemption time, efforts related to planning and installation of the technology, lack of information and consumer anxiety about the reliability of solar PV. The author aim at comparing essentially different organizational configurations for the installation of residential PV in three markets using the concept of the business model as an analytical tool for examining US, Japan and Germany (Strupeit 2017).

In Germany domestic craft firms could flourish on a national unified system of feed-in tariffs as well as low interest loans that prevail PV deployment. From 2000 onwards, almost all electricity produced by solar PV has been directed to the grid and repaid by the utility according to a regulated feed-in tariff. Such arrangement is called "host-owned feed-in model". Lately, coming after severe drop in PV systems' prices and adaptation of feed-in tariff, the value proposition of solar PV in Germany has gone through an essential shift from the prevailing *feed-in model* to a *hybrid-model* that means more self-consumption and a reimbursement of surplus electricity through the feed-in tariff scheme. In such a hybrid model the essential customer proposition is (especially when incorporated with energy storage systems) – reduced electricity expenses, hedging against future electricity price increases as well as increasing self-consumption (Bohringer et al. 2017).

The author regards installer firms as the central point for building owners as they have the capability to tackle diverse barriers to customer PV adoption. From 2000 onwards a focal element of the customer value proposition of the German host-owned feed-in model has been to suggest building owners "a green, low-risk financial investment that is competitive with other financial investment opportunities" (Strupeit 2017,131). Furthermore, economic persistence had a major role in the adoption of solar PV systems in Germany. The principle of competitive return on investment was assured with a guaranteed revenue rate for each kWh, as established in Renewable Energy Act (Bundesgesetzblatt 2000). Legislators intentionally have fixed the level of the feed-in tariff to a rate that would assure a return of investment of approx. 7 % - a value that has been competitive as compared to other investment opportunities. The principle of low risk in the value proposition has not only been safeguarded by the fact that the feed-in tariff was legally established, but also that this rate was legally secured for a 20-21 year period, which generally removed any price risk for solar PV owners.

In the US, solar service firms have increased fast by means of a third-party ownership (TPO) and leasing model. Essential to the model of TPO are solar service firms which "plan, install, own and maintain PV systems at the premises of an electricity end-customer while using financing from a third party" (Strupeit 2017, 123). Following such full-service notion, the companies additionally assure needed building permits, deal with utility interconnections and proceed with applications for incentives and tax breaks. Building owners purchase the electricity generated from the solar PV for a set price over a 15-20 year time period under a power purchase agreement (PPA). TPO products suggest consumers an immediate decrease of the electricity bill of usually 10-20 %, a foreseeable electricity price over 15-25 years and eliminates the need for upfront investments.

From the perspective of the customer, the simplicity of the TPO model is seen from the business model. The consumer's single contact point is usually the solar service firm instead of a number of counterparts like maintenance and construction companies, bank, insurance firms or government agencies. Thus, the model is considered as a "full-service concept" since all the arrangements linked to the deployment of a PV system are carried by the solar service company. The solar service company makes the PV system available in return of periodic payments that are offset by the reduced electricity bills (Farrell 2018).

In Japan, cross-selling of solar PV systems in relation to other services and products is common, the construction industry especially has taken the lead in integrating solar PV in the prefabricated homes. In 2011, approx. 60 % of all prefabricated houses were sold together with a solar PV; while some home construction companies sold around 85-90 % of houses with PV (Strupeit 2017). The first houses with PV systems were sold in 1990s when the subsidies for residential solar PV were established and various subsidies at both, national and local levels, were launched. Safeguarding by the government in the 1990s that those subsidies will remain for several years urged increasing number of house construction companies to integrate into their houses. Hence, gradually, PV systems became as a standard equipment.

In Japan, both environmental and economic concerns played a role in purchasing solar PV systems. A new feed-in tariff scheme initiated in 2012 encouraged more consumer segments, which were concerned with improved household economy, to install PV systems. PV systems are presented as removing all of a household electricity costs and improving energy security, especially if incorporated with energy storage (Friedman & Seel 2016).

The expenses for the solar PV are usually embedded into the house mortgage, which reduces transaction costs as well as interest rates. From the perspective of the financial institution, the incomes generated by the PV system improves the creditworthiness of the loan-taker, and "a building-integrated system is even better as it cannot easily come adrift" (Strupeit 2017, 129).

An essential context factor accounting for the success of the solar PV diffusion is the predominance of highly industrialised prefabrication sector: "Japan's prefabrication industry is the most industrialized house-building industry in the world" (Strupeit 2017, 130). Another crucial contextual aspect is the domestic PV Industry. House producers usually prefer stable long-term partnership with the suppliers of PV modules rather than low costs or high conversion efficiency.

2.4. Drivers of cost reduction of solar PV

The authors aim to give a new perception into the long-term dynamics of deployment-related costs of PV (Strupeit & Neij 2017). The analysis of the composition of upfront costs for the deployment of a complete PV system represents the importance of costs that stem from the downstream segment of the value chain. Soft deployment costs come from diverse activities like: technical planning, installation works, operations concerned with financing and support schemes etc. The authors found that for a 5kWh residential system, soft deployment costs amount for approx. 38 % of the upfront costs (Strupeit & Neij 2013).

The analysis also shows that just like PV system hardware, the soft deployment costs have notably decreased over time. In Germany, the costs of soft deployment have plummeted by 65-85 % since the emergence of the residential solar PV market in 1990s. However, still the soft costs decreased slower than the costs for most of the hardware parts. For instance, costs for crystalline silicon PV modules dropped by approx. 92-94% from the 1990s to 2015; while the prices of inverters have plummeted by about 85-87% since the 1990s (Photon 2015). The analysis provided essential insights that more elaborate PV hardware components had an impact on part of the reduction in soft deployment costs. For instance, technology standardization processes, modularization as well as integration made possible easier reproduction of PV systems and consequently reduced the needed labour time for planning and construction (Strupeit & Neij 2017).

When examining the organizational and institutional aspects which impact the dynamics of soft deployment costs, the author stresses five points that impact the German solar PV sectoral innovation (Strupeit 2017): First, demand growth inflicted the market entry of many firms that functioned through various streams of the value chain. Downstream, numerous small companies got involved in the planning and installation of the PV systems. In the upstream, the increase of demand influenced market entry of many manufacturers of products which are essential integrating PV systems in the domestic infrastructure. This has most probably acceded to the drop of soft costs going along with market expansion.

Second, demand influenced a broad range of *interactions* between customers, companies, government authorities and other institutions. One major form of interaction is competition. As a consequence of increase in demand and of number of companies (producers, installers etc.) market concentration decreased and competition gained ground. Even though it is not fully investigated in the study, competition is believed to have influenced the pressed margins.

Third, knowledge generation and learning connected to deployment were discovered to be present across the whole value chain. Upstream, the progress of science and technology knowledge came as a consequence of progressively elaborate PV system elements, like inverters, modules etc. Technological progress made possible easy replication of PV systems and substantially decreased the labour time needed for planning and installation.

Fourth, the analysis found that the sectoral system encompassed an increasingly diverse and comprehensive knowledge base that also became present in more diverse portfolios of technology. Additionally, it can be considered that the significant increase in the number of companies (installers, producers etc.) in the solar PV market also resulted in a larger diversity of structure, strategies as well as agents. However, the selection environment in the sectoral system has become increasingly more rigorous. For solar companies, the decrease of industry concentration meant largely increasing competition.

Fifth, institutional development is considered to be a further factor that acceded the decrease of soft deployment costs. Diverse support schemes which have been conferred by federal as well as state governments, municipalities, utilities and citizen initiatives enabled demand growth and market enlargement. Additionally, the explanation of the grid connection process rules, The Renewable Energy Sources Act, tax and building law all in all resulted in simplified routines, shorter planning times, diminished uncertainty and a reduction in transaction costs (Strupeit 2017).

2.5. The history of solar PV in the Netherlands

In the beginning of 1990s Dutch government had considered solar PV as one of the most essential renewable energy sources after 2010 (Dincer 2011). However, in 2010, solar power share in the renewable electricity production was still only 0,6%, while it contributed just the modest 0,05% to the total Dutch electricity production. The questions arise – "what has gone wrong" or rather after decades of development with obviously little success, why solar power in Holland is still around at all? (Verhees et al. 2013). The authors claim that from socio-technical perspective, innovations, which are still not competitive with conventional technologies, can exist and improve in protective spaces, called niches, for long periods of time, because these spaces are free from diverse selection pressures arising from prevailing socio-technical regimes. Regimes usually choose to go against radical innovations because they present a contradiction with existent way of doing business in diverse dimensions (ibid.).

Protective space analysis is explored, examining the concepts of shielding, nurturing and empowering, in order to understand how PV proponents could create and sustain spaces for PV development in the Netherlands (Verhees et al. 2013). Shielding functions with the aim to repel selection pressures from socio-technical regimes and give space for experimentation. Nurturing then is aimed at assuring that this shielding space is utilized and to improve economic performance of solar technologies in order to diminish its reliance on shielding. Empowering means that sustainable innovation that was shielded and nurtured can turn into a market niche without the need of additional support (Smith & Raven 2012).

In Holland, solar power has become analysed by physicists and chemists as early as in the 1920s. However, in the 1950s nuclear became considered to be the most prominent Dutch energy source and the discovery of large natural gas fields further decreased the necessity of any renewable energy sources. Daey Ouwens, who was conducting experiments with silicon PV cells at Philips in the late 1950s indicated the perspective for solar power if utilized to abandoned large areas with high solar radiation. A 1973 symposium discussed the proposal and was well visited, mainly because energy had emerged as a central societal concern due to 1973 oil embargo of OPEC and political opponents of the nuclear energy proposed investing in solar power. However, the Minister of Economic Affairs claimed that it is "unacceptably expensive". Eventually, the Dutch government became worried about the risks of dependence on foreign fossil and consequently the National Steering Group Energy Research was set up, aimed at diversification of the Dutch sources of energy (LSEO). By the middle of 1980s few initial solar PV proponents took influential positions of university professors with direct connections to the Ministry of Economic Affairs. Therefore, the first research program exclusively for solar PV (NOZ PV 1986-1990) was set up with the aim to follow global solar PV developments. Consequently, by 1990s the government became more enthusiastic with regard to solar PV and the Dutch organization for energy and environment, the Ministry of Economic Affairs energy agency released a memorandum that pointed out that despite the fact that solar PV is still too costly it could become "the most important renewable energy option after 2010" (Statistics Netherlands 2010). The subsequent alteration in the 1990s was that from research to development and demonstration and, thus, solar PV made up the highest share of spending on research as well as implementation of renewable energy in Holland (Verhees 2013).

Following the energy crisis, electrical engineering firm Holec developed an interest in energy sector and in 1979 founded Holecsol Components – the first PV factory in the Netherlands. Furthermore, trade organization Holland Solar was set in 1983 in order to promote solar power (mainly thermal) as well as to represent its 15 members that were manufacturers,

academic institutes, consultants, constructors (Verbong et al. 2001). By 2008 approx. 30-40 small-medium size companies were participating in the solar PV sector in the Netherlands with different activities such as equipment supply to production and distribution. During this time the profit of the sector has grown by four times as compared to 2004, benefiting from rapidly developing foreign markets such as Germany with considerably more auspicious policies, exports of solar PV has grown considerably. As the expertise was dispersed between numerous rather small companies that did not have a common representative, the Solar Industry Platform (SIP) was established in 2011 in order to represent the interests of the multiple PV industry players (Verhees 2013)

First experiments with independent solar PV systems happened abroad, particularly in rural places that did not have well-functioning grid connection and where solar radiation was more substantial than in the Netherlands. For instance, Dutch firm Ceteco began selling water pumps powered by Holecsol's solar cells in the 1980s (Verbong et al. 2001). During this time solar PV proponents had considered solar PV as a tool for rural electrification in the former Dutch colony of Indonesia. Autonomous solar PV demonstrations were carried out in the Netherlands too. The first residential building was constructed with independent solar PV system in 1988 by R&S. The project was started by Daey Ouwens and the resident of the end-of terrace solar house in Castricum. It was subsidized by the Ministry of Economic Affairs and its energy research organization – Novem that made use of the house to represent its activities (ibid.).

In 1989, first grid-connected PV system was tested on a test house on the Dutch Energy Research Centre premises; it represented that grid-connected solar PV was technologically feasible in the country. Besides, when the government perspective on the support of PV turned to market development and the NOZ PV bunged has grown considerably, a number of building-integrated PV projects were constructed, making up few hundreds of houses. For instance, the Amersfoort 1 MW project was made up of around 500 houses (Jol 2008).

In 1995 energy company PNEM started promoting "green electricity" – the project that was largely successful despite higher prices. The campaign encouraged switching to green electricity by claiming that it tackles climate change. It was upheld by financial tools that paid off the price difference between 'gray' and 'green' electricity almost zero to consumers. As of 2000, the Implementation Scheme Energy Subsidies EPR – a subsidy tool set up to partly compensate customers for the buying of energy saving measures, also compensated the acquirement of solar PV technologies. The EPR subsidy budget was distributed annually and covered from the regulatory energy tax (REB) on the use of electricity. This substantially

increased sales of solar PV technologies, that plummeted after the EPR was stopped in 2003 by a new centre-right government, which considerably cut subsidies for green electricity. However, when a new centre-left government claimed power since 2006, new policies to urge domestic market for PV were introduced. A subsidy on use of solar panels was established (different from EPR that subsidized purchase). It became one of the Ministry of Economic Affairs broad Stimulus Policy Renewable Energy Production (SDE). The SDE aimed at both private individuals and companies, subsidizing the generation of of green electricity per unit being supplied to the grid. This policy tool also proved to be popular and the budget was rapidly used. From the 2011 onwards the rules were considerably altered by a new centre-right government and instead of "differentiated cost-of-production estimates for different renewable sources, a single amount was set for all renewables which for solar PV meant a drastic reduction" (Verhees 2013, 282).

2.6. The history of solar PV in Lithuania

In Lithuania renewable energy received attention from businessman after the adoption of renewable energy law (REL). This law provided numerous benefits for small power plant development. Legal environemnt was the most favorable for solar photovoltaic, whose common installed capacity was no more than 30 kW. According to REL 49.6 art. for power plants smaller than 30 kW there were simplified procedures for acquiring permissions. In addition, national price and energy control commission (NPECC) used to provide generous fixed feed-in tariffs that were 1.44 Lt/kWh and for integrated type solar power plants 1.80 Lt/kWh. It is obvious that such tariff attracted the attention of both, small and large entrepreneurs. Everyone who wanted to become electricity producers were in a hurry to obtain the permission from the energy ministry that would have guaranteed fixed tariff for 12 months time. Because such procedures were simplified, every citizen could have submitted the request and the fee of such service was symbolic (Milčiuvienė 2014).

However, legislators did not predict that 15 000 applicants will show interest in solar power development. Common installed capacity of solar power in 2011 was 0 MW, while in 2012 it reached 1.1 MW. It is obvious that for this reason the additional burden would be carried by all electricity consumers because the tariff for solar power was being paid from public services budget. Therefore, in 2013 the amendments to REL came to force that erased almost all the benefits (for power plants up to 30 kW) that were existing before. Generous feed-in tariff until the amendments of the law guaranteed stable income for solar power generation,

but from 2013 the article at hand became void. This happened because in 2013 NPECC introduced new fixed tariffs that were twice lower. In addition, new order changed power plants separation according to installed capacity. The amendments of the law fixed new gradation, because the small power plants were considered those, whose capacity is no more than 10 kW (previously 30 kW). Hence, fixed tariff became valid only for those power plants, whose capacity is no more than 10 kW, while larger power plants had to participate in auctions. Because producers who participate in auctions have to provide the lowest price for generated electricity, it became difficult to enter the market (Marčiukaitis et al. 2016).

In general, the legislator has clarified that REL amendments are valid even in reverse date. Even though it may seem as the most fundamental breach of the law, the state has defended itself because of the need to protect public e interest. However, businessmen were unsatisfied with such radically changing green energy policy. Businessmen highlighted that REL amendments breach legal generosity and legal expectations' principles of the Constitutional court (Milciuviene 2014).

2.7. The benefits and challenges posed by prosumers

There is a number of benefits posed by prosumers: First, avoided system losses – by producing power onsite, distributed PV eliminates the energy that is lost as a result of inefficiencies in supplying energy to the customer through transmission and distribution (T&D) system. Most of countries in Europe and North America experience transmission and distribution system losses of approx. 4%-8% (IEA-RETD 2014).

Second, avoided T&D capacity – by producing power onsite one can avoid the urge for investments in T&D capacity and this can make up crucial savings for utilities. PV prosumers have the possibility to be employed as an alternative to the expansion of transmission system. In sparse population countries spread over large area, encouraging the development of local prosumers can be less costly than expanding transmission system (Edenhofer et al. 2011).

Third, resilience – prosumers that also have storage can configure their systems to give back-up power in case of grid disruption. Fourth, local economic benefit – prosumers who obtain their own systems can get the full value of the system for themselves that has a more significant local economic multiplier effect than systems owned and operated by not local developers. Fifth, price hedging – PV systems have minimal operational and no fuel costs, hence, it effectively locks in the price of electricity purchases of prosumer in a long-run. Such price certainty can be a hedge for the prosumers in the face of volatility of other fuels (IEA-

RETD 2014; IEA 2011). However, there is a number of financial challenges for incumbents that arise from the development of prosumers. Prevailing local power production will divert revenues of electricity system away from one market participants towards others. PV prosumers (as energy efficiency measures) lessen electricity sales that results in the drop of revenues among incumbents of electricity infrastructure, reduces profitability, as well as likely increases in electricity prices as the fixed costs are distributed across fewer consumers. It is crucial to point out that prosumers mean lowered profitability as a consequence of reduced sales (Hansen et al. 2013). Electricity consumers are usually charged according to their quantity of usage with rather small fixed monthly or demand based charges. Hence, regulated electric system infrastructure owners have a financial inducement to urge increasing consumption and to prevent efforts to reduce consumption. Besides, incumbents have reduced profitability due to the suppression of the wholesale market price. Furthermore, there is reduced earning possibilities as a consequence of lower capital investments. Capital investments in the infrastructure of electric system is driven usually by the load growth. By reducing the growth of load, prosumers may consequently decrease the opportunities for new investments in electricity infrastructure by incumbents (similar as in the case of energy efficiency).

Entity	Possible Financial Challenge
Owners of electric system infrastructure	• Lower profitability due to reduced sales • Reduced earnings opportunities due to lower capital investments • Increased integration costs
Electricity consumers	• Rate increases/cost-shifting
Taxing authorities	• Revenue loss from reduced retail sales • Revenue loss on income tax from transition from FITs to self-consumption

Table 1: Potential financial challenges posed by prosumers (IEA-RETD 2014, 47)

3. Methodology

3.1. Overall research design

The thesis is a qualitative study explaining the energy transition from centralized to decentralized energy generation by prosumers in Lithuania and the Netherlands. It focuses on policies, financial and other measures encouraging prosumers in the two countries. The history and current status of solar power development is described as well. There is no research done in the field of solar power prosumers done in Lithuania and little research exist in the field of solar power in general. While there is some research done on solar power development in the Netherlands with little research regarding prosumers. Therefore, this study must broaden the perspective on solar power prosumers in both countries and show what urged the transition from centralized to decentralized generation and what are the measures encouraging the development in this sector. This leads to the approach of developing recommendation that can be used by the policy-makers and other key stakeholders that can be elaborated and used in the future, both in Lithuania and the Netherlands and other European Union member states.

Since there is a broad range of literature in the field of solar power and prosumage in the Western European member states, this thesis applied both, inductive and deductive approaches: conclusions raising from the research data were contrasted with other experiences in more advanced countries in the field.

The transitions in Lithuania and the Netherlands were analysed from a meta-theoretical framework perspective when techno-economic, socio-technical and political perspectives are integrated to analyse national energy transitions. Economic advancement, technological development, and policy changes are particularly essential features influencing energy transitions in different countries. Hence, analysing energy transitions requires a combination of variety of perspectives. Techno-economic perspective reflects energy flows related with energy extraction, conversion and use processes incorporated in energy production as well as consumption as regulated by energy markets. Socio-technical perspective is influenced by knowledge, practices and networks related with energy technologies; while political perspective explains the influence of energy-related policies (Cherp et. al 2018). Lastly, the thesis follows Grubler et al. (2016) definition of energy transition "as a change in the state of an energy system as opposed to a change in individual energy technology or fuel source". Therefore, following the approach of Cherp et al. (2018) this thesis focuses on national instead of regional or sectoral energy transitions. With all their complicacy, national energy transitions are connected with

national economies, policies and regulations, technologies, natural resources and innovation as well as infrastructure. These aspects are included in in national statistics and strategies available for empirical examination, which can confirm or refuse theoretical considerations.

3.2. Methods and problems of data collection

3.2.1. Interviews

The interview subjects were selected to represent a diversity of sectors in order to reveal the diversity of perspectives on the topic of solar power prosumers. Sampling in the thesis, as in any qualitative research, was done not randomly but purposively, which means that interviewees are chosen because they are "fit for the purpose" to reveal the peculiarities of a particular field of study. This qualitative research purposefully looked for knowledgeable experts, "who can contribute significantly to enriching the understanding of a phenomenon" (Carmichael & Cunningham n.d.) In the Netherlands the interviewees revealed their positions from these perspectives:

1. public sector (municipality of Leeuwarden - the most advanced municipality in the Netherlands in terms of solar power development);
2. private sector (solar power development company)
3. financial sector (sustainable bank)
4. distribution system operator (Westland energy solutions)
5. citizen perspective (prosumer)

In Lithuania the interview-subjects represented these perspectives:

1. public sector (Ministry of Energy of Lithuania)
2. distribution system operator (ESO)
3. private sector (the association of solar power of Lithuania)

The sampling process was affected by the idea of theoretical sampling. Theoretical sampling is a method when collection of a data and analysis are not separate processes of the research, but analysis of a data begins while collection of a data is still in progress. This examination gives direction for further collection of a data. This procedure stops when there is

enough of theoretical data collected. That is when further collected information does not produce any advancement of the theory but rather approve the so far reached conclusions (Robinson 2014). In the thesis theoretical saturation cannot be fully reached because of time limitations.

Most of the interviews were carried out in person. Nevertheless, in some cases Skype or telephone interviews were used in order to reach needed persons on time suitable to them. Regarding the interviews form, semi-structured interviews were carried out. That means that general interview protocol was used while at the same time the interview subjects were encouraged to engage in an open discussion, enabling them to widen the scope of the interview to areas not included into the list of questions asked. This enables the interviewer to avoid making essential mistakes, for instance, not examining crucial questions due to the lack of expertise in the topic analysed. With regard to the interview data, the information received was being continuously tested through the research that also led to the sustained development of the interview questions. The framework of the protocol of the interview was related to the interviewee (government authority, company representative, citizen etc.) and was aiming to reveal their positions in the process. The instances of the interview questions were as follows:

1. What do you think of government policies targeting solar power prosumers?
2. How does your organization relate to or encourage prosumers?
3. What are the key barriers to solar power and prosumage development?
4. What should be done in the country so that it would see a more rapid development of solar power prosumers?

Problems encountered during the data collection were numerous. First, it was hard to get in contact with a sufficient number of interview subjects, especially, in the Netherlands. For instance, The Ministry of Economic Affairs and Climate Policy of the Netherlands after the request to participate in the research responded that the Ministries in the Netherlands do not participate in the interviews. Besides, many solar power companies and NGOs responded that they are too occupied to make time for an interview. Second, the citizens interviewed had very little knowledge about solar power and the project they participated in. Third, other interview subjects, such as representative from the municipality of Leeuwarden, had a very extensive knowledge about the issue discussed but it was hard to find some official data (documents or articles) validating their arguments.

3.2.2. Methods and problems of data analysis

The interview data was examined by employing a qualitative research technique that has its foundations in the grounded theory approach. In this method the whole approach is based on gradually integrating the information collected into a narrower set of conceptual notions and categories. This is called lessening the information through abstracting. The examination of data then means going from the description to conceptualization. Coding is a process of attributing an interpretive label to notions, constructions, paragraphs or even themes that come from the collected information. Literature outlines approx. 40 diverse approaches to coding that obviously cannot be applied in a usual study. In this thesis, it is started with "open" coding, in which pieces of information are analysed line-by-line and given a code made up of word or phrase. To add more analytical depth, in addition to just using descriptive codes, during the analysis simple questions: "what?", "so what?", "now what?" where applied to the codes. First, (what?) a descriptive code is sufficient for denoting what is in the information. Second, one has to ask "so what?" aiming to code the meaning of the information. Third, "now what?" question regards the implications of the true meaning of the information (Carmichael & Cunningham n.d.). This resulted in few levels of coding that added analytical depth to the research.

The main difficulties arose from the fact that no similar research was done on this topic in Eastern Europe. Besides, little research is done on prosumers in general, as it is a relatively new topic in the EU. Without a predefined research tradition in this field of study, the thesis must have set up a basic knowledge framework in this science-policy area.

4. Electricity transition to decentralized generation by prosumers in Lithuania

4.1. The closure of INPP – political decision with economic impacts

The main source of electricity in Lithuania for more than thirty years was Ignalina nuclear power plant (INPP), which used to provide about two thirds of electricity in the country. However, due to political circumstances at the moment Lithuania is decommissioning INPP as a part of the country's accession's agreement to the EU. The main reason for such request was that nuclear power reactors were the same type (RMBK) as in Chernobyl NPP. Lithuania agreed with the demand that accession to the EU was possible only if the INPP was closed. Hence, the two reactors were shut down in 2004 and 2009 respectively (Aidukiene & Skaiste, 2013).

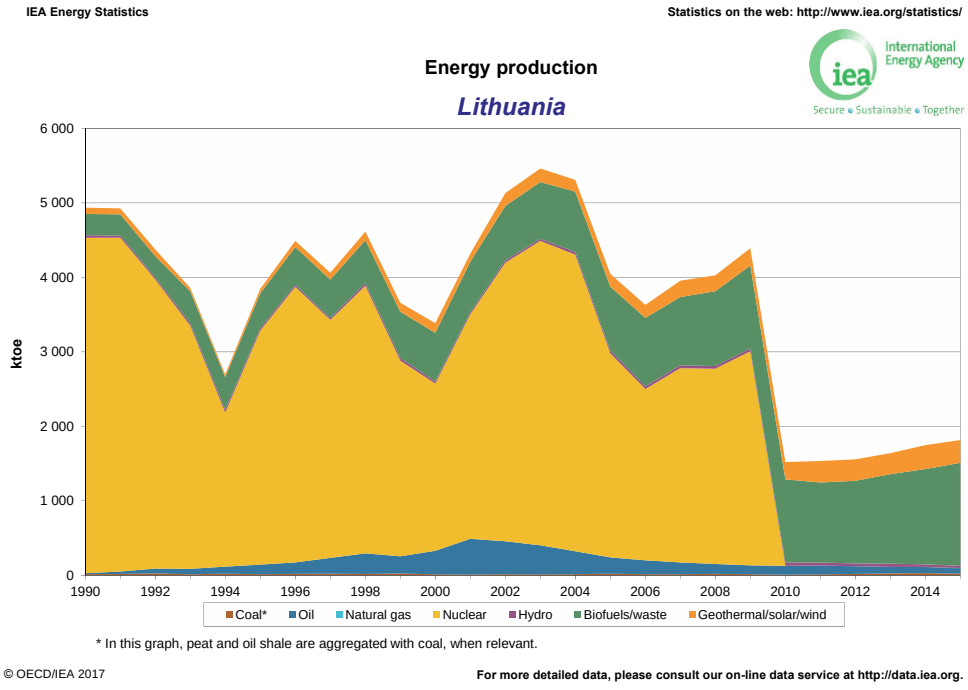

Figure 1: Energy production in Lithuania (OECD 2017)

Consequently, the local energy production has plummeted as shown in figure 1 and Lithuania became one of the largest energy importers in Europe (as shown in figure 2) with 68 % rate of imports (En.Strat. 2017). Also, Lithuania became an energy "island" as it had "one route of supply, one major energy source, and one supplier" (Svedas, 2017, p. 183).

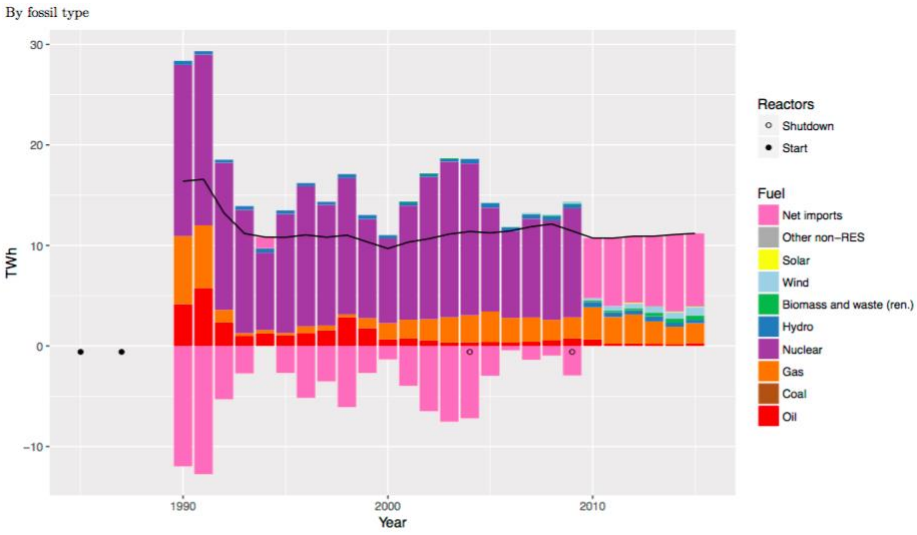

Figure 2: Lithuanian electricity balance

The Russian Federation, as a prevailing energy supplier, misused its predominant position, which raised economic and security threats. As we can see from figure 3, the prices of energy (in the example of industry) sharply increased since the closure of the second reactor in 2009. It again started to decrease from 2014, when liquefied natural gas terminal "Independence" was received and created more competitive gas market in the country (Stropute 2018).

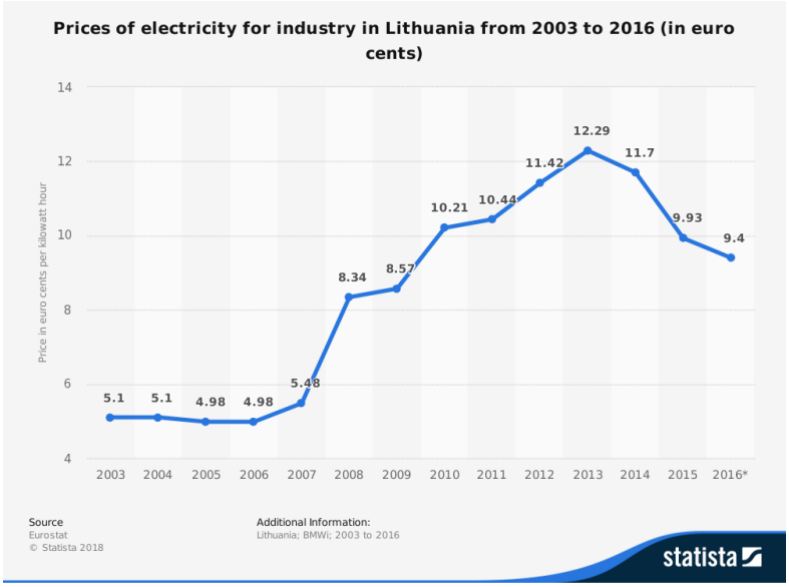

Figure 3: Prices of electricity for industry (statista 2016)

Lithuanian Energy Strategy (2012) clearly indicates Lithuania's dependence on a single supplier – Russia. The figure 4 highlights that imports from Russian Federation have amounted to 60-80 % of total electricity consumption between 2010 and 2013 (Norvaisa & Galinis 2016;

Svedas 2017). The chart depicts Lithuania's primary energy mix in 2009 and 2010, and the projection of how the structure should alter from 2016 to 2020. As mentioned before, in 2009 the INPP was closed, hence Lithuania's energy dependence from Russian Federation increased up to 80 %. From 2010 the separated line into continuous and dotted depicts that the level of dependence on Russia would slightly decrease due to increased share of renewables. At the same time, the continuous line shows the possibility to reduce energy dependence from Russia by implementing projects such as electricity interconnections with Poland (LitPol) and Sweden (NordBalt) as well as LNG terminal (2016). The new Visaginas Nuclear Power Plant should have played a major role in assuring energy independence from 2020 (Stropute 2018).

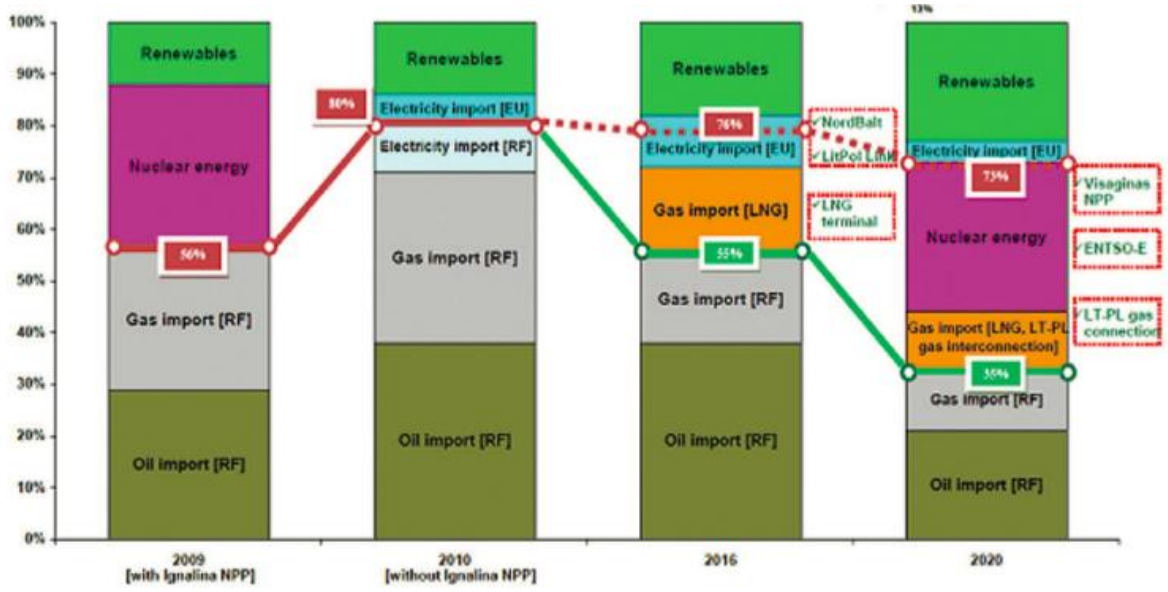

Figure 4: Lithuania's primary energy mix: reducing energy dependence on a single external supplier (Svedas 2017)

4.2. Techno-economic perspective suggests importing electricity

It is important to point out, how Lithuania succeeded to assure its energy security by strategic projects outlined in the Energy Strategy (2012). Regarding electricity sector, Lithuania belongs to BRELL (Belarus, Russia, Estonia, Latvia and Lithuania) electricity ring, which had been supplying the region with the electricity for about five decades. The system that was designed by the Soviet regime and still controlled by Moscow, is now regarded as a major energy security risk in Lithuania (Kokstaite 2017).

Therefore, Lithuania made considerable progress in developing new interconnections with the neighbouring countries. By the end of 2015 the 700 MW Lithuania-Sweden power link was built; the 500 MW electricity link Poland has been constructed in 2016 and eventually

connected Lithuania with the Western and Central European power systems. The power link's capacity will rise up to 1000 MW by 2020 (Norvaisa & Galinis 2016). Also, Lithuania has strong power connections with Latvia, Estonia, Belarus and Russia (Kaliningrad) as shown in figure 5. With all the interconnecting power lines operating, the adequate competition between the markets is assured and the opportunity to import electricity from the market suggesting the lowest electricity price in time will be accessible (Stropute 2018).

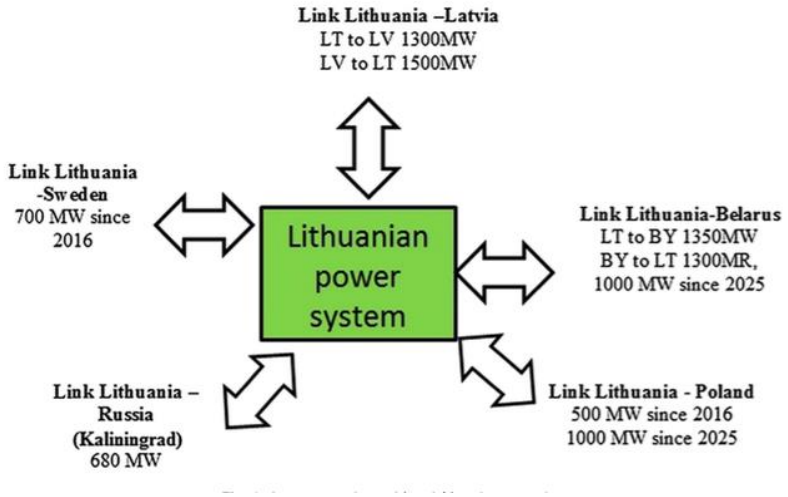

Figure 5: Interconnections with neighbouring countries (Norvaiša & Galinis 2016)

Therefore, the most attractive choice in terms of price – is importing electricity. It is seen from the figure 6 that different energy policies[1] have a substantial impact on the perspective electricity generation cost. Increasing the share of local production and increasing the security of electricity supply in all possible scenarios also increases the costs (Norvaisa & Galinis 2016). For instance, in "business as usual" scenario (IMP) the electricity price would be approx. 63 EUR/MWh; while 80 % of local production policy would raise the electricity price up to almost 120 EUR/MWh. The figure 6 highlights that from the economical perspective the most sensible choice is high share of electricity imports to provide electricity to Lithuanian consumers. Nevertheless, according to Norvaisa & Galinis (2016) "high share of energy imports makes the country vulnerable and raises concerns on security of energy supply" (p. 38).

[1] IMP – business as usual (Lithuania produces only electricity that is competitive under market conditions and remaining part is imported).
CAP50 – 50 % of local production from 2025.
CAP80 – 80 % of local production from 2025.
CAP100 – 100 % of potential local production from 2014.

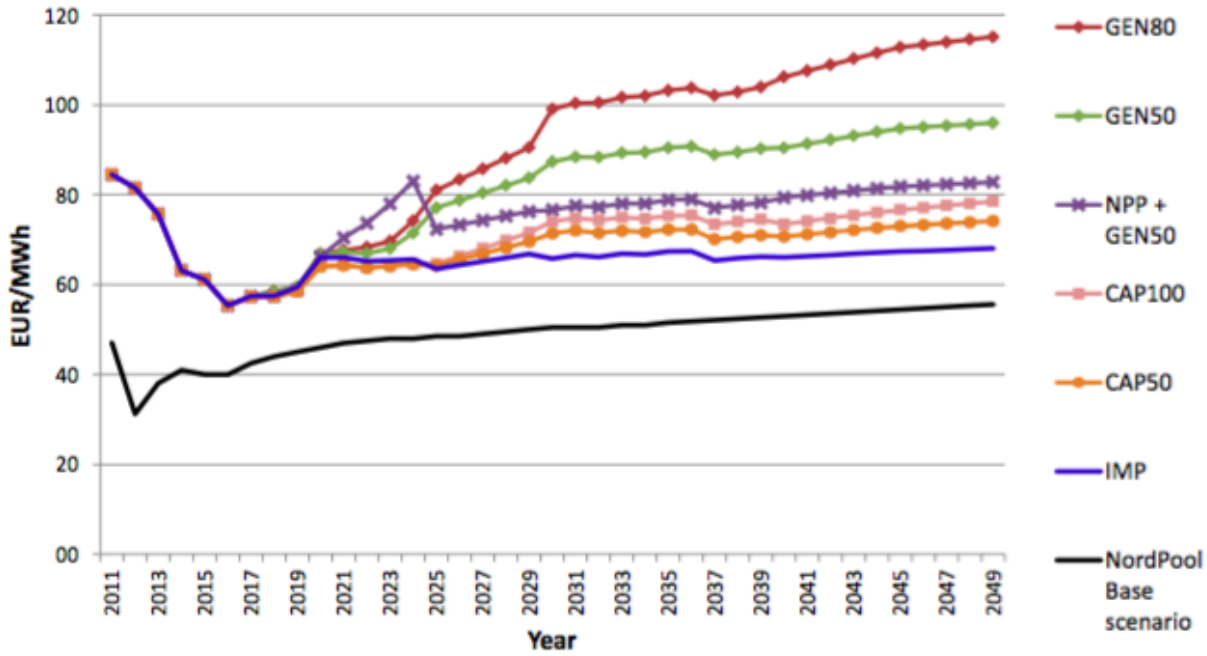

Figure 6: Electricity generation cost in Lithuanian power system (Svedas 2017)

4.3. Overcoming technological lock-in of nuclear power

Both, the Lithuanian energy strategy of 2012 and current project of the energy strategy 2017 highlight that Energy security is a top priority at least until 2020, with competitiveness and sustainable development becoming increasingly important later in 2030 and 2050 respectively (Stropute 2018). The Energy strategy (2012) points out that the energy demand will be met by local and diversified energy sources, including new nuclear power plant in Visaginas (VNPP). From the state-centric approach the VNPP was crucial to assure independence from external suppliers, especially Russia. Hence, already in 2007 Lithuanian Parliament adopted the law of Nuclear Power Plant. In 2011 Hitachi (Japan) was selected as a strategic investor and started preliminary works on the new NPP. However, in 2012 an advisory referendum was held on the issue of new nuclear power plant and 62.68 % of voters were against the VNPP. Consequently, the new NPP was not built and Hitachi closed its office in Lithuania in 2017 (Kokstaite 2017).

There was a number of reasons why VNPP project failed. First, the regional cooperation did not work as planned. The projects of such scale as VNPP usually are not in capacity of one small country like Lithuania (Stropute 2018). According to Cherp et al. (2017), nuclear power is usually deployed in large, rich and politically-stable countries (p. 614). Therefore, the regional cooperation was crucial for success of the project. Already in 2006 three Baltic countries agreed on the NPP project in Visaginas. Also, Poland was suggested to join the project with a total cost

of approx. 5 bln. EUR. Nevertheless, seeing the political instability with regard to the VNPP project in Lithuania the states eventually failed to agree and Poland was the first to leave the project (eadaily 2016). Second, Moscow seeked to discourage investments in the Visaginas project by suggesting two nuclear power plants near Lithuania's borders: one in Belarus (Ostrovets) and the other in Kaliningrad. Both projects aimed at creating commercial threats to VNPP. Third, election cycles played a major role in forming the discourse about the need of VNPP. In 2012 the socialists' opposition party started to review the energy strategy of Lithuania and decided to disagree with the VNPP project. The opposition party (now – the rulling party) organized an advisory referendum which eventually resulted in the closure of the VNPP project (Stropute 2018).

On the one hand the failure of the VNPP resulted in diminished energy security of Lithuania; while on the other hand it helped to overcome the technological lock-in of nuclear power in Lithuania and opened the window of opportunity for the renewable energy technologies. "For a niche to replace an incumbent regime, the regime first must be destabilized, for example by external (landscape) pressures" (Cherp et al. 2018, 180). Hence, the multiple reasons of the VNPP project failure served as the essential landscape pressures that eventually encouraged RES technologies and prosumerism in Lithuania (Stropute 2018).

4.4. Prosumers' policy - niches replacing incumbent regime

One of the major principles of the Energy strategy project (2017) is the energy independence as the energy dependence from the electricity imports has to be significantly decreased. Instead, local, reliable, competitive and sustainable energy production has to be encouraged. Hence, it is aimed that until 2020 35 % of total country's electricity consumption would be made of local electricity production; until 2030 – 70 % and until 2050 – 100 % (En. Strat. 2017, 23).

The question arises, how Lithuania aims to achieve these ambitious targets? One of the main measures to meet the energy independence goals is to increase the share of prosumers. In a long-term perspective energy consumers are expected to become active market participants since they will have a possibility to consume the energy produced for own needs and the excess energy to supply to the grid and to get paid according to the market price (Stropute 2018). It is expected that until 2030 there will be no less than 30 % of prosumers as compared to the number of total consumers, and until 2050 – no less than 50 %. The opportunities will be created for the prosumers to participate in the market through energy services providers. Also,

active energy community participation is supposed to be encouraged in order to urge the investment in joint ownership RES installations (En.Strat. 2017).

However, as Geels (2002) puts it, "radically new technologies need protection because they usually emerge as *hopeful monstrosities*" that have rather low technical performance and are expensive (p. 1261). Consequently, the conditions for those willing to become prosumers in Lithaunia have been improved. First, the prosumers' technology list has been widened, including not only solar power, but also wind and biomass energy consuming power plants. Second, corrections in the laws made that prosumers can be made not only residents and public companies but also legal entities. Third, the bureaucratic burden has been reduced as the time of administrative procedures was shortened by four times (EnMin 2018). The reduction of the administrative burden means that before you needed to get 30 documents, which would last between 100 and 130 days (Rytis Kevalaitis 2018). Today one needs to get only 3 documents, which lasts up to 20 days only. As Rytis Kevalaitis (2018) puts it "people should not be dedicating that much time for installing a power plant on their roof as this is not their main activity in life". Fourth, common installed capacity increased 10 times, from 10 MW to 100 MW (EnMin 2018). Since the quota is not that big (as compared to 750 MW of wind power) it is planned to review it after 2020 and maybe even refuse having the quota eventually at all (Rytis Kevalaitis 2018).

Key policies policies encouraging prosumers are as follows. First, sliding feed-in premium (FIP) provides RES plants with the exceeding capacity of 10 kW with guaranteed tariff rate (0.136 EUR/kWh). Also, installations integrated in buildings get a higher FiT - 0,169 EUR/kWh. The sliding FiP makes sure the prosumer gets the best available price. The guaranteed FiT is set once a quarter; if the sale of electricity is higher than the feed in tariff a premium is paid, which is equal to the difference. In case the sale of electricity is less than the FiT, the prosumer is rewarded by the value of the FiT. The sliding FiP is obtainable for 12 yeas from the moment of signing an agreement to connect to the grid together with grid operator. Second, the prosumers can apply for subsidies from the Lithuanian Environmental Investment Fund. Maximum amount of funding for small-scale projects is 14.500 EUR and amount of subsidy should be no more than 80 % of the all eligible expenses for the project. Third, prosumers are exempt from excise tax on electricity (Stropute 2018).

Fourth, for solar, wind and biomass power installations net-metering is applied. Following the Law on Energy from Renewable Sources, surplus electricity produced by prosumers can be fed into the electricity grid and fed back to the self-generating customers when electricity isn't produced. Suitable for net-metering are prosumer installations that are

operated by individuals (< 10 kW) and legal persons (< 100 kW). Net-metering time-period is set for calendar year from April 1. This means that consumers can produce electricity in summer months and use it in winter and autumn months (En.Min. 2018). For the self-generated and consumed electricity prosumer is exempt from paying a Public Service Obligation Levy. However, prosumers must pay the fee for the utilization of electricity grid fixed by the National Commission for Energy Control and Prices (Tallat-Kelpsaite 2017). For instance, according to Petras Mažeikis (director of Lithuanian solar energy association), he consumes just a part of the electricity produced by his own power plant, the surplus is supplied to the grid and then from late autumn till March, he takes the electricity from the grid. Then this energy is 10 cents cheaper per kilowatt hour after paying 0,37 cents for kilowatt hour grid fee (Šliužas 2017).

Fifth, from the 1st of June 2018 consumer producing electricity from renewable energy sources for their own use can more conveniently pay for the use of electricity network. After the creation of clear and transparent pricing, prosumers can choose one of the four payment methods. Just as before, prosumers can choose to pay a set tariff for each kilowatt hour taken back from the electricity network. Second alternative is – permanent monthly fee for power plant capacity (kilowatts). Third alternative unites both above mentioned measures, when the consumer every month pays both, the monthly fee for the power plant's capacity and the tariff for each kilowatt hour taken back from the network. However, both fees are lower than in the above mentioned cases. Finally, there is a possibility for consumers to pay with their own produced electricity (regula 2018).

Regarding a long-term prosumer development vision, the goal of the government is to implement necessary amendments so that every electricity consumer would have an opportunity to become a prosumer. To reach this goal decentralized energy production development will be carried out in four stages:

1st stage (from 2018.06): encouraging prosumers development in private houses;

2nd stage (from 2019.01.01) encouraging prosumers in apartment buildings;

3rd stage (from 2019.07.01) encouraging prosumers with providing the opportunity to geographically separate electricity production and consumption places;

4th stage (from 2020.01.01) involving prosumers in systemic services supply market (En.Min. 2018).

According to the energy minister Žygimantas Vaičiūnas, the goal of this strategy is that: "own power plant in Lithuania would be not an exception but a very usual thing. That is why we announced favourable conditions' start for small energy. After the implementation of

numerous amendments, to install a power plant at home and produce own energy from now on is simple, fast and financially beneficial" (enmin.lrv.lt 2018).

5. Challenges and opportunities for prosumers' development in Lithuania

The major opportunity with regard to prosumers' development lies in the expansion to the apartment houses market. Even though individual houses are the low hanging fruit, where the results can be achieved most easily, the government wants to empower as many people as possible including those living in the apartment houses too. "Here we see the synergy with the renovation of apartment houses. Those who take the opportunity to improve their environment and energy efficiency by renovation, at the same time could become prosumers", claims Rytis Kevalaitis. This is important because to take the decision for installing solar power plant separately you need the community agreement, which is difficult to attain. Hence, taking those decisions together could be more efficient. Therefore, the next call for applications for financing will be for apartment houses together with renovation. Still, the major obstacle to become a prosumer in an apartment house is that you need the agreement from all the residents, which is almost impossible to attain. Also, the question arises how to separate the energy produced among all the electricity users in the house (Maciulis 2018)

However, the research shows that, for example in the 5, 7 or 16 floors apartment house there can be only respectively 49,8 %, 19 % or 11 % of all the electricity demand of the house covered. Besides, after the economic valuation it becomes clear that the investments in solar power plants do not pay off (Valancius & Grigaliunas 2016)

Still, regarding the apartments, there can be few types of solar power plant ownerships. First model is when it is owned by the community and some part of the power plant belongs to each apartment, while the costs can be included together with the renovation. Second, is when ESCO company can install the solar power plant at its expense and then sell the electricity as a service. In this case the community does not own a solar power plant but signs an agreement to buy the electricity from the investor. Such a power purchase agreement is not widespread in Lithuania. This is mainly because it is new and also due to the fact that the most profit can be generated with legal entities (larger prosumers). However, the company Green Genius in Lithuania has started to work with small consumers and receive thousands of applications. This is in line with the aim of the Energy Ministry to have the diverse energy market for prosumers because not everyone has spare 5000 EUR for the instalment of a solar power plan. Hence services, of companies like Green Genius provide major opportunities for the market development (Rytis Kevalaitis 2018).

The next opportunity is geographically disconnected generation and here the Ministry of Energy looks at the variety of technologies. The remote generation is important as not all

individual and apartment houses have suitable roofs for generation. Hence, the goal is to have an opportunity to connect to the internet and by few clicks become a prosumer (Rytis Kevalaitis 2018). However, what has to be kept in mind is that prosumers from virtual power plants will still be using the grid, which means that they will not get the saving effect as in the case when you produce and consume electricity straight away. As the grid will be loaded anyway, prosumers will have to pay the fee for using the grid. Now, the prosumers of individual houses do not pay the grid fee for the produced electricity that they consume straight away (Giedrius Kvedaravicius 2018).

Furthermore, the role of the local government is essential in encouraging prosumerism. However, municipalities and energy communities are the stakeholders that are not employed enough in this development. Especially, in terms of communication the municipalities' role is crucial.

> It is very simple, people usually do what other people do. If the person sees an example in the neighbourhood, he or she is likely to copy it. We consider that we need to build a fake solar power plant in a remote village so that the passers by would see. This is due to the fact that people are not willing to do something first. Hence, I think that the communication of municipality is important (Rytis Kevalaitis 2018).

Also, municipalities could show a good example by installing solar power plants on their public buildings and have more innovative green energy solutions to make people see that it is not that risky, but rather accessible and understandable for a society. For instance, the Parliament in Lithuania declared willingness to build solar panels on its roof (Maciulis 2018).

Nevertheless, it has to be considered that from the Soviet times the powers in Lithuania are more centralized within the government. Hence, municipalities are the executors and not the formers of political environment. Besides, very few municipalities in the country have spare money to use it at their own disposal for issues like prosumer development (Giedrius Kvedaravicius 2018).

Financing prosumers development in Lithuania is one of the main opportunities for prosumers' development too. From June 2018 Environmental Projects Management Agency (APVA) announced the calls for applications for renewable energy sources use in individual houses, including the compensation for solar power plants installation. The planned budget for the call of 2018 reaches 3,3 mln. EUR. It is planned that consumers could get fixed compensation for installed power of the plant (kilowatts). The compensation will be provided for both, the power plants installed during the past 3 years and for the planned to install power

plants in the upcoming year. In total until 2020 the planned budget for support is 20 mln. EUR (vž.lt 2018). The financing system based on fixed tariff (about 300 EUR for installed kilowatt) is more transparent and less burdensome administratively (Rytis Kevalaitis 2018). The APVA support will cover around 30 % of all expenses of buying a solar panel. Hence, a person will have to invest its own 70 % and "17 mln. EUR support will become 50 mln. EUR of investments in the energy independence of Lithuania, which has not happened in the country before" (Maciulis 2018).

In addition, in June public investment development agency (VIPA) announced a call for soft loans for energy saving service provider (ESCO) companies that install electricity energy from renewable energy energy sources generating power plants for consumers. Although, according to the opinion of Vitas Maciulis (2018), the president of solar power association, VIPA's soft loans will not be a major encouragement as people installing solar panels will not find 2000-5000 EUR loan a very significant support.

This strong financial support led to the situation that there are very few prosumers, who installed solar panels without the financial support. In fact, 85 % of prosumers emerged due to support and only 15 % without support. Hence, if it is counted that an average prosumer has a 7 kW solar power plant, there could be approximately 15.000 to 17.000 new prosumers as a result of 20 mln. EUR support from the government. Therefore, the goal to have 34.000 prosumers seems rather unrealistic when observing the statistics (Giedrius Kvedaravicius 2018).

Still financial mechanisms are tightly linked to the need for an appropriate communication. In 2017 there was no communication in advance before the calls for financing prosumers, hence this led to a situation that there were not enough of applicants as expected. While in 2018, after the advanced communication people are constantly calling the Ministries of Energy and Environment asking about financial possibilities for prosumers (Rytis Kevalaitis 2018).

However, the main challenge that Lithuania is facing when seeking to have more prosumers is awareness raising. People do not know about this opportunity to become a prosumer. However, if they know, they think that it does not pay off or that it is very expensive. There are a lot of myths around solar power in the country, like that sun does not shine in Lithuania. Therefore, there is a need to have an extensive communication campaign. However, the results will not be reached instantly because the government is aiming at a relatively large group of people – few hundred thousand consumers and enterprises (Rytis Kevalaitis 2018).

Still, “the change can be seen as some people now become the ambassadors of prosumerism”, - says Rytis Kevalaitis (2018).

In addition, the Lithuanian association of solar power suggests that the government should establish at least 5 consultancy centres in Lithuania that would provide the information for the residents how to become a prosumer, would advise on solar power electricity and heating opportunities combined (Maciulis 2018). The Energy Ministry has declared that there should be more information sources on how to become a prosumer but did not dedicate the essential resources for this. The Lithuanian association of solar power organizes seminars in Vilnius, where around 30 people come. But there is a need to reach more people, especially in the regions. There should be offices in the regions with exemplary solar panel installations and professional well-paid consultants. Now, the Lithuanian solar power association is being contacted to answer the questions how to become a prosumer, but it does not have enough time and resources for professional full-time consulting (Maciulis 2018).

Furthermore, the bureaucratic procedures for becoming a prosumer are still excessive (Giedrius Kvedaravicius 2018). The procedures are simplified for power plants up to 5 kW, while most of the power plants are 7kW. Besides, it should be ESO that would decide where it is feasible to install a power plant and where not. There should be not a legal but technological control when an engineer could see if there is a free capacity in the grid. In this way permissions for development and generation could be avoided (Giedrius Kvedaravicius 2018).

In addition, in Lithuania the solar power plants are perceived as a very risky business. “For instance, the bank gives 7 % interest rate for the period of 5 years, which is not logical because the reliability of solar power plant installation is the same as to built a house” (Giedrius Kvedaravicius 2018). Hence, the ESO and VIPA fund will be first of such a kind (with lower interest rates), but it is hoped that later other banks would follow too.

Besides, there is no maturity of market participants. There is a need to have installer companies that would install the solar power plants and provide the performance guarantee. In other words, if the power plant is built, there should be a guarantee that it will produce electricity for 10 years and if it will produce electricity for a shorter period, the client will be paid the guarantee. The risk that would be taken by the company is minimal but it would contribute significantly in building trust among the consumers (Giedrius Kvedaravicius 2018). Now, there is a lack of market participants in the solar energy sector because after the unsustainable policy of solar power development in 2012 most of the solar companies switched to other sectors. Thus, to have more solar power installing companies, there is a need for

sustainable policy in this area and that the current ambitious energy strategy would be implemented (Maciulis 2018).

Most importantly, there still is a need for increased cross-institutional communication, because the encouragement of prosumers is not the field of the Ministry of Energy only. Also, there is a need for cooperation between both, private and public sectors. If all stakeholders will have one goal of encouraging prosumers, then the goals enshrined in the new Energy Strategy will be met (Rytis Kevalaitis 2018).

Lastly, distribution system operators need to change their role and adapt in a changing environment with prosumers. For instance, ESO chose a new strategy to be proactive with regard to prosumers' development. The company even installs solar power plants themselves delivering it as a service. It does not help to earn a large profit but assists in clearing the role of ESO as smart platform managers. Besides, the company looks at blockchain opportunities to change the electricity infrastructure system, when people could directly trade with each other. In this scenario, ESO becomes more as a facilitator and manager of an infrastructure (Giedrius Kvedaravicius 2018).

6. Electricity transition to decentralized generation by prosumers in the Netherlands

The Dutch energy transition is deeply rooted in the state's energy discussion since its beginning in the National Environmental Policy Plan of 2001 (VROM 2001). Following this plan, the energy system of Holland was one of the first where transition management (a novel governance approach towards sustainability) was invoked in an integral manner. Nevertheless, despite the policy goals, the energy transition of the Netherlands is markedly behind other EU countries: Holland was able to only slightly raise the share of renewable energy in final energy consumption from 2,6 % in 2006 to 3,8 % in 2010. In the meanwhile, the approximate share of the EU has increased from 9 % to 12,4 % (Eurostat 2012). The literature concentrating on the Dutch energy transition highlights that the main reason for such being behind is a considerable fossil fuel regime in which incumbents play a major role (Van der Loo and Loorbach 2012).

The study of Bosman et al. (2014) reveals that dealing with the climate change is the main issue regarding the energy transition, even though assuring the energy supply and maintaining it affordable is considered as equally essential. Social and political anxiety about climate change is regarded as the main stimulus of the energy transition. Thus, reducing CO2 emissions is largely regarded as the main challenge facing the energy system (ibid.). Nevertheless, the aim of decarbonisation is usually considered as clashing with the pillars of the *golden triangle* (security, affordability and sustainability). It is generally argued that the government should develop a favourable investment environment aiming to decarbonize the energy system. However, as the government makes an effort towards such development it is criticized due to the fact that these interventions can negatively affect the investment climate. Therefore, it is claimed that the intervention of the government should be minimal (ibid).

As a member of the EU, the Netherlands participates in being a part of the EU directive on renewable energy. The Dutch government also signed the EU directives in a format of a National Renewable Energy Action Plan (NREAP) (Sutrisno et al. 2015). The Dutch energy agency forecasts that if the NREAP policy on boosting renewable energy use is carried out, the percentage of renewable energy will raise to 8 % in 2020. However, it is not enough to achieve the target of 14 % by 2020 enforced by the EU (Verdonk and Wetzels 2012).

The main interest groups in the energy transition of the Netherlands are the Dutch energy firms, government and citizens as a consumer of energy products. The consumer mainly will have affect on demand side of the energy system, mostly based on affordability of energy price compared to the income. The energy company on the other hand prefers to have a high energy price to increase their profits. Such relationship develops a conflicting interest between

two actors. The Dutch government has made an effort to form a task force that failed to achieve desired results. The reason behind poor RES performance was an effect of having a low price of energy. As the energy price was decreasing, the energy consumption was rising to a point where measures of adding conventional energy had to fill the deficit between the supply and demand. The lack of government encouragement urged the energy companies to return to traditional energy development (Shell 2012). Besides, consumer satisfaction questionnaire revealed that 83 % of the Dutch citizens think that the government has to put more efforts in attaining the RES goal.

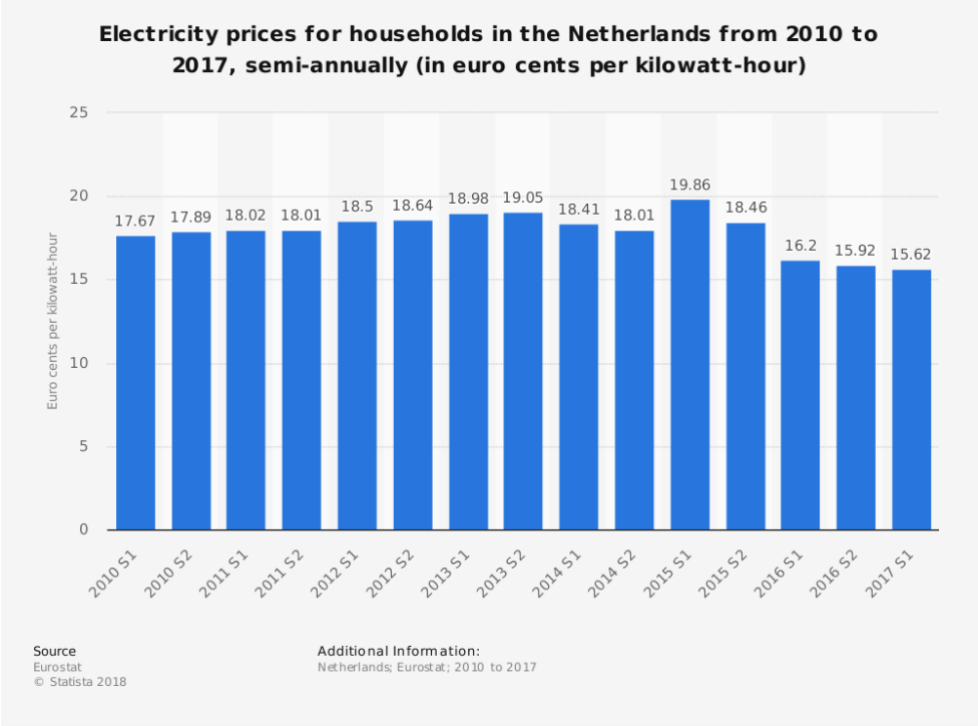

Figure 7: Electricity prices for households in the Netherlands 2010-2017 (statista 2018)

6.1. Supply of energy shows dependence of fossil fuels

The Dutch energy mix is predominated by fossil fuels that produce more than 90 % of total primary energy supply. Natural gas delivered 41.7 % of energy (2012), 39.4 % were supplied by oil. While only around 6 % of total supply was coming from renewable energy that was mainly made up from biofuels and waste (4,7 %) and just 0,5 % from wind, 0,1 % from solar (IEA 2014).

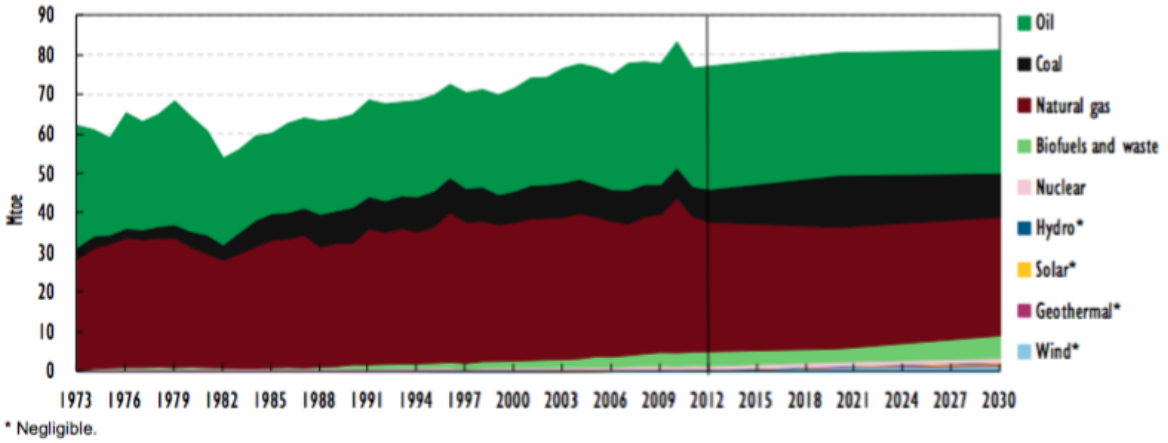

Figure 8: TPES with projections, 1973 – 2030 (IEA 2014)

The Netherlands is the second largest producer as well as exporter of natural gas in Europe. The country owns offshore natural gas fields in the North Sea and onshore natural gas fields in Groningen. Political concern due to earthquakes caused by extraction of gas has influenced the Government to cap gas production from Groningen field. Consequently, net gas exports have fallen considerably since 2014, causing production to fall from 27 bln. Cubic meters in 2014 to 21.6 bln. Cubic meters in 2017. Even larger production limits are expected to cause further production decreases in the near future (export.gov 2017)

In the past years there has been a moderate change in the energy mix towards increased use of renewables that is expected to further raise because of the earthquakes in Groningen. The most evident change has been in wind power, biofuels and waste, with energy from these sources rising by 427 % and 85 % respectively. The consumption of solar energy has increased by 60 % as well (IEA 2014).

6.2. Political perspective focuses on a low-carbon economy

From 2008 onwards the Netherlands has been relying on the Clean and Efficient Program and the Energy Transition Framework. The energy policy of the country is relying on the EU framework of the EU 20-20-20 goals that insist on 20 % in GHG reduction, 20 % increase in energy efficiency as well as 20 % of renewable energy by 2020. Consequently, the Netherlands has a national target of 14 % of renewable energy following the EU Renewable Energy Directive 2009/28/EC. Furthermore, it is bound to reduction of GHG emissions by 16 % in 2020, below levels of 2005 (IEA 2014).

In 2011, the Dutch government introduced the Energy Report 2011 that is meant to set the energy and climate policies. It represents the ambition of the country increasingly more

sustainable with respect to energy as well as less reliant on fossil fuels in the transition to a low-carbon economy in 2050. The report introduced the essential pillars of the energy strategy of the Netherlands: assuring reliable supply of energy with competitive prices as well as green growth as major economic goals, while keeping an international perspective in the long-term transition to sustainable supply of energy. Sustainable development is a central priority of the Rutte-Asscher coalition government with an aim to attain a sustainable system of energy supply following the international perspective of the Dutch economy (Green growth n.d.).

It has been observed that the energy transition policy of the Netherlands, had come to a point of stagnation due to the experiencing of short-sighted priorities of ever changing government coalitions. Thus, the parliament of the Netherlands created a longer-term vison and more coherence in policy making with respect to energy in its 2011 "National Energy Transition Agreement" (IEA 2014). Furthermore, a new Energy Agreement for Sustainable Growth was released in 2013, which introduced a ten-point action plan for 2020 aiming to secure the balance between competitiveness and sustainability. For prosumers, the third point is of particular importance as it promotes sustainable energy when introducing tax breaks for locally produced renewable energy by "cooperative or by an association of owners located in the same neighborhood (with the same four-digit postcode plus adjoining postcode areas), and using the production for self-consumption" (SER 2013).

6.3. Prosumption in the Netherlands

The development of electricity supply has altered substantially since the liberalization agreements in the Member States enactment in the 1990s. Consequently, consumers progressively shifted themselves from being merely consuming electricity to also producing. The most significant instance being households installing solar panels to partly generate own environment friendly electricity. This has been largely influenced by decline in cost of solar photovoltaics technology (IRENA 2017). As a consequence of these trends, PV is being recognized as a "disruptive" technology that can revolutionize the whole utility sector. In the Netherlands the amount of electricity produced by solar PV systems has increased 10-fold from 2000 to 2014. It is expected that power generated with residential PV sector will soon be less expensive than centrally generated electricity (Belkom et al. 2016).

Besides the financial motivations, the environmental reasons motivate households to pick renewable energy. Also, the awareness and knowledge of the technology are strong drivers of solar power development (Zahari et al. 2016). Furthermore, local energy storage is

getting increasingly more attention when considering prosumerism. Until now the sector has developed largely on the grid scale, but the significant opportunity lies behind the meter, which would really drive the storage sector from forebearance to mainstream (D'Aprile et al. 2016).

Self-consumption is increased with increasing number of solar PV systems in the community in a linear manner in the presented scenarios 1 and 2, where no peer-to-peer exchange takes place. Scenario 1 indicates lower self-consumption as compared to the 2nd scenario which depicts higher self-consumption when storage technologies are installed. In scenarios 3-5, the rise in the number of PVs in the community positively affects communities' self-consumption, but the effect is evened out at higher PV system penetration (since all households have PV systems in the community, exchanging energy within community is hardly possible because prosumers produce enough for themselves). Overall, adding more peer-to-peer exchange in a community appears to be more efficient in raising the self-consumption than adding more batteries (Figure 9) (Belkom et al. 2016).

Table 2: Five prosumption scenarios (Belkom et al. 2016)

Table 1 Five prosumption scenarios

	Residential storage	Peer-to-peer exchange	Preferred application of excess electricity
Scenario 1	No	No	–
Scenario 2	Yes	No	–
Scenario 3	No	Yes	–
Scenario 4	Yes	Yes	Peer-to-peer exchange
Scenario 5	Yes	Yes	Store

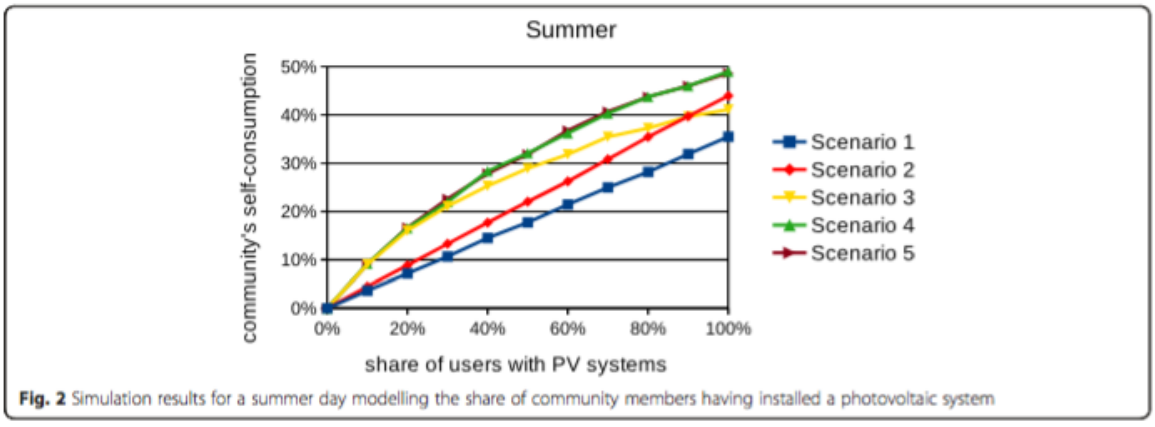

Fig. 2 Simulation results for a summer day modelling the share of community members having installed a photovoltaic system

Figure 9: Simulation results for a summer day modeling the share of community members having installed a photovoltaic system (Belkom et al. 2016)

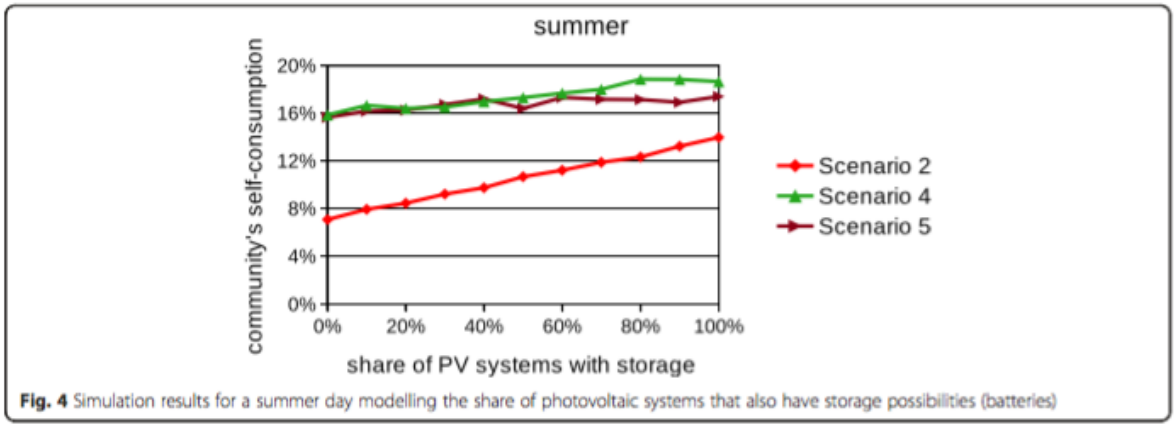

Figure 10: Simulation results for a summer day modelling the share of photovoltaic systems that also have storage possibilities (batteries) (Belkom et al. 2016)

Prosumption has implications for grid management and the supply of electricity. Following the conditions of local energy storage combined with peer-to-peer consumption the community has the potential to develop approx. 28 % prosumption share. Hence, balancing the local electricity grid becomes increasingly crucial for the DSOs with the central grid as the the exchange and back-up option. The business case relying on the cost-of-service is still prevailing and charges for the utilization and services supplied by the grid. This model becomes irrelevant when the number of prosumers increases and less consumers use the grid (GEODE 2018). Thus, the transportation costs have to be shared with less customers and this might result in what is considered as "utility death spiral" when fewer users will confront increasing transportation costs, motivating increasing number of consumers to become prosumers. In Holland the electricity transfer costs are socialised, meaning that every customer in a particular area pays the same price for electricity transmission. Thus, the price of transport will rise for those users who further use the grid as the number of prosumers increases. The Dutch operators realised this risk and thought through their role in the future energy system by offering additional services such as storage and demand flexibility (Belkom et al. 2016).

Area-based storage capacity has the potential to be a novel service of the DSO that is currently tested in pilot settings in Holland. Additionally, grid manager could suggest expertise to local consumers who consider to become prosumers or develop new ways to arrange production and supply in local communities. Moreover, DSOs could have an impact by urging electricity saving and efficiency, such as "Buurkracht" initiative that enables energy savings in the neighbourhood. All in all, DSOs in Holland are currently developing novel financial market models to connect to the evolving electricity market in order to sustain the grid as a trustworthy and affordable foundation, to suggest price flexibility and grid connection. Here, the

telecommunication tariffs can be an instance for electricity supply: customers purchase capacity instead of paying for a connection to the network. Thus, electricity tariffs could evolve similarly – charge for transmission capacity rather than connection to the grid. Such capacity tariffs would provide a much better solution for prosumers' flexible needs. Flexibility in the market of electricity supply, for instance, to deal with different weather conditions like strong winds and sunny days that add up to significant peaks in energy supply, demands considerable storage capacity in the grid to outbalance the volatility in the supply of electricity (Belkom et al. 2016).

6.4. Measures encouraging prosumers in the Netherlands

There is a number of policies encouraging prosumers in the Netherlands and assisting solar power to develop from a protected niche to a regime. First of all, net-metering system (*salderen*) is in place, which means "setting off the consumed electricity with the supplied electricity by the customer via the same connection" (Leeuw 2017). It assures 23 cents per kwh for producing energy, while in reality it is just approx. 14 cents per kwh (Boer de Bouwe 2018). Nevertheless, the system does not encourage overproduction because one gets less (only 5-7 cents per kwh) if produces more than consumes. Thus, people get only the amount of solar panels that would cover their own consumption (ibid.). The net metering system that urged the installation of residential solar power capacity of about 1,5 GW was set to expire in 2020 (Bellini 2017). However, the Ministry of Economic Affairs of the Netherlands has announced that the net metering system for residential renewable energy generators will most probably be prolonged to 2023 (ibid.). This is due to the fact that "the net metering system is the breakthrough in Holland" (Boer de Bouwe 2018). According to official statistics, 69 % of total generated PV market volume in the Netherlands came from residential PV capacity (Bellini 2017).

However, since the national government started with the national program for solar panels, many people could not join the program because they did not have a suitable roof. Therefore, the system of *postcoderoos* was created (Boer de Bouwe 2018). Postcoderoos is a defined area in which a local energy cooperative can recruit participants for the renewable energy project. The participants invest in the common solar power project and get the right to be exempt from the energy tax (Berix 2018).

So normal consumer would pay 18 cents per kwh, of which around 12 cents is a tax. People that invest in the solar system do not have to pay the tax. Hence, they would have to pay around 6

cents per kwh for 15 years. After 15 years they are not the owner anymore and have to pay according to a regular energy contract (Berix 2018)

The condition is that these participants are connected to the grid through a small-user connection (max. 3 x 8o Ampere). This *postcoderoos* area is determined by the place (postcode) where the energy generation project is located. This 4-digit area is the center of the "rose". The whole *postcoderoos* area is formed by this centre together with connected all other four-digit postcode areas (that form the leaves of the "rose") (postcoderoosregeling.nl). Nevertheless, the project is not actually connected to the house through the grid, it is just an administration (Boer de Bouwe 2018)

The responsibility for administration of the project goes to local energy cooperative. However, the developing company also bears some responsibility. Since local energy cooperations are founded by the citizens, they often do not have the knowledge to run a project. Therefore, the developer is asked to find the location and offer the best solution. For instance, in Maastricht the suggested location for the project was the local stadium. Nevertheless, it is just a first such *postocoderoos* project in the region due to the concerns of the people about the ruining of the landscape (Berix 2018).

In addition, even though the system works as if the PV system was connected to your roof, it is even cheaper to operate it as a community. According to Boer de Bouwe (2018), this is because of the larger size of the project, during which you can install 1000 solar panels instead of 10 and you can even place them on the ground instead of the roof. However, the program is very complex and often requires assistance of other companies to take care of the administration of the project. Therefore, for instance, in Leeuwarden municipality there are only 4 such projects at the moment. Still, it expected that the number will increase to 20 projects in the next year since it was made simpler by private sector companies, such as *postcoderoosregeling* (ibid.). Also, an increasing number of consumers are joining the program due to a community feeling and urge to be part of one project.

However, if a person does not have enough income (around 4000 EUR) to buy own solar panels or invest in a community project, one can rent a roof to another company through a third party ownership system (TPO). Since the company rents one's roof to put solar panels on it and sell the produced electricity at a fixed higher price, the house owner gets the reduction on the energy bill of around 10 EUR a month as well as 50 EUR when for joining the project. The challenge of this system lies in the complexity of the contracts being made. The specific contracts made with the building owner have to answer questions such as, what if owner has a

mortgage, looses the house or sells it? The projects are being build for 25 years and have to address diverse situations that can occur within this period of time (Berix 2018). So when the roof is rented the owner can either buy the electricity from the company that installed the PV system or not. In the latter case the installing company can apply for the SDE + program.

The SDE+ (*Stimulering Duurzame Energieproductie*) is a currently functioning grant program for renewable energy. Producers get financial compensation for the generated renewable energy. This is due to the fact that renewable energy is not always lucrative because the cost price of RES is higher compared to the market price. The difference is known as unprofitable part. Thus, SDE + covers producers this unprofitable component for a set number of years, which depends on the used technology (rvo 2018).

Seeing the opportunities to earn money through the TPO system housing cooperations put solar panels on the rented houses' roofs.

At this moment in Leeuwarden a big race is happening among housing companies putting solar panels on roofs. In the rented houses it is a tornado and this is all because of the business case. Also, if one housing cooperation has found a formula how to put solar panels, then others are also keen to know how to do it. Why? Because of the urgency created by people asking for it (Boer de Bouwe 2018).

A further encouragement to get a solar PV system stems from seeing a possibility to get a higher energy label (A+). In this case insulation is essential too, but it is popular in the Netherlands to invest both, in energy efficiency and renewable energy production by solar panels (Langereis 2018). Improved energy label allows to raise the value of the house. The study of Naes-Schmidt et al. (2015) shows that energy standards have "clear and significant influence on house prices, no matter the number of control variables included" (p. 9). In addition, green energy label positively influences residential property sales since the favorable A label raises the transaction price by approx. 12.000 EUR, while an unfavourable F label diminishes the sales by around 13.000 EUR (TIAS 2015). Besides, Banks like Triodos provide loans for houses to convert them from energy label C to A and give lower interest rates for mortgages for houses with higher energy label (Dieen 2018).

Lastly, the prosumers, who buy their own solar panels, can get 21 % VAT tax refund. However, since the measure is new for the Netherlands, it functions rather poorly. For instance, some people were waiting for more than 3 months to get their refund (around 740 EUR) (Goedewagen 2018).

6.5. Local initiatives: the case of municipality of Leeuwarden

It is crucial to analyse the case of solar power development in Leeuwarden as the municipality is exceptional in creating additional measures for renewable and solar power development. First of all, the energy coordinator Boer de Bouwe (2018) points out that at the beginning it is essential to to talk to interested people instead of making the program and telling people what to do exactly. Therefore, the first step in encouraging solar power in Leeuwarden in 1998 was suggesting the people to have energy neutral houses. According to Boer de Bouwe (2018), "at that time it was world shocking but still we succeeded in four places in a city to convince people to have energy neutral houses with solar panels". As a consequence, Leeuwarden won a competition – national PV award in 1999 for these 4 projects and had an opportunity to increase the regional knowledge about solar power.

In 2000 the project with the dentists was started. This business sector was chosen because they have high income and usually own a building with a suitable roof. At that time the conditions were very favorable for solar power as there was a possibility to get solar panels for free as well as reduce energy taxes. Hence, out of 40 dentists in the area 20 agreed to install solar PV. Later other companies were being encouraged to get solar panels too.

Furthermore, as the SDE + program was introduced it was noticed that in Leeuwarden no one knows about national renewable energy incentive scheme. Thus, the breakfast for companies were organized to inform the local population and the businessmen about the opportunities to invest in renewable energy and solar power. The consequence of the breakfast was 400 new applications for SDE + program in the province of Friesland and now it has by far most solar power systems in Holland.

In addition, a special subsidizing program for house owners was released in 2008 with a budget of 1,5 mln. EUR. The attractiveness of the program was in the feed-in tariff: while there was a national program offering 30 cents per kwh electricity produced, in Leeuwarden there was 40 cents per kwh. Due to such incentive, installers in the province intensely advertised that in Friesland one has the best subsidizing program in Holland. Hence, large part of the population made use of the program.

All in all, it is important to make short-term programs, as the long-term programs do not work, it is essential to look what is good for the moment. With such programs "in 2-3 years 50 % of the houses will have solar projects" (Boer de Bouwe 2018).

7. Conclusion and recommendations

The thesis analysed two countries, Netherlands and Lithuania, that have chosen energy policy strategies of transitioning to prosumers that enables essential changes to regulatory and policy structures to urge prosumer expansion. The thesis aimed to determine the measures needed to assure a smooth transition from centralized to decentralized generation by prosumers in Lithuania.

One of the crucial measures that can urge prosumerism is a third-party ownership (TPO) model. Central to the TPO model is solar service companies that manage PV systems while being financed from a third party. From the customer perspective, the simplicity of TPO model is regarded from the business model, when the consumer's single point of contact is usually just a service firm and not numerous counterparts, such as maintenance, construction companies, banks and government agencies.

Cross-selling of solar PV in relation to other services and products and integrating solar PV in the prefabricated houses is another measure encouraging prosumerism. The expenses for solar PV are usually embedded into the house mortgage, which reduces transaction costs as well as interest rates.

The energy transition to prosumers in Lithuania has been largely influenced by the demand for accession to the EU to close the Ignalina nuclear power plant (INPP). Two reactors were shut down in 2004 and 2009 with a consequence that the local energy production has plummeted and Lithuania became one of the largest energy importers in Europe. As an alternative Lithuania made significant progress in developing new electricity interconnections with the neighbouring countries. However, from the state-centric approach, the new nuclear power plant (VNPP) was crucial to assure independence, but due to the lack of international cooperation and local political struggles it was not built. While the failure of the VNPP had implications on diminished energy security of the country, it helped to overcome the technological lock-in of nuclear power in Lithuania and opened the window of opportunity for RES and prosumerism.

Therefore, one of the main principles of the new Energy strategy project is the energy independence. In a long-term perspective, energy consumers are expected to become active market participants because they will have the opportunity to consume the energy produced for own needs and supply excess energy to the grid. However, since radically new technologies require protection, the conditions for those willing to become prosumers in Lithuania have been improved. The list of prosumers' technologies has been widened, corrections made in the law

that prosumers can be also legal entities, bureaucratic burden has been significantly decreased. Key policies encouraging prosumers in Lithuania are sliding feed-in premium and net-metering. Creation of clear and transparent pricing is expected to contribute significantly to encouraging prosumers too. To reach the ambitious goal of having 50 % of prosumers by 2050 the government has planned 4 stages of development: encouraging prosumers in private houses; encouraging prosumers in apartment houses; providing the opportunity to geographically separate electricity production and consumption places; involving prosumers in systematic services supply market. To successfully go through all 4 stages and reach the targets of electricity production by prosumers further measures are recommended.

Recommendations

- There is a synergy of solar power development in apartment houses with the renovation program. Those who take the opportunity to improve their environment and energy efficiency by renovation, at the same time could become prosumers. This is crucial because to take the decision to install solar power plant separately, the community agreement is needed and taking the two decisions together is more efficient. Therefore, the further financing of prosumers should be in line with the apartment houses renovation program.
- Local government should have a more significant role in encouraging prosumers by, for instance, installing solar power plants on the public buildings and showing the benefits of becoming a prosumer to the local population.
- The communication campaign encouraging prosumersim and the development of solar power should be carried out. There is a need to raise awareness about the opportunities to become a prosumer and deny the prevailing myths such as that solar power installations are very expensive, do not pay off or that sun does not shine in Lithuania. The communication at the local level could be carried out in the form of renewable energy breakfast, following the example of the municipality of Leeuwarden. The companies and residents of the town should be attracted to informal information dissemination sessions to urge the development of renewable energy in the region.
- At least 5 consultancy centers should be established in different regions in Lithuania. These centers would provide the information for the residents how to become a

prosumer, advise on the most suitable technologies as well as suggest on solar power electricity and heating opportunities combined.

- The emergence of market participants, such as installer companies that would install solar power plants and provide the performance guarantee, should be encouraged. Besides, the emergence of TPO companies like Green Genius should be urged too to provide more opportunities for the residents that do not have enough resources to buy own solar panels, to rent them through a TPO system. There is a lack of market participants in the solar energy sector due to the unsustainable policy of solar power in 2012. Now, to boost the emergence of solar power companies the government should sustainably carry out the strategy encouraging prosumers in Lithuania.
- To geographically separate electricity production and consumption places, system similar to Dutch *postcoderoos* should be implemented in Lithuania. The *postcoderoos* is determined by the postcode area, where the energy generation project is located. The project is not actually being connected through the grid with each project participant, it is rather a system of administration. Increasing number of consumers are joining the program in the Netherlands due to a community feeling and urge to be a part of one project.
- To increase the number of solar power prosumers in municipalities there is a need to have more direct interactions with the residents before making particular programs encouraging prosumers at the local level. For instance, the local government could encourage the residents to have energy neutral houses. Few first examples, as in Leeuwarden, could urge the emergence of more prosumers in the region. Then, the business could be involved in the development, following the case of dentists' offices becoming prosumers in the Netherlands.
- The municipalities could use a part of their spare budget to urge prosumers by measures such as special subsidizing programs for house owners with solar power plant installations. The measure should be based on increasing the local feed-in tariff as compared to the nationally set price per kWh.

To conclude, during the research of the thesis it became clear that Lithuania has not only ambitious targets set for the development of prosumers but also rather clear guidelines and measures how to achieve it. The main challenge remains following the set strategy and guidelines to avoid the case when the support measures for solar power were stopped in 2012

and resulted in devastation of the whole solar power market in Lithuania. However, some improvements to the prosumer encouragement guidelines can be made as indicated above in the recommendations. Following the example of the Netherlands, special attention should be drawn to urging local governments to take more actions to encourage solar power and prosumers' development at the local level.

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9. Appendix

Transcripts of interviews

Boer de Bouwe (Municipality of Leeuwarden)

Biomass is a big issue, in Holland we do not have a lot of forest, but in your country there is a lot of forest. So it should be logical that a lot of people have their own trees to burn.

How local and national government contributes to the development of solar power prosumers in the Netherlands?

So I work for the municipality of Leeuwarden is one of the 20 municipalities of this province (Friesland) and I am doing this job for almost 25 years – energy coordinator. So I am responsible for energy program in this municipality. So I have seen renewable energy coming up since 1998, before that there was no solar program, so it started in 1998. Because at that time solar energy was very expensive, electricity prices were quite low in this province. If you have a house and you buy electricity, it costs 22 cents per kilowatt hour. That is a very important thing to know – what is the price of electricity. In 1998 – 1999 energy focus in this province was growing and growing because we have written …you had a Kyoto protocol…and then municipality started to have a program for energy. I was in that time one of the first energy coordinators in this country. What I did was talking to all kind of people and who were responsible for big projects in a city, for example building a new house area or a new company, because I thought if energy is to be a success here I have to talk to people who are really interested and not that we make a program and then we tell the people what to do. But my way of working from the beginning was to listen to people in this municipality and if they want to do something with energy – then we have a project. So I started talking to few developers of houses and I knew there was a national program for energy neutral building, a lot of money was available. So I talked to a few people who want to built not a normal house in the area but fossil free housing area. So I brought a lot of people together and I came up with an idea – ok this is your plan but we have still half a year developing time – so why don't we make it like this – energy neutral. So they got interested and they said, well that's quite risky, so let's focus on plan A and plan B. This is plan A – we can do all the time, but if everything goes right we got plan B – that's energy neutral. And if you tell everyone all the time (people, architects, developers..) – energy neutral, then all they want in the end is option B – energy neutral. So in that time it was very special in Holland – to have energy neutral houses. And energy neutral means that you produce as much energy in a year as what you use. In that time it was world shocking, but it succeeded in four places in a city. So we got a lot of money from the national government, we have project developers, installers who wanted to have a famous job… And in that time in 1999 there was a competition, the best municipalities doing something with solar energy, so we won that price. In 1999 we won a national PV award (this municipality), and that made the political people quite proud because we had even 4 projects with solar PV and since we did those 4 projects – we knew a lot about PV. So from that moment on we started to look, even though its expensive to realise projects that are affordable. So then we started a project with the dentists, because the dentists are very rich, they have a building and they pay a lot of taxes. So in 2000 we started a project with the dentists because at that time, they could lower a tax by investing in solar energy. So they could get for free solar panels on their roof. In that time. So we have around 40 dentists here and around 20 of them were interested to have solar PV on their roof. And then we listened very well what is a subsidized program. So we started a lot of projects

and next year we did it with other companies, then the national government started national programs, the prices of PV were lowering, then we had an SDE program and nobody knew about the SDE program. So I organized breakfast for companies and we told to them – there is a very interesting program for renewable energy (SDE). So I had a company who filled in a form…and then we had 400 claims for SDE program in this province, because of breakfasts, meetings.. So that was quite simple, because to organize a breakfast is quite simple. You send letter, then you have someone with you to fill in the forms and then you have companies signed in. They could at any moment say no. But we had by far the most SDE subsidizing projects in Holland, so now this province has by far the most solar systems in Holland. Because we took the..

And then it was before the subsidizing program for house owners. And it was I guess 30 cent per watt p , in 2008 I made a subsidizing program for this province, because I was working for the province and I had an amount of money – 1,5 mln euros and I made a subsidizing program for house owners, because there was a national program for 30 cent per watt p and then we from the province, made it a little bit higher – 40 cents per kilowatt hour, So the installers in the province made a very big advertising in the local papers – in Friesland you have the best subsidizing program in Holland, there is 9 days.. so here a lot of people went in this program because of subsidizing was higher than anywhere else. So in every time now this is good for house owners, now this is good for companies, now its good for dentists… so it is jumping in the situation of that year. And now we have an SDE. So its reacting on a local situation. Normally municipalities make a program for 4 years, and you can never jump in. But I never make a program for a long time, just looking at what is good now, good tomorrow, good in a year. And with a little work you have a lot of success because you can do something that is already helping that is there.

So I am just wondering, you think that municipalities are more flexible and have sometimes more power than the national government? Because the national policy for subsidizing solar power was changing very much in Holland, depending on the government?

Yes…I was in a position to do anything what was good for the situation on that moment and that made us quite famous and a lot of municipalities copied us.
And now its much more stable policy from the national government. Because now there is every half a year a new SDE calling. The last one was in March. And we spread information about this, but no more breakfast meeting because now other companies do that. Now a lot of companies in Holland have ability (have their roof or land), now the situation is different that 15 years ago. Then it was new, expensive, unstable from the national government. Now if you have a house, the price of electricity is 33 cents, quite affordable to have solar panels on your roof. So it makes sense to have solar panels, because the payback time is 7 – 8 years and a lot of companies have an ability so you can rent the solar panel and do not have to invest anything. We have 2 types of houses in this country, its rent or buy – 35 % of houses is renting, you rent a house from cooperation. The most of housing cooperations now put the solar panels on the roofs of the renters. So at this moment in Leeuwarden a big race is housing companies putting solar panels on the roofs. Thousands a year.

And the motivation for this is?
Money. Because the housing cooperation has 20.000 houses – they have 20.000 roofs, and they rent their roofs to solar company who is using their roof to put on a solar panel.

So this is like a third party ownership program?

Yes. So the renter who is renting a house has an effort that is 10 EUR a month. So the solar panels are connected to his house. He says yes, I want solar panels. From that moment on – the energy bill is 10 EUR a month lower. And when he joins a project he gets – 50 EUR. So that's the reason why its increasing in big amounts every day – 10, 20 systems on the roofs. And that is only because the housing cooperation earns money by it. Because they rent their roof. The renting person is earning money by it. Now, the price of the solar panel is so low that everybody has quite a possibility to get PV.
If you have 4000 EUR on your bank account and you buy solar panels, because the interest is so low, it is more affordable that you invest your money on solar panels on your roof.
And if you want to have an energy neutral electric situation – you need mostly …because the average use of electricity of a house 3500 kilowatt hours – so you need ..one soalr panel is delivering 300 kilowatt hours a year, so then you need 12 -14 solar panels to have your electric situation near to zero. So that is an investment of 4000 euros. But if you do not have 4000 euros, then you can rent your roof. So there is not a big limit for the people who have a house and a good roof. But 40 % of people do not have a good roof, or they live in an apartment. So if you are in a situation that you do have a house but you do not have a roof. Then there is a possibility in Holland to join a project, called Postcoderoos. And that is starting to be popular here in Friesland, because we have 52 energy cooperations. And the energy cooperations focus on Postcoderoos program so that people can join a PV project if they do not have a good roof. Its quite difficult (postcoderoos) its quite complicated – but now there is someone trying to make it less complicated. It complicated because a lot of people join and they have to pay money and they have to give results to the government – it's a big administration. And you have to do it for 15 years. Financially it is the biggest issue for these energy cooperation. They haier other companies to do the finance.

And who pays for the project?

The banks, or sometimes own money. So if you have a postcoderoos project of 500.000 euros, you can get some money from the bank, some people bring in the money, because they buy solar panels.

If you have a village, you can join a project in a same postcode area. So this is a national regulation, psocoderoos law. If there is a farmer with a big roof, then lets say 100 people say – yes – I want to join a project. Its not actually connected to your house – its only the administration. But it works almost the same as having them on your own roof. So the payback time is less– its even cheaper to have solar PV on this roof rather than on your own roof.

Why is that so?

Because this is a big project, and you buy more solar panels, you can install 1000 solar panels at one time and not 100 times 10. It can also be on a ground.

So since national government started with national program for solar panels, many people could not join the program because they did not have a roof, and then they came up with this system of psotcoderoos, which at first was too difficult but now some companies made it easier. So the hard work, administration, can be done by the companies.

It took 3 years to develop it, its very complicated.

Now I know in this province 4 postcoderoos projects, so this is very slow. But now this year, 20 more will come, because it is simpler and now its going to speed up. For me what is interesting – is that a lot of people are working together, they are part of a project. I think in 2-3 years 50 %

of the houses have solar panel. Its quite fast. In the renting houses it is a tornado – this is all about the business case, and if one housing cooperation has found a formula how to put solar panels on their roofs, then others say – how did you do that? And they tell, they are not competing. If one housing cooperation finds the solution, then its not so difficult for others to find a solution. Why? Because of the urgence – people are asking for solar panels on their houses. Then, companies come with a system.
But Why is Holland so bad in renewable energy? They compare it with other countries. We do not have mountains – no hydro power. But Denmark and Holland are almost the same, but Denmark has 40 % of RES. But 40 years ago Denmark made energy program, because they were importing all the energy (they had no oil, they had no gas) so the main reason they speed it up in RES was independence from energy imports, they made a very effective program. They have highered the price of electricity to 30 cents, in Holland we have 30 cents per kilowatt. In Holand we have our own gas, it was clean, cheap and clean. But now we have an earthquake in Groningen a few times and now a minister has said we close the natural gas production by 2030, and lowering every year, Everyone is panicking. If we want to stop using our gas, we will have to buy it from Russia, but we do not want to do that. So now the urgency of the energy program since one year is rising.
But we have the whole gas industry built around gas, so its hard to stop it from one day to another. It takes time to make the transition.

Do you see it as an opportunity for increasing more solar power and more prosumers?

Yes. The long-term effects are more important, but the short-term effects are that people will loose jobs. Of course the training could help to transfer those jobs from one sector to another. But that takes time. People are afraid to make this transition.

Postcoderoos has tax exemptions?

If you have solar panel and you produce most of your electricity during the summer while you consume mostly during the winter, the final accounting can be made yearly. Its Saldiering – the breakthrough in Holland. It means that you get 23 cents for producing of solar energy. In reality it costs just 14 cents, so you earn money if you use your own roof. Almost the same system is in Postcoderoos.

Because so much houses have solar panels on their roofs, the housing ccoperations create now with hundreds houses with solar panels – now we have a grid problem already. In some areas in the city – they stopped laying solar panels on the roof because there is a grid problem. So that could also be that is some cases municipalities say – you can better join Postcoderoos project because there is more space on the grid for it.

There is already problems in the grid. Last Saturday there was a big problem in Holland with the grid because the weather man said it is going to be sunny and windy, menaing lots of wind and sun, but there was no wind and sun, so they had to buy some electricity from Germany, from Belgium and produce more in Holland. The day before there was a crash in the grid because there was an overproduction of electricity, because of the instability of the grid. And we are not prepared to what is happening now.

The problem is that is very difficult to store the energy produced by wind and solar. There is no option to store it.

What about investments in the smart grid?

Grid companies really have a problem, I know – this year in 2018 in Friesland there will be more than 40 solar parks on the ground, more than 5 ha are being built between now and tis year, and grid company has to connect it to the grid, they have no choice, it's a law, but the they have a problem, because in some days its sunny – and they don't know what they should do – should they invent thicker cables, should they invent storage? And the law is not ready for this, because it is made 20 years ago. Because this is a democracy – it will take a lot of time to change it. For example, to create storage is not allowed to be done by grid company. They want but its not their job. So they are now making new laws. Now they get the possibility to invest in storage, but last year they could not invest in storage. So the only thing they could do is change the thicker cables. The law however will be changed during this year. So what grid company is allowed to do and what they are not allowed to do is changing now – now they will be able to invest in storage. More abilities to react in the changing energy world. But this also presents an opportunity for the private sector. There is for instance a company from the UK – they developed

What about households getting storage?

It happens if there is a law. For instance, you see a big difference between Holland and Germany. Because if you have a roof in Holland – on Dutch houses you see 14 solar panels – because they use 500 kwh and they produce in total 3500 hwh. Why? We have soldiering. If you produce more than 500 kwh you get only 4 cents per kwh. So that's the reason why in Holland you see a roof – partly with solar and without. If you come to Germany – you see same house – only solar panels on the whole roof, because they get the fair amount of money for every kwh produced. That was 2 years ago, then they could not pay it anymore, and the people got storage at home. Because if they produce more – they get no money anymore.

In 2023 the soldiering law in Hollland will stop, so from that moment on – if you produce more, you get no money anymore for the electricity going out of the house. What is the solution? Storage. From 2023 – people will have to get storage. The combination of solar and wind is very important for countries like Holland

Rico Berix (Naga Solar Holding B.V.)

In the Netherlands if you would install solar panels on every suitable roof in this country – others do not have a suitable roof or a house – you only make like 10 % of total energy consumption in the Netherlands. So the potential of household solar is very limited in the Netherlands. It is because commercial and industrial electricity consumption is very high. That is also the reason why the government has put more and more emphasis in the past years on industrial and commercial solar.

So already a concrete advise for policy makers in Lithuania is starting with a good strategy and with that also a good potential study. Ask yourself two questions – what way would I want to go and how am I gonna do that? You see if your energy goals say that you have to have 30 % of solar power prosumers, you can already start calculating the percentages, then you will see that the situation of the households it is never gonna be enough. But another side of the coin is that Netherlands is a very crowded area, there is not much area where you can build the panels. So the point is you have to either find sufficient land area (that is scarce), then you can search for large roofs, industrial rooftops. Here in the Netherlands we have quite a few logistic areas, really large distribution centers, that are around 100.000 sq.m. roofs, that can be directly used. This combination of different types of solar PV is one of the strengths we have in the Netherlands.

With regard to wind, there is even more potential than solar, but NIMBY effect blocks the development. With solar parks the social resistance is much lower, it does not have noise, shadow. And even with a large solar park, you have some resistance. Your transition, the development of new projects is difficult.

So the way it works in the Netherlands is completely different. For example, if you look to Germany, you see solar park after solar park. The government had a completely new policy there, they closed the nuclear power plants as well, but then A.Merkel said we are going to go for solar and wind with a good subsidy scheme. No difficulties in social resistance, no permitting or landscape issues, and that's a very good environment to build projects. But then you have this bubble that runs like 2 years, which explodes. You even now see on good days, the electricity price of solar is negative, so me as a project owner, who wants to get rid of the electricity, its every project has to deal with difficulties.

Social resistance leads to municipality saying - there is no social acceptance. And so the project runs for more than a year. We made local meeting that would involve the residents. Those kinds of dynamics are happening here in the Netherlands, it is not easy to develop projects here. I think on average you need for each project around 2 years of developing time. It depends on a type of location. The time is influenced on permitting procedure. You can apply for a permit then your municipality starts to look at the project. And if someone files a complain you have 8 weeks. Then you need to apply for a subsidy, there is a subsidy for every kilowatt hour you produce. So we call it SDE. It's a very advantegous system because it subsidizes – cost difference of your electricity. See if you build a solar park, you're gonna produce electricity, you have costs, the electricity you produce it has a certain cost, some LCOE (levelized cost of electricity). But its of course way higher that the electricity you see here produced by conventional electricity plant (like coal), its way lower, its around 4 cents, while your solar PV price is around 10 or 11 cents. So that difference is completely subsidized by the government. That is very advantageous, because then you are able to sell your electricity from the solar park as if it would be conventional electricity. In order to be able to apply for this subsidy scheme you need to have your final permit in place. So the municipality has to have approved your project. The subsidy scheme runs only twice a year.

So the SDE is only for the commercial solar PV projects?

Yes, and it has a very technical reason. In the Netherlands we have different grid connection types. For example, in households they have a very small connection, while the larger companies they have a larger connection and these larger connections are purely for commercial use, only these connections can file the SDE.

Why SDE is not for smaller projects?

Actually, for the smaller projects there are other stimulations. For example, if me as a normal consumer is about to install solar panels…If I buy solar panels, I have to pay VAT and as a consumer I can fully ask back this VAT, so its already a 21 % reduction on the price that I get back from the government. That's the first thing. And secondly, the amount of money I get for the generated electricity for consumers is different that for commercial systems. We call it saldiering (net-metering) – consumers they are able to…For example I have 4000 kwh consumption per year, I produce 2000 kwh, so I only have to pay for 2000 kwh. But if I had no solar panels I would have bought it for 18-19cents per kwh including taxes. That's only the case for households – small connections. You get more than the costs are. Now all these households are installing solar panels that are enough for their electricity consumption just to be a prosumer.

But for commercial systems you do not get this. You only get 4-5cents per kwh. You cannot run your business on this – so you need additional system – and that's the SDE.

The soldiering system it somehow does not encourage overproduction?

If I produce more than I consume myself – then I have an access of for example 500 kwh.So the government then says – well for this 500 kwh you do not get this anymore, because this is not your own consumption. So we are gonna feed this back into the grid and then you get between 5 and 7 cents per kwh. That's ok, because you already have your own electricity already supplied, and the access goes to the grid, but that is the reason why all these people are not installing more systems that would be more than their own consumption. Because why would they do it?

So the main systems that encourage solar power is SDE – for commercial and Saldiering for households? And there is also postcoderoos?

The government said that not all people have suitable roof. Only the postal code areas are directly around the solar PV project can ask the electricity from the solar PV system. And that is only an administrative regulation. So its not physical. There is no extra cable going to the house. The solar PV system feeds the electricity back into the grid. But its only the people who live around that can buy one or more panels (they invest in it) and in return they get a reduction on the tax of electricity price. So normal consumer would pay 18 cents per kwh of which around 12 cents is a tax. People that invest in the solar system – they don't have to pay the tax, so then they would have to pay like 6 cents per kwh for 15 years. After 15 years they are not the owner anymore and they have a normal energy contract. For 15 years they have a complete tax exemption. This regulation is very attractive for people who do not have a suitable roof or who do not have money to install solar panels on their roof, or living in the apartments. So the whole community shares the costs.

Who administrates it?

That's local energy cooperation. That's also the company who develops the solar PV project and also sells the panels. Actually we are just developing a project on the stadium roof and will sell the panels to the people living in Maastricht. And then we try to finance it that way and give people this advantage.

So now the initiative comes from the company not from the people?

Actually, local energy cooperations are mostly founded by the people, but they usually do not have the knowledge to develop something like this. Because they don't know anything about solar PV, they now about local people, about how these people think. So these local energy cooperations they are always looking for a developer – we are a developer. So this local energy cooperation they came to us and said yes we want to do this – can you help? So they came first, but we are developing a project. So they said we want to do this but we don't have a project, we don't have a location – so can you supply us with a location? So we found this stadium. In Maastricht this is a first postcoderoos program. Actually, here in Limburg we are running behind. In Leeuwarden, Groningen they are way ahead.

Why is that so?

It has to do with the attitudes of the people. People are anxious about the landscape, they are afraid it will ruin the landscape. That makes it difficult to build large scale projects, because people resist it. So you have to look for alternatives such as old landfills or industrial sites that cannot be redeveloped. Or we always check for double ground use. If we would allow sheep graze underneath the panels. That is agricultural use. Then you have to fix your panels 1 metre above the ground. That's our USP (unique selling point) in NL.

So you think that the government policy that encourages prosumers is sufficient in the Netherlands? Or you would add something more?

It has benefits and it has also disadvantages. Because the subsidy scheme that we have now is good for making your business case, so there is no problem. But the downside is that a lot of people are applying for this SDE and there is of course a limit to it. And this SDE goes – the cheapest project will get the SDE first. Last year there was more than 6bln euros access budget, the government

If you are to install solar panels on a building and the building is not yours, you need to make a specific contract with the building owner, just to be able to install solar panels on that roof. That splits the ownership, because the building is not yours but the solar panel could be yours. So if you have a building and you say I don't want solar panels, then I could say to you – can I build my solar project on your roof? Then the panels are mine, the roof is yours. I can offer you the electricity for 12-13 cents – that's then your benefit. But if that is my solar system – then I will sell this electricity to the building owner or the grid. So that can also be the case – it does not have to be the same person who owns the solar PV and the roof. For households it is not the case, but for commercial systems it is completely different. Then you need to arrange specific contracts and these contracts are very complex.

Do you know anything about third-party ownership?

Yes, so if I have a building and this building is owned by mister X, and there comes the developer – mister D, who wants to install solar panels on your roof. The electricity produced by solar panels – you can do 2 things with it – either just put it all into the grid, but that would be not optimal because then I get only 4-5 cents per kwh, or I could also supply the electricity to mister X, building owner, now you know just buy my electricity and I can offer this cheaper. Imagine he pays 15 cents per kwh, and then I say I offer it for 12 cents. Then I get a lot more than I would feed into the grid and the consumer pays less. But then I have to make an agreement with mister x, otherwise I have no chance to get rid of my electricity.

Now imagine I have the same building owned by mister X, but the building is rented to another user – mister Y. For instance DHL are renting the buildings, and now I come with my solar panels and have to make an agreement with both – mister Y and the building owner. This is a very difficult and usual situation in the Netherlands. Because you have to split the ownership of the building and supply of electricity.

Are there many companies that do this?

Yes, there are some, but there are a lot that cannot handle this.

How it works organizationally TPO?

You lease a roof through the right of superficies (notarial deed). You me as an owner and then a project developer, and the owner gives me a right to built panels on the roof. But it has to be

very formal. Because there is a risk – what if the owner looses the house or sells it? I cannot loose the solar PV project. You have to imagine that the projects are built for 25 years, and something can happen in these 25 years. So we rent the roof and give options to the building owner – you can either buy electricity from us, or if you don't want it that's fine we just go into the grid + SDE. Even if I sell electricity to the building owner, even then I can get SDE. And that's when it gets interesting because then I get almost 20 cents per kwh and my payback time is only 5 years, and that makes it a very good business case. How I finance the system it does not matter – I can pay it myself as a project developer or I can ask one of our institutional investors to invest in it (like banks or rich families).

One of the projects we are developing now is financed by the protestant church in Germany, one of the richest churches in the whole world and they want to do something with their money. This is a very good risk-free investment for 25 years they will get their returns and we develop the whole project for them. We do this development of projects only for investors. We have our network of investors, who come to the Netherlands because they see the whole market is well – we have a subsidy scheme etc. We see a lot of capital now in the Netherlands, almost every day we get a call from a company who wants to invest in our projects and they are all from abroad. Imagine, parties from China are coming to invest in our projects, because they get their return.

So is the policy for solar power becoming more stable in the Netherlands?

No, the change is still happening. Its already changing, we expect that in 2019 this SDE system will look completely different. Because now the government sees that everything is going too well, the developers are running like crazy people, so let's change it again. They do not want the developers to have too much advantage. They say that we as a developer get too much advantage. But they say that in some situations you will not get the SDE anymore. That stops the development. If that happens – the bubble in the Netherlands might be gone and so we are preparing ourselves for looking for alternatives.

So now we are working hard to secure contract where we can because as a developer you can not influence the policy. When this happens we still have projects to develop for upcoming 3-4 years. Eventually, the SDE system will be gone, so when it happens we hope that the installation costs have decreased enough to the point that I don't need subsidy anymore. But I hope that this moment comes before the situation in Germany is reached. When the grid capacity limit is reached so I have to pay get rid off my electricity. If that happens then the market is not satisfied, then you better focus another country. Or do storage.

Regarding storage we see that the investment costs are way too high now to build a storage plant next to solar project. There is no investor that would accept it, We have to wait. The costs are going down. Eventually we will manage.

What are the barriers for the solar power prosumers?

Making these contracts, because problems arise when a building owner has a mortgage on this building, then you have a bank that does not accept that another ownership is attached to a building and that is one of the major problems, the banks almost never give their agreement on these contracts. Last year 15 projects were cancelled because of this reason. We were ready to start building but banks did not give their consent. So now we are working to make standard agreements upon which banks can give their approval, this is a very important thing.

The second one, is the constructional work inside the building. A lot of buildings in the Netherlands cannot deal with additional load on the roof – they will collapse. You need reinforcement of these constructions and that is a very costly and complex case. Even new

buildings need these things. So we are working on a very lightweight system to limit the additional weight and we are already reaching only 8 kg per sq.m. load. Normal PV system would reach up to 20 kg per sq.m.

The third one, is a grid connection capacity. Most of the times this grid connection is very limited. You need to make this grid connection larger and it is very costly to do that, that can mean that your project is not feasible anymore. Grid connection costs.

Social resistance and municipalities. Municipalities are subject to political games. Permitting is a requirement.

Paul Langereis (Westland distribution system operator)

Can you tell about how your company and its relation with prosumers?

DSO, regions is famous for greenhouses (most dense in the world), very few people, several billions dollars of revenues in fruits, flowers (Westland), manager of operations. Two parts with prosumers: the customer that has solar power has influence on the grid, how to strengthen the grid. The greenhouses have own power supply, electricity, big generator from gas (consume and produce electricity, sell the electricity when it is profitable). In terms of electricity, we have 20 years of experience of generators by gas (prosumers), grid is adapted for prosumer, because there are thick cables, if people produce more than consume, over dimension happens in the grid, extended grid in a capacity way.

Smart grid is being constructed – tariff break in slower (when the demand is lower), filling the "bathtub", laying the cable – for the maximum capacity use, lot of time you do not use the maximum, but when people come back home, peak happens and the aim is to help people get better price.

Smart grid is a local initiative, but national tariff system applies. If you want to differentiate, it is difficult. There is a struggle with national government – ministry of economic affairs (also responsible for energy). How long it will take? Really quick! Maybe a year. It could be interesting for other areas too.

Small DSO but decentralized authority against central authorities, because small – more possibilities to be a local player. Bigger DSO struggle to have local impact, to talk to local authorities. We are in a good relationship with local authorities.

What do you think of government policies targeting prosumers or solar power development in the Netherlands?

National government – prosumers – centralized government is always one step behind the transition, they are constantly adjusting with policies, the policies have to follow new technological development. We are trying to improve. Energy transition now is a bottom up transition – we are thinking a lot about geothermal sources. But policies are really behind what we are doing here - 10 years behind.

What is the drive behind DSO supporting prosumers?

Electricity grid will be around for a long time – things we invest now – it will stay for 50 years – it is an investment in the future and what we are believing in (environment etc.) Yes, we need large investment in electricity grid – it is pretty "dum" now, we should make it smarter – because as an asset manager you want to know how your grid is doing – more digital. Yes, prosumers will have to make some payments for these costs, but DSOs are rich in the Netherlands. I

What about solar power prosumers?

It is growing quicker than we anticipated – its surpassing our expectations – the big solar parks – they are difficult. we put them on high voltage grid – we can lay another cable to the solar park), but the real problem is roofs. Because it is low voltage network, lots of capacity on the roof. Storage is important, if consumers have storage, it would be easier. We have net metering system and 50 % of consumers have smart meter – its obligatory if you have solar panels.

What about the support system?

There are subsidies for that - national subsidy arrangements – VAT tax exemption, subsidy on buying of the panels, and of course net-metering. Money back for producing electricity.

What are the barriers for solar power development or ways for improvement?

There is a need for a more controlled development in some areas. It is annoying when we do not get a report that people get solar panels because we get congestion. Sorry, we are not able to transport electricity to the grid, they are paying a lot of money – we are not able to transport – they do not get their money.

Perhaps for those individuals it could work better if there would be more local cooperation, common storage. Its very individual at the moment. I think we should have a local community/municipality connecting people – we miss that.

Postcoderoos program – is working alright but not everywhere. Its one initiative, it is one policy stimulus.

What are the drivers for solar power development?

80 % financial and 20 % environmental friendly motivation. Mainly personal financial because people see it as an investment. People see it as an interest – if you pay 10.000 EUR – if you lay it on house – 2/3 years for return – money making opportunity.

Solar panels are seen as a possibility to get your house condition – energy label - certificate – A+ - insulation is very important too, but in combination – its very popular to invest in – energy efficiency and energy production – money back. Energy label – its getting more important – people will pay less if its F. If you have good label – solar power – better value of the house. Environment is pretty positive for buying panels. Improvement of solar power technology – Moores law – energy efficiency of solar panels grows more – as in LT we don't have lot of sun but it is a lot of production.

Banks give out green loans or green mortages. If you have green investment, you get better interest rates or higher amount of loan. Triodos kind of banks have trouble getting their own targets – want to invest in green projects – too much money laying there and waiting for consumers and companies – there is a lot of money granted for initiatives. The only barrier is that more initiatives are needed. How to improve the growth? We are working on collaboration – many parties look at it very individually – you got producers, transporters, consumers. Collaboration is little between three parties – hard to get along. Gas producers are still used to go to the central government to lobby – but if government takes more stand on pricing CO2 – it has a certain price – we are going to get, everyone has own view, one-sided, not many companies working with open agenda.

For geothermal sources grid needed and infrastructure is expensive – you are not sure if people will invest. How can you invest in a new grid without having a risk of having a stranded asset – if you are trying to improve electricity grid – its easy, but with biogases more difficult.

What should be done in Netherlands so that the country would see a more rapid development of solar power prosumers?

We are going away from fossilized gas, which has a big impact on infrastructure – big problem. We are a very gas oriented country, considering less gas use – almost impossible to exchange totally. Governemet said that they want to stop using gas by 2050 fossilized gas; 2030 – Groningen gas fields, but it is impossible – so much electricity would be needed – so much energy – energy discussion is about things almost incomprehensible.

Deborah Goedewagen (prosumer)

What was your motivation to get solar panels?

In Holland when you have a shared roof you have to form a community, you got to organize, you got to have union savings, so that when something is wrong with your building (your roof…), you have to have money to repair your home. And you have large unions (in big apartment buildings) but we are only 3 homes. We saved money until there was so much money in our savings account, more than we would spend on a building. So the neighbours suggested that we would use it to put solar panels on a roof. Half of money was from the savings and other half came from each owner individually.

So we did some investigation if we could get it subsidized but in The Hague its like this: you can get subsidy, but to get subsidized you need official burro advice and you would pay them more than what you would get in the end. We would have to pay burro 400 and we could get subsidized only 300 EUR. This is the policy of The Hague. That was not very interesting.
And how de we get the VAT back? Its not as easy as it sounded. So you can get 21% VAT back, that could be lucrative. But unfortunately …because both of us (with my husband) we have an enterprise…because this is so new to the Netherlands, the tax system does not know how to deal with this. You can dial a number and get the information, we did it 3 times and we got different information all the time. We are still waiting for VAT back (around 740 EUR). The information we get is confusing.

What is also interesting…for the union of apartments we are trying to find out whether the solar panels are part of the building. When the neighbours would move, can they say "we are taking the panels with us", if someone new moves in, can they say they don't want solar panels.

You got an agreement on that, right?

Yes.

Again, where did you get the funding from?

Half of it came from the owners' association (for maintenance of the building), half from own funds. And because we saved too much money, we thought it could be nice to do something for the energy and for the environment.

Can you feel that you save money too with solar panels?

Yes, it reduces the prices.

By what percent? How much?

Not sure…

So the financial motivation was quite secondary, because you are not sure when and how much you will earn with the solar panels?

Yes.

Are there any barriers or further improvements for the development of solar power?

The tax thing. Or there could be a possibility to get subsidy. Because we have saved money, but for some people it is the issue to get this money.

Daan van Dieen (sustainable bank)

You would always need some sort of government support for renewable energy. One of the most effective measures have been when individual houses were encouraged to have solar panels on their roofs. They exempt you from all sort of energy taxes for the amount of kilowatt hours that you generate yourself.

What I was working on in Triodos bank was initiative by the government – for people that for some reason were not able to put solar panels on their own roofs, because they did not have their own roof. So if you live close to some sort of cooperative source of energy generation (it could be any source of renewable energy, but usually it is solar) and you would get a full tax rebate on your generated amount of energy. The ruling was incredibly complex, which made it difficult to finance it. But it was also advantageous because you made solar power available to people who have lower budget. Also, in the Netherlands, where you pay 20 cents for kwh and maybe 12 cents of that is tax. But it was incredibly hard to implement.

Was triodos bank cooperating with the government in Postcoderoos program?

It is a government initiative but what we spent a lot of time on was trying to finance it, while other organizations missed the idea, because its incredibly complex. Projects are typically small in size… so the idea of people becoming prosumers is what we were really trying to stimulate. Cause people say small is a new big.

How triodos was financing these projects?

The idea was to do it through the green fund. These green funds they also are also existing for other banks. It provides lower interest rates. It is something that does help.

So the triodos were using their funds to finance postcoderoos and individual solar power projects?

No not necessarily, basically it is a project finance, but it was a matter of mapping what we would need from them, and streamlining the process. Triodos does not do any loans for households (except for mortgages). But there is a possibility to take a larger loan to take a solar

panel. Basically what they did is the interest rate on the mortgage for household for energy label, they coupled it to that. For example, you can take a loan to convert your house from C label to A label (with a slightly lower interest rate). But the loans in particular are just for business parties (SDE).

Rytis Kėvalaitis (advisor to the Energy Minister)

What do you think of Lithuanian government policy about solar power prosumers?

Solar power dvelopment policy is ambitious enough in the government program. In four years it is planned to increase the share of prosumers by hundred times (from 300 to 34.000 prosumers). This is enshrined in a national energy strategy. Hence, with all the stakeholders we are taking measures how to achieve this goal. We also have a whitepaper that shows the structure of our plan. But what is done already is decreased administrative burden, just price making regulation. Also, we have a long-term solution for financing for upcoming three years. So now we have a good regulatory environment for individual house owners and further the conditions will only be improved through legal regulation. Here, a big attention will be paid to apartment houses, distant presumption. This is one of the government priorities as well as Energy Ministry's and even Parliament's.

Can you elaborate what does the lessening of the administrative burden means?

Yes. This is needed bureaucratic procedures when you want to become a prosumer. This is optimization of the process. Before you needed to get 30 different documents and this would last around 100 work days. While today you need to have 3 documents and this may last up to 20 work days only. Even though in practice it can be handled in a week. Another thing that needs to be understood – the more documents, more permissions, more institutions, the higher the likelihood that you will not have something and then the process will take even longer. So the 100 work days used to reach 130 days sometimes. People should not be dedicating that much time for the power plant instalment as this is not your main activity. Therefore, we have shortened the procedures for the smallest consumers (up to 5 kW). This year this procedure should be shortened for all the consumers.

Without administrative burden, it is the lessening of legal restrictions. Now, prosumers can be legal entities (before it was just physical persons). Then, another thing, now all the technologies can be included, such as sun, wind and biomass.

Besides, the quota for prosumers has been increased from 10 MW to 100 MW.

But 100 MW is not much…

Yes, but this is just a beginning. This is just up to 2020. Then, maybe to refuse the quota at all.

Besides, the maximal power of prosumer was 50 kW and now 100 kW. This is needed mainly for small and medium enterprises (legal entities).

How do you see the development in business?

There is a lot of SMEs up to 100 kW, if they have a peak demand for cooling or heating and they want to be green and have a BREEM certificate. Now, they have opportunities to become prosumers. And this development will be organic. But first you need understanding about prosumerism and the knowledge that you can save costs in that way. This awareness is a long process. What we have started working on last year, we just see the first fruits now. Next year the eagerness to become a prosumer should grow exponentially together with information seeking and decision to become a prosmer among physical and legal persons.

What do you mean by awareness raising? Need for communication?

Yes. The first level is that people just don't know about this opportunity. Second, if they know, they think that it does not pay off and that it is expensive. There are a lot of myths, like that sun is not shining in Lithuania. This is a long process this communication. The result will not be reached instantly, especially that we are targeting a relatively large group of people – few hundred thousand consumers and enterprises. But we see the change, especially that we see the results. We have people that become ambassadors of prosumerism.

Going to the topic of financing, Lithuanians like to count and takes the decision only when it is financially reasonable, so everyone waits for support. Last year we had 1,5 mln EUR support budget. This year we have bigger budget – 3,3 mln. EUR and for upcoming 2019 and 2020 we have 17 mln EUR with an opportunity to increase it even more. This is European Union Funds money. What are the changes with regard to the support administration – now it should be a fixed tariff – about 300 EUR for installed kilowatt and a person is made clear how much support he can receive. This is very clear and transparent and administrative burden is less.

Coming back to communication, we have started to communicate about it in advance. This support is from the Ministry of Environment agency – APVA. This is cross-institutional cooperation which may be challenging at times, but it seems that it works this time. Last year, there was no communication in advance and this led to the situation that there were not enough applicants as was expected. While this year we have a mass of people calling to the Ministries of Environment and Energy. People ask even personally. This is advance communication that raised the awareness. So it might be that the support will not be enough and we will have to seek for other funds.

What is more interesting is geographically disconnected prosumerism as well as apartment hosues' prosumer development. What do you think about that?

Yes, individual houses are the low hanging fruit where the result can be achieved most easily. But we want to empower as many people as possible in the apartment houses too. Big part of Lithuanian society lives in apartments. Here we see the synergy with the renovation of apartment houses. Those who take the decision to improve their environment and energy efficiency by renovation, at the same time could become prosumers. Why it is important. To take the decision separately for the instalment of solar power plant – you need the community agreement. I know how difficult these decisions can be. So to the decisions together could be more efficient. We agree on that with the ministry of Environment. Hence, the next call for applications next year should be for apartment houses together with renovation. The next thing is how to install the accounting mechanism in the apartment house. There are few models in Europe – how to distribute among apartments this electricity generated. So yes, this is our plan to have an accounting mechanism that would enable to generate and distribute electricity in apartments too.

The next thing is geographically disconnected generation, the Dutch example. We look at variety of technological solutions. This remote generation is important as not all the houses and apartment houses too have suitable roofs for generation. Hence, we would like to see the opportunity when you can just connect to the internet and with few clicks become a prosumer. This is the envision for 2019. After that demand side response can be considered. Few connected prosumers can sell balancing services to the grid. Or maybe there will be solutions to collect energy in accumulators, storage, but this is long-term. But we need it as by 2030 we talk about half a million prosumers in the energy strategy. These are the perspectives.

Do you thin that in Lithuania we have enough of competence to arrange the contracts for installing solar power plants in apartments?

Yes, these are few different models how this ownership question can be solved in apartments. One form of ownership is when it is owned by community, some part of the power plant belongs to each apartment. Analogically, these costs can be included in renovation. Community can pay everything straight away or take a loan.

Second model is when ESCO company can install the solar plant and sell the solar electricity as a service. The community does not own the solar power plant but signs an agreement to buy this electricity.

Regarding competences, the question is the same as with renovation. A lot of arguments are being raised but the community leader should be responsible for the agreement which should bring benefits to everyone. I think that this question will be solved automatically. The installers, other service companies cannot take advantage of their clients as this will be seen later on.

Is ESCO model like Green Genius example in Lithuania?

Yes, it is a PPA (power purchase agreement). In Lithuania it is not widespread. But in the world it is popular. Around 40 % of new installed solar capacity is through PPA. When you make the contract that I will buy electricity from you for a certain price. Then it is clarity for investor as it assures the profit after some period of time. Of course, here the most profit can be generated with legal entities (larger consumers). Green genius has started to work with small consumers and receive thousands of applications. I think that our aim is to have as diverse market as possible. Because not everyone has extra 5000 EUR for the solar power plant, hence services from companies like Green Genius are essential.

What are the remaining barriers to further development of solar power prosumers?

There must be the work of all institutions towards one direction – cross-institutional cooperation is crucial This is not just the field of energy ministry. We need involvement from both private and public sector too. If everyone will be solving the rising issues then the goal will be reached.

Also regarding the market expansion, we want to have a natural growth of the market. We can achieve our goals quickly but at a big cost, but you cannot sustain it. At first we will encouragement, but then we will have the decrease of support as we see that the prices are dropping. We want trust in regulatory environment to have a sustained growth.

What do you think about the local government's role in the ecosystem of prosumers?

Can they influence this sector.

Of course. But this is the party among the stakeholders that we do not use enough always (municipalities, energy communities etc.). I think that in terms of communication mainly the municipalities are very important. It is very simple – people usually do what other people do – so if a person sees an example in the neighbourhood then he is likely to copy it. We often joke that we need to build a solar power plant in some remote village and the passers by will see. This is proved by the research that people are not willing to do something first. Hence, I think that municipalities communication is important. Also, municipalities can install solar power plants on their public buildings and have green solutions to make people see that it is not that that risky, it is accessible, understandable for the society.

Giedrius Kvedaravicius (ESO, energy distributing operator)

We take the fee only for the use of infrastructure. The consumers sell the electricity usually to the market and later when they consume the operator buys this electricity and it comes back. There is no difference in prices then, the net-metering is applied. So today we have around 600 prosumers, most of which are household consumers, while there are only 4 enterprises.

Another interesting fact is that there are few prosumers who bought solar panels without the support. Before we used to have support called LIFE, which used to encourage investments in RES. Now, new financing is planned from July. 85 % of prosumers emerged due to support and 15 % without. Hence, the ministry has planned around 20 mln EUR for encouragement of prosumers and they will finance the fixed tariff through the kilowatt. If we count that an average consumer gets around 7kw solar power plant and the support reaches up to 300 EUR per kilowatt. Hence, for this 20 mln EUR they will be able to support around 100 MW of solar power. Or else, it would be around 15 to 17.000 average consumers. Thus, this goal to have 34.000 prosumers is rather unrealistic, we doubt it when seeing the statistics.

Another interesting thing is that another measure that encourages prosumers is the reduction of bureaucratic burden. This process used to be quite complicated as it used to take up to 6 months, the longest procedures where considering the permission for development and for production. And for what were those permissions – in order to control the quota. Thus, we even say that we don't need these quotas or permissions, but if we want to control the quota, then ESO can do it. We provide all the technical conditions for the connection and we can control the quota and when the limit will be reached, we will simply will not provide the permissions. In this case we could further shorten the procedure. The Ministry now plans to apply the simplified procedure only up to 5 kW power plants, but this simplification what it gives to the client is reduction of procedures from 9 to 3, then around 1000 EUR is saved and the connection time was reduced from 6 months to 2 weeks. This is a very good thing. Everything happens faster and cheaper. But our suggestion was to simplify this procedure for those power plants up to 10 kW, because the average power plant is 7 kW.

What else, we are establishing a new fund – ESO together with VIPA by which we will encourage prosumers. It means that we can provide loans that you cannot find it the market now, because the interest rates will be lower. Hence, the prosumers could get both – subsidy and the loan for the remaining amount.

So you mentioned that ESO can regulate the quota…

The quota of 100 MW is enshrined in the law. Theoretically, we can connect only that much of solar power. But the problem is control mechanism. And thus we say that we can control it easily in our system and then the residents would not have to deal with any excessive procedures. And now we have this simplified procedure up to 5 kW, we say lets do it up to 10 kW.

Generally speaking, how ESO reacts to the prosumers development?

This is very strange. Historically, we were always against. But with a new board of the company we were considering what should be our new position? We could be against, which according to my opinion is total nonsense. Then we could just observe from the side. And third position could be to be proactive. So we took a third role. And thus we even assist energy ministry how to change the laws, how to make processes faster. Also, we install solar power plants ourselves that can be ordered by the residents, we try to shorten the processes. Also when reconstructing electricity infrastructure, we take the risk either ourselves, or invest ourselves to burden the prosumers as little as possible. Considering a more longer term perspective, the role of distributing operator should change. Because the electricity infrastructure should be managed more smartly. Solar power batteries in combination with car batteries, this is the whole system in which getting rid of one element, you do not get the balance. This is our role to assure the balance in the ever-changing environment. Hence, solar power plant is an opportunity for us to innovate and manage the grid even better. So we are only in favour of solar power.

You mentioned that the residents can order a solar power plant from you..?

Yes, we install the solar power plants ourselves. We deliver it as a service. We started 1,5 months ago and have 9 solar power plant orders. This is good in terms of Lithuanian scale. Especially considering that in a month we have approx. 20 new prosumers. Since the consumers trust us as a company they tend to order with us.

We don't earn a lot from this. But we try to answer the question – how to manage the grid and who we are. We tend to see ourselves not as much as infrastructure managers but as smart platform managers – we integrate renewables, we also incorporate electric cars in the system and say – if you charge your car off-peak we will not apply the distribution tariff. What is good for us – we don't have the overload of the grid. These are the questions that we have to answer.

Also, another thing is blockchain is another opportunity. Maybe in 5 years seeing the technological development we can refuse the suppliers licence and that people after choosing particular algorythms could directly trade with each other. Of course, then the role of the supplier would decrease, but on the other hand if we see suppliers as taxi operators, then blockchain could do the same what uber did to taxis. Here, of course many questions arise – how to manage balancing.

How the ESO sees their role here, as facilitator?

Yes, as facilitator, as the manager of the infrastructure.

This will be especially important when there will be a need to geographically disconnect the consumption and production, right?
Yes, we also see opportunity here. Its called a virtual power plant. The distributed generation, community solar… But what it means basically is that the solar power plant is built somewhere

and its capacity is dedicated to some particular consumer. I think this is great. Its just that they will still be using the grid that means that they will not get the saving effect as you produce and consume it straight away. The grid will be loaded anyway, thus they will have to pay the fee for using the grid. While the prosumers of individual houses don't pay the fee for the straight away consumed electricity (around 15 % of total produced electricity). But another part is given to the grid for "storage". If the electricity is produced in July and consumed in December. For this part is the fee for using the grid applied – 3,8 EUR cents for kwH. And the remaining part that is produced or consumed more is being paid as a simple consumer.

What about the administration of solar communities?

Here what we need most is IT system changes – the accounting. But the challenges arise when 10 people decide to have a solar power plant even though 3 belong to one supplier, another 3 for another and so on. The problem is that is difficult to manage this situation legally. Also, what if some consumers consumer the electricity when it is produced, others at night and in winter. Should they have the same pricing and if not then how to set the price? Here are a lot of nuances. One solution is juts to sell the produced electricity and then to divide the money. But then this model is very financially unattractive. Historically in Lithuania our electricity price is low and the solar power plant would not pay off next to these prices. Hence, the prosumers save by avoiding grid fees and the benefit becomes twice more – at least 8 or 9 EUR cents per kilowatt.

Also the question is how you distribute the benefits – according to the investments?

What are the remaining barriers for the devekopment of prosumers?

I think that bureaucratic procedures are still excessive. Because it is simplified for power plants for up to 5 kWs. So it should be left up to ESO to decide where we can install a solar power plant and where not? Not to control it by law, but technologically, that an engineer could see if there is free capacity in the grid and in this way we could avoid permission for development and generation. This could be one.

Next, we perceive solar power plant as a very risky business. For instance, the bank will give you 7 percent interest rate for 5 years, which is not logical because the reliability of solar power plant installation is the same as to build a house. If the market participants would start considering the building of a solar power plant the same as house, then it would be a totally different business case. So with our fund we will be first, but we hope that later banks should pick up too.

Also, there is no maturity of market participants. The installers companies that would install the solar power plant and take the performance guarantee. So if I build a solar power plant I guarantee that for 10 years it will produce electricity. If it will produce for less years – I will pay you anyway as a guarantee. We don't have such companies in a market. But if we did, it would sound totally different. Because now there is a technological risk that something will break is carried by the consumer. The risk that would be taken by the company is minimal but it would build trust.

We have Green Genius, but as far as I know their business case is not sustainable. They approach the market with a marketing purpose. Also they rent the technology. Still, they are the first in Lithuania. If we had more it would be good.

Another thing is we need sustainability from the government policy and of course education – to tell what it is, what are the benefits.

What about the role of municipalities here?

I don't know about the local government. I would say they have very little role. Who has more role is the ministry of Environment. They should pursue their influence through requirements for the building of new houses and regulating CO2 emissions. This is the field of Energy and Environment ministries. Then we also have the executives, such as ESO, building inspections… Also, we have to have in mind that the powers in Lithuania are more centralized within the government. While municipalities are more like executers and really not the formers of the political environment. Besides, if municipalities have spare money, they ususally use it for something else. Also there is not much spare money left usually.

Vitas Mačiulis (the president of Lithuanian solar energy association)

How do you evaluate the measures to encourage prosumers in Lithuania?

They are ambitious. The measures are very logical and if it is bound to appropriate financing, it will be effective. APVA finansing is really significant. Only for this year, the supprt will be enough for 5100 promuers. Of course 34.000 prosumers is rather unrealistic. But the major increase in prosumers can be reached if apartment houses would be involved. But now the major legal restriction is that to get solar panels on the apartment house you need the agreement from all the residents, which is really hard to reach. Also, the question arise how to separate the energy produced among all the electricity users in the house.

Also, you mentioned that to have more prosumers in Lithuania there is a lack of companies?

Yes, there is a lack of installing companies. Because after the solar bubble in Lithuania disappeared, the solar companies switched to other sectors. Now, as there is a new demand for solar companies, people have to believe that it is a long term goal. Because now the support for prosumers is secured for 2-3 year. But what after that? Will the support for the sector remain. We need the sustainability of the policy. We need that the current energy strategy would be simply implemented. First time in Lithuania we have concrete numbers as goals for solar power development. Until now all the strategies were very abstract and vague.

Now we need the market to follow the policy, correct?

Correct, it develops now, but rather slowly.

And APVA is providing subsidies?

It is a support, it was successfully agreed that the support would be 336 EUR per kilowatt. Not a percent. Because when it is a percent it seems ambiguous, it encourages to buy more expensive ones. And also, the support now is clear and quick.

But still, it does not cover all the expenses?

Yes, it covers only around 30 %. But the person has to contribute himself. And imagine how it will boost the development of the energy sector. Because a person will still have to invest the remaining 70 %. So next year 17 mln. of support will become 50 mln. EUR of investments in the energy independence of Lithuania. This has not happened in Lithuania before.

And what about VIPA loans for prosumers?

Loans…well, solar energy is not for low income people. Usually it is people that will not be encouraged by few thousands of Euros loan. In our opinion, as solar energy association, it will not be a major encouragement.
And what about the administrative burden that has been decreased for solar power plants until 5 kW?

Yes, very good. Just now we try to push for lessening the administrative burden for 10 kW.

What about additional measures that could encourage prosumers?

The association has advised the Energy Ministry to establish 5 consultancy centres. To set up an office where a person could come, see and consult. And the Ministry has included this in their set of measures for prosumers saying that there should be more information sources on how to become a prosumer. But the financing is not dedicated for it.

We, as an association, we organize seminars in Vilnius. But what does the seminar in Vilnius mean for the people in the regions? Also, around 30 people come to our seminars, but we need to reach much more, the information dissemination has to be massive if we are to reach the goals. We need to go to people, to reach them directly. And this costs. If there were finances for this, then it would be a progress.

What about the Lithuanian solar panels production?

Yes, we have a very good quality one. Our markets are Switzerland, Austria. Although, we have Lithuanians who buy it too.

How are the companies affected by the development of the prosumers?

Well, the companies can become prosumers too until 100 kW. And they can enjoy the benefits of net-metering. This is very useful as they can avoid energy taxes. However, this may be even too beneficial for large prosumers. We will see how long it will last.

Another barrier for prosumers development is our protection of monuments in the cities. In other old cities in Europe you can see solar panles. For instance,prince Charles in UK got a permission to build solar panel in the centre of London. But in Lithuania it would not be a case. Even though, for instance on the house of presidency in Lithuania the roof would be very suitable for solar power. But it is not allowed. However, the parliament of Lithuania, has decided to build solar panels. This could be a strong communicative message.

What should be done to have more producing companies in Lithuania?

Well, we have enough, 4 companies in Lithuania is too much. We rather need installers. But even more that that we need good consultants. Because an active house cannot have only solar panels. It has to have the heat pumps too. Because the solar power use for electricity and heat use is really effective.

We have an example house in Lithuania, which pays only 100 EUR per year for energy. But they do not want to reveal the location of their house, because people will start coming and coming to see. That is why we cannot have a house as an example. We need more consultants that know about electricity, heating and energy efficiency.

Of course, in Lithuania people do not value much technical consultations. However, there is a need for professional consultants.

What about the activity of Green genius?

Very good, but the company has to have spare money to carry out such an activity. Of course, for other members of our association it is not very good. Because they give solar panels for free and other companies request payments. It is just when you pay you will have yours.

What has to be done most importantly to boost the development of prosumers?

I would build 5 consultancy units in 5 regions. I would build exemplary solar panels and provide professional consultants. The salaries should be decent too. Just later the salaries should be decreased as those centres will become profitable. It is important to have reliable consultants.

True, because now if people have questions, whom they have to contact?

They are constantly contacting association. But we do not have enough time for that. There should be people who consult all day how to become a prosumer.

Also, the renovation of apartment houses should be linked to the instalment of solar panels.