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Becoming a prosumer − the new possibilities of the energy customer

Prosument − nowe możliwości dla odbiorcy energii

Abstract: *Greater energy efficiency is an essential part of overcoming the challenges facing the energy sector. More energy is expected to come from renewable resources (RES) in order to reduce dependency on fossil fuels. The next generation power network called the Smart Grid (SG) will allow customers to make informed decisions about their energy consumption. The role of the typical energy customer evaluates from passive to active. Households with rooftop solar panels, small wind turbines or micro CHPs will no longer be only consumers of energy provided by the grid, but instead will become energy 'prosumers' – producing, consuming, managing and even trading energy.The paper will discuss the idea of the prosumer in the SG and present some current European schemes of supporting energy from renewables. The short result of Polish residential customer inclination to purchase DER based of survey done in central Poland region in 2013 will be presented.*

Keywords: Smart Grid, Energy market, prosumer

Streszczenie*: Zmiany w rynkach energii i systemach elektroenergetycznych zachodzą w niemal całym świecie. Oczekuje się zwiększenia produkcji energii ze źródeł odnawialnych w celu uniezależnienia od paliw kopalnianych. Zwiększenie efektywności elektroenergetycznej jest podstawowym elementem przezwyciężania wyzwań stojących przed sektorem. Nadchodząca generacja sieci elektroenergetycznych, określana mianem Inteligentnej sieci pozwoli odbiorcom na podejmowanie świadomych, bazujących na aktualnych danych o cenach, decyzji w zakresie zarządzania zużyciem energii. Rola odbiorcy energii zmienia się z pasywnej w aktywną. Domy wyposażony w panele PV, małe turbiny wiatrowe czy źródła kogeneracyjne przestaną być tylko konsu-mentami energii dostarczanej przez sieć elektroenergetyczną, a staną się prosumentami – jednostkami, które produkują i konsumują energię, świadomie zarządzają jej wykorzystaniem, a nawet ją sprzedają. Artykuł przedstawia rolę prosumenta w przyszłych inteligentnych sieciach elektroenergetycznych i prezentuje wybrane mechanizmy obecnie wykorzystywane w Europie dla wsparcia producentów energii z odnawialnych źródeł. W zakończeniu zaprezentowano fragment wyników badania przeprowadzonego w centralnej Polsce na temat skłonności polskich odbiorców sektora gospodarstw domowych do zakupu urządzeń produkujących tego typu energię.*

Słowa kluczowe: inteligentne sieci elektroenergetyczne, rynek energii, prosument

Introduction

Greater energy efficiency is an essential part of overcoming the challenges facing the energy sector. More energy is expected to come from renewable resources (RES) in order to reduce dependency on fossil fuels. The big corporate energy business suffer from lack of if investments, environmental protection protests and social aversion to nuclear power plants. Dispersed Energy Resources (DER) and small producers can supply part of the energy demand on

the market. The coming generation of the power network called the Smart Grid (SG) will allow customers to make informed decisions about their energy consumption and decide not only how to use energy, but also when to produce and sell it. Since 2003, the EU-27, an annual increase can be observed in the amount of energy from renewable sources year on year. In 2010 the increase was the largest and in the EU-27 it reached 12% (13.7% for Poland). Also the contribution of electricity produced from renewable energy in gross electricity consumption has been growing. Although the growth is different for EU members, Poland recorded a growth from 2,1% to 7% comparing years 2004 and 2010, while all EU-27 13,7% to 19,9%[1]. According to a 2009/28/EC Directive, each UE Member State shall ensure that the share of energy from renewable sources in gross final energy consumption by 2020 is at least its national overall target for the share of energy from renewable sources in a given year, as specified in the directive. For Poland this goal was set at 15%.

The development of DER together with ICT technology is a key element of SG deployment. There are generally two types of distributed generation based on renewable energy resources (solar electric systems - photovoltaic, wind turbines, small wave hydroelectric generators and generators that use landfill) and combined heat and power (CHP) technologies run on fossil fuel, biomass, natural or bio-gas or waste. The first group strongly depends on weather conditions, so the quantity of energy produced is not stable, the second one can operate non-stop and can be used to control imbalances or grid problems. The very important problem is the lack of storage capacities. Because the prices of new technologies are decreasing every year, small energy consumers can invest in DER technology and trade their own generation or storage capacities Many research projects aim at successful predicting the level of critical price whereby customers will start to invest in such technologies.

Prosumer in energy market

European countries have moved from regulated regional monopolies to liberalized power markets where power trade on the wholesale level is divided into many separate areas and power usually has different prices for each market interval. A uniform European power market does not exist, but the idea of merging all markets into a pan-European coupled-market is becoming a reality, mainly for Central-West and Nordic countries, because some initiatives towards integrating those markets have been undertaken.

On today's market, to include Poland, small energy customers can choose a supplier (a free choice from market offers), and then have to pay for energy consumed, pay a transmission tariff (there is no choice, usually there is one transmission system operator) and pay a number of fixed costs and taxes.

The concept of a prosumer comes from A. Toffler, who noted that by involving customers in the production, distribution or service associated with the business of the organization, specialized and affordable products could be created

[1] G. Berent-Kowalska, J. Kacprowska, I. Gogacz, A. Jurgaś, G. Kacperczyk, *Energy from renewable sources in 2010,* GUS, Warszawa 2012, www.stat.gov.pl.

and sold. The concept strongly concentrated of the supplier-customer interaction. With the Internet, concept of "prosumtion" has gained the status of peer to peer communication. With Web 2.0 customers could participate actively in domains that were previously reserved for professionals, which gave prosumerism a much broader societal dimension.

With the coming "Internet of Things" the concept of the Smart Grid will introduce a new demand response system in which consumers, producing their own energy and controlling consumption, will react to incentives such as market spot prices.

The prosumer is supposed to be an energy market participant, either directly or indirectly (through aggregator services), who can be affected by the market. The role of the prosumer can be played not only by big entities like plants, but also by smaller entities like offices and individual households with solar panels, small wind turbines or other installed energy generators. Each prosumer can be equipped with a different type of distributed energy generator, some type of storage system and a ICT system to control and manage energy usage and production. It will be an economically motivated entity that will be closely involved in the value chain of commercial energy suppliers. In particular it is supposed to[2]:

- consume, produce, and store electricity and energy in general,
- optimize the economic, technological and environmental decisions regarding its own energy utilization,
- become actively involved in the value creating effort of an electricity or some kind energy service.

The project Improsume which goal is to find the best solutions for prosumer-market interactions defines prosumer as[3]:

"A consumer that becomes resonant with the energy market through systematic actions and reactions that aim to increase personal or collective benefits".

Small prosumers can supply energy to the local microgrid or directly to the regulated power grid. To increase the influence of their actions, they can be grouped into collectives integrated by entities like aggregators and service providers and managed in an intelligent way. Equipped with ICT and AMI solutions, those groups may enforce price changes and create a negotiating platform.

New advanced ICT solutions are necessary to help prosumers actively participate in the market (the contribution is on a voluntary basis). Direct participation means the ability of prosumers to take actions such as. consuming energy at a low price signal, producing while high, loading storage devices at low prices and selling this energy while electricity prices are high over a short period These steps may be based on profit maximization in response to real time signals coming from the market.

Some prosumers can face difficulties achieving optimal trading performance on their own because of the lack of commercial skills, trading infrastructure and the management time needed. For those future market participants an indirect model could be recommended. With an indirect scheme the prosumer signs

[2] I. Shandurkova, B. A. Bremdal, R. Bacher, S. Ottesen, A. Nilsen A., *A Prosumer Oriented Energy Market Developments and future outlooks for Smart Grid oriented energy markets*", 2011, http://www.ncesmart.com/Documents/SOTA Improsume Final version B.pdf.

[3] Ibidem.

a contract with a commercial service provider (aggregator − an entity interested in energy trading on behalf of other market participants) establishing the characteristics of prosumer flexibility (readiness to react to market signals, types of fixed fees, etc.). The role of aggregator can be played by local energy suppliers, ESCOs (Energy Service Companies), Commercial Virtual Power Plants or other new market entrants. This entity is expected to make a profit by selling the aggregated energy in the most beneficial way for prosumers and share this profit according to the agreements. Several new services need to developed with strong ICT support[4]. A lot of current ICT solutions for energy market, home energy management systems are based on SOA architecture and agent-based technology to support real-time monitoring and management and the respective brokering services[5]. The ICT technology trading bots responding to a price signal in milliseconds, can remove the boundaries between those two schemes.

The large number of energy customers interested in prosumerism will be a great challenge for the electricity markets. They will trigger a higher demand for flexibility consumption and production, coupled with higher price volatility and higher balancing costs. The benefits depend on the local market and energy prices. It is possible that households and property owners in countries that have comparatively low prices, will benefit only marginally[6].

Energy prosumer behavior

The anticipated massive scale of energy production by entities, who until now have consumed energy only, demands new incentives and wide activity projects on customer acceptance of the new possibilities.

Energy customers are expected to change their behavior and pay for products and services offered by SG that are valuable for them in terms of financial, environmental, or others. For a particular residential customer, the effect will depend on several circumstances. Although financial incentives play the most important role, the influence of other factors connected with other roles of the consumer at an energy market level and those played as community members are also very important[7]. Designing a new program for residential energy management must consider several issues affecting customer decisions like:

- habits, beliefs, motivation, curiosity about new technologies,
- local society pressure, status in the society,
- the level of engagement in environmental protection,
- the ability to reduce energy consumption and take Demand Response action,
- the level of commitment in investing in DER facilities,

[4] A. Pamuła, *Usługi DSM w inteligentnych sieciach elektroenergetycznych*, [w:] Gospodarka elektroniczna - wyzwania rozwojowe, Tom II, pod red. J. Buko, 2012, Zeszyty Naukowe Uniwersytetu Szczecińskiego nr 703, Ekonomiczne problemy usług nr 88, Wydawnictwo Naukowe Uniwersytetu Szczecińskiego

[5] S. Karnouskos, M. Serrano, P. J. Marrón, A. Marqués, *PROSUMER interactions for efficient energy management in smartgrid Neighborhoods* Proceedings of the CIB W78-W102 2011: International Conference–Sophia Antipolis, France, 26-28 October 2011, http://diktio.dyndns.org/files/2011_CIB.pdf.

[6] Shandurkova…, op. cit.

[7] W. Timmerman, *Energy Management Services for Prosumer Communities,* Flexines, 2012, http://www.flexines.org/publicaties/eindrapport/BIJLAGE13.pdf.

- the attitudes to operate DER facilities,
- the lever of RES installed in local community.

As an important element for the future SG prosumers ability to control energy production and consumption in response to incentives, mainly market signals, will be crucial any price setting mechanism. The level of this response and the degree of those incentives are explored through researches done on local markets.

Tariffs for RES promotion and prosumers

Two main systems of renewable energy promotion are in use in Europe: one is the quota regulation in combination with a tradable green certificate (TGC) market, and the second - the feed-in tariff (FIT) scheme. The basic element of the TGC system is the obligation for a particular body of the electricity supply-chain (e.g. consumers, suppliers or generators) to provide a specified minimum share in total electricity consumption from renewable energy sources. The second element is a market established for renewable energy certificates. By selling certificates of green energy on this market, producers receive financial support in addition to the electricity sales on the power market. The FIT system allows electricity generators to sell green energy at a fixed tariff for a determined period of time. Alternatively, the feed-in tariff can be paid in the form of an additional premium on top of the electricity market price[8]. A feed in tariff scheme is a special type of tariffs, that promotes DER technologies, currently much more expensive than fossil fuels. In the FIT scheme, electricity suppliers are legally obliged to buy electricity produced from renewable energy producers at fixed prices over a certain, known period of time. Tariff rates are fixed through production cost estimates, or by additional overheads for conventional energy costs. The suppliers pass those additional costs onto the consumer.. The tariff scheme uses different prices depending on several factors such as: type of DER, year of installation or plant size. Tariffs for future contracts can change according to the market and technological conditions. The important factor determining the tariff is the size and quality of the site. This type of solution, implemented for example in Germany, allows different sizes of producers from many regions to participate at a profit instead of restricting generation to large organizations or the most preferable regions. Most of the EU Member States applied FIT systems as the system supported RES generation.

The tariffs system for residential customers on today's energy market does not reflect actual energy market prices. The prices in the future SG are expected to reflect the momentary market conditions. The most suitable system, proven through some pilot installations in USA and Europe, is Real Time Pricing (RTP), where prices are changed in minutes (although the most often used now interval is an hour). The lack of an AMI infrastructure time is necessitates the testing of time differentiated tariffs: Time of Use (TOU) and Critical Peak Pricing (CPP) for residential customers.

[8] A. Klein, B. Pfluger, A. Held, M. Ragwitz, G. Resch, T. Faber, *Evaluation of different feed-in tariff design options – Best practice paper for the International Feed-In Cooperation, Energy Economic Group, 200,* www.feed-in-cooperation.org/.../best_practice_paper_2nd_edition_final.

European experience in prosumer energy

In Europe Energy the form prosumers is widely used in Germany, UK and the Netherlands. Germany uses a feed in tariff model since 1990. The model was revised in 2000. The scheme guarantees a fixed tariff for electricity generated from DER that would allow normal profits with current technology and geographical advantage. Grid operators are obliged to prioritize connections to DER producers, and pay the statutory tariff to the plant operator. These higher costs are passed on to all consumers. Tariffs are fixed by contracts for 20 years, from the installation of the plant, at which point they expire. The fixed tariff, the obligation for the grid to purchase renewable energy, and the time horizon create a guaranteed market and revenue stream, a lower cost of capital due to reduced uncertainty, and allow the creation of economies of scale over time[9]. For a long time Germany was a European leader of solar technology and the largest market for clean and renewable solar energy. Germany had the fastest-growing PV market between 2006 and 2007. German tariffs are lowered every year to encourage a more efficient production of renewable energy. For example, in 2010 Germany cut the feed in tariffs for installations on farmland[10]. At present (2013), feed-in tariffs for newly installed arrays are reduced by 2.2 percent each month and next reduction is planned. Those rate changes do not affect systems already connected to the grid[11].

Important lessons from the German case indicate that a successful feed in a tariff should provide tariffs for all potential developers, provide financial security over the long term, have no barriers to grid connection, have limited administrative barriers, and enjoy strong public support.

In the UK before 2010, there were almost no such installations. In April 2010, the government initiated a Feed–in-Tariff scheme to promote micro-generation amongst homeowners and other investors[12]. Small investors found it very attractive especially with regard to solar PV and wind energy. Concerning PV cells, the assumption that the cell will work 750 hours per day. After 2 years number of installations arise to 250 thousand. Almost all of the micro-CHP (which is limited to 2kW) and 85% of solar installation were done by domestic users. A small but growing contribution of community renewables was also observed during those years[13]. In 2013 the number of DER installations was about half a million, and it is expected to be about 8 million by the end of 2020, so that means that every third household in the UK will be equipped with some kind of DER. The other estimation is that by 2020 the number of people employed in the sector will exceed 100 thousand. In the case of the solar panel, British OFGEM offers a payment for each KWh for 25 years since date of installation.

Prosumer energy on Polish energy market

Poland has adopted the renewable energy support model based on green certificates. Some Polish experts forecast that Polish energy systems will suffer

[9] http://www.sustainbusper.com/feed-tariffs-germany.
[10] http://www.solarfeedintariff.net/germany.html.
[11] http://www.renewablesinternational.net/german-pv-drops-to-15-cents-max/150/510/62457.
[12] V. Kashya, *The Solar PV revolution in UK – is it generating enough for you?,*metering.com, 2012, http://www.metering.com/node/21386.
[13] ww.fitariffs.co.uk/FITs/.

from a lack of power in a few years. Under the EU LCP Directive Poland will have to decommission 6.5 thousand MW of installed capacity and there is no plan to install new generators that could replace them at the same time. The energy from prosumers could help the system to stay secure. The PV market is growing in Poland, and is also netting city residential customers. For solar PV in Poland the assumption of 500 working hours per year for cells can be estimated. To promote large-scale energy production amongst Polish prosumers the following dimensions should be supported[14]:

- legislative – changing the rule of obligatory open sole trader requirement, removing insurance contribution payment, removing requirement to have licenses, building permits and environmental impact analysis);
- financial – introducing feed-in-tariffs, the approval of micro-CHP;
- operational support provided in the form of assembly services, guarantees of quality and market support services.

Polish residential energy customers are interested in installing RES. The Figure 1 presents part of the result of the survey conducted in central Poland in April 2013. The aim of the research was to find out how Polish energy customers are prepared for new SG solutions. For the question "Did you consider the installation of RES", 60% expressed a lack of interest, but 38% were interested in, browsing the offers, but found them too expensive and not profitable. Only 2% of respondents installed RES due to some type of governmental financial support.

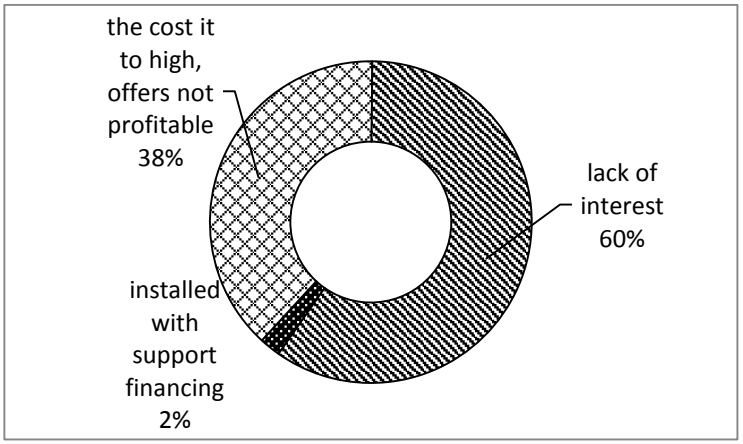

Figure 1. Polish residential customer inclination to purchase DER
Source: based on author's research

Conclusions

For the Smart Grid to operate at optimum levels, it is essential that consumers adopt the technology which it encompasses, particularly DER generators and

[14] *Report on debate: Prosumer energy: what does it mean for end consumers and distribution companies?*, NFOŚiGW, 2013, http://www.proinwestycje.pl/index.php?option=com_content&view=frontpage&lang=en&limitstart=5.

devices that allow two-way communication between consumer and the energy service provider. Further role of prosumer can be drafted before the market is fully functional. The examples of Germany and the UK show the support of prosumers plays a crucial role the deployment of DER. Equipping customers with energy generators requires strong governmental support, because technology is still rather expensive for the majority of customers. A parallel step could be to equip them with AMI. AMI infrastructure facilitates prosumer interaction and is seen as a basic element of the future energy market, but it must be noted that DER technologies have their own development trajectory. In some cases DER solutions are ahead of the development and use of smart meters. Before AMI infrastructure is fully available, energy customers may be offered other programs, which will allow them to to get used to the idea of treating energy as a trading commodity.

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