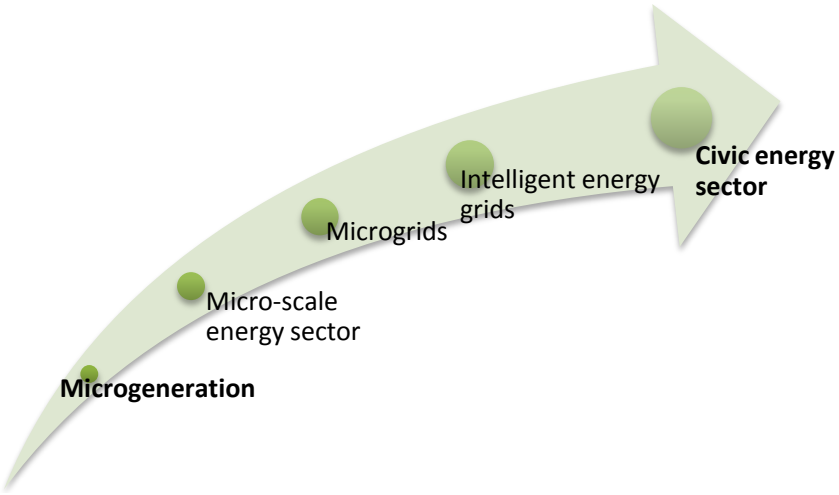

The Development Plan for Microgeneration for Poland based on Renewable Energy Sources until 2020

A Synthesis

Institute for Renewable Energy

in collaboration with

the members and partners of
the Association of Employers of the Renewable Energy Forum

Instytut Energetyki Odnawialnej

ZP FEO
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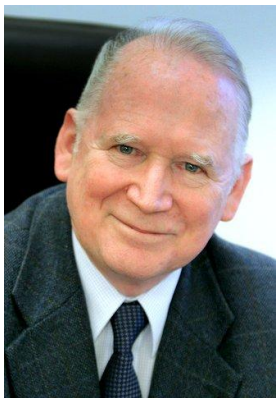


Prof. Maciej Nowicki

A few years back, the future of the Polish energy sector would not be a topic of any major discussions. It was obvious that Poland had vast coal deposits ensuring its self-sufficiency with regard to power and heat generation for many decades to come. Any kind of renewable sources energy were treated only as a fringe, with no chance of any broader application. At present, this simple strategy is, by and large, no longer valid. It turns out that by 20-30 years all lignite deposits and most of the so-called operative (i.e. extractable) hard coal deposits will have been exhausted. Moreover, the exploitation of Polish coal is becoming increasingly more expensive, hence less competitive. Additionally, there are no funds available to develop new mines.

The situation of the power generation sector is not any better. A large proportion of power plants, heat and power plants and thermal power plants rely on appliances that are 40 or more years old. In the coming years they will have to be excluded from exploitation because of wear and tear. Thus, the question that arises is the following: what will happen to the main energy carrier in our country in the coming decades? The government has decided to have the first nuclear power plant built, with the capacity of 3 000 MW, but its ability to diversify power sources will be insignificant (below 10%) while the costs horrendous. Information about large resources of shale gas in Poland has also revived hopes but it will be long before we find out about the scale of its profitable exploitation. It is also not clear whether this gas could be used in large power stations or in small systems dispersed across the country. The third element of the new energy strategy that is being developed is Poland's obligation towards the EU to obtain as much as 15% of end-user energy from renewable sources by 2020, which is already a large proportion.

All the aspects mentioned above make the current situation especially difficult because now is the moment to take key investment and financial decisions whose effects will be felt for several decades to come. This should be done bearing in mind the variety of imponderables, both with regard to the kind of energy carriers available in our country and international technological, economic and even political trends in the energy sector. Wrong decisions are likely to reduce the competitiveness of Poland's entire economy and the living standard of its citizens

for many decades while good decisions may bring nothing but benefits in this respect. The greatest difficulty in choosing the right path is caused by two, completely different, energy system models that are in place in Poland at present:

- the 20th century model, extremely centralised and based on large power plants, heat and power plants and thermal power plants fuelled with coal,
- the nascent 21st century model, highly decentralised, based on renewable energy sources and many small intelligent energy systems.

The main problem is the right choice. What is better: to continue to support, above all, large power stations fuelled with coal, increasingly imported, and strengthen even more this centralised system by building a nuclear power plant or rather promote diffused, small and intelligent systems ensuring energy security on the local and national level to a much greater extent and providing tens of thousands of jobs as well as an opportunity to develop new industry sectors with a great export potential?

It is evident that both models will continue to co-exist for a long time to come. The proportions, however, are important. Now, it is necessary to create good conditions for the development of diffused energy generation. The first important step in this respect will be to adopt the act on renewable energy sources that will stimulate the development of such conditions in our country. The draft act mentioned gives prominence to the promotion of microgeneration and prosumer energy. These are relatively new notions in the public debate about the future of Poland's energy sector. So far, reliable information concerning this important topic has been missing.

This study fills in the gap providing a comprehensive description of the potential hidden in microgeneration based on renewable energy sources as well as the requirements that have to be met to tap into this potential. I do hope that it will be useful in taking political, economic and legal decisions that stimulating the fast development of microgeneration and prosumer energy in our country.

Prof. dr hab. inż. Maciej Nowicki*, Minister of the Environment in 1989–1991 and 2007-2009. Founder of EcoFund, a foundation established to manage the eco-conversion of the Polish debt. In 1994–1995 he was Deputy Head of the UN's Commission on Sustainable Development and in 2008–2009 Deputy Head of the UN Framework Convention on Climate Change. Winner of "Der Deutsche Umweltpreis" (the so-called "Environmental Nobel Prize").*

Senator Norbert Obrycki

The time of the publication of this study coincides with an increasingly more vocal postulate of many groups calling for the urgent adoption of the act on renewable energy sources. An additional incentive for the implementation of this task is definitely Poland's need to fulfil the provisions of the EU directive on RES by 2020.

The prosumer energy sector seems to cause little controversy among legislators in this context. On the one hand, we have to fulfil the obligation towards our citizens so that they are able to make as independent decisions as possible about the energy mix in their own households. On the other, our job is the ensure the right balance of regulations so that the citizen that generates electricity in his or her microgeneration is not treated in the same way as a power plant. Regulations should enable the implementation of tasks limiting conditions and executive provisions to the lowest extent possible. The key question seems to be to what extent the producer will be a consumer and to what extent the producer will be a seller of surplus energy to the grid?

Recent conferences and debates about diffuse energy, both within the industry and political circles, including the ones organised at the Polish Senate by the Senate Committee for Renewable Energy and at the Office of the President of Poland, have demonstrated that the prosumer energy sector may play an important role in the context of our country's energy security.

Above all, we have to realise that the simple model involving few active producers of energy connected to the grid supplying many passive consumers will become history. The 21st century will see many producers, many interconnected intelligent distribution networks and many consumers who, at the same time, will have the technological capacity to generate energy for their own needs. Future solutions also include storage of the surplus energy produced.

Taking the above into consideration, in my opinion, a better term to describe the prosumer, or diffuse energy sector, is the civic energy sector, i.e. one based on the citizen's freedom of choice and the universality of energy generation technologies applied in home energy systems.

The Plan for the Development of Microgeneration for Poland based on Renewable Energy Sources until 2020 prepared by the Institute for Renewable Energy shows clearly that this sector is the near future and a great socio-economic challenge

facing our country. I am convinced that this study will assist us, politicians, in taking the right decisions to create good legislative environment stimulating the development of the civic energy sector in Poland.

***Norbert Obrycki**, Senator of the Republic of Poland, Head of the Senate Committee on Renewable Energy, Marshall of the Zachodniopomorskie Province in 2006-2008.*

1. Introduction

Relatively recently, the notion of a microgeneration in the renewable energy sector and the definition of a prosumer, inseparably linked with it, have become an element of a public debate in Poland. The catalyst for the discussion was the first draft act on renewable energy sources[1] published in December 2011. It soon turned out that citizens are becoming increasingly more aware of these new notions.

Following the draft act, a **microgeneration** is a renewable source of energy whose total power capacity installed does not exceed 40 KW or total heat capacity installed does not exceed 70 kW. A **prosumer** is a natural or legal person or an organisational unit which is not a legal entity producing energy in a microgeneration in order to use it for its own needs or to sell it, but, following the legislator's intent, the prosumer's activity is not a business activity. Because of these breakthrough concepts introduced to the Polish energy system by the draft act, it is also called "the prosumer act".

The idea of the prosumer energy system is extremely popular. But if it is to be developed and enjoy a significant support among the society and politicians, which is necessary for a new act, a broader strategy for the development of the micro energy system (based on microgeneration and the prosumer concept) as an element of both the renewable energy system and the diffused power generation system must be developed. This study is the first attempt at a more precise specification of the plan for the development of the "national roadmap" for microgeneration based on renewable energy sources, including power and heat sources, in households. It is also an attempt to include microgeneration in the broader trends of the development of micro energy, prosumer energy and civic energy systems, which have already been developed for a number of years abroad. These ideas have led to a breakthrough in the world's energy system and a revolution that is happening before our very eyes and will not bypass Poland, either. The fundamental principles for the development of the prosumer energy system and microgeneration were introduced as early as in 1980 by Alvin Toffler, an author and a futurist, in his book "The Third Wave" where in the chapter entitled "The Sun and Beyond" he accurately presented the vision of a breakthrough in the energy system, which is currently being verified by reality, also in Poland. He indicated the stages and the inevitability of changes as well as pointed out the fact that these processes would not be simple or devoid of conflict.

[1] Source: Draft act on renewable energy sources of 20 December 2011.

In this war of ideas and money that is already raging in all the high-technology nations, it is possible to discern (…) antagonists. To begin with, there are those with vested interests in the old, Second Wave energy base. They call for conventional energy sources and technologies — coal, oil, gas, nuclear power, and their various permutations. They fight, in effect, for an extension of the Second Wave status quo.
(…) In short, though nuclear reactors or coal gasification or liquefaction plants and other such technologies may seem to be advanced or futuristic and therefore progressive, they are, in fact, artifacts of a Second Wave past caught in its own deadly contradictions. (…)
By contrast, those who favor the advance to a Third Wave energy base—a combination of consumers, environmentalists, scientists, and entrepreneurs [Toffler also includes prosumers in this group] in the leading-edge industries, along with their various allies — seem scattered, underfinanced, and (…) Second Wave propagandists regularly picture them as naive, unconcerned with dollar realities (…).
Source: Alvin Toffler. The Third Wave. Bantam Books. United States of America,1981.

The trends presented by Toffler have materialised because they lower the costs of energy provision and ensure fairer benefit division. However, they required a technological breakthrough as well as an act that does not restrain grassroots initiatives and a certain level of maturity among the civil society. A renowned Polish sociologist and philosopher, the key representative of the so-called "Post-modern School", Professor Zygmunt Bauman, emphasizes that local initiatives with truly global ambitions, e.g. environmental or consumer movements, which definitely include the prosumer energy system, are very important in a civil society. Professor Bauman, however, warns that "similar initiatives are difficult because while the tasks are global, their contractors are local and it is difficult to organise them." But currently, thanks to the enormous technological progress in the area of renewable energy sources, telecommunications, intelligent networks and expected new regulations, beneficial for energy consumers, the energy users who have been passive so far may become active prosumers in practice. As early as in 2002, the authors of a well-known publication *Small Is Profitable*[2] counted as many as 207 benefits brought by diffused energy generation to consumers and citizens. A large proportion of these benefits is directly or indirectly related to the increase of the individual, local and national level of energy security.

An increasing number of citizens in Poland keep looking for ways to increase their independence and security of energy supply. For a long time now, such options have been provided by small-scale energy technologies. The search for alternatives becomes more intense as costs rise and power supply quality deteriorates (power outages, lower voltage incidents, etc.), which affects some groups of consumers connected to low voltage grids, most often in rural and suburban areas. But in this situation the consumer finds it difficult to take up remedial measures and supply the missing energy by him or herself. Roman Kluska, a well-known Polish entrepreneur active in the IT industry in the past and a farm owner at present, decided to have a microgeneration (a PV system) installed in his household. Having an extensive and

[2] Amory B. Lovins (ed.) et all: „Small is profitable. The hidden economic benefits of making electrical resources at right size". Rocky Mountain Institute, Snowmass, 2002.

unique experience in industry, he did not expect that the construction and connection of a micro power plant to the grid would be such a difficult endeavour lasting five years.

My solar power plant (…) on sunny days generates much more energy than I can use. At the same time I am not allowed to feed this power to the national grid, even for free. To do that, I would need to have a concession and obtaining one is a long administrative process starting with a certificate confirming the absence of criminal record. This is why in a moment the automatic system will switch on enormous immersion heaters that will return surplus energy [produced for one's own needs but not used] to the atmosphere. After the assembly of the system the German supplier could not understand why Kluska told him to immediately disconnect the system he had just built from the grid. All appliances meet the EU standards that can be automatically connected to the European network with no need of adjustment or fine-tuning. When I explained it to him that by feeding power to the grid I would become a criminal, he answered that they had installed this kind of power plants in 18 countries across the world and nowhere else had they encountered an equally absurd law.
Source: Roman Kluska, Tygodnik Powszechny 20-12-2010.

The prosumer energy system requires an incubation period and is introduced to energy systems in stages, which inevitably lead to a true energy revolution. Microgeneration based on renewable energy sources and their promotion is the first necessary and extremely important step without which the energy system may not undergo further changes. Although the national energy system is changing slowly, there are more and more groups advocating new paradigms and practical actions. The strength of and the basis for the prosumer energy system involves microgeneration technologies, already available and developed in our country (but more often exported than sold here so far) such as solar collectors, pellet boilers, biomass briquettes, small wind farms and a number of other appliances and green industry components. There are also companies that install, design and build more and more microgeneration in Poland and the entire construction sector. But the greatest strength lies in numerous home owners, farmers and small enterprises that, following the consecutive steps of the energy market liberalisation process and the increasingly smaller ability of the centralised energy system to meet the needs of diffused energy consumers, have been actively looking for energy alternatives. Microgeneration based on renewable energy sources are not just "the technology of tomorrow" but already the technology that is in place now. Over 230 thousand active citizens have decided to invest in microgeneration based on renewable energy sources.
This plan, the "roadmap", focuses on the presentation of the current situation of microgeneration based on renewable energy sources in households and the real path for their development until 2020 as the first and key, according to its authors, pillar of the prosumer energy system construction in Poland. A complex presentation of the current state of microgeneration and possible options for their development has been quite a challenge. The results of analyses obtained may include a small margin of uncertainty. Ultimately, these are the prosumers, their location and individual preferences and choices that will determine the directions of development. In a special public opinion survey the authors asked citizens about

their preferences in this respect. But at the current level of the market development the government's initiative is indispensable. This is why the most important starting point for analyses was "The National Renewable Energy Action Plan" (the so-called NREAP) that will be supported by "The Roadmap of Intelligent Networks" prepared by the Energy Regulatory Office. The most important condition of and guarantee for the implementation of the plan for the development of microgeneration and prosumer activity is the removal of legal barriers and the adoption of the act on renewable energy sources. The recommendations developed as a result of analyses and presented at the end of this work focus on this very aspect.

The authors hope that this publication, combining the idea of the prosumer system with renewable energy, will become an impulse for a wider debate on the subject supporting the actions already undertaken by the government (but not finished) and the initiatives of a number of non-governmental centres aiming to tap into a huge but still unused national potential of microgeneration based on renewable energy sources. It is also our intention that this publication will contribute to the overcoming of the current deadlock in the prosumer energy market development that began in Poland.

2. Microgeneration based on renewable energy sources as key prosumer technologies

The National Renewable Energy Action Plan and the draft act on renewable energy sources provide a list of key microgeneration:

1. Solar collectors,
2. Biomass boilers,
3. Small wind farms (micro wind turbines),
4. Photovoltaic microgeneration,
5. Cogeneration microgeneration fuelled with biogas and bioliquids (powering electricity generators with various internal combustion engines),
6. Heat pumps,
7. Small hydropower plants.

The chart below includes a brief characteristics of prosumer microgeneration based on renewable energy sources. The microgeneration listed include three "home" technologies for heat production (solar collectors, biomass boilers and heat pumps) and three technologies for the generation of electricity, including cogeneration (PV systems, micro wind mills and micro biogas plants).

PV modules[3]	Appliances changing solar energy from radiation into electricity. The fundamental module element is a photovoltaic cell made of thin layers of semiconductors, most often silicon. The amount of energy produced by a PV module depends on the level of insolation, the location of the PV system and the output of its modules. The appliances may be easily assembled and integrated

[3] Photo: Euro Com Project Sp. J

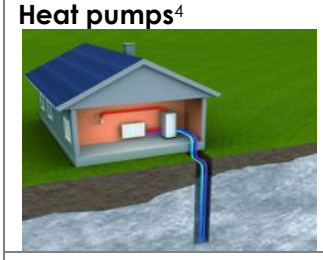
	with other buildings.
Small wind farms 	These appliances change the energy of air mass movement into the kinetic energy of the wind farm rotor rotation. Next, the rotor connected to the generator produces electricity. The amount of energy produced by a wind farm depends on its size, the effectiveness of the turbine and the wind speed. This, in turn, is mainly determined by the location and weather conditions.
Solar collectors 	Solar collectors change solar radiation into heat that may be used to obtain hot domestic water and support the heating system. The main element of the collector is an absorber that intercepts solar radiation and changes it into heat absorbed by the heating factor, for example the aqueous glycol solution circulating in the system. The amount of energy obtained depends on the total radiation per hour or per season reaching the absorber as well as the location of collectors and the output of appliances.
Heat pumps[4] 	Appliances using heat circulation for heating. Thanks to thermodynamic changes, just like in a fridge, heat from a low temperature area flows to a high temperature area. The upper source that supplies heat is water (rarely air), heated by a pump, which circulates in the heating system. The pump does not generate heat but transfers it from the lower to the upper source.
Biomass boilers[5] 	Biomass boilers are designed to burn low calorie, high-volume and long burning fuels such as wood waste, branches, wooden briquettes, straw briquettes and other plant waste. Energy obtained from plant biomass incineration is used for central heating and domestic hot water preparation. Fuel may be supplied automatically by means of fuel containers with feeders.
Micro biogas plants[6] 	Micro biogas plants are used to produce electricity and heat. Small biogas plants as an element of a production line for a plant or animal production process are especially profitable in the dispersed model of agriculture present, among others, in Germany, Austria and Poland.

Fig. 1. A synthesis presenting various kinds of microgeneration based on renewable energy sources

The Institute for Renewable Energy (IEO) estimates that there are 3200 small wind farms in Poland. What is characteristic for Poland is not just a very small number of

[4] Photo: www.zielonedomy.pl
[5] Photo: Przedsiębiorstwo Produkcyjno Handlowe KOSTRZEWA®
[6] Photo: Abrys

power-generating microgeneration based on renewable energy sources, but also the fact that a relatively large proportion of these sources is not connected to the grid (*off-grid*). This is a rare situation in Europe. According to the 2010 studies conducted by IEO as little as 6% of the total number of small turbines sold were the appliances designed to be connected to the grid. At the end of 2012 there were 32 agricultural biogas plants exploited in Poland, including 2 *off-grid* micro biogas plants with the capacity of 30 kW. Out of about 130 PV systems in Poland over 120 are the "home" systems (of the total capacity of about 1.8 MW) not connected to the grid. This is confirmed by the latest data on microgeneration of the lower capacity than 40 kW (included in the definition of microgeneration as provided by the draft act on renewable energy sources[7]) provided by the Energy Regulatory Office. Overall, the segment of microgeneration in Poland at the end of 2012 included 270 systems installed with concessions and certificates of origin for renewable sources of energy. The average capacity in this segment is 25kW and the total capacity equals 6.7 MW. This is an especially untypical situation in the EU, both with regard to the low off-grid capacity and a very high proportion of systems not connected to the grid. It may indicate huge and difficult to overcome barriers to the owners of microgeneration based on RES in the access to the grid and certificates of origin available in the national support scheme for green energy.

In 2008 in the UK there were 98 thousand power and heat-generating microgeneration based on RES. Starting from 2008, when the new act on renewable energy sources providing for the support scheme of fixed feed-in tariffs (FiT) entered into force, this number has been quickly rising. At the end of 2011 there were 283.5 thousand electricity generating microgeneration based on RES and at the end of February next year the number reached the level of 358.3 thousand and the total capacity of 1.66 GW (average capacity – 4.6 kW). The market of microgeneration is dominated by home systems whose number equals 346.1 thousand (12.2 thousand are not related to buildings) and the PV systems integrated with buildings are beginning to take the prominent role (almost 86% among the new sources on the market).
Source: Department of Energy & Climate Change, Central Feed-in Tariff register statistics, May 2013.

Many more microgeneration are developed in the "green heat" sector (biomass boilers, heat pumps and solar collectors). Investors are not discouraged by an excessive number of administrative barriers and absurdly high barriers in the access to the grid. Table 1 shows the estimated number of prosumer microgeneration based on RES in Poland at the end of 2012, following the IEO data.

Table 1. Power and heat generation microgeneration in Poland (*on-grid* and *off-grid*) as of the end of 2012. *Source: IEO's study results and estimates*.

Small systems and microgeneration based on RES in 2012	**Average power [kW]**	**Average unit cost 2012 [PLN/kW]**	**Average cost of the entire system [PLN]**	**Total estimated capacity of power**

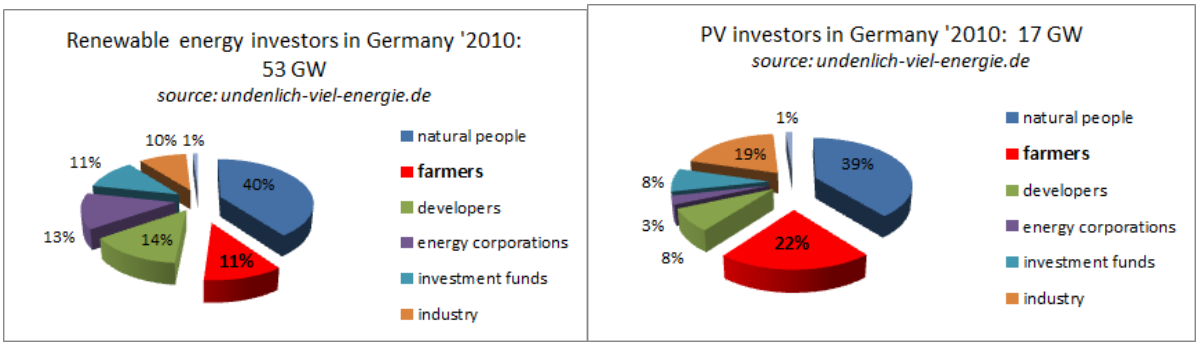
[7] Letter sent by the Head of the Energy Regulatory Forum to the Head of the Association of Employers of the Renewable Energy Forum. February 2013.

				systems
Solar collectors	7.0	3 200	22 400	120 000
Small furnaces and biomass boilers (dedicated)	20.0	900	18 000	90 000
Heat pumps (geothermal)	10.0	2 500	25 000	10 000
Small wind farms *(on and off-grid)*	3.0	9 000	27 000	3 000
PV systems *(on and off-grid)*	3.0	8 000	24 000	139
Average / Total	9	4 720	23 280	223 139

The level of investment (about PLN 6-7 billion) made by natural persons and entrepreneurs in the past 10-12 years led to the establishment of the foundations for the prosumer and civic energy system in Poland. It includes over 230 thousand systems in total. This impressive investment effort, almost on a mass scale, shows that investments into micro energy systems in households and farms may amount to a few dozen thousand zlotys, a sum corresponding to the price of a city car, and thus affordable for an average household.

In the recent decade about 230 thousand of households and other entities have invested the total amount of PLN 6-7 billion in the purchase and installation of microgeneration based on RES, thus establishing the foundations for the prosumer and civic energy system in Poland.

The EU leader in microgeneration is Germany where as early as in 2010 there were over 4 million producers of electricity based on RES. Most of them owned small systems (average capacity of about 20 kW). The chart below presents the structure of German investors in the entire RES sector and in the sector of photovoltaics, just as an example.



About 11% of all RES investors (share of the capacity installed) are farmers and in the PV sector their share reaches the level of 22%. Farmers only invested over EUR 14 billion in the PV sector. Natural persons (households) in Germany are the major investors in RES (about 40 %) while the share of traditional energy concerns is 13% and in the PV segment just 3% of the capacity installed.

The structure of the prosumer micro energy segment reflects the fact that investors took into account not just energy production and sale but also its use by specific end consumers. Prosumer microgeneration based on RES, aiming to meet the demand and limit energy losses in the external chain of supply, have excellently

fitted in with the idea of intelligent energy networks (iEN), including micro networks. The elements of iEN and micro networks also include the systems of decentralised energy storage (close to the consumer and close to the microgeneration) and the elements coupling prosumers and household systems with the home network (energy and IT network).

The wide range of technological solutions available means that practically there is no household, farm or small service company that would be unable to use at least one microgeneration based on RES. The development of microgeneration and prosumer energy is inseparably linked with buildings that become not only green thermal power plants but also power and heat plants and green power plants in the new model of diffused energy. The construction sector is the largest industrial employer in the EU responsible for 20% of its GDP and 40% of the end-user energy consumed, according to the Eurostat. In the entire EU area there are over 190 million buildings which may be turned into micro power stations. As indicated by Jeremy Rifkin[8], the third industrial revolution involves the transformation of almost every building into a two-function facility: a place of residency and a micro power plant. The analyses conducted by, e.g. the PV industry, show that PV cells and modules may be put up on 15% of building roofs and facades in the EU. As a result of this kind of investments, the capacity of the PV systems installed on buildings in the EU would amount to 1.5 TW and make it possible to meet 40% of the EU's total electricity demand. The alliance of the construction business with microgeneration is especially evident in Japan where flats with their own sources of energy are sought after and obtain much higher prices. In consequence, developers have expanded their offer to include an option of individual energy generation by the user in the standard offer, which would make consumers independent of corporate and local energy suppliers.

According to the Chief Statistical Office at the end of 2020 there were 5 215 328 buildings in Poland, which included 83% of single-family houses, 7% of two-family houses, 6% of houses with 3 to 9 flats and 4% of houses including 10 flats and more. Single-family and two-family buildings, so 90% of all of them, are in particular in a privileged position when it comes to using various kinds of microgeneration based on RES and even combining them into hybrid systems including many sources in one building. Chart 2 shows typical areas of application for microgeneration in buildings with special emphasis on locations in the areas that differ in terms of development. The application of microgeneration in rural areas (marked in green) will differ from the application in urban areas.

Table 2. General segmentation of buildings with regard to the best application of different microgeneration based on RES.

[8] Jeremy Rifkin: The Third Industrial Revolution. Palgrave Macmillan 2011.

		Power generation		Power and heat cogeneration		Heat generation		
		MEWi	PV	mB	mCHP	KS	gPC	KB
Residential buildings	Single-family	W,P	W,P,M	W	W	W,P, M	W,P,M	W,P,M
	Multi-family	W,P	W,P,M	W	W,P	W,P,M	W,P	W,P,M
Offices and factories	Factories	W,P	W,P,M	W	W,P	W,P	W,P	W,P
	Tourist services	W,P	W,P,M	W	W,P	W,P,M	W,P	W,P
	Offices	P	P,M		P,M	P,M	P	P
	Trade and services	P	P,M		P,M	P,M	P	P
	Storage	W,P	W,P,M			P	P	
Public utility buildings		P	P,M		P,M	P,M	P	P

Legend: W - rural areas, P- suburban areas, M - urban areas, MEWi – small wind farms, PV- photovoltaic systems, mB- micro biogas plants, mCHP- cogeneration systems fuelled with bioliquids, KS- solar collectors, gPC- geothermal heat pumps, KB- biomass boilers

The most universal microgeneration based on RES with the widest spectrum of application are the PV systems and solar collectors, i.e. convertors of solar energy. Micro biogas plants, which, in fact, may only be used in rural areas, have the lowest potential of application in the construction sector because of the type and location of buildings.

A wide range of commonly available types and technological solutions with regard to microgeneration based on RES means that any owner or user of a household, farm or small service company is able to become a prosumer.

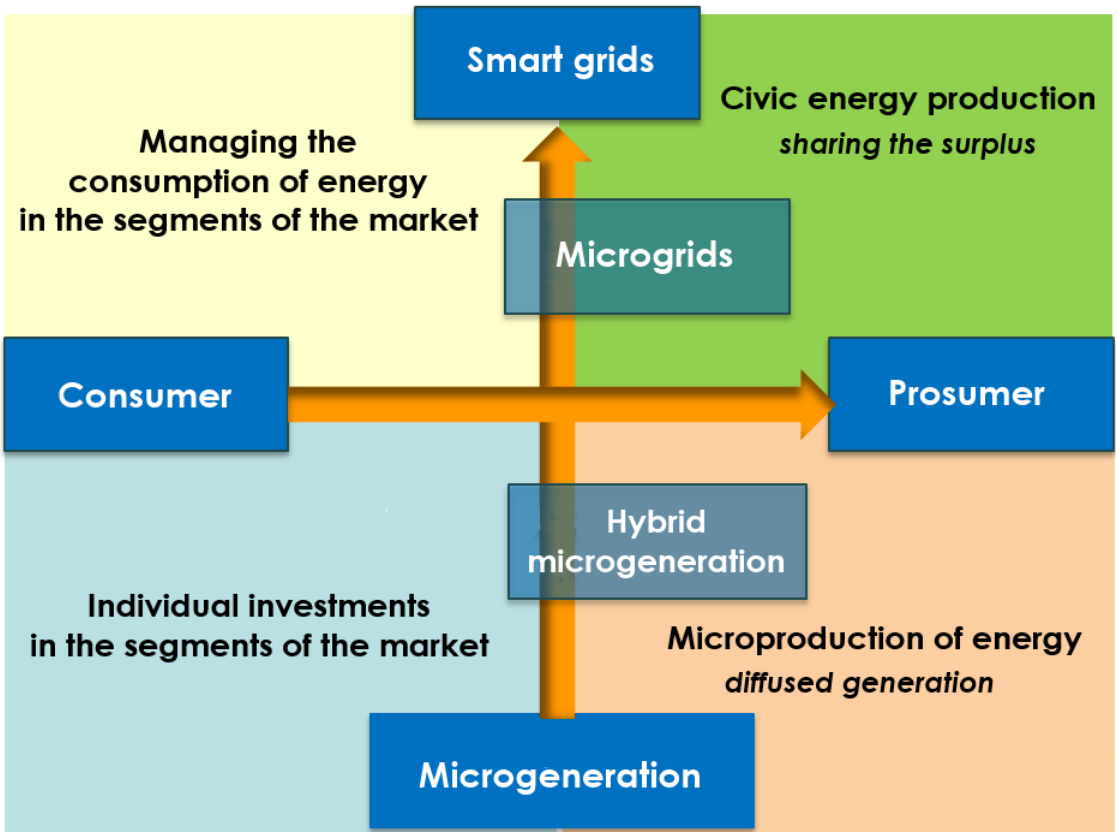
There are about 3 million prosumers with access to buildings and facilities where microgeneration based on RES may be installed according to estimates, which take into account the capacity of the building related to its type and location. It should be noted that by 2020 there will be about 700 thousand new residential and public utility buildings. Following the directive on the promotion of the use of energy from renewable sources, starting from 2015 each new building should have at least one microgeneration based on a renewable source of energy.

3. The scenario for utilizing microgeneration based on renewable energy sources in Poland until 2020

Microgeneration based on RES are the starting point of and the basis for the development of micro networks, intelligent networks and the prosumer energy system in its broadest sense. The prosumer energy system requires a period of incubation and is introduced to energy systems in stages. The best definition of these stages, taking into consideration the role of RES and microgeneration, has

been provided by Jeremy Rifkin in his latest book "The Third Industrial Revolution"[9]. He called them the "five pillars of revolution", which included: 1) the development of technologies and transfer to renewable sources of energy, 2) the transformation of building owners into prosumers and buildings into micro power plants with microgeneration, 3) the application of energy storage technologies in combination with microgeneration, 3) the application of the Internet technologies, the so-called "energy Internet" to exchange information between prosumers (buildings) and share surplus energy, 5) the introduction of electric cars and intelligent networks.
Because of a short time perspective (2020), the scenario analysed in this study is limited to the first 2-3 pillars, which, just like the entire revolution in the energy sector, cannot be imagined or implemented without microgeneration based on renewable energy sources.

Figure 2 shows the role of a microgeneration based on RES in a broader technological and market environment. Without these systems, it is very difficult to imagine the creation and development of intelligent energy systems and prosumer energy. On the other hand, most microgeneration may not be developed on a large scale or go beyond niche (individual) applications without the friendly social environment (civic energy), technological progress in the area of energy networks and the right energy market model with space for prosumer energy.



[9] Jeremy Rifkin: The Third Industrial Revolution. Palgrave and Macmillan 2011.

Fig. 2. Microgeneration based on RES as a basis for the transformation of the consumer-based model into the prosumer model of the energy system based on sharing surplus energy.

Microgeneration based on RES as a separate segment of the renewable energy market have become an element of the national energy strategy with the adoption of the "The National Renewable Energy Action Plan"[10] (NREAP) by the government. NREAP includes a technological path for the development of renewable sources of energy by 2020. Until now, it has been the only formal basis for the planning of the development of the microgeneration market as part of the renewable energy system in Poland. NREAP provides that in 2020 the share of RES in the gross end-user energy consumed in Poland should increase by at least 15%[11]. This document also defines the interim and industry targets for the electricity sector (19%), heating and cooling sector (17%) and transport (11%).

Figure 3 presents the target structure of power and heat generation in 2020 according to NREAP. It also includes the micro energy system and microgeneration. According to this document, in order to implement the directive objective, it is necessary to develop small systems and microgeneration to generate power, such as small hydropower plants, small wind farms (micro wind mills), PV systems, cogeneration microgeneration fuelled with biogas and bioliquids and solar collectors, biomass boilers and heat pumps.

[10] NREAP approved by the Council of Ministers on 9.12.2010 r.: http://www.mg.gov.pl/files/upload/12326/KPD_RM.pdf

[11] This target was set on a moderate level taking into consideration the fact that Poland had a lower GDP per capita as compared with the EU average. As there is an urgent need to install new power in the energy system and diversify energy sources and, at the same time, there are enormous and diversified resources of RES in Poland, it is considered as a minimum for our country. Following IEO's analysis of the possibilities of using RES in Poland (report for the Ministry of the Economy in 2007), the quantitative target of 17-18 % in 2020 in economically justified.

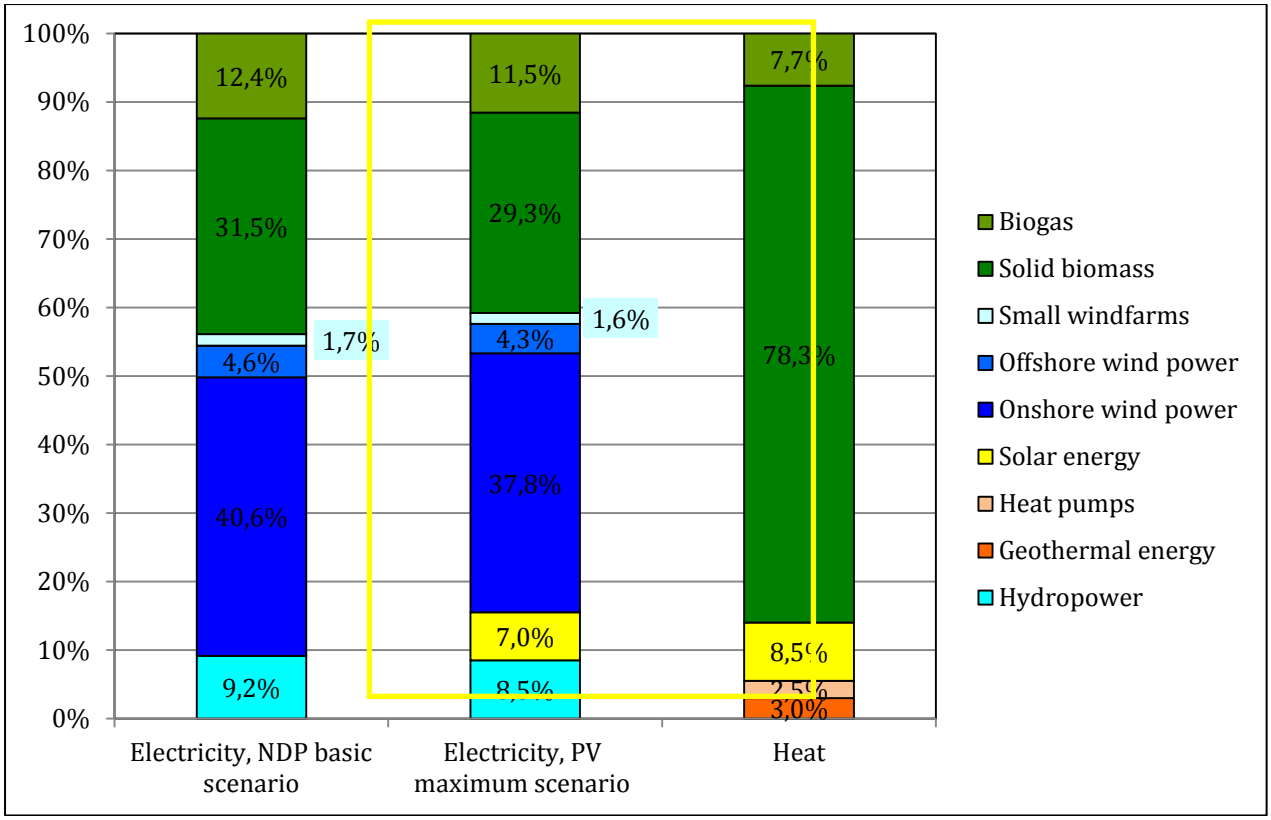


Fig. 3. The structure of power and heat generation based on RES in 2020 following NREAP.

The figure also includes the scenario with the increased share of photovoltaics. Its implementation was provided for in the document only on the condition that the system of guaranteed feed-in tariffs is introduced to support the PV sector. Following the NREAP assumptions, in 2020 modern microgeneration are to achieve at least 1/3 of the main target in the area of renewable energy. Prosumers' investment outlay will exceed PLN 26 million according to IEO's estimates.

NREAP describes in quite extensive detail the paths for the development and share of individual kinds of RES in the green energy balance by 2020. But a further analysis of microgeneration (up to 40 kW of power capacity and up to 70 kW of heat capacity) requires an adoption of specific assumptions, especially with regard to their average capacity, output and share in the NREAP implementation.

Table 2. Target capacity for microgeneration in 2020 on the basis of NREAP and the assumptions adopted, including the role of microgeneration in individual groups of RES technologies. *Source: IEO's study based on NREAP.*

	Capacity installed in 2020 [MW]	Share of microgeneration [%]	Average capacity in 2020 [kW]	Energy consumption indicator [h]	Microgeneration capacity in 2020 [MW]
Hydropower stations	142	10%	30	3000	14

PV systems	1 800	80%	5	900	1 440
Small wind farms	550	70%	5	800	385
Biogas and bioliquids (CHP)	980	10%	10	5000	98
Solar collectors	9 341	80%	7	630	7 473
Biomass boilers	26 958	54%	20	2000	14 579
Heat pumps	782	100%	10	2200	782

With the assumptions presented above, the total capacity (heat and power) of microgeneration in 2020 would reach 24.7 GW, which includes 1.9 GW of electric capacity. The average power factor would equal 2100 h/year and the average capacity of a home energy microgeneration – 12 kW. Figure 4 presents the paths for the development of power and heat-generating microgeneration.

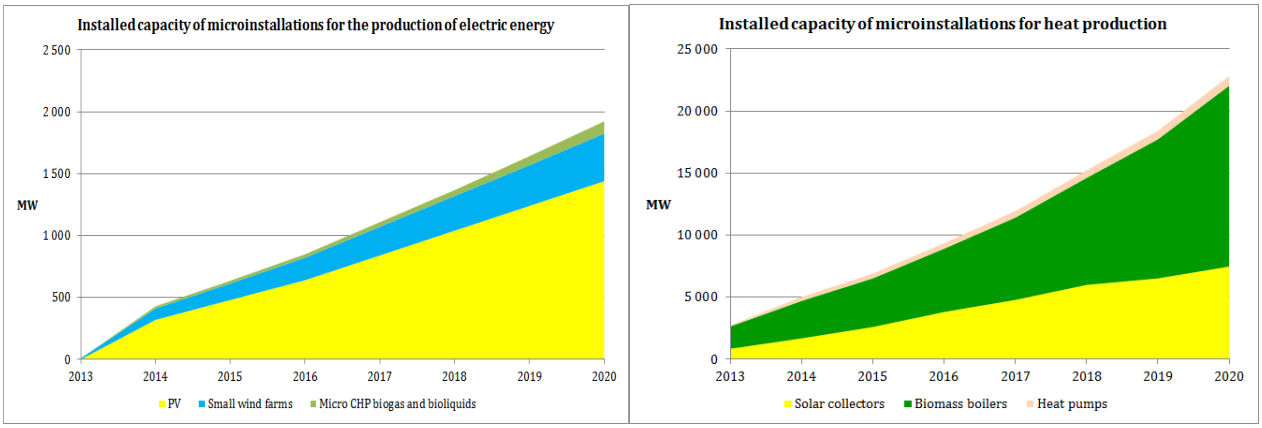


Fig. 4. Development options for power and heat generation microgeneration based on RES in 2013-2020. Source: *IEO's study on the basis of NREAP*.

The comparison of the NREAP scenario and the actual situation as of 2013 leads to the conclusion that the development of heat production is not far from the NREAP assumptions while the development level of power-generating microgeneration is below expectations.

The capacity of microgeneration based on RES in 2020 will be 24.7 GW, including 1.9 GW in new microsources for electricity generation. The total energy output obtained from microgeneration in 2020 will amount to 38.5 TWh, which includes 2.9 TWh of electricity.

Figure 5 shows power obtained from microgeneration in 2020 and figure 6 presents the role of microgeneration in the achievement of NREAP's general goal.

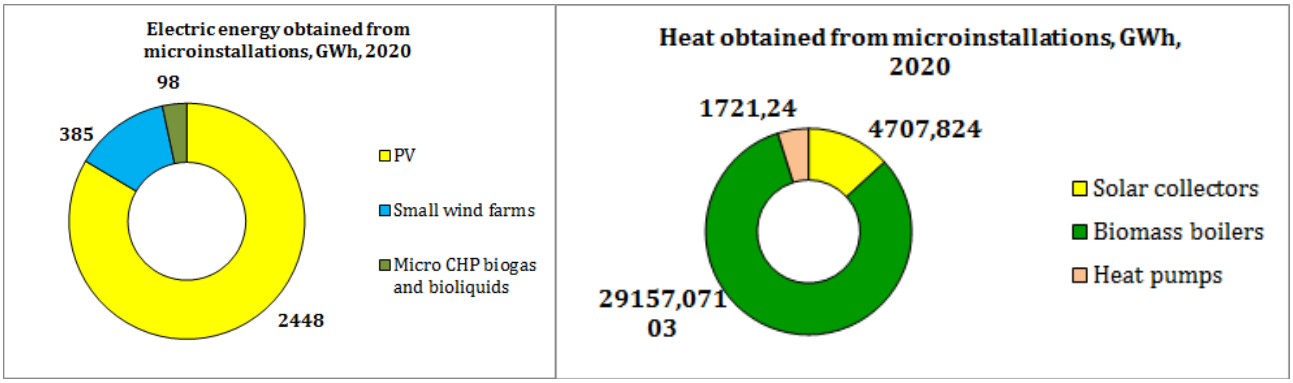


Fig. 5. Power (heat and electricity) obtained from microgeneration in 2020. *Source: IEO's study on the basis of NREAP.*

Total energy produced from microgeneration in 2020 would amount to 38.5 TWh, including 2.9 TWh of electricity. The leading prosumer technology in the green heat sector in 2020 would be biomass boilers (82%) followed by solar collectors (13%). Following the assumptions, the greatest share in the microgeneration of green electricity (648 thousand microgeneration) would belong to PV systems (85%) followed by wind farms (13%).

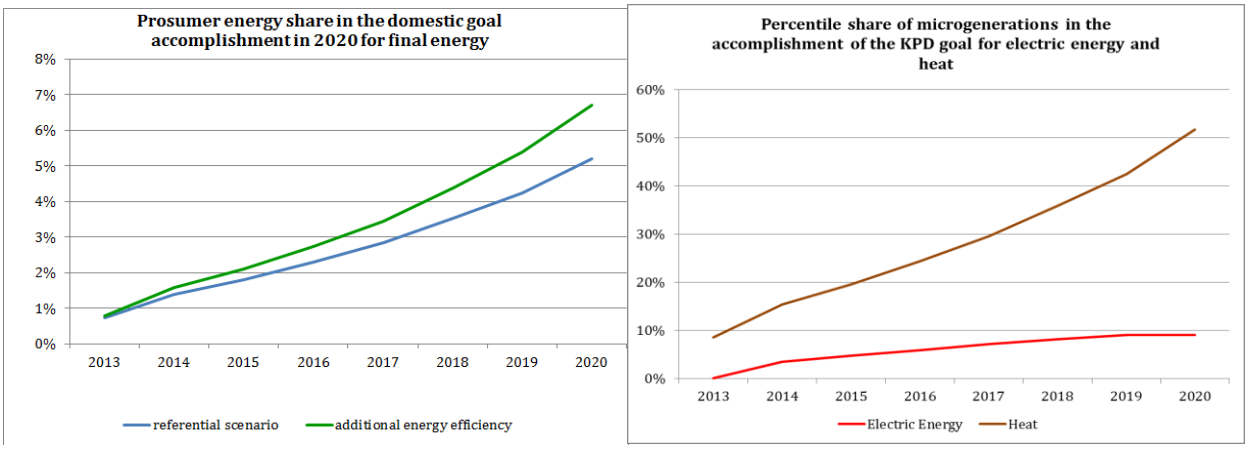


Fig. 6. Share of microgeneration based on RES in the achievement of NREAP targets. *Source: IEO's study on the basis of NREAP*

The implementation of the scenario for the development of microgeneration based on RES presented here would enable the achievement of NREAP's general goal in 40 %, which would result in supplying 6.8 % of energy on a nationwide scale if the activities for the improvement of energy effectiveness were successful or 5.8 % if the consumption of gross end-user energy remained at the level forecast in the reference scenario of NREAP. The share of electricity generated by microgeneration in power generation based on RES in 2020 would slightly exceed 9%.

The results of analyses lead to the conclusion that already in 2020 the total capacity (power and heat) installed in microgeneration based on RES will reach almost 25 GW and the number of systems (and prosumers if the assumption is that one

prosumer uses only one system of the average capacity of 10 kW) will exceed 2.5 million. As the significance of prosumer energy is still commonly underappreciated in Poland, the results obtained should become a subject of a debate and comparison with other countries as well as the technological potential for the development of microgeneration in Poland.

Micropower Europe in its "moderate" scenario[12] forecasts that in 2020 there will be about 50 million microgeneration in operation in the EU. The current number of consumers in Germany is almost double the number predicted for Poland for 2020, as estimated above. Experts working for the UK government predict[13] that until then there might be over 13 million microgeneration on the British Isles.

Poland is a large country where a significant proportion of the population (almost 40%) lives in rural and peripheral areas, thus such a numerous group of prosumers is thoroughly justified. The potential for the development of microgeneration based on RES is definitely not limited by access to renewable sources of energy on a national scale. Because of its location in temperate climate and a large proportion of rural areas, Poland has enormous and diversified sources of renewable energy, yet untapped to a large extent. The Institute for Renewable Energy in its expert's opinions for the Ministry of the Economy[14] and the Ministry of Regional Development[15] determined the real economic potential of renewable energy sources until 2020. Poland uses less that 18% of the resources (including a fraction of one per cent of the energy from the sun, wind and geothermal sources) that it could be using at the current level of technology, taking into consideration all limitations related to the environment and infrastructure. Even the most extensive exploitation of renewable energy sources until 2020 will not exceed 50-60% of their current economic potential. At the same time, limitations are greater for larger investments in RES and do not involve any barriers to microgeneration at present. The forecasts available for Poland say that in the long term, together with the technology development and infrastructure upgrade, the total share of energy obtained from RES in energy consumption in Poland will go up to 60% in 2050[16] and it is hard to imagine it stopping until it reaches the level of 100%.

The analysis of availability for the buildings with the relatively best location demonstrated that it will be possible to install at least one microgeneration based on RES in 3.7 million buildings, which indicated an enormous potential with regard to location. It should also be noted that according to the Chief Statistical Office in

[12] Bethan Fox, Micropower Europe - a European Perspective. All Energy Conference May 19 -20, 2010 r., Aberdeen, UK

[13] Element Energy Limited. The growth potential for microgeneration in England, Wales and Scotland. 2008 r., Cambridge

[14] Institute for Renewable Energy. Options for Utilizing Renewable Sources of Energy in Poland until 2020. An Expert's Opinion prepared for the Ministry of the Economy, Warsaw 2007.

[15] Institute for Renewable Energy. Determining the Energy Potential of Poland's Regions with Respect to Renewable Sources of Energy. An Expert's Opinion prepared for the Ministry of Regional Development, Warsaw 2012.

[16] Institute for Renewable Energy and Institute for Applied Thermodynamics DLR: The Scenario for Supplying Poland with Clean Energy Carriers in the Long Term. Greenpeace Poland, Warsaw 2008.

2011 there were 14.3 million consumers in total connected to the low voltage grid, which included 4.8 million in the countryside with just a few thousand power-generating microgeneration based on RES. Here, the potential is in fact not utilised in 100%.

3.7 million buildings in Poland have the technical conditions necessary for the installation of at least one microgeneration based on RES.

The determination of the microgeneration development limitations is far more complex as they may result from the necessity to balance power supply in the situation when most microgeneration based on RES belong to the "unstable" group (i.e. dependent on atmospheric conditions). This especially applies to PV systems and small wind farms. It may be safely assumed that "unstable" capacity already has a 50% share in the total capacity installed by a given operator. This is confirmed by a few current power supply systems in the EU. The capacity of unstable sources (1825 MW) is not a constraint for the implementation of the prosumer scenario in the power section as even after taking into consideration the capacity of all RES and limiting their total share to 50%, the connection potential in this respect would be used only in 18%. In practice, the issues of balancing capacity should be dealt with at the level of the distribution network operator taking into consideration its production profiles and needs as well as the number and distribution of microgeneration connected to the grid in a given area that needs balancing. This kind of analyses have been prepared on the basis of the calculations performed by the ENERGA group[17] (currently it is the area with proportionally the largest technological limitations for microgeneration based on RES) and the results extrapolated to the entire country. With conservative calculations (16 microgeneration of the average capacity of 12.6 kW per one circuit) the proportion of consumers served by the ENERGA operator that may connect a microsource to the grid is 11%. With these assumptions, over 1.5 million power-generating prosumer systems based on RES might be connected to the grid in the entire country (this is also a conservative assumption because of ENERGA's specific nature). If the capacity of a single microgeneration is on the level of 5 kW, this number goes up to almost 4 million.

No limitations related to the technology, the grid or the access to renewable energy sources or the number of "prosumer" buildings using energy are a barrier to the implementation of the bold scenario for the development of microgeneration based on RES until 2020 and meeting 6% of Poland's end-consumer demand for fuel and energy in this way.

In this way technological potential exceeds manyfold the number of 648 thousand of power-generating microgeneration based on RES.

[17] Rafał Czyżewski. Energa operator: Development of diffused energy sources from the perspective of the distribution system operator. Expert's seminar "Development of diffused energy sources". Warsaw, the Office of the President of Poland, 18 April 2013.

In the light of the data above, the scenario for the development of microgeneration presented in the *Roadmap* will be fully feasible, also taking into consideration the technical limitations in the field of construction, the network and balancing. The microgeneration scenario proposed until 2020 takes into account all technical limitations of the location potential (buildings – 34%, energy needs of prosumers – 10%) with a large margin, including the grid connection potential, at absolutely safe levels of balancing capacity (current grid potential would be used in just 16-18%)

4. Socio-economic benefits of the development of microgeneration based on renewable energy sources

The implementation of the scenario for the development of microgeneration based on RES brings benefits not just in the form of clean energy generation as part of the obligations related to RES that must be fulfilled by Poland as a member state, but also a number of socio-economic benefits that may be estimated or evaluated in many ways. They are related both to the growth of business activity across the country and the stimulation of private investment (including households) into the energy sector, which may be expressed by the value of the turnover on the market, the number of jobs and pollution emission reduction with special emphasis on CO_2. These benefits are not reflected by typical macroeconomic gains but play an enormous role for sustainable development, both economic and social.

According to IEO's annual studies, published in a collective report for the entire EU[18], concerning employment and business activity in the sector of renewable energy in Poland, turnover on the RES market in Poland in 2011 amounted to EUR 3 055 million and employment was at the level of 34 600 (calculated as full-time jobs). The actual share of Poland in the financial turnover and employment in the RES sector in the EU as compared with its potential is moderate and amounts to, respectively, 2.2% and 2.9%. Thus the model for RES development applied so far does not make it possible to maximise benefits in the country. The development of microgeneration based on RES is related to the social, economic and environmental added value, much greater than so far. It may improve the measurable indicators of the results of the policy implemented (direct results of the support policy) and have a positive impact on the image of the entire sector of renewable energy. The prosumer energy system development is related to a considerably more democratic division of the benefits of the support policy, fairly distributed among an extensively larger group of beneficiaries. It will also involve millions of active citizens into the development of the country and build sustainable social support for further changes.

Prosumers

The implementation of the microgeneration scenario would mean activating many small and dispersed investors across the country and thus achieving a significant number of prosumers in 2020 – see fig. 7.

[18] The state of renewable energies in Europe, EurObservER Report 2012.

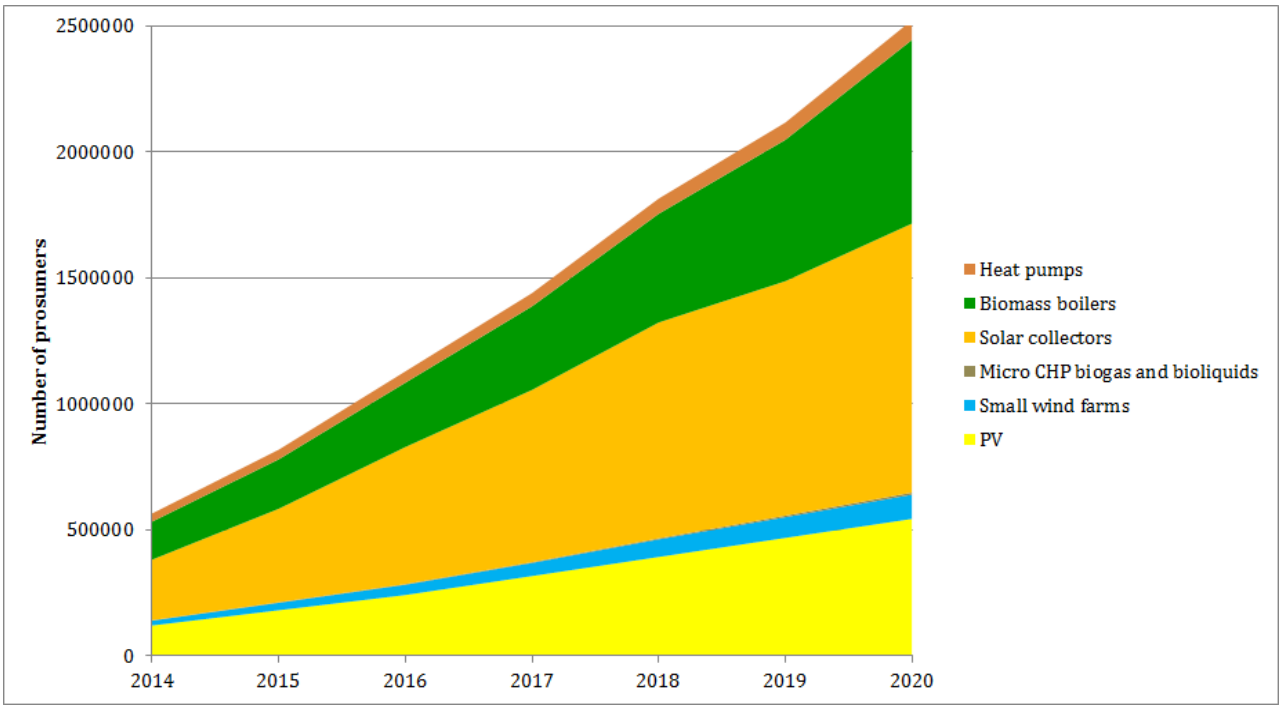


Fig. 7. Number of prosumers on the market of microgeneration based on RES until 2020.

Following the scenario analysed, the number of prosumers will grow by over tenfold, from 223 thousand at present to 2 523 thousand. The largest changes in the structure of the microgeneration owners in 2013-2020 focus on the fast increase of solar collector users (growing by almost 948 thousand of systems and achieving 38% of the market share).

Number of prosumers using microgeneration based on RES will increase over tenfold, from 223 thousand at present to 2 523 thousand in 2020.

Workplaces

An extremely important consequence of the development of microgeneration is new workplaces in micro-, small and medium-size enterprises. These jobs are created in the area of production, installation and operation of appliances as well as in fuel supply. Fig. 8 presents aggregate results for the entire microgeneration sector calculated for full-time jobs over the entire period provided for in the scenario. As a result of the NREAP scenario implementation in the area of microgeneration and taking into consideration the assumptions adopted, by 2020 there should be almost 53 thousand new jobs created, including 32.8 thousand in the sector of biomass boilers (including fuel preparation), which is the largest proportion, and over 12.4 thousand in the sector of solar collectors. But the condition for the creation of such a large number of workplaces in the sector of small biomass boilers is departure from supporting the co-firing of biomass with coal in power plants. Excessive aid for this technology, without supporting small boilers,

caused a deficit in the biomass market and, as a result, an almost double increase of its prices[19]. This, in turn, became a barrier to the development of the market of small, automatic biomass boilers. The removal from supporting co-firing, planned by the government in the draft act on RES, and the prospect of losing unstable jobs in the sector supplying power plants with biomass provide an additional social argument for supporting the development of small automatic boilers fuelled with pellets and briquettes and creating an alternative for national suppliers of biomass and its processors.

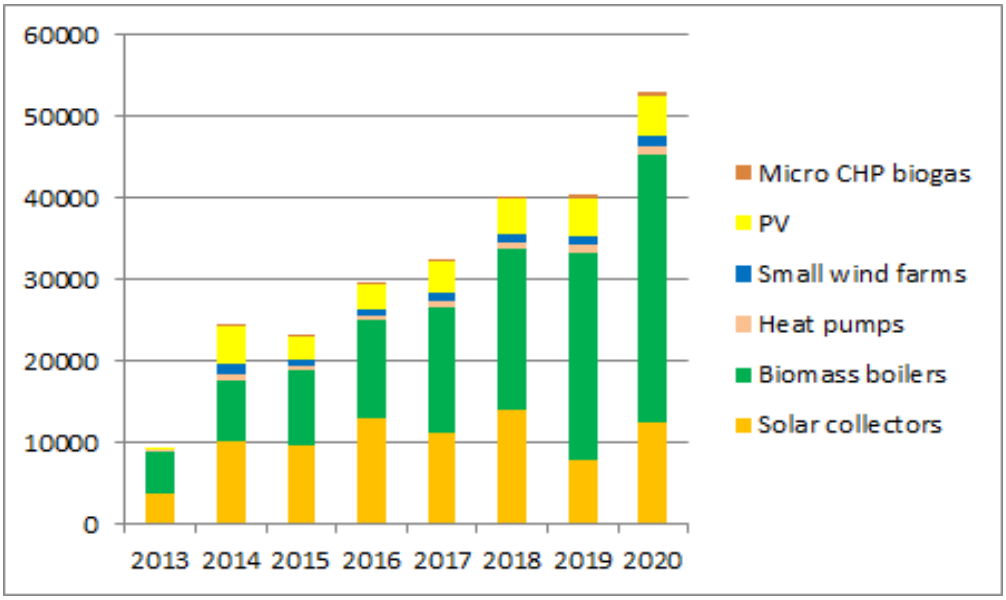


Fig. 8. Illustration of the forecast for the creation of jobs in microgeneration based on RES – aggregate results divided into types of microgeneration in 2020.
Legend: mB – micro biogas plants, mCHP – cogeneration systems fuelled with biofuels, KS – solar collectors, gPC- geothermal heat pumps, KB – biomass boilers.

In 2020 over 50% of the new jobs created will be in the microgeneration production and installation, including: 14.6 thousand in equipment production and 13.9 thousand in installation. Production and fuel supply for biomass boilers only created the demand for over 10 thousand jobs and the workplaces created by 2020 will remain on the market at least until 2032 (taking the 20-year period of the equipment life span).

The total of almost 53 thousand of new jobs will be created by 2020, a large share of them in the production (14.6 thousand) and installation (13.9 thousand) of microgeneration.

CO_2 emission reduction

RES technologies, including microgeneration, are an effective method of CO_2 emission reduction. This applies both to the situations when a microgeneration

[19] http://www.ieo.pl/pl/aktualnosci/525-wspospalanie-patologia-rozpoznana-ale-w-polsce-bagatelizowana-i-nie-leczona-raport-ieo.html

based on RES replaces electricity from the national grid generated in almost 90% in high-emission coal-fired power plants and the ones where a microgeneration based on RES replaces a local, coal- or gas-fired source of energy (usually heat).

As part of the microgeneration scenario implemented, CO_2 emission reduction would grow from 2 million tons per year in 2013 to 18.8 million tons per year in 2020. In the entire period it would exceed 75 million tons of CO_2. The annual emission reduction amounting to 18.8 million tons of CO_2 amounts to 5.8% of fossil fuel emissions in Poland in 2010 (325 million tons of CO_2). This level would be maintained over several years in the period after 2020 and contribute, almost entirely, to emission reduction in 2030. Fig. 9 shows the aggregate forecast of CO_2 emission reduction achieved until 2020 thanks to microgeneration based on RES.

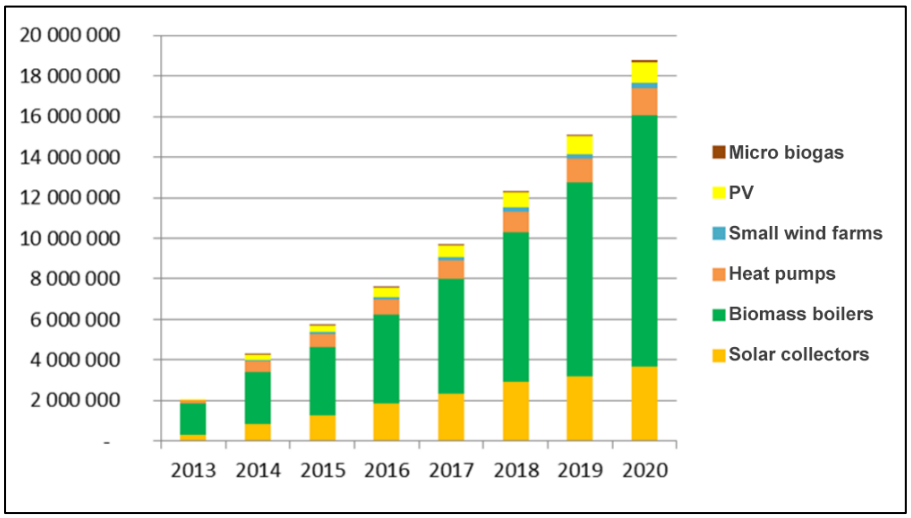


Fig. 9. Forecast of CO_2 emission reduction [t/year] for microgeneration based on RES as a result of the implementation of the programme for the development of micro energy sector following NREAP until 2020.
Legend: mB - micro biogas plants, mCHP – cogeneration systems based on bioliquids, K S – solar collectors, gPC – geothermal heat pumps, KB - biomass boilers.

The largest share in CO_2 emission reduction thanks to the implementation of the microgeneration scenario belongs to biomass boilers (66%) and solar collectors (20%) followed by heat pumps and PV systems (about 6-7% each).

The implementation of the plan for the development of microgeneration based on RES would bring an increase in annual CO_2 emission reduction from 2 million tons in 2013 to 18.8 million tons in 2020 (the equivalent of 5.8% of emissions from burning fossil fuels in Poland in 2010).

Turnover on the market of microgeneration based on RES

The turnover on the market of microgeneration based on RES was assessed on the basis of the value of investment outlay (taking into account the division into the equipment produced in Poland and imported from abroad), exploitation costs and

the energy costs calculated (the assumption was that the cost equals the price of energy on the market).

Fig. 10 presents the turnover on the construction and installation market in the RES sector from 2013 to 2020. It takes into account only domestic production of equipment (on average, 50%, the largest proportion for solar collectors – 70%, biomass boilers – 65%, heat pumps – 60% and micro wind mills – 50%) and the entire cost of their installation. This turnover grows from PLN 4.5 million in 2013 to PLN 2.6 million in 2020 (excluding imports). The largest share belongs to solar collectors (47%) and biomass boilers (24%). In general, the share of investment into heat production reaches the level of 80% of the total investment outlay. Total turnover on the investment market (PLN 44 billion) accounts for just about 5% of the funds available to Polish households, i.e. target investors.

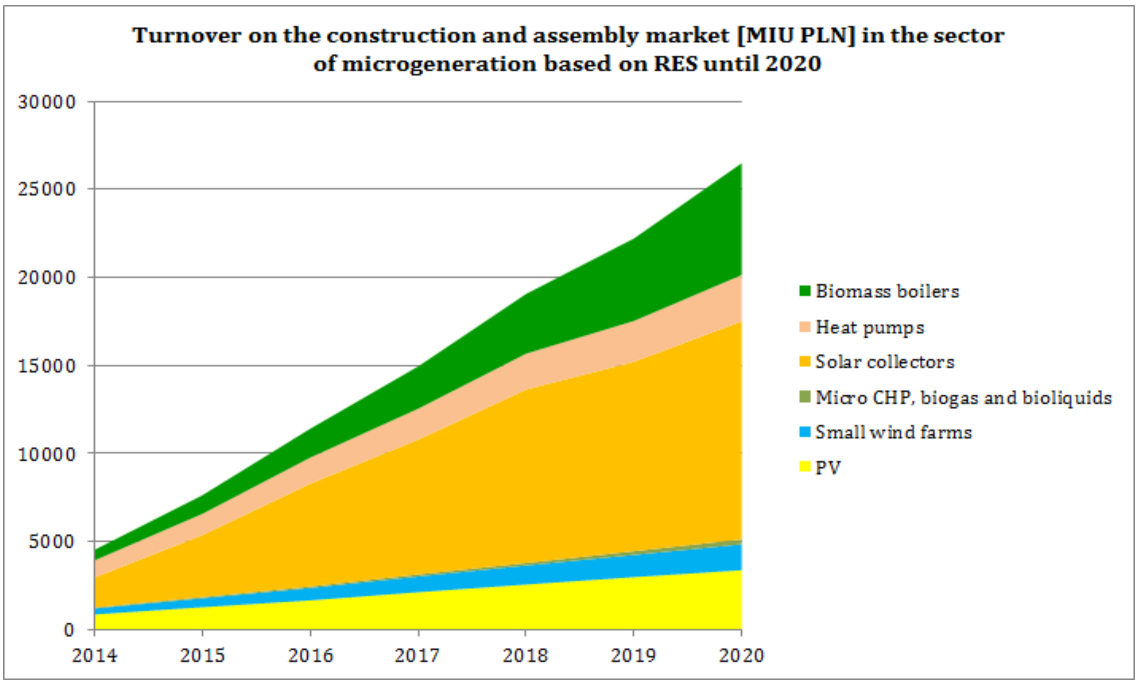


Fig. 10. Turnover on the construction and assembly market [in PLN million] in the sector of microgeneration based on RES until 2020.

Figure 11 shows similar results of turnover analyses for the period of the microgeneration exploitation. Exploitation costs are lower and amount to just over PLN 7.5 billion in 2020 but will stimulate the economy and become an impulse for the labour market in the long run, also after 2020.

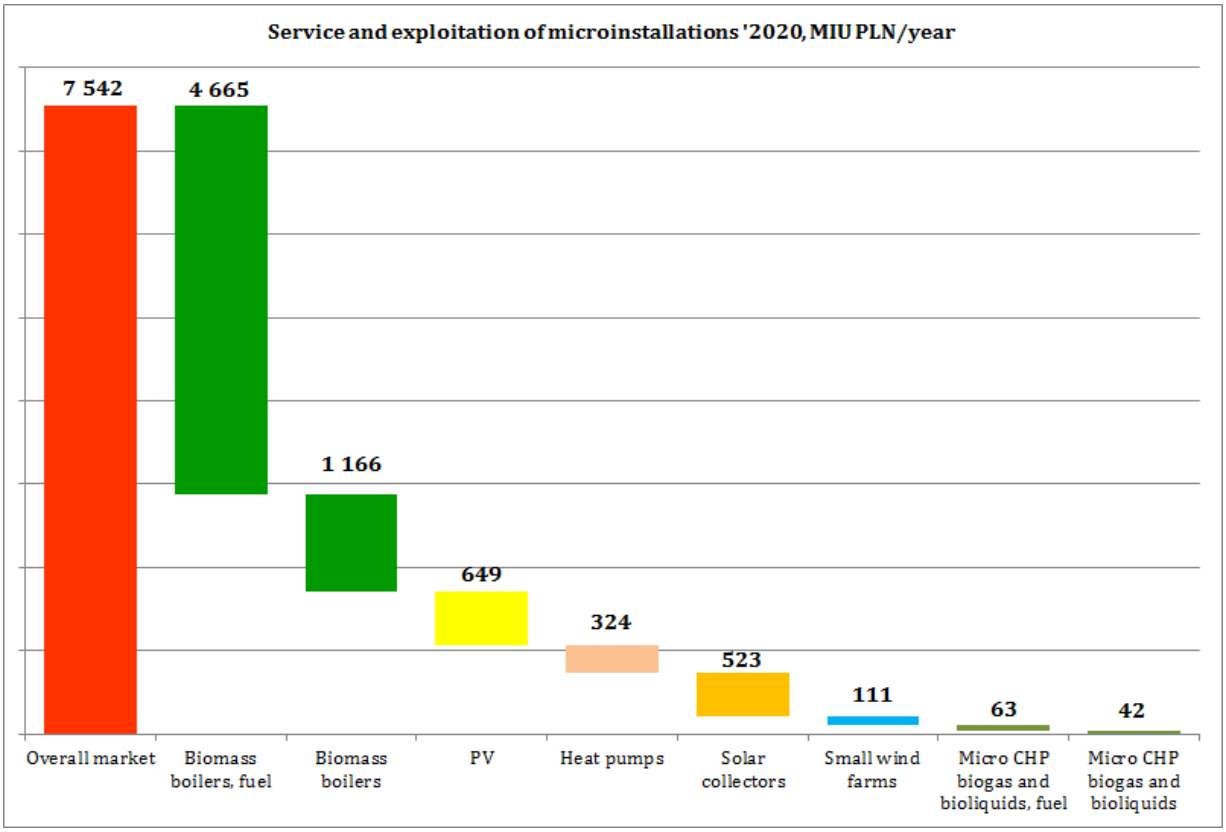


Fig. 11. Turnover on the RES microgeneration exploitation market in 2020.

A large majority of heat will be used by households and farms, thus lowering their demand for the energy purchased from the outside and achieving savings. The situation on the electricity market is different as when it is possible to sell energy (surplus or all) to the grid, households and other prosumers will not only achieve savings on the energy purchased from the national distributor but also acquire an additional source of income. The aggregate value of the power generated by microgeneration in 2013-2020 will exceed PLN 3 billion and in 2020 alone - PLN 864 million.

5. The implementation of the prosumer scenario

The scenario for the development of microgeneration is based on the country's potential and provided for in the fundamental document formulating the platform for renewable energy in Poland, i.e. "The National Renewable Energy Action Plan" (NREAP). It is also fully in line with the objectives of the EU legislation (directive 2009/28/EC on the promotion of the use of energy from renewable sources). This does not mean, however, that it will be automatically implemented. Access to the market of prosumer energy is blocked by legal barriers and the policy of the state which is insufficiently explicit for prosumers, especially with regard to energy.

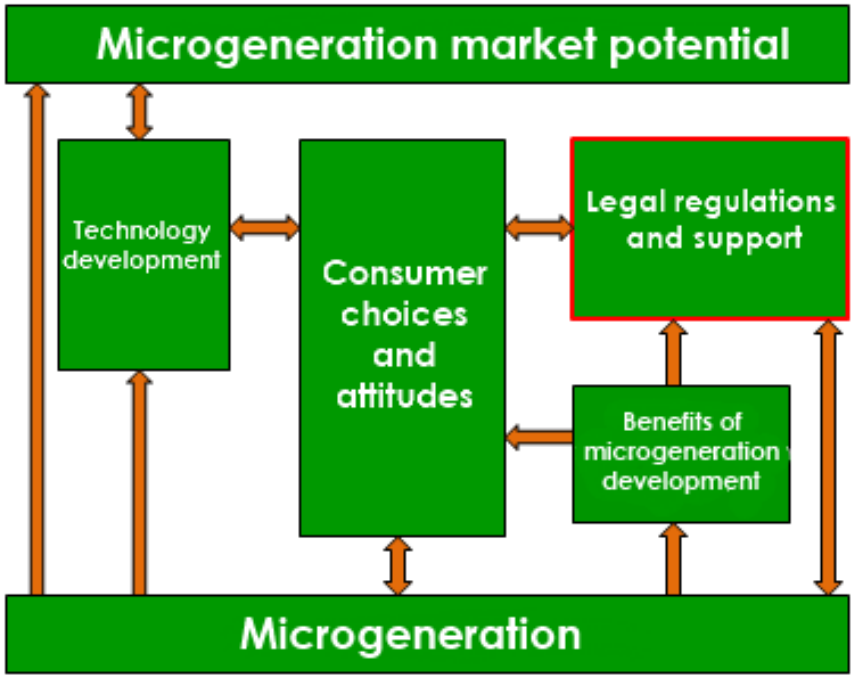


Fig. 12. The market and the regulatory environment and channels for the development of microgeneration based on renewable energy sources.

Out of many elements of the implementation environment surrounding the scenario for the development of microgeneration (see: fig. 12), these are the legal regulations (plus, possibly, the support scheme) that seem to be the least unambiguous at present and thus become a barrier to prosumers.

Overcoming regulatory barriers

Directive 2009/28/WE on the promotion of the use of energy from renewable sources establishes the fundamental framework for the development of microgeneration based on RES and prosumer energy. By introducing obligatory quantitative targets for the renewable energy share in 2020, the directive also creates space for the sustainable development of microgeneration. For a number of reasons (technical, economic and environmental) the obligations imposed by the directive may not be implemented just and only by means of generating energy by large renewable sources.

The directive preamble includes the statement directly addressing prosumers: *„(…)In order to stimulate the contribution by individual citizens to the objectives set out in this Directive, the relevant authorities should consider the possibility of replacing authorisations by simple notifications to the competent body when installing small decentralised devices for producing energy from renewable sources"*. Moreover, the directive recommends the promotion of small, local systems based on RES as in „(…) *promoting the security of energy supply, promoting*

technological development and innovation and providing opportunities for employment and regional development, especially in rural and isolated areas", emphasises *„(…) taking particular account of all the costs (…) associated with the connection of those producers to the grid and of the particular circumstances of producers located in peripheral regions and in regions of low population density"* and obliges member states to establish *„(…) minimum requirements for the use of energy from renewable sources in new and renovated buildings"*. Thus, the message and nature of directive 2009/28/EC is remarkably prosumer. In the first place, it indicates the need to introduce administrative simplifications and facilitate access to the grid.

The thesis concerning investment barriers, including access to the grid for prosumer systems, is confirmed by surveys conducted starting from 2012 by the Energy Regulatory Office (URE) [20]. A number of conclusions drawn from these studies may be directly applied to microgeneration.

They provide that an important hindrance to the development of small scale power generation involves problems with the location of sources, especially no indication of areas where such sources could be located in local development plans. Another barrier is also the character and duration of administrative procedures related to spatial planning and development in terms of land purpose or change in the purpose of land used for their location. This is important because, following art. 7 paragraph 8d of the Energy Law, the producer requesting connection to the grid must attach the excerpt and map extract from the local development plan or, if there is no such plan, a decision on the conditions of development for the property specified in the application to the application concerning the conditions for the connection to the grid.

The study results undermine the grounds for the need of extensive obligations related to concessions and business activity in the legal system, a condition for using the support scheme regardless of the source capacity. Moreover, it should be noted that in the light of the law in force it is forbidden to conduct production activity (including energy production) in the area where, according to the local development plan, there should only be residential developments or services.

One of the key conclusions of URE studies is the absence of an adequate procedure, compliant with legal provisions, for examining applications for the issuing of grid connection conditions. Additionally, the distribution network operator (DNO) may arbitrarily design the agreement on the connection to the grid. It has been confirmed by studies that DNO may engage in illegal activities towards power generation sources that apply for the connection to the distribution network. They especially focus on transferring more obligations upon the entity connected to the grid than is even required by the current provisions of the law.

[20] Energy Regulatory Office: Barriers to the Development of Small-Scale Generation – an interim report for the Lubelskie Province, 2012.

The prosumer energy environment confirms the results of studies conducted by URE. On the basis of the analysis of the position of distribution network operators, the Association of Employers of the Forum for Renewable Energy (ZP FEO)[21] emphasizes the existence of bad practice in law making where some operators acquire excessive competencies to make arbitrary decisions about connection to the grid and controlling the development of microgeneration according to unclear criteria, determined only by them.

The government has noticed these problems during its work. By adopting the NREAP resolution in 2010, it decided that the fundamental part of directive 2009/28/EC will be implemented by passing a comprehensive act on renewable energy sources. In October 2012, the Ministry of the Economy submitted the draft act[22], prepared after extensive consultations, to the Committee of the Council of Ministers in order to forward it to the Parliament. The draft proposes solutions that may radically improve the attractiveness and scale of the prosumers' investment in RES. It makes an effort to tackle real problems of those who invest in small sources and microsources based on RES.

The breakthrough elements of the regulation are new support instruments for micro- and small systems based on RES, including administrative simplifications, lower costs of connection to the grid and the system of fixed feed-in tariffs (guaranteed for 15 years), proposed too late although for the first time in Poland, as well as an adjusted and well-balanced support scheme including certificates of origin. Technological differentiation of support is used to obtain an economically optimal and balanced energy mix. As the intensity of support is made dependent of the system size, it also excellently fits in with the capabilities of the energy system and provides opportunities for those who are currently the most exposed to the increase of energy prices, i.e. households, farms, small business, etc. The solutions proposed in the project may unblock the prosumer market development and enable the creation of the key elements of intelligent networks (e.g. microgeneration, hybrid systems). They may also activate millions of citizens – investors and stimulate the development of peripheral areas, especially rural areas. What is more, regulations will enable the rationalisation (elimination of excessive support) and optimisation of the costs of the support scheme.

The draft act on RES differentiates between the systems based on renewable energy sources on the basis of the size - microgeneration with the capacity of up to 40kW, small systems with the capacity of 200 kW and other (large) systems. It also introduces administrative simplifications based on capacity, especially with regard to the smallest microgeneration based on RES.

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[21] Text available at ZP FEO website: http://zpfeo.org.pl/stanowiska-i-dokumenty/205-opinia-zwizku-pracodawcow-forum-energetyki-odnawianej-do-uwag-polskiego-towarzystwa-przesyu-i-rozdziau-energii-elektrycznej-w-sprawie-przyczania-mikroinstalacji-oze-do-sieci-energetycznych-w-szczegolnoci-instalacji-fotowoltaicznych

[22] Draft act on renewable energy sources, version of 9-10-2012, URL http://legislacja.rcl.gov.pl/docs//2/19349/69284/69285/dokument51403.pdf?lastUpdateDay=31.12.12&lastUpdatheour=3%3A16&userLogged=false&date=wtorek%2C+1+stycze%C5%84+2013

Fig. 13. Simplified administrative procedures and incentives for connecting small and microsources based on RES to the grid, as proposed in the draft act on RES.

Administrative and operating requirements	**Microgeneration**		Small system				RES system (*large*)					
	10 kW	40 kW	50 kW	75 kW	100 kW	200 kW	500 kW	1 MW	5 MW	10 MW	20 MW	50 MW
Administrative requirements	Information sent to the operator including the system description is sufficient; not a business entity		For small systems, an entry to the register of power generators is required; business activity				Concession required					
Connection to the grid	No connection fees provided that the microgeneration operates on lesser power than the current connection conditions issued – notification of the operator is sufficient		Half of the connection fee is charged							Full connection fee is charged		

In practice, PV systems, small wind farms, cogeneration systems fuelled with biogas and bioliquids and small hydropower plants supported with a system of fixed tariffs with maximum capacities of 100-200 kW may be connected directly to the low-voltage grid without expensive investments into the development of network infrastructure. In terms of the grid connection, the draft act on renewable energy sources gives preference to microgeneration with lower capacities than the actual connection capacity available to the specific power consumer (in practice it is the hook-up in the building) before he expresses his interest in connecting the microgeneration based on RES to the grid as a future prosumer. In such cases the legislator not only plans to exempt the investor from the procedures of applying for the connection conditions but also wants to ensure him the possibility of connecting the microsource free of charge because the hook-up and the intelligent power meter are to be installed at the cost of the distribution company. There is a strong justification for it as the costs in the system may be reduced thanks to better and more extensive use of the existing network infrastructure. Moreover, the costs of connecting typical prosumer systems to the grid are relatively low.

The draft act on RES also provides for the possibility of taking advantage of administrative simplifications and exemptions with regard to concessions and business activity by micro- and small systems based on RES. Exemption from business activity seems to be the key element in the promotion of microgeneration and prosumer energy. This solution has so far been especially well received by farmers insured in the Agricultural Social Insurance Fund but does not apply to all prosumers because low revenues from the sale of surplus energy do not justify by any means disproportionally high administrative costs. The simplifications proposed are fully in line with the government's deregulation policy.

The draft act on renewable energy sources provides for the possibility of taking advantage of administrative simplifications and exemptions with regard to concessions and business activity by micro- and small systems based on RES. Exemption from the requirement to conduct business activity is a key element in the promotion of microgeneration and prosumer energy.

Overcoming economic barriers

At the initial stage, microgeneration based on RES will have to face the challenge of overcoming the economic barrier of entry onto the market. It will not be removed immediately, just by the administrative simplifications proposed. Provisions will only enable access to the market. Before microgeneration based on RES may indeed enjoy the absence of discrimination and the benefits of the market (the best instrument for cost reduction), their initial development should be shaped and supported using economic instruments, just like in other countries. This is directly provided for by the EU law. The directive on the promotion of the use of energy from renewable sources recommends that the EU member states, when implementing their objectives, use various schemes of support, which include, following art. 2 of the directive: investment aid, tax exemptions or reductions, tax refunds, renewable energy obligation support schemes including those using green certificates, and direct price support schemes including feed-in tariffs and premium payments. The directive recommends that the support scheme should include the sources for both power and heat generation. It treats large scale and prosumer microsources as equal, which confirms a balanced approach of the EU to the use of diffused sources of renewable energy. As there is a large proportion of spontaneity in the development of the renewable energy system (fast decline of costs and increase of effectiveness) and especially the microgeneration technology, the determination of the required amount of subsidies and the rate of their decline is a great challenge.

The analysis of the so-called levelised cost of energy, LCOE[23] (in this case calculated for the period of 15 years), in microgeneration demonstrated that some microgeneration based on RES are more competitive in the lowest capacity range (e.g. PV systems) and others in the capacity of 40-50 kW (small wind farms). But the costs of energy from all microgeneration used for power generation are still higher than electricity tariff prices for individual consumers (see: fig. 14). The smallest energy consumers pay the most indeed, but the smallest microgeneration based on RES, whose popularity is low, generate energy at the highest cost. The reduction of the costs of equipment and systems will be accompanied by the parallel increase of tariffs, especially in tariff groups G11 and C11 (provided that there will be an exemption from the obligation of tariff application). The process of energy liberation for individual consumers, expected already in 2013 or at the start of 2014, will result in the rise of energy costs for this group of consumers. This will be especially

[23] LCOE (Levelised Cost of Energy) is the cost of generating electricity or heat distributed over a defined number of years, which is directly related to the level of investment outlay, annual exploitation costs and the capacity of a given system. It enables comparison between various energy technologies.

difficult for households, including rural households, consuming 20% of electricity that is traded in total.

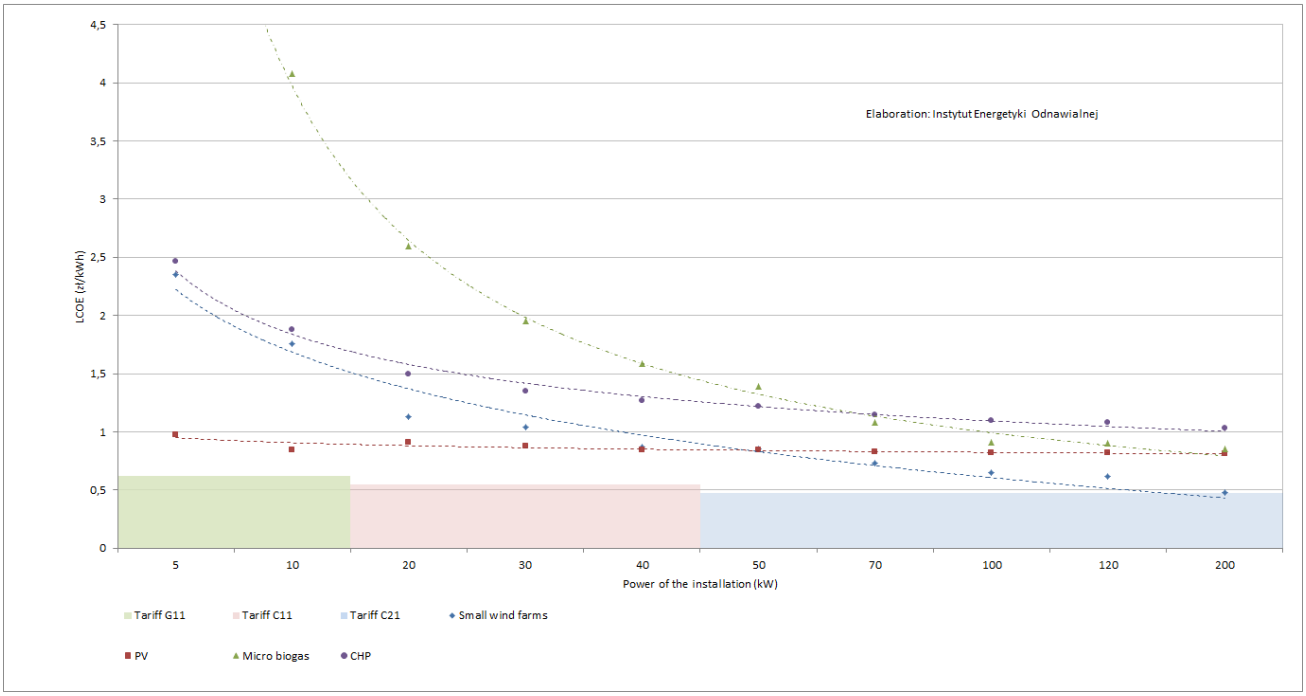

Fig. 14. Cost calculation results for electricity generated by microgeneration based on RES as compared with the capacity installed (data for 2012). *Legend: MEWi – small wind farms, PV – photovoltaic systems, MB – micro biogas plants, CHP – cogeneration systems fuelled with bioliquids. Source: IEO's study*[24].

In the draft of the most recent amendment to the Energy Law the Parliament and the government, expressing its position, are going to support selected energy consumers: energy-intensive industries (thanks to the transfer of costs upon all energy consumers) and the poorest energy consumers by means of the so-called energy bonuses (the ceiling of budget funds for 2014-2020 has been established at the level of almost PLN 1.2 million) [25]. This is definitely a step in the right direction but by focusing exclusively on this kind of solution the government ignores alternative options of improving the situation for a large number of households with an enormous prosumer potential. The needs of the middle class are ignored while this the group that will suffer the costs and not get a chance to engage in consumer activity.

[24] The analyses apply the method of the so-called Levelised Cost of Energy (LCOE). The LCOE method was used in the expert's opinion prepared for the Ministry of the Economy. Cf. Institute for Renewable Energy: The Analysis of the Options of Implementing the FEED-IN TARIFF System for Micro and Small Systems Based on RES. Warsaw 2012. URL: http://www.ieo.pl/pl/ekspertyzy/doc_details/619-analiza-moliwoci-wprowadzenia-systemu-feed-in-tariff-dla-mikro-i-maych-instalacji-oze.html

[25] The government's position regarding the Parliament's draft act on the amendment of the Energy Law and other specified acts (document no 946). The so-called small energy three-pack, *the authors' note*.

The energy policy targeting the use of coal, shale gas or uranium does not bring significant effects in terms of investment. Moreover, as it has been proven by the experiences so far, it seldom leads to taking a "final investment decision" by concerns. If this kind of decision is taken by concerns and improves the general situation in terms of new capacities, it will translate into supply for large industrial agglomerations, above all. Implementing the energy strategy only in this way would result in the weakening of the socio-economic policy cohesion and combating energy exclusion and "energy poverty". Thus, it is indispensible to build a grassroots pillar of prosumer energy.

Before the decision on investing into microgeneration is made, the interested parties rightly assume that the prices of fuels and energy will rise and calculate the period of return for the outlay. The life span of a microgeneration is usually estimated as 20 years but it is difficult to predict the scale of energy increase for the smallest consumers for the period of, e.g., the next 10 years. But on the basis of the recent experiences only, the annual energy price increase by about 7%, including inflation, seems a conservative solution. Table 3 shows the return of investment outlay into power and heat-generating microgeneration when this solution is applied.

Table 3. Simple periods of return for investment into microgeneration and small systems based on RES.

Microgeneration based on RES / capacity range	**below 10 kW**	**10 - 40 kW**	**above 40 kW**
Microgeneration based on RES – power generation Period of return with *net-metering* (without energy storage, 30% of own consumption)			
PV systems	18,3	14.9	14.2
Small wind farms	> 20	19.0	13.5
Micro biogas plants	No data available	> 20	13.9
Cogeneration systems using bioliquids	> 20	14.5	11.8
Microgeneration based on RES – heat generation Period of return as compared with a gas boiler			
Geothermal heat pumps	> 20	17.9	16.8
Systems of solar collectors	17,2	15.2	13.2
Small, automatic biogas boilers	11,2	11.1	10.2

Analyses lead to the conclusion that microgeneration based on RES, especially the smallest ones with the capacity of less than 10kW, tend to pay for themselves after over 10 years and sometimes over 20 years. In the second case it is impossible to obtain a full return on investment over the life span of the microgeneration without any support. But public opinion surveys and consumer preferences[26] show that

[26] The survey entitled "The Attitudes Among Poles to Small, Domestic Renewable Sources of Energy" was conducted by TNS OBOP as commissioned by the Institute for Renewable Energy in March 2013.

individual investors expect return periods of below 10 years and, by and large, below 5 years.

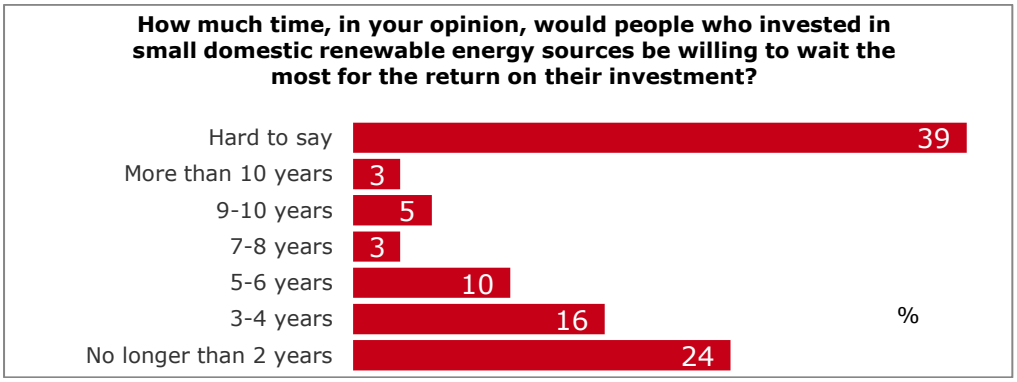

Fig. 8. Willingness among Poles to invest into microgeneration based on RES depending on the return on investment. *Source: TNS OBOP survey for IEO.*

This is why a well-designed support scheme is necessary to initiate investments into microgeneration, especially the ones in households with the capacity of below 10 kW. This is the area where the EU prefers state intervention. Active policy in this respect, effectively implementing social and environmental objectives, ultimately leads to cost reduction and puts technologies on the market basis. It may also be an effective instrument stimulating investment in construction, which is the driving force for the entire economy, as well as a way of meeting important social needs and expectations of citizens, especially the most active ones. According to public opinion surveys, the largest number of people expressing willingness to invest into small household sources of renewable energy were among: farmers (56%), young people (57%) and people in active employment (53%), private entrepreneurs (70%) as well as managers or specialists (61%). It is them who should have the opportunity to realise their aspirations in the civil society conditions, especially that this facilitates the achievement of general social objectives.

Studies of consumer preferences show that individual investors expect return periods of below 10 years, usually below 5 years. Currently, the largest numbers of people already willing to invest into microgeneration are among farmers (56%), young persons (57%), those in active employment (53%), private entrepreneurs and managers/specialists (respectively, 70% and 61%).

Similar solutions are provided for by the draft act on renewable energy sources. It proposes different intensity (level) of support for power generation using different RES technologies (see: fig. 9). Forms of support should also be diverse (a system of certificates of origin for large systems and a separate new system of fixed tariffs for energy from microgeneration and small systems). In the shape proposed, the act would be a breakthrough as regards the promotion of power-generating microgeneration based on RES. The tariffs proposed, guaranteed for 15 years, would enable the first investors – prosumers a safe entry to the market while the support instrument itself is a convenient tool to control the development of this market segment by the government (in terms of costs) in a safe way. The Minister of

the Economy, depending on the rate of the technology cost reduction and the situation of the energy market, could lower the tariffs for each new group of investors in a flexible way.

Fig. 9. Forms and amounts of aid proposed for various kinds and technologies in the draft act on RES. *Source: IEO's study.*

Kinds of RES	Fixed price PLN/kWh	**Microgeneration**		Small system				RES system (*large*)						
	Correction factor	10 kW	40 kW	50 kW	75 kW	100 kW	200 kW	500 kW	1 MW	5 MW	10 MW	20 MW	50 MW	
Wind power	**onshore**	0.95	0.65				1,20	0,90						
	offshore	1.80												
Biogas	**agriculture**	0.70		0.65				1,50	1,45	1.40				
	waste tips	0.55						1.10						
	sewage treatment plants	0.45						0.75						
Biomass	co-firing	0.30						0.30						
	solid biomass	1.30						1.30				1.05	0.95	
	biomass +CHP	1.70						1.70				1.40	1.15	
	bioliquids	1.15						1.15						
Hydropower		0.70				1.60		1,60		2.00		2.30		
PV systems	**on buildings**	1.30	1.15				2.85	2.45						
	free-standing	1.15	1.10				2.75							
Geothermal energy		1.20						1.20						

While the new act would be legally binding, small PV systems and small wind farms in particular would obtain an opportunity to develop under the new system of tariffs. They could grow not only in market niches as off-grid systems, which is happening now, but also as on-grid prosumer systems that can sell surplus energy to the grid. The prosumer act on renewable energy sources would be the most serious impulse to implement the necessary changes and it would help to make micro energy generation competitive to the model of a "central power plant" which has been supported with regulations and subsidies so far.

The prosumer law on renewable energy sources would be the most serious impulse to implement the necessary changes and it would help to make micro energy generation competitive to the model of a "central power plant" supported with regulations and subsidies so far.

The costs of the renewable energy system are openly available, just like the objectives and costs of RES support, which cannot be said about the traditional energy sector. The draft act, a kind of declaration and constitution of prosumer energy, spurred unprecedented interest in microgeneration and prosumer energy. Quickly, it raised social awareness and became an inspiration to look for business opportunities in this field, unknown so far. Unfortunately, as this is a complex issue, it encourages stereotypes used for misinformation and attacks at the idea of prosumer energy itself. Typically, it is done through a direct comparison of the costs of energy production from the sources that have already paid for themselves and new sources and suggesting that costs equal prices while withholding information that the latter are still, by and large, shaped by the state and not related to the actual costs. This kind of doubts are seldom verified by a reliable cost analysis. But reporting them together with overwhelming controversies around the directions for

the development of the national energy sector is one of the reasons why the act adoption process is being delayed.

It is a mistake to wait until one day microgeneration will become profitable. The costs of introducing new technologies into the market or any new investment in the sector of energy always initially involve higher energy prices, especially in the situation when the legal system supports old technologies and blocks access of the new technologies to the market raising their relative costs. Apart from the costs of the appliances alone, the high costs are mainly transaction costs. They may be constantly discouraging investments. LBNL[27], an American institute, analysed why the prices of home PV systems with the capacity of 10 kW in the USA are twice as expensive as in Germany despite the fact that the costs of equipment are not much different. It turns out that Americans pay about 10 times more than Germans for the system design and the service marketing and the costs of permits and the grid connection are as much as 7 times higher in the USA. The costs of microgeneration based on RES in Poland will not go down unless specific actions are taken soon. In the initial stage the act on RES is indispensible but insufficient. Pilot and bridging programmes of subsidies for microgeneration based on RES and for macro networks and energy storage systems (National Fund for Environment Protection and Water Management, Regional Operational Programmes for 2014-2020) are also needed, especially that the act adoption is being delayed. When they are developed, the good experiences of the first, nationwide programmes of subsidies, i.e. the National Fund for Environment Protection and Water Management programme of subsidies for solar collectors, should be applied. It is also recommended to use the experience of ROP 2007-2014 related to the implementation of the so-called collective projects for the co-financing of microgeneration. Prosumers and the market will optimise the selection of technologies but it is the government's role to shape the market of microgeneration. Only through its coordinated and consistent activities may it fully unleash the potential of prosumer energy, implement the NREAP objectives for 2020 and achieve a true change in the energy sector. The period after 2020 should be reserved for the total phasing out of the support instruments for microgeneration with the exception of support for new technologies at the stage of research and development.

Complementariness and coherence of activities for microgeneration and prosumer energy

The promotion of prosumer energy development should be examined in the larger context of solving infrastructure problems and, even more, structural problems in the national energy sector. The problems have been growing and will continue to do so, just because grids are 50 years old and the average age of boilers in coal-

[27] Seel, Joachim, Barbose, Galen L, and Wiser, Ryan H. "Why Are Residential PV Prices in Germany So Much Lower Than in the United States? A Scoping Analysis", Lawrence Berkley National Laboratory 2013.

fired power plants is 35 years[28] while no significant investments have been made into grids and new capacities. Poland is one of the few EU countries where large investments into conventional blocks are still planned, focusing especially on coal-fired ones, although increasingly fewer of them arrive at the stage of implementation. This is confirmed by energy corporations' withdrawals from investment projects, ready to be implemented and worth over PLN 20 billion, concerning four coal blocks of the capacity of 900 MW each (two in Elektrownia Opole, one in Elektrownia Rybnik and one in Elektrownia Ostrołęka) at the turn of 2012/2013. Professor Jan Popoczyk, commenting not just on these plans but also on the general situation in the energy sector regarding its capacity to ensure energy security, said[29]: "If preparing these projects for implementation cost just 3% of the investment outlay, then over PLN 600 was wasted. And this money could have been used to build thousands of solar, gas and biogas micro power plants." Meanwhile, as a result of coal-fired power plant closedowns until the end of 2015, the system is likely to lose 5-6 GW of capacity. Additionally, the upgrade of the energy transmission and distribution sector, especially of the low voltage distribution grids in rural areas is delayed, which has direct consequences for the security of energy supply[30].

The so-called SAIDI index of outage duration (planned and unplanned, including disasters) in power supplies in Poland published each year by distribution network operators was, depending on the distributor, from 76 minutes (RWE) to over 530 minutes (PGE) per consumer per year. This index, describing the time of the absence of power supply, is almost 10 times higher than in European countries. It is difficult to evaluate the exact costs of the failure to supply power on a nationwide scale, but they are extremely annoying for each consumer. For example, according to the American analysis, 1 minute of power outage for Sun Microgeneration costs one million dollars[31]. The problem concerns, e.g., large commercial farms whose production value is growing and becoming more and more dependent on electricity-powered appliances (for milk or poultry production). The USA[32] implements a comprehensive programme for the development of microgeneration based on RES in rural areas and the modernisation of rural grids as part of the development of intelligent networks. The programme has been in place since 2007 and in 2012 received the financing of USD 6.1 billion from the budget of the US Department of Agriculture[33]. Out of this amount, USD 4 billion were

[28] Institute for Renewable Energy: The Evaluation of the Economic Effects of Maintaining the Aid for the Technologies of Coal and Biomass Co-firing. Warsaw, 2013. URL: http://www.ieo.pl/pl/biomasa.html

[29] Jan Popczyk: Jak zapewnić bezpieczeństwo energetyczne Polski [How to Ensure Poland's Energy Security], Zielone Wiadomości, nr 5/2013.

[30] Zygmunt Maciejewski: Potrzeby inwestycyjne sieci elektroenergetycznych[Power Grid Investment Needs]. Materiały z konferencji: Finansowanie inwestycji energetycznych" [Materials from the conference on funding energy investments]. Procesy Inwestycyjne, Warsaw, 31 March 2010.

[31] Report prepared for the U.S. Department of Energy by Litos Strategic Communication under contract No. DE-AC26-04NT41817, Subtask 560.01.04

[32] National Science and Technology Council: A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future. Washington DC, June 2011.

[33] 2012 budget for the U.S. Department of Agriculture (USDA)

earmarked for the construction of small systems based on RES in rural areas (wind farms and PV systems mainly). The cost of the necessary grid development for microgeneration based on RES at its "ends" is much lower that of the development of large energy sources (both RES and e.g. nuclear). In Germany as many as 97 % of RES need a high voltage line[34]. Thus, the energy revolution does not mean just and only the need to expand transmission networks but also to open up to local alternatives available.

The liberalisation of the market, which is advancing despite resistance, should improve the quality of energy supply. But it will be linked with enormous costs for consumers in the areas where demand for energy is dispersed. Conventional energy costs for end users cannot be maintained at the acceptable level despite the absence of new investments and the cross-financing of tariffs for individual consumers connected to the low voltage grid that is in place. In 2010, so before the coal-based energy could feel the costs of the climate package, the two EU countries with the highest prices of energy for households were the Czech Republic and Poland[35]. The annual cost was over EUR 2000 (while in the UE-27 it was on average EUR 1500 per year). The energy costs in Poland accounted for 9% of an average household income.

Many foreign solutions may be applied in a creative way. For example, in Germany, which has successfully implemented the scenario of prosumer energy, there are 4 million prosumers and over 60% of systems based on RES supply power for households. Home systems based on RES just outside our western border have already reached grid parity, which means that the power produced by the household's own power plant will be cheaper than the power from the grid. This applies especially to photovoltaics. A German prosumer pays 25 eurocents/kWh from the grid while power generation in PV microgeneration costs 13-15 eurocents/kWh.

Meanwhile, technological backwardness and the discrepancies between the needs of increasingly larger numbers of active citizens (potential prosumers) and legal regulations, still oppressive, continue to grow. This may have negative effects, both socially and economically. Instead of cooperation mechanisms for prosumer sharing of surplus energy, the trends that arise focus on the activity outside the grid. As noticed by professor Krzysztof Żmijewski[36], if the state does not regulate the entire sphere of prosumers (producers and consumers of energy, both at the same time), it will spontaneously develop outside its control and not necessarily in the desired direction. The absence of regulations and state support will not prevent people

[34]Dieter Rosenwirth and Kai Strubbe; Integrating Variable Renewables as Germany Expands Its Grid . RenewableEnergyWorld No3/2013 http://www.renewableenergyworld.com/rea/news/article/2013/03/germanys-grid-expansion?page=all

[35] ENERDATA: What is the future for housing energy expenditures? 2012 http://www.leonardo-energy.org/what-future-housing-energy-expenditures

[36] Materials from the conference "SMART GRIDS - the challenges for the distribution system operators". Procesy Inwestycyjne, 15 April 2013.

from setting up microgeneration. This kind of activities, when implemented without any broader plan, would not reduce the costs in the system in any significant way. This is why "prosumer proposals" prepared by the Ministry of the Economy in the draft act on RES are necessary and appear at the right moment as constructive solutions. The project of a new programme of the National Fund for Environment Protection and Water Management called "Prosumer" fits in very well with this scheme. It will be a microfinancing instrument until 2016 for all home systems based on RES, including heat production. It should be noted that these proposals ensure the "legislative minimum" required from the perspective of prosumer energy.

The developed market of dispersed heat is not regulated by the state to the same extent as the electricity market. Nor is it supported by the provisions of the act on renewable energy sources, which means that heat is more susceptible to the rule of value and individual activities. Prosumer energy built on good experiences related to microgeneration for heat generation is thus the best experimenting field. Following good market models, using increasingly better and more intelligent microgeneration (such as smart grid ready equipped systems with heat storage facilities and controlling systems), they may be treated as learning tools for the entire groups of prosumers, installers and technology providers. It may be easily assumed that green heat prosumers will also become the pioneers of electricity-generating microgeneration based on RES. Along with the interest and involvement of a sufficiently large group of prosumers, access to technologies and qualified installers, activities in the field of power-generating microgeneration based on RES require complementary actions from network operators and the application of IT technologies to manage local energy sources cooperating with the grid. Investments will be necessary here. They may not, however, be excessively expensive or as arduous as investments in the construction of power lines. The ones primarily considered are the investments in security infrastructure and telecommunications. According to the operator's representatives, technological aspects may still be tackled by distribution companies[37]. Legal regulations should only ensure the complementariness of actions and the effect of synergy.

This Roadmap for microgeneration based on RES shows the direction and the necessary sequence of activities, also indicating the need of departure from business-as-usual activities in the energy sector. It is becoming increasingly more obvious that RES are prosumer energy and prosumer energy is a breakthrough. When promoting strategic activities to improve the competitiveness of the economy, Professor Jerzy Hausner[38] called for the "trajectory of development" that should be applied instead of single interventions. He believes that the energy sector, which is a bottleneck, instead of "more of the same" needs a different

[37] P. Zalewski, J. Ziobrowski: Energetyka obywatelska – aspekty techniczne, sieciowe i prawne [Civic Energy Sector – technical and legal aspects of the grid]. Forum Debaty Publicznej „Nowe źródła energii" [Public Debate Forum "New Sources of Energy"], 12.12.2012 at the Presidential Palace.
[38] Jerzy Hausner: thesis to the report on the competiveness of Poland's economy. Materials from the Public Debate Forum entitled "Competitiveness and Poland's Economic Development". The Office of the President of Poland, 23 January 2013.

approach, just because of the exhaustion of traditional resources and sources of development.

6. The summary of analyses and fundamental conclusions

Roadmap – "The Plan for the Development of Microgeneration for Poland based on Renewable Energy Sources until 2020" is not an entirely new document. Nor is it a study that ignores the current trends, energy technologies present on the market (across the world, in the EU and in Poland) or commonly accepted development concepts. The study is based on two fundamental documents developed at the Ministry of the Economy. The first one is "The National Renewable Energy Action Plan" (NREAP) adopted by the government in 2010 that determined the technological paths of development for the renewable energy sector until 2020. The other one is the draft act on renewable energy sources (version from October 2012) that should help to implement NREAP in Poland and directive 28/2009/UE on the promotion of the use of energy from renewable sources. These documents make the foundations for the prosumer energy system where microgeneration based on RES play the key role.

Both microgeneration based on RES and prosumers already exist and confirm that the entire concept is real. The study presents the level of development for home microgeneration based on renewable energy sources and the real path for their development until 2020, based on solid technological and economic foundations. Microgeneration are the first and key, according to the authors, "pillar" of the prosumer energy system in Poland. Attention has also been drawn to other pillars transforming building owners into prosumers (and buildings into micro power plants) and using temporary energy storage technologies integrated with microgeneration. The key conditions for the development of microgeneration based on RES and the most important development activities include: 1) the promotion of prosumer attitudes among consumers, 2) the removal of legal barriers to investments, including access to the grid, 3) an alliance with the construction and housing sector and 4) synergy with the activities for the implementation of intelligent energy networks in Poland.

The key conditions for the development of microgeneration based on RES and the most indispensible development activities include: 1) the promotion of prosumer attitudes, 2) the removal of legal barriers, including access to the grid, 3) an alliance with the sector of construction and housing, 4) synergy with the activities for the development of intelligent energy networks in Poland.

The Roadmap, with the existing methodology limitations, shows the potential for the development of microgeneration based on RES through the potential of prosumer investments and the increasing number of prosumers producing energy in microgeneration in order to use it for their own purposes or sell it. A large group of prosumers, a wide range of available microgeneration solutions and favourable legal conditions will make the prosumer energy system based on microgeneration

using RES a common phenomenon in the coming years and a mass scale trend by 2020. Growth dynamics for prosumers/investors, from the current situation (as of 2012) to 2020 has been shown in figure 10.

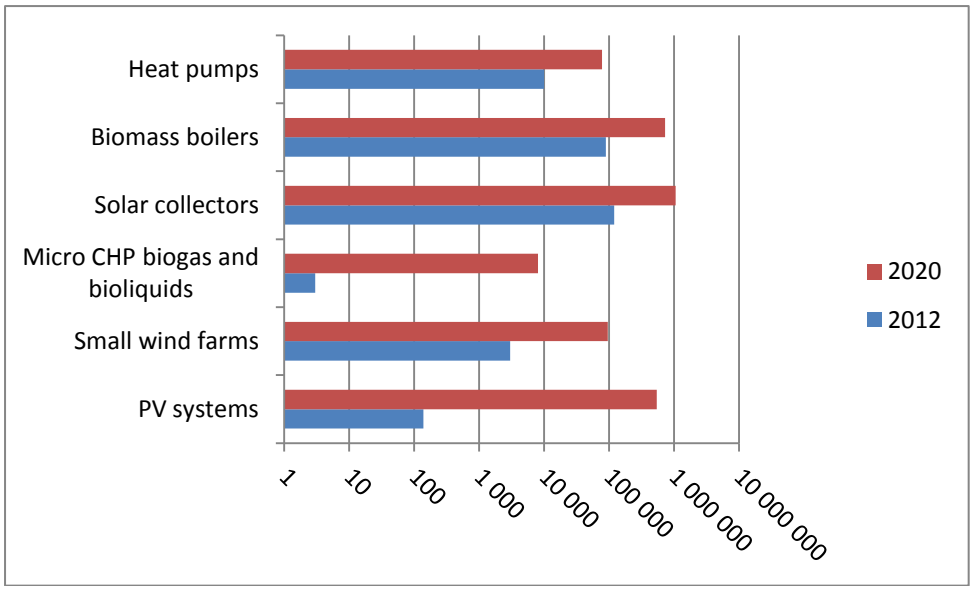

Fig. 10. The number of prosumers – users of microgeneration based on RES in 2012 and in 2020 (logarithmic scale). *Source: IEO's statistics and estimates for 2012 and the results of analyses prepared for NREAP for 2020*.

If NREAP is consistently implemented over the period of 7 years, by the end of this decade the number of RES prosumers and the number of microgeneration based on RES should go up from 223 thousand (including 220 thousand of heat-generating microgeneration based on RES, primarily solar collectors and biomass boilers) to 2523 thousand, i.e. by 2.3 million. Following the analyses conducted, the advantage of green heat prosumers (about 1875 thousand systems) over the new prosumers of green power (about 650 thousand systems) will remain in place until 2020 but the growth rate for the latter will be higher. To compare, the number of microgeneration in the EU is estimated at the level of 10 million items, with the largest share of solar collectors followed by PV systems and small wind farms. In 2020 the number of microgeneration based on RES should reach the level of 50 million in the EU.

Table 5 presents a synthesis of the microgeneration scenario implementation results divided into microgeneration for heat and power generation (following the assumptions provided for in NREAP and the draft act on RES).

Table 5. The prosumer energy sector development effects based on the development of microgeneration based on RES in Poland. Situation in 2020. *Source: IEO's study*.

	Number [items]	Capacity [MW]	Energy [GWh]	Share in NREAP [%]	CO_2 emission reduction 2013-2020 [million tons]

Heat-generating microgeneration	1 875 000	22 834	35 586	51.7	69 777
Power-generating microgeneration	648 000	1 923	2 931	9.0	5 690
TOTAL	2 523 000	24 757	38 517	38.0	75 467

The results of analyses for 2020, conducted on the basis of the real assumptions following from the government documents, are impressive indeed: 2.5 million prosumers, 25 GW of the capacity installed (including almost 2 GW in power-generating sources), CO_2 emission reduction by 75 million tons per year, almost 38% share in the implementation of NREAP targets. It should be emphasised that the annual CO_2 emission reduction at the level of 18.8 million in 2020 only accounts for 5.8% of fossil fuel emissions in Poland in 2010.

There are other, extremely valuable, effects of the prosumer scenario implementation. By 2020 there should be almost 53 thousand work places, including 32.8 thousand in the sector of biomass boilers (together with fuel preparation) and 12.4 thousand in the sector of solar collectors. Over half of the new jobs in 2020 will be created in the microgeneration production and installation, including: 14.6 thousand in equipment production in Poland and 13.9 thousand in the system installation performed by local companies.

The development of microgeneration also provides a strong, nationwide economic impulse. The turnover on the market of microgeneration based on RES will increase from PLN 4.5 billion in 2013 to PLN 26.5 billion in 2020 (including imports amounting to PLN 44 billion). The largest share in financial turnover belongs to solar collectors – 47% and biomass boilers – 24%. The total turnover on the investment market will be PLN 44 billion. By and large, these will be the investments made by households and farms as target investors. These investments would make it possible to modernise home energy systems, reduce emissions and make a large proportion of households independent of the fuel and energy price hike for dispersed consumers.

Microgeneration based on RES in 2020:

- Number of prosumers – owners of microgeneration based on RES – about 2.5 million;
- Capacity installed in microgeneration: about 25 GW;
- Energy generation: about 40 TWh/year;
- Share of microgeneration based on RES in the implementation of the national target for RES for 2020: about 40%;
- CO2 emission reduction in 2020: about 19 million tons (6% of the energy sector emissions in 2010)
- Jobs in 2013-2020: about 54 thousand, including about 15 thousand in equipment production.

Currently, it is hard to find another sector in Poland that could have such a significant, common and sustainable contribution to the country's socio-economic development. Thanks to prosumer energy, Poland would have a chance to

implement the EU climate policy, which is considered expensive, and make good use of the EU's green budget in 2014-2020.

In order to implement a comprehensive programme for the modernisation of home energy systems and turn houses into environment-friendly thermal heating plants, heat and power plants and power stations, it is necessary to adjust the support scheme to this objective. The instruments of active market shaping are needed now, at the start of the process. The analyses conducted for the purpose of this work indicate that the anticipated cost reduction for the technologies and installation of microgeneration based on RES as well as the optimisation of their selection, together with improved effectiveness, should lead to the reduction of the costs of energy obtained from microgeneration in 2020 by 10-15%. Taking into account the trends of rising prices for energy from fossil fuels, the above-mentioned processes should lead to the quick reduction of any need for the microgeneration support after 2020 until its total elimination.

The fundamental step towards sustainable and effective development of prosumer energy, which does not require any new obligations, is to ensure the conditions for the development of microgeneration based on RES, following NREAP and the requirements of the directive on the promotion of the use of energy from renewable sources. The implementation of this scenario depends on the adoption of the act on renewable energy sources in the version similar to the draft prepared by the Ministry of the Economy last year and additional support with micro subsidies for the development of off-grid microgeneration based on RES, especially the systems for heat generation. Further postponement of the implementation of NREAP becomes dangerous for the energy system and the entire country. The absence of the act on renewable energy will be felt by consumers as the prospects of energy cost reduction will be moved into more distant future. Bearing in mind the energy crisis and the economic slowdown when increasingly greater numbers of energy consumers are becoming "sensitive users" expanding the area of energy poverty, can postponing beneficial changes and blocking the development of the prosumer market be considered economically sensible and socially desirable?

A fundamental step towards ensuring sustainable and effective development of the prosumer energy system is conscientious implementation of NREAP adopted by the government, following the requirements of the directive on the promotion of the use of energy from renewable sources. It requires the adoption of the act on RES in the version similar to the draft prepared by the Ministry of the Economy. Because of legislative delay, legal barriers and the need to shape the mass market, it is indispensible to launch a strategic nationwide "bridging" programme of micro subsidies for the purchase and installation of microgeneration based on RES, especially those not connected to the grid.

The authors hope that this publication, combining the idea of prosumer energy with renewable energy, will become an impulse for a wider debate on the subject and a reflection of administration, decision-makers and politicians, which will support the activities aiming to tap into the enormous unused potential of microgeneration

based on renewable energy sources, launched but not completed, and will create the foundations for the development of the prosumer energy market in Poland.

7. Recommendations

In the light of the analyses conducted and the results obtained, the recommendations that may be formulated should, above all, be targeted at the authors of the energy policy and the administration responsible for its implementation. The activities proposed below aim to unleash the opportunities for the development of microgeneration based on RES used for power generation and especially on-grid systems. They should also become a new impulse for the development of all microgeneration based on RES, especially those used for heat production, presented in "The National Renewable Energy Action Plan."

Legal recommendations:

A joint recommendation for both heat and power-generating microgeneration based on RES (regardless of whether the energy produced is to be used to meet the producer's own needs or sold to the grid, entirely or partially) is as follows:

- ✓ Exemption from the obligation to obtain a building permit for a microgeneration based on RES and the infrastructure related to it.

For power-generating microgeneration based on RES it is indispensable to eliminate "artificial" legal barriers related to administrative procedures and the grid connection procedure, including:

- ✓ Exemption from the need to obtain a concession and entry to the regulated business activity register;
- ✓ Exemption from the need to register business activity in order to sell surplus energy to the grid;
- ✓ Imposing all duties related to the registration of the system in the registers and records as required on the distribution system operator;
- ✓ Ensuring the option of connecting buildings and facilities with an electricity hook-up to the grid on the basis of a notification.

The other group of recommendations, parallel and coherent with the first, concerns the launch of the support scheme for microgeneration, following the requirements of the directive on the promotion of the use of energy from renewable sources. They include:

- ✓ Exempting prosumers from the fees for the connection to the grid and the installation of the measurement systems by the network operator, free of charge;
- ✓ Ensuring adequate support with a system of guaranteed (for a given investment) fixed feed-in tariffs, phased out with time for new investors (to zero in 2020), which will make the cost of energy from a microgeneration (LCOE) equal to the cost of energy from a low-voltage network in a given tariff;
- ✓ Ensuring the long-term support (at least to 2016) of investment microsubsidies from environment funds (The National Fund for the Environment Protection

and Water Management) with an option to use bank microloans for the amount enabling prosumers to obtain a simple return period at the level of 6-8 years. Energy storage systems (especially heat storage), the costs of the microgeneration integration with hybrid systems and the costs of measuring the functional effect should be fully eligible;

- ✓ Determining a separate thematic priority in Regional Operational Programmes related to the financing of the purchase and installation of microgeneration based on RES by natural persons and small and medium-size enterprises. There should be separate calls for proposals related to the production of equipment and components for microgeneration based on RES and the subcategory of complex projects, rewarded in the evaluation system of proposals for the economic effects of the integration with energy storage systems (without "automatic" rewards for, e.g., a greater number of RES technologies and a greater number of partners).

Strategic activities:

It is necessary to ensure the framework conditions for the development of systems based on RES, following the NREAP scenario specified in more detail in this Roadmap. Whether the scenario is fully and consistently implemented depends on:

- ✓ Full implementation of directive 2009/28/EC on the promotion of the use of energy from renewable sources by adopting a act on RES, not later than by the end of 2013, in the version similar to the draft prepared by the Ministry of the Economy in October 2013;
- ✓ Departure from the "apparent" implementation of NREAP by means of the promotion of large-scale biomass and coal co-firing in power plants and hydropower stations that have already paid for themselves, which does not bring Poland closer to the implementation of RES targets for 2020. Instead, it is important to channel the funds saved into investments bringing sustainable economic, social and environmental effects, especially the development of microgeneration based on RES;
- ✓ Full implementation of NREAP, including the most delayed component, which is the plan for the development of microgeneration based on RES presented in this roadmap.
- ✓ Full integration of NREAP and the scenario for the development of microgeneration based on RES by 2020, together with the perspective after 2020, with the new "Energy Policy of Poland until 2035" and the timetable of executive activities;
- ✓ Providing for the needs and conditions of independent energy producers and prosumers in all legal solutions developed in order to unblock the access of microgeneration based on RES to the energy market and improve their competitiveness. At the same time, limiting the practice of developing legal solutions that strengthen the position of the traditional large scale energy system and energy concerns.

Supporting activities:

- ✓ Launching, from the start of 2014 the latest, the national educational and awareness campaign targeting all citizens, which will enable prosumers to find out about the potential and broad range of microgeneration based on RES to choose from as well as make it easier to take practical activities and balance the impact on social awareness by other governmental campaigns, launched earlier, promoting nuclear policy and shale gas;
- ✓ Establishing, by the end of 2013 the latest, a strategic research programme focusing on the development of the technologies of microgeneration based on RES and their integration with hybrid systems and micro networks together with the options of energy storage in power and heat storage facilities. The funds available in this programme should not be less than the funds in the programme for the national shale gas potential, i.e. about PLN 1 billion. It should include a dispersed but integrated and coordinated programme of activities targeting real threats, which will involve many public and private centres of research and development and cooperate, in particular, with innovative small and medium-size enterprises from the green economy sector that produce equipment and develop advanced design technologies. It should also include the programme for the home energy microgeneration assembly;
- ✓ Active involvement of Poland into the works of the EU on new technology standards for microgeneration based on RES (e.g. as part of CEN/CENELEC Committee) and immediate application of these regulations in Poland (e.g. the translation of standards). Assigning all fundamental microgeneration based on RES adequate symbols of the Polish Classification of Business Activity, which is often the requirement before this sector may be monitored or noticed by public administration. In order to support high-quality equipment and installation services, public administration should start a register of microgeneration based on RES and appliances with certificates admitting it to the market, just like the list of microgeneration installers provided for in directive 2009/28/EC;
- ✓ On-going promotion of the export of equipment and microgeneration based on RES by supporting the participation of companies in foreign fairs and trade missions and formal inclusion of the RES microgeneration sector in the programme promoting "sectors with a high export potential". Aid for national companies should be supported with a list of requirements applicable to RES equipment which are in force in the countries with a large export potential. This list should also include concise and up-to-date information concerning the support scheme for RES in these countries and its extent with regard to individual RES technologies.

If the implementation of the above recommendations is abandoned and the situation when directive 2008/29/EC, NREAP and the above mentioned activities for prosumer energy have not been fully implemented continues, Poland, despite high costs, will not achieve the EU targets set for 2020 with respect to RES or any socio-

economic targets that accompany the development of the renewable energy sector such as greater local and national energy security, new and sustainable work places, development of small and medium-size enterprises, stimulation of private investment, development of innovation and green economy, reduction of emissions to the atmosphere. Moreover, it may freeze and deform the strategy for the development of the national energy sector and, as a result, have no alternative to the use of outdated technologies with growing energy costs over the long term.

Declaration of the companies representing the green economy and the prosumer energy sector

Having in consideration that:

- Directive 2009/28/EC on the use of the energy from renewable sources is a challenge for Poland as well as a unique opportunity for increasing the role of microgeneration based on RES in the achievement of environmental and energy targets for Poland for 2020 and will make it possible to obtain a number of additional socio-economic benefits;
- Despite the absence of a systemic and comprehensive support for prosumer energy, citizens and prosumers have spent almost PLN 7 billion on the purchase and installation of 230 thousand microgeneration based on RES in the past decade;
- The report entitled "The Plan for the Development of Microgeneration for Poland based on Renewable Energy Sources until 2020", which is a social and industrial roadmap for the development of the prosumer energy system in Poland, confirms the thesis of "The National Renewable Energy Action Plan" prepared by the government that there are rational premises and justified forecasts that in 2020 the capacity of the microgeneration based on RES installed should reach 2 GW for power generation and 23 GW for green heat generation and the number of prosumers will grow to 2.5 million making the prosumer energy sector a key component of renewable energy and an important element of energy, economic and social policy;
- The implementation of the above mentioned investment plan estimated at the level of PLN 44 billion of "green investment" (including, by and large , the investments made by households and farms as target investors) will make it possible to obtain almost 40 TWh of green power and heat in 2020 (almost 40% share in the NREAP target achievement) and CO_2 emission reduction by 75 million tons/year (about 6% of emissions from fossil fuel combustion in Poland in 2010).

We, undersigned below, representatives of the green economy businesses involved in the development of the prosumer energy sector, declare that:

- Poland has the necessary manufacturing and organisation capacity to produce, supply to the Polish market and install the required number of microgeneration based on RES that may achieve the total capacity of 26 GW in 2020, which will provide jobs for over 23 thousand Poles;
- We have the resources, knowledge and skills necessary to develop national technologies for the production of microgeneration based on RES in order to systematically optimise costs and increase their effectiveness as well as meet the expectations of their buyers and prosumers – who will use microgeneration based on RES to the fullest extent possible.
- We have the export potential and we are competitive on foreign markets; our contribution to the improvement of the national trade balance and the competitiveness of the Polish economy continues to grow.

Signatures of persons [name and surname] representing the companies and organisations that are members of the coalition [list of names of companies]

Katarzyna Motak
Caldoris

Krzysztof Brzozowki
Stowarzyszenie Wolna Przedsiębiorczość

Michał Burklewicz
Hoven

Aneta Gocek
W4e

Andrzej Kaczmarczyk
Opa Labor

Romuald Kalyciok
Sunex

Przemysław Kowalski
Ren Ventures

Monika Krawczyk-Rudnicka
Polskie Centrum Solarne

Zenon Laszuk
Rapid

Agnieszka Domańska-Ławicka
POLBUD

Robert Wichłacz
NMG

Paweł Wyszyński
Optima Polska