Zeszyty Naukowe Politechniki Częstochowskiej
Zarządzanie Nr 26 (2017) s. 51–63
dostępne na: http://www.zim.pcz.pl/znwz

MANAGING PROSUMER ENERGY IN THE ASPECT OF LOW EMISSION REDUCTION

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Abstract: The paper presents solutions based on prosumer energy, which in a broad aspect of its application facilitates reduction of harmful low emission impact on the environment. Additionally, the authors characterize in it issues concerning prosumer energy and limiting negative influence of low emission, which have a direct influence on widely understood ecosystem. A very important feature of the paper is the presentation of the research results on the surveyed group awareness in the scope of low emission harmfulness and counteracting it through implementation of prosumer actions.

Keywords: prosumer energy, management, low emission

DOI:10.17512/znpcz.2017.2.05

Introduction

Permanent technological progress, which has a decisive influence on civilization changes, requires supplies of more and more energy. These changes have very negative environmental consequences. Rapidly growing demand for electricity and diminishing natural resources (in case of Poland mainly fossil fuels) stimulate the need to search for alternative energy sources and the ways energy may be utilised by individual recipients. One of the ways which might have an influence on reduction of low exhaust emission as well as a decrease of energy consumption from conventional sources is a widely understood utilization of renewable sources, particularly in case of holdings (Herbuś 2015, p. 126-127). This solution is an effective response to growing pollution of the natural environment and its degradation.

Prosumer energy concerns energy production by a unit which is simultaneously its producer and consumer. Energy production in this aspect is carried out first of all for own needs – so called off grid, concerning small holdings not connected to the national power grid, which usually consist of installations based on renewable sources and defined as microgeneration (Bukowski et al. 2014). This is a relatively new solution applied in Poland, which mainly due to lack of awareness on possibility of subsidizing and measurable benefits of savings is not properly widespread.

The goal of the paper is to present the issue of prosumer energy management in the context of its application in the scope of low emission combating. In the paper the authors present results of the questionnaire studies conducted in the group of residents in selected areas of Poland where air quality is low due to pollution caused by harmful substances at low altitude.

Current state of low emission in Poland

From the document *Diagnosis for the Needs of National Development Strategy 2020* developed in 2012 by the Ministry of Regional Development one can learn that the main source of non-compliance with the air quality standards with regard to PM10 dust in the recent years is so called low emission coming from the communal and living sector, transport and industry. In 2008 the biggest threat to air quality concerned 150 cities, which concentrated 67,7% of the national emission of particulate matters and 64,4% of gaseous pollutants.

According to the report of the Supreme Chamber of Control on *Air Protection Against Pollutants* of 2014 low emission is the emission of dusts and harmful gases coming from house heaters and local coal boilers, where coal combustion takes place in an ineffective way (https://www.nik.gov.pl/…). It is important that although in the years 2007-2008 several factors were indicated as main causes of air pollution by PM10, later in the years 2009-2012 one can notice that the dominant cause of pollution of this type was so called low emission.

According to the Supreme Chamber of Control the present rate and scale of remedial actions do not constitute a basis to forecast a visible improvement in the situation in the years to come. It must be stressed that the scale of normative values exceedance for the PM10, PM2, 5 dusts and benzo(a)pyrene in Poland is significantly higher than in other European Union countries. Thus, the risk of financial penalties being imposed on Poland by the European Union's bodies is growing. The penalties are imposed for failure to maintain the standards of air quality and they can be as high as PLN 4 billion.

According to the report by the Supreme Chamber of Control the most polluted cities in Poland include, among others: Kraków, Rybnik, Nowy Sącz, Zabrze, Katowice, Gliwice, Dąbrowa Górnicza, Bielsko-Biała, Bytom, and Częstochowa. Taking into consideration an average number of days when the daily PM10 concentration is exceeded in the chosen European cities, with respect to the normative value, Polish cities are above the standard value. These cities include Rybnik - 113, Katowice - 123, Nowy Sącz - 126 and Kraków with the level of 150.5. Moreover, the report of the European Environmental Agency which mentions Kraków, Nowy Sącz, Gliwice, Zabrze, Sosnowiec and Katowice in the top ten most polluted cities of the European Union emphasizes that the standards of air pollution caused by low emission are clearly exceeded.

The above information shows how important the problem of low emission is, both in the environmental as well as social dimension. Additionally, a complex nature of the low emission issue must be stressed here. This results from settlement and demographic reasons (scattered housing which hinders connecting to heating networks), cultural ones (attachment to traditional for Poland energy sources such as coal, lignite, charcoal and wood), and economic ones (relatively high cost of microgeneration installations).

The Ministry of Environment has published annually since 2011 a document *A Study on the Awareness, Attitudes and Pro-Environmental Behavior of Polish Citizens* (https://www.mos.gov.pl/…). One should notice that the notion of low

emission appeared for the first time in the study presented in October 2014. As the findings of the report show Polish citizens do not know what low emission is and do not perceive ineffective coal burning in household fireplaces as a problem. It is worth stressing that coal is the most popular fuel in Polish households (41%). One in every ten Polish citizens heats their homes with wood (11%) and gas (10%). Only 1% of the respondents use renewable energy sources. In relation to 2013 the percentage of people who declare the use of coal has grown by 9%, while the number of people who use heating and gas network has decreased respectively by 4% and 6%.

Taking into consideration significant effects of low emission it should be stated that pro-environmental awareness of the society should be improved with the use of educational programmes of various kinds. Indicated target groups should include residents (household owners), teachers (the use of educational cascade model teacher-student-family-local community), as people who shape attitudes of others and can pass the knowledge to a wide group of people and entrepreneurs, who can directly propagate the information on preventing low emission through installing modern technological solutions. In this aspect, the authors of the paper present in it the results of the survey concerning social awareness in the scope of low emission effects.

Results of the survey on low emission awareness

The still relevant issue of low emission prevention constituted a basis to conduct a survey that comprised three voivodeships directed at few groups of respondents. The present paper includes the survey results for the chosen group, namely the citizens from the following voivodeships: Śląskie, Małopolskie and Opolskie. The survey questionnaire was sent to the respondents via e-mail as an invitation to take part in a survey placed at eBadania.pl portal. The invitation to participate in the survey was delivered by mailing targeted at the citizens of the above mentioned voivodeships.

The choice of regions where the survey was conducted was not a coincidence and was connected with low level of air quality in the mentioned regions. It should be stressed that low emission, especially high concentration of particulate matter, is a vital problem in the aspect of air pollution in Śląskie Voivodeship. Particulate matter comes from numerous sources: municipal, industrial and transport ones. It is mainly connected with car traffic and fuel use for heating purposes, including the common use of coal and other low-quality fuels and waste of different kinds in individual heating as well as large amounts of corroded construction materials containing asbestos. The Śląskie Voivodeship occupies the first position in the country with reference to emitting dust or gas pollutants into the air. About 23% of national dust pollution, 37% of gas pollution and 21% of CO_2 are produced in the area of Śląskie Voivodeship. This situation confirms the necessity to take actions aimed at reducing pollution coming from both industrial and municipal sources (*Development Strategy of Śląskie…*).

The second surveyed area was Opolskie voivodeship. The evaluation of air quality shows that in the area of the whole voivodeship permissible limits were exceeded and steps must be taken in order to improve air quality. Therefore, one of the strategic goals concerning high quality of environment is supporting low-emission management. Assumed actions in this scope will be connected with, among others, improved energy efficiency of residential buildings, facilities and industrial plants as well as implementing air protection programmes (*Development Sategy of Opolskie…*).

The third region included in the survey was Małopolskie Voivodeship. It must be stressed that in 2010 permissible levels of air pollution were exceeded in all air protection zones in this voivodeship qualified as C zones. The largest share in the load of emitted PM10 dust and benzo(a)pyrene in the voivodeship belongs to surface sources, that is, among others, domestic ovens or small industrial plants. According to the *Strategy for Development of Małopolskie Voivodeship for the Years 2011-2020*, the directions of the development policy in the scope of pro-environmental protection improvement and utilization of ecology for development of Małopolska indicate successive reduction of emitting pollutants into the air. This concerns in particular the ones that come from individual house heating and smallest entrepreneurs. Especially stressed is the growth in use of renewable energy sources (*Development Strategy of Małopolskie…*).

The survey participants included 131 people, in this 37 women and 94 men. As the survey questionnaire contained questions about an interest in taking part in online trainings, the authors decided to address the questionnaire to people over 45 years of age. This criterion resulted from the knowledge on how to use ICT with particular consideration of Internet resources and openness to such a solution. The largest age group of the survey participants constituted people at the age of 36-45 (*Figure 1*).

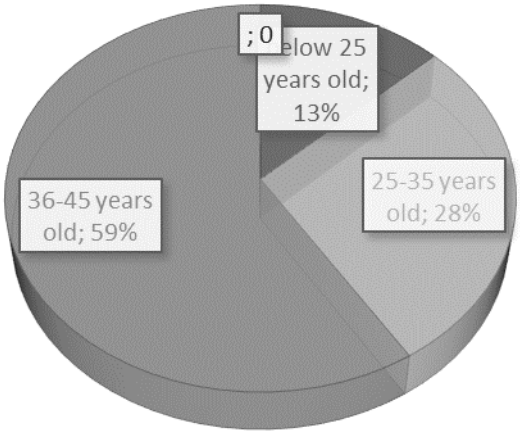

Figure 1. Respondent age structure

Source: Own analysis

The dominant group of respondents had secondary educational background (38%), the lowest percentage of the survey participants received lower secondary education (11%).

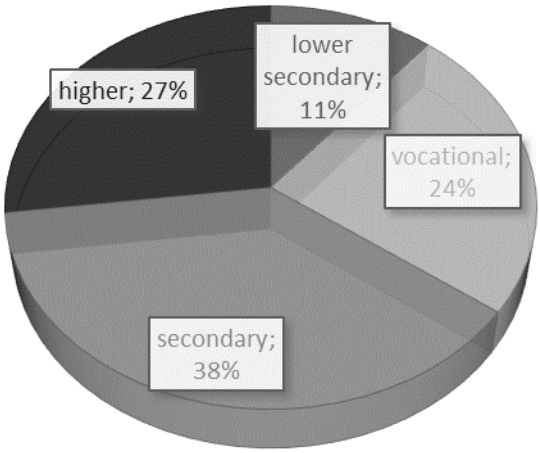

Figure 2. Respondent educational background structure

Source: Own analysis

The biggest number of the survey participants came from Śląskie Voivodeship – 39%, and the lowest number of the respondents came from Małopolskie Voivodeship – 28%. In the surveyed group more than 60% of the participants evaluated the quality of air at their place of residence as bad, and 14% as very bad. The opposite opinion on the air quality expressed 18% of the survey respondents.

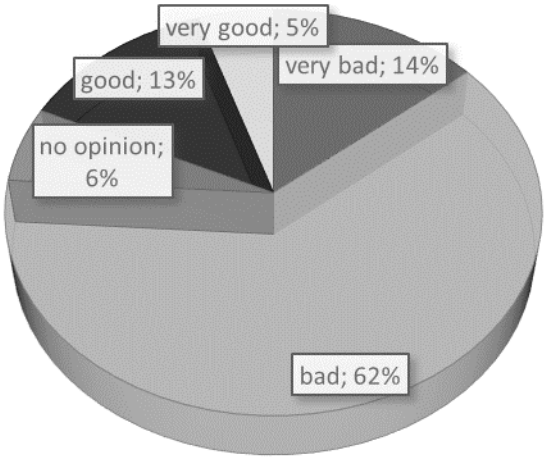

Figure 3. Air quality evaluation at the respondents place of residence

Source: Own analysis

The fuel which is most frequently used by the respondents to heat the building and prepare domestic hot water is coal (*Figure 4*), followed by heating networks, wood, gas and electricity. The least favourite fuel is heating oil.

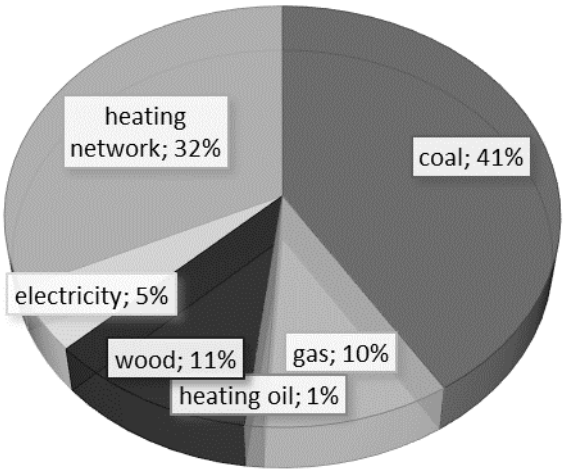

Figure 4. Fuel used for heating buildings

Source: Own analysis

The YES answer to the question whether the building is heated by burning waste was given by 24 respondents, which constitutes 27% of all the respondents who do not use heat provided by the heating network.

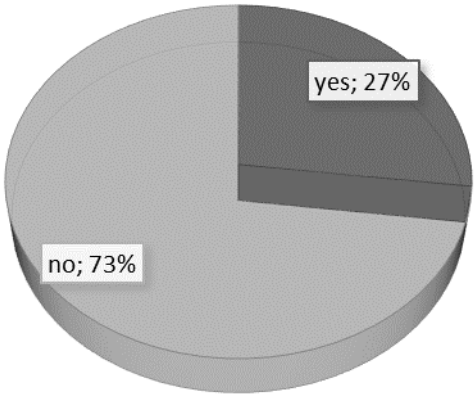

Figure 5. Answer to the question about burning waste in heating stoves

Source: Own analysis

In the course of the survey its participants were asked if they were planning thermomodernisation of the building in the near future. Our of those surveyed who

gave a positive answer to this question (47 people), 31% of them indicated exchanging windows or door, 27% was going to insulate external walls of the building and 17% were planning to exchange a heating boiler for a new one. The least interest the surveyed demonstrated in installing solar collectors (*Figure 6*). It should be stressed that the low interest in the last solution is caused by lack of knowledge among the respondents on the possibility of acquiring funds for eco-innovative solutions connected with the use of solar energy in the process of heat or electricity production.

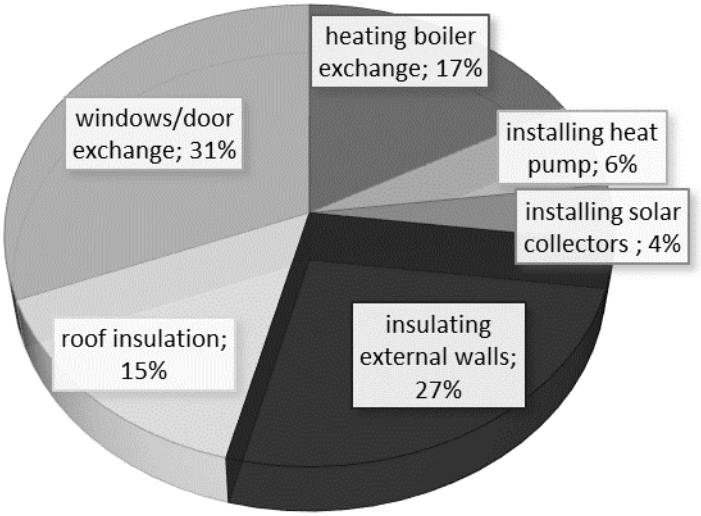

Figure 6. Scope of planned thermomodernisations

Source: Own analysis

The next part of the questionnaire concentrated on the evaluation of the awareness level on threats being the result of low emission. Almost 80% of the surveyed are against the introduction of a prohibition to heat buildings with solid fuels, while over 30% of the respondents are aware how harmful toxic gases freed as a result of burning low-quality fuels are to human organism. At the same time almost 70% of the respondents agree with the statement that raising social awareness on dangers resulting from low emission will contribute to actions aimed at preventing its negative effects, which illustrates *Figure 7*.

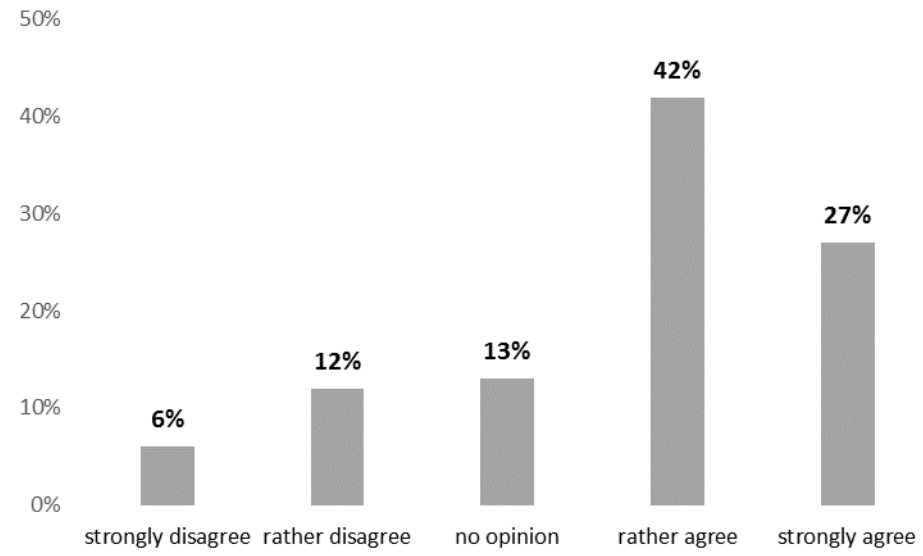

Figure 7. Acceptance level of the statement on taking actions reducing low emission through raising social awareness on threats that it causes

Source: Own analysis

However, this awareness was not reflected in knowledge connected with ways to eliminate low emission, as only 12% of the surveyed confirm that they know the methods of combating this phenomenon. At the same time the survey respondents practically do not possess any knowledge on possibilities of acquiring financial resources from national projects or the EU projects for pro-environmental solutions supporting low emission reduction – only 6 respondents admitted that they knew such possibilities existed, while this was information they had only heard about but had not confirmed it.

Within the conducted survey attention was also drawn to the importance of benefits resulting from low emission elimination. So the respondents were asked for the evaluation, consisting in determining the importance on a scale from 1 to 10 (where 1 – the least important criterion, 10 – the most important one), of the presented benefits. According to the respondents the most important one was health improvement, followed by increased investment attractiveness of the air and clean natural environment. High importance was attributed to the improved life quality of the local community and lower cost of treating illnesses. The lowest meaning was attributed to the delay in global warming (*Figure 8*).

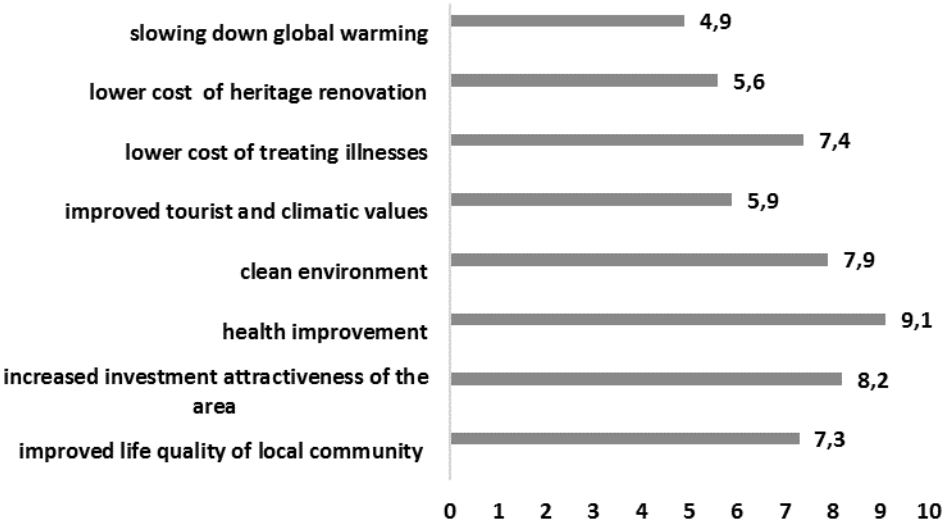

Figure 8. Importance of benefits of low emission elimination

Source: Own analysis

The above presented results of the survey show a relatively low awareness level of the population concentrated within the following regions: Śląskie, Małopolskie and Opolskie on low emission phenomenon and the possibility of preventing it. In the paper the authors present chosen pro-environmental solutions that can have a positive influence on the natural environment and human health as well as result in measurable economic benefits for households that will decide to implement them – namely prosumer energy.

Prosumer energy as an alternative to reduce low emission

The importance of the share of fuels coming from renewable sources is currently considered vital in the aspect of the world economy, both in economic and environmental respect. Particular attention is paid to the issue of the negative impact of low emission. Growing degradation of natural environment and a decrease in conventional fuels extraction stimulate the search for alternative methods of energy acquisition. Social awareness in the scope of worsening energy crisis connected with exhaustion of fossil fuels is relatively low. According to H. Rusak a lower utilization of fossil fuels can be obtained as a result of (Rusak 2013):

– an increase in the share of renewable primary energy in the world energy balance,
– reduced demand for primary energy.

Currently Polish energy sector is based on big energy producers that produce almost the whole energy necessary to ensure energy security of the country. These concerns produce energy primarily from conventional carriers such as hard coal and

lignite. That is why the role of producing energy in microgenerations[1] functioning in local communities and local governments is more and more often indicated.

Energy production at micro level is conditioned by several factors (Buowski et al. 2014):

- growing energy consumption connected, among others, with a growing number of electrical appliances among the users from the household and welfare sector,
- growing prices of energy caused by the increase in carrier prices,
- high distribution cost (large losses in out-of-date distribution networks),
- taxes,
- growing interest in new technologies,
- growing environmental awareness.

Priority technologies used in prosumer energy, which are based on renewable energy sources, require application of various methods of energy production, which take into account geographical location and availability of carriers in the given area. The most important ones include (*Prosumer Energy …* 2013):

- small hydro and wind power plants,
- photovoltaic systems dedicated to individual households,
- systems functioning in the biogas-bioliquids cogeneration,
- solar collectors,
- boilers for biomass burning,
- heat pumps.

While analyzing the literature on the subject one can encounter numerous definitions of the prosumer. However, one of the most accurate ones is presented by Jan Popczyk. According to him "a prosumer is a previous recipient who undertakes energy production for own needs". Moreover, the author also defines prosumer energy as "transition from products (electricity, heat, transport fuels) purchased from particular suppliers into prosumer value chains, that is energy management that integrates the demand and supply in all three product segments" (Popczyk 2014).

A particular attention should be paid to prosumer energy development, which through the utilization of microinstallations that use renewable energy sources will have a vital influence on reducing the negative effect of small emission emisji (Zawada et al. 2015, p. 19). Such an attitude will also enable significant changes in the scope of professional energy, mainly in the aspect of conventional electricity carrier exhaustion, which will reduce exhaust emission. Additionally, prosumer energy prevalence will facilitate diversification of production sources, which is of

[1] Resolution of the European Parlament on *microgeneration* … defines it as: 1) small-scale energy production by individual citizens and SMEs which is used for heating/cooling as well as electricity production in order to satisfy own needs; and 2) various forms of group or cooperative small-scale energy production on community level in order to satisfy local needs; remarks that microgeneration comprises different technologies (hydroenergy, geothermal energy, solar energy, marine energy, wind energy, heat pumps and biomass energy), which particularly concentrate on the area of renewable and sustainable energy - B7-0388/2013

essential importance for ensuring energy security of the country (Niedziółka 2014, p. 44; Kucęba, Bajor 2014, p. 231).

Proper prosumer energy management in the context of limiting low emission caused by households is primarily connected with a high level of social awareness. The most important elements of managing prosumer energy of the communal and living sector include identifying the environmental and economic problem. Further steps should include an analysis of particular technological solutions application depending on the climatic conditions. Another measure is evaluating the possibility of investment financing from own sources and co-financing i the scope of loans and subsidies. A potential decision on starting the investment and the following installation of chosen prosumer technologies constitute another element, the natural result of which is proper operation of implemented solutions and rational use of acquired energy.

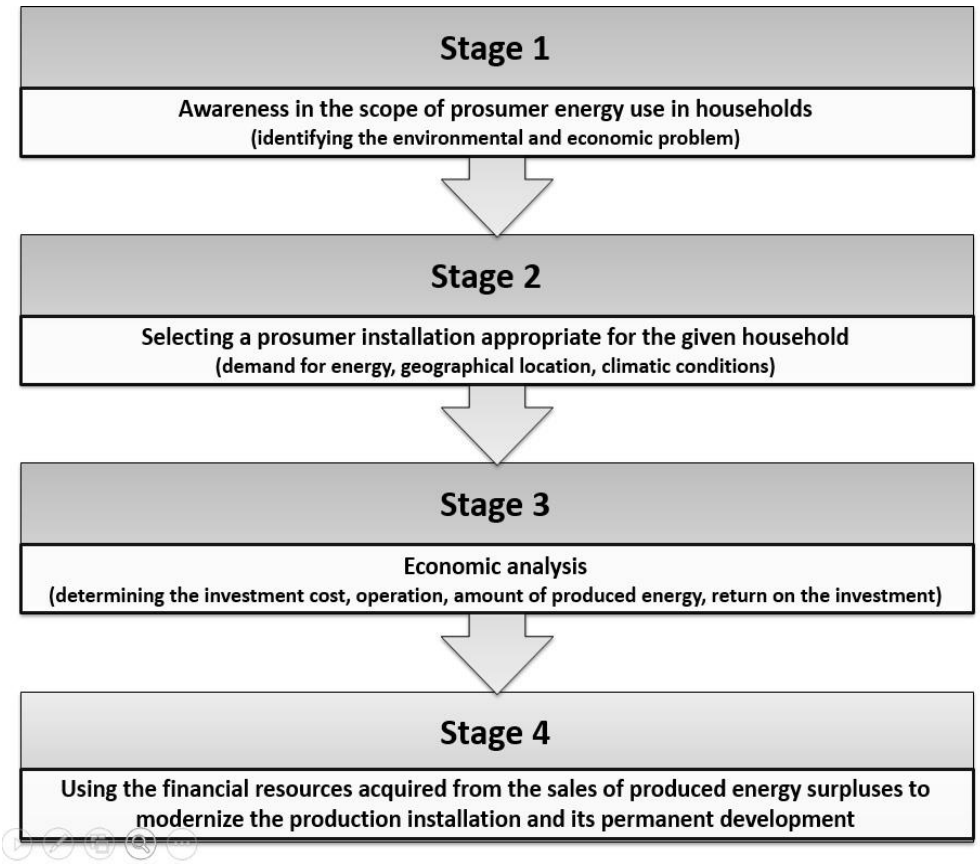

Figure 9. Stages of prosumer energy management in the living and communal sector

Source: Own analysis

Conclusion

Economic and industrial development is directly connected with energy security. A steady decrease in conventional energy carrier sources as well as growing demand for energy and widely understood aspect of environmental protection, including low emission reduction, encourage actions connected with rational management of energy resources. Transformations are taking place in Poland at a relatively slow pace, which is not reflected by a decreased demand for energy – both electricity and heat.

Therefore, measures should be found, which will effectively eliminate the above mentioned threats. This also involves a decrease in low emission level. One of such solutions is prosumer energy, which is becoming more important in the context of ensuring energy security. The subject matter of this paper describes most important issues in the scope of prosumer energy, which will make it possible to reduce the negative impact of low emission. The research which was carried out unambiguously show that the society, although not entirely aware of the possible harmful effects of the discussed phenomenon, is beginning to notice the growing danger and is committed to implement the solutions, which will let the citizens satisfy their own energy needs and at the same time improve the health and environmental conditions.

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ZARZĄDZANIE ENERGETYKĄ PROSUMENCKĄ W ASPEKCIE OGRANICZENIA NISKIEJ EMISJI

Streszczenie: W opracowaniu przedstawiono problematykę energetyki prosumenckiej, która w szerokim aspekcie jej stosowania umożliwia w znacznym stopniu ograniczenie szkodliwego wpływu niskiej emisji na środowisko. Scharakteryzowano zagadnienia dotyczące energetyki prosumenckiej, zaprezentowano etapy zarządzania energetyką prosumencką w sektorze komunalno-bytowym oraz ograniczenia szkodliwego oddziaływania niskiej emisji, mające bezpośredni wpływ na szeroko pojęty ekosystem. Istotnym elementem tego opracowania jest przedstawienie wyników badań dotyczących świadomości właścicieli gospodarstw domowych w zakresie szkodliwości niskiej emisji oraz sposobów przeciwdziałania jej poprzez wdrożenie działań prosumenckich.

Słowa kluczowe: energetyka prosumencka, zarządzanie, niska emisja