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Management of renewable energy sources by the households in context of the economics of sustainable development¹

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Abstract: The aim of this paper is to indicate and analyse the main factors of renewable energy sources (RES) management at local scale basing on the individual end-users (households) behaviour. The article discuss the survey results conducted within the ENERGYREGION project and The National Fund for Environmental Protection and Water Management financing incentives for the development of renewable energy sources microinstallation. The survey was carried out in August 2012 and encompassed the region of Lower Silesia in Poland. The first part of the paper presents the new economics of sustainable development principles in order to underline the key role of sustainable energy development in the newborn science. The second part indicates the renewable energy sources political development implications, especially related to the EU obligations. The third part of the article analyses the results of the ENERGYREGION survey in terms of ways to manage the renewable energy, while fourth focuses on financial incentives.

Keywords: renewable energy sources, survey, economics of sustainable development

1. Introduction

The new economics of sustainable development principles have crystallized since the UN conference on the environment in 1972, the publication in the same year of *Only One Earth, The Limits to Growth* and *Blueprint For Survival*, followed in 1973 by *Small Is Beautiful: Economics As If People Mattered* (Robertson 1999: 4).

They contrast directly with the conventional economics approach. The concept is based on a realistic view of human nature, recognizing that people are both altruistic and selfish, co-

¹ The project was financed by the National Science Centre, decision number: DEC-2012/07/D/HS4/00733”

operative and competitive, self-centered and emphatic. Thus it recognizes evolving the homo oeconomicus conception to homo cooperativus. Human is seen as socially and environmentally responsible. This approach promote sustainable development in every field,

systematic conservation of resources and environment, as the basis for environmentally sustainable development, evolution from a “wealth of nations” model of economic life to a one-world model, and from today's inter-national economy to an ecologically sustainable (Rogall, 2010:128-134, 192-193).

Sustainable economics, the newborn science indicates to change course towards a sustainable energy future- one that simultaneously meets the energy needs of a growing global population, addresses environmental concerns, especially climate change and enhances people's quality of life. It is normative, focusing on action to create a better future for people and Earth, critical and constructive, based on recognition that effective opposition to conventional economic development and thought is a necessary part of the transformation (El-Ashry, 2014).

Renewable energy sources (RES) are often called win-win solution for green economy. They provide opportunities for satisfying the energy needs in rural areas and remote regions, generate employment, local development, enhance energy security through reliance on domestic energy sources, help curb global warming, contribute to the protection of human health caused by air pollution. RES development is a crucial issue of sustainable energy development which is the part of economics of sustainable development as well.

The concept of sustainable development provides a balance between respecting the natural and anthropogenic (including economic) environment, and human's environment. The renewable energy development maintains this balance. The term ‘*Sustainable Energy Development*’ (SED) is the result of the transfer of sustainable development at the energy production level. The fundamental principle of sustainable energy development is the efficient use of natural, economic, human, and energy resources. The need to compare the different options for power generation allow to emerge their advantages and disadvantages and to see the ongoing process of environmental degradation and the inevitable depletion of fossil resources. It becomes necessary to treat economic development and environmental protection not separately, but as interdependent tasks, and that economic development do not contribute to environmental degradation (Graczyk, 2012: 97-112).

Defining the concept of sustainable energy development has prompted the EU Member

States and many other countries to adopt a model of sustainable energy production and to reorient the purposes of national energy policies. The primary objective of a sustainable energy policy is to limit the effects of the negative impact of energy on the atmosphere by (Lorek, 2007: 163-176):

- support for the policies and measures leading to the use of energy environmentally safe and cost effective for economy from unconventional sources of renewable energy;
- less harmful and more efficient energy production, its transmission, distribution and use;
- maintaining a balance between energy security, the satisfaction of social needs, economic competitiveness and environmental protection.

Most of the previous attention has been devoted to the smaller scale, in search for energy efficiency and to using renewable energy. Renewable energy development at local level is a broad concept that should focus on energy security, ability of the energy supply system, energy pricing, energy supply and demand within accepted standards of reliability, timeliness, quality, safety and environmental impacts. In practice, the household encounters many obstacles which has to overcome to use environmental-friendly source of energy. Beginning 2014 in Poland, the customer on rural areas is able to produce the green energy for its own needs (is called prosumer). But there are only two supporting national programmes co-financing such investments. On the other hand, rural community is not widely interested in renewable energy development.

The aim of this paper is to indicate and analyse the main factors of renewable energy sources (RES) management at local scale basing on the individual end-users (households) behaviour. The article discuss the survey results conducted within the ENERGYREGION project and The National Fund for Environmental Protection and Water Management financing incentives for the development of renewable energy sources microinstallation.

2. Renewable energy sources development implications

Management of energy demand is an important tool enabling the European Union to influence the energy market and hence the security of energy supply in the medium and long

term.

In line with the 'climate and energy package: 3*20% the EU members are required to reduce their CO₂ emissions below 1990 levels by 20%, reduce primary energy use compared to projected levels by 20%, and meet a target of 20% contribution of renewable energy to total energy consumption by 2020. Stabilization of CO₂ concentrations will require an almost complete dismantling of existing energy systems and tremendous growth of new technological systems (Directive 2009/28/EC, 2009).

In order to meet EU obligations, the expansion of renewable energy is inevitable. By shifting reliance from fossil fuels, renewable energy should lead to absolute emission reductions and is therefore central to the fight against climate change. At present, energy demand in Poland is sourced nearly entirely from fossil fuels (coal). The *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources* provides for the promotion of energy efficiency in the context of a binding target for energy from renewable sources accounting for 20% of total Union energy consumption by 2020. The EU sets the national binding targets for every Member State, for Poland it is 15% Directive 2009/28/EC establishes a common framework for the promotion of RES which are common used in low energy housing (Directive 2009/28/EC, 2009).

3. Renewable energy sources management based on ENERGYREGION survey

In recent years, the author participated in several research projects on issues of energy management, funded by the EU and the National Centre for Research and Development. Survey of energy management in the municipality of Prusice in Lower Silesia by Wroclaw University of Technology enabled obtaining data from end-users of energy. This chapter presents the results of those tests. The role of the author in carrying out the survey was limited to evaluate the survey methodology in the external expertise. The survey was conducted in 2012 in households within the European ENERGYREGION project. ENERGYREGION project² - effective development of distributed renewable energy in combination with conventional energy within regions, is

² The ENERGYREGION project is implemented by 36 months, starting from 2011. The project is financed by the EU within Priority 3 "The responsible use of the environment", area 3.3. "Promoting the use of renewable energy and energy efficiency" as part of the Central Europe Programme. The author analysed the project survey, within an expertise commissioned by the coordinator of the project, Poltegor Institute, in August 2012.

implemented through the EU funds in the framework of the Central Europe Programme. The main objective of ENERGYREGION project is to create strategy of sustainable development of renewable energy in selected regions of particular countries (Poland, Germany, Czech and Slovenia), taking into account the technological and social aspects.

The ENERGYREGION survey was carried out in August 2012 and encompassed the Lower Silesia region in Poland. Households were surveyed for methods used to save energy, demand for renewable energy, fuel and type of energy used, structure of buildings, etc.

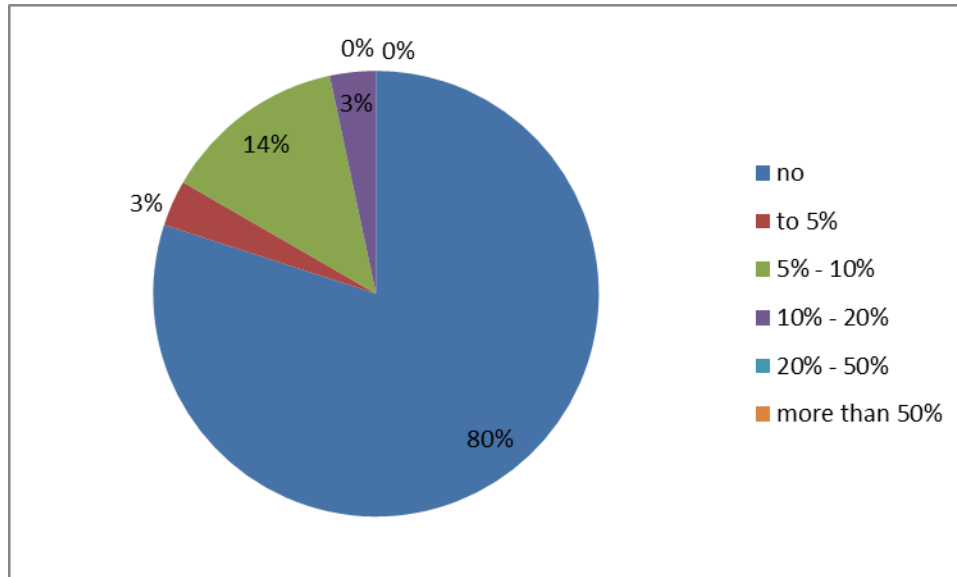
Respondents asked if they think that energy saving is important, answered positive in 97%.

Which might mean that they care about saving energy and environment. On the other hand,

survey results show there was no renewable energy installations among the respondents. Respondents declared a will to install solar panels in the future (6.7%). Over $\frac{3}{4}$ of respondents used wood for heating.

There is a pronounced low emissions phenomenon in Prusice municipality, due to the combustion of waste in the houses. People were aware of the fact that the installation of renewable energy in their households would reduce pollution to the environment and therefore improve the air condition, but 80% of them did not agree to raise the price of energy in this respect. On the question: "Do you agree to rise in energy prices, if it would come from renewable or innovative technology?" 20% of respondents answered in the affirmative way. Among the respondents willing the rise, 13.3% preferred a rise from 5% to 10% (4 people out of 30 respondents) (Fig.1).

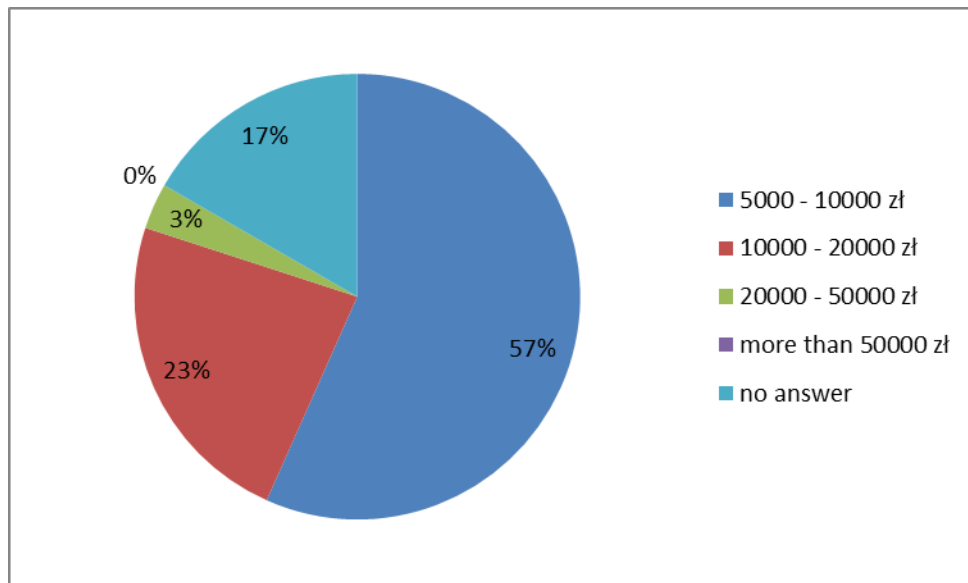
Figure 1. Would you consent to pay higher cost for energy if it would be connected with RES or innovative energy technologies use? ENERGYREGION survey results.



Source: authors' own elaboration.

Every second household was willing to spend on renewable energy installations the amount of PLN 5,000-10,000, which that time- 2012 year, already would allow installation of a small solar panel (see Fig.2). And only one in five respondents was willing to spend the amount up to PLN 20,000. That amount would allow installation of recuperation devises, solar panels or small wind turbine. The heat pump would mean spending of about PLN 40,000. An interesting relationship could be observed by the respondents willing to spend the amount above PLN 10,000 for renewable energy installations, half of them agreed to the rise of energy prices, if it would come from renewable sources or from new technologies. Most accepted a 5-10 year payback time of renewable energy sources and used biomass for heating and domestic hot water heating.

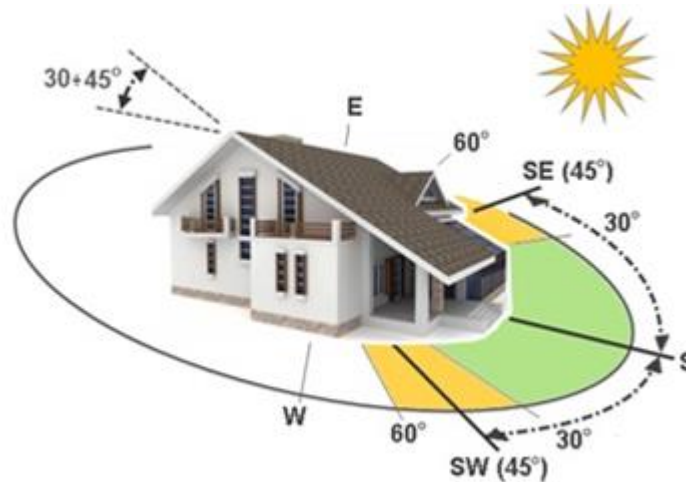
Figure 2. How much money would you like to invest in RES installations to cover your personal demand? ENERGYREGION survey results.



Source: authors' own elaboration.

One of the criteria for selecting the type of solar collector is the free area of the roof, as well as its azimuth and inclination. The ENERGYREGION survey has proved that only 10% of respondents have the free roof area smaller than 100 m². One third of respondents declared to have from 100 to 200 m² of free roof space. For four -person family 4m² solar collector is enough for domestic hot water year-round use. Regardless of the slope of the roof, it is recommended installation of solar panels at an angle of 30 ° to 45° (Fig.3). In the case of flat roofs or the roofs with too small roof inclination there should be applied free-standing structures.

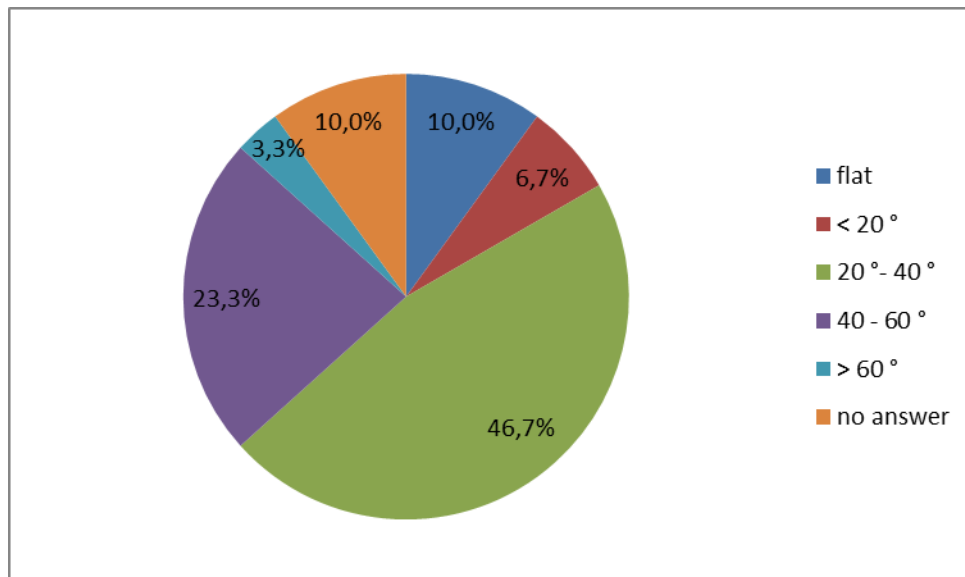
Figure 3. Roof inclination and azimuth recommended for solar panel.



Source: (Kolektory słoneczne, 2014).

Every second household declared to have the roof inclination between 20-40° whereas one fifth 40-60° (Fig. 4). Flat plate solar or tube solar collector should be directed to the south with a maximum deviation of $\pm 45^\circ$. Only larger deviation from the south of 60° or more degrees, noticeably reduces the yields of heat from a solar collector.

Figure 4. The angle of inclination of the roof. ENERGYREGION survey results.



Source: authors' own elaboration.

4. Financial support for individual RES investments

The financial instruments are used to give practical effect to the EU objectives. They are used for providing appropriate and innovative means of financing to catalyse investment in low energy building and renewables. The financing possibilities are delivered by national, regional and local energy efficiency funds, instruments or mechanisms. Financial support is addressed to private property owners, to small and medium-sized enterprises, to energy efficiency service companies and to institutions or public authorities (f.e. subsidies to social buildings in municipalities, buildings occupied by public authorities). The financial support is usually delivered by subsidized technical assistance and advice, direct subsidies, subsidized loan schemes or low interest loans, grant schemes and loan guarantee schemes.

Most developing countries like Germany (the world leader in wind and PV installations) introduce a special financial regulations to support RES development and enhance the access to the electric energy on rural areas. In Poland financing occurred a major barrier. Gap between needs and current local recourses is widely seen especially on rural areas.

By now, there are only two programs financing renewable energy microinstallations development at local level.

The National Fund for Environmental Protection and Water Management (NFEPWM) initiated in 2010, the nation-wide programme of subsidies to loans for purchase and installation of solar collectors by individual investors and housing associations. The subsidiary is up to 45% of the bank loan amount and is paid to beneficiary at the end of the project after obtaining the required confirmation that the solar collector is in use. In 2011, the offer for individual investors (through local government units) has been expanded to include grants and loans for home sewage treatment plants and connecting buildings to the cumulative drainage system (Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej, 2014).

The solar collectors programme enjoys great popularity and brings very good results: 52 000 households joined the programme. In 2011, NFEPWM as the only Polish institution, received a prestigious award – Best Practice Certificate EPSA 2011 for the programme of aid to solar panels. In addition, the NFEPWM launched in 2013 a programme of co-financing loans for construction or purchase of energy-efficient buildings.

In 2014 National Fund initiated programme targeted to individual clients (households), housing cooperatives or territorial government units planning using RES called Prosumer. Prosumer is co-financing facility for purchase and installation renewable energy microinstallations. The program is planned for the years 2014-2020. The programme budget is PLN 600 million. The support will take the form of a partial repayment of the bank loan capital to buy and install microinstallations of RES to produce electric energy or electric energy and heat together. The grant will be paid to the credit account of the beneficiary at the level of 20% or 40% financing (15% or 30% after 2015 r.) (Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej, 2014).

The environmental performance of the utilisation of RES microinstallations will involve CO₂ reduction of 165 000 Mg per year and yearly green energy production at the level of 360000 MWh. The goal of the programme is to support the RES development in local scale and to rise the ecological awareness.

5. Final remarks

The main factors determining RES management at local scale basing on the individual end-users (households) behaviour are:

- political factors : energy and climate policy of the EU, which obligate each country to implement instruments supporting RES development. Before launching such instruments in Poland only good will, promotion ecological way of life drive the consumers to RES microinstallation. Nowadays, as National Fund supporting programmes were launched on the market, we still need the willingness to rise ecological education (including RES information) and to benefit from National Fund programmes supporting RES microinstallation,
- economic factors: responsible for making RES microinstallation cost-effective. People are willing to spend no more than 5 000 to 10 000 PLN for solar installation (which is now the real cost of the 4 m² solar collector 45% granted from National Fund. The survey was conducted before the National Fund programme was introduced to the consumers, so now it can be said that grant exactly meets the market needs). Consumers also accepted a 5-10 year payout time of renewable energy sources

installations. Solar collector payout time accepted by the consumers is now in accordance with the real payout time conditions taking into account the National Fund grants.

- psychological factors: involving f.e. the level of ecological awareness, myths about RES, demand trends concerning fashion like bandwagon effects and social, economic model of behaviour. The survey showed that despite the growing ecological awareness, individual benefits remain incentive for pro-ecologic behaviour. Submission of self-interest over the public good lies in the classical economics behaviour and the so-called homo oeconomicus - mechanism to increase own prosperity. However, the economics of sustainable development outlines evolving the homo oeconomicus conception to homo cooperativus. As survey has proved, municipality benefits like better environment and saving energy resources play secondary role. When interpreting a model of energy management one should take into account the gap between the declared attitude of consumers and their actual behaviour. It is worth noting that there is a problem confronting the general questions to the specific ones (specific behaviour) in the analysis of ecological behaviour. Rate of environmental response decreases with the way the questions go from affecting most abstracted issues to those directly touching the respondent. Fewer respondents declare environmental behaviour when confronted with a situation in which the care of the environment makes necessary to incur additional expenses or costs.

Reduced energy consumption and an increased use of energy from renewable energy sources have an important part to play in promoting security of energy supply, technological developments and in creating opportunities for low energy market development. According to the Directive 2010/31/EU, Member States should include within their national plans measures to support public authorities and private investors (households) to become early adopters of energy efficiency improvements and to implement the recommendations as soon as feasible (Directive 2010/31/EU, 2010). To meet the EU obligations and to catalyse the sustainable energy development, Poland has to provide the appropriate financing in the light of national

circumstances. In order to help investors (households) to install in RES at their buildings and became the prosumers, the National Fund introduced two financial instruments. The nation-wide programme of subsidies to loans for purchase and installation of solar collectors are very popular with individual investors. Another programme hasn't started yet.

The new concept of house energy generation enables the prosumers the generate the power for their own needs in their own house and sell the surplus of power to the power grid. However, it concerns a new approach to energy management at the local scale. The 'new economics' based on a vision of effective preservation of resources and the environment, shows the necessity of enhancing and raising social awareness of using RES. Nowadays, households in Poland rather declare the environmental behavior than obey and follow the ecological management of energy consumption principles.

Achieving the EU objectives will be quite difficult in Poland without national campaign (programmes to provide information, training and awareness-raising at national or regional level). Rising demand on RES microinstallations is a big support driver to flourish the energy market and enhance energy security. However, limited knowledge of consumers and installers can lower the upward trend.

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Gospodarowanie odnawialnymi źródłami energii przez gospodarstwa domowe w świetle ekonomii zrównoważonego rozwoju

Streszczenie

Celem artykułu jest wskazanie i analiza głównych czynników gospodarowania odnawialnymi źródłami energii (OZE) na poziomie lokalnym bazująca na zachowaniu gospodarstw domowych. Artykuł dotyczy wyników badań w ramach projektu ENERGYREGION oraz zachęt inwestycyjnych dla rozwoju mikroinstalacji odnawialnych źródeł energii wprowadzonych przez Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej. Badanie przeprowadzono w sierpniu 2012 r. na terenie Dolnego Śląska w Polsce. Pierwsza część artykułu prezentuje zasady nowej ekonomii zrównoważonego rozwoju niezbędne do ukazania kluczowej roli zrównoważonego rozwoju energetycznego w nowo powstałej nauce. Część druga wskazuje przesłanki polityczne rozwoju OZE, w szczególności związane z zobowiązaniami unijnymi. Część trzecia analizuje wyniki badań ENERGYREGION związane ze sposobem gospodarowania OZE, a część czwarta koncentruje się wokół zachęt finansowanych tegoż rozwoju.

Słowa kluczowe: źródła energii odnawialnej, badania ankietowe, ekonomia zrównoważonego rozwoju