PRACE NAUKOWE UNIWERSYTETU EKONOMICZNEGO WE WROCŁAWIU
RESEARCH PAPERS OF WROCŁAW UNIVERSITY OF ECONOMICS nr 502 • 2018

Gospodarka przestrzenna XXI wieku.
Jakość życia w przestrzeni zurbanizowanej

ISSN 1899-3192
e-ISSN 2392-0041

Monika Janiszek
University of Economics in Katowice
e-mail: monika.janiszek@ue.katowice.pl

GREEN INNOVATIONS AND THEIR TOWN APPLICATIONS

ZIELONE INNOWACJE I ICH APLIKACJE MIEJSKIE

DOI: 10.15611/pn.2018.502.08

Summary: Actions that are environmentally friendly are increasingly being undertaken by private organizations, the public entities and the community. This process strives to meet the needs of society and to maintain balance between the natural environment and the economic activity. One of the solutions is sustainable building for energy efficient buildings, waste recycling and water saving and in addition, the use of renewable energy, regional materials and raw materials, recycled and environmentally friendly, as well as the promotion of bicycles and public transport. The process of making a dialogue between the local authority and residents is supported by spatial information acquisition and processing technologies and Internet communication tools The aim of the article is to analyze the resource-efficient and effective projects implemented in the city and to indicate the benefits for the economy. These benefits are to be achieved through green innovations that combine innovation with environmental sensitivity and ecological awareness.

Keywords: sustainable business, green innovations, sustainable development, urban applications, geographical information systems .

Streszczenie: Coraz częściej przez organizacje prywatne, podmioty publiczne i społeczeństwo podejmowane są działania przyjazne środowisku. Proces ten dąży do zaspokojenia potrzeb społeczeństwa oraz zachowania równowagi między środowiskiem przyrodniczym a prowadzoną działalnością gospodarczą. Jednym z rozwiązań jest zrównoważone budownictwo stawiające na energooszczędne budynki, recykling odpadów i oszczędzanie wody, wykorzystanie energii ze źródeł odnawialnych, materiałów regionalnych i surowców najlepiej z recyklingu i produkowanych w sposób przyjazny środowisku, jak również działania promujące transport rowerowy i publiczny. Proces podejmowania dialogu między władzą lokalną a mieszkańcami wspomagany jest technologiami pozyskiwania i przetwarzania informacji przestrzennej oraz narzędziami komunikacji internetowej. Celem artykułu jest analiza przedsięwzięć realizowanych w mieście oraz wskazanie płynących z nich korzyści z zasoboszczędnej i efektywnie prowadzonej gospodarki. Mają one zostać osiągnięte za pomocą zielonych innowacji, które są połączeniem innowacyjności z wrażliwością środowiskową i ze świadomością ekologiczną.

Słowa kluczowe: zrównoważony biznes, innowacje ekologiczne, zrównoważony rozwój, aplikacje miejskie, systemy informacji geograficznej.

1. Introduction

Today, a growing number of companies build a competitive advantage based on new environmentally friendly tools. The activities of companies support the concept of corporate social responsibility which is a response to the challenges of sustainable development [Wieteska-Rosiak 2013]. The impulse to take these actions was an increase in the importance of rational use of natural resources and the activities friendly to the environment undertaken by private entities, public entities and society. The sustainable development is defined as "the socio-economic development, in which the process of political, economic and social integration takes place while maintaining natural balance and permanence of basic natural processes. The aim is to guarantee the possibility of satisfying the basic needs of individual communities or citizens of both the present generation and future generations" [Ustawa z dnia 27 kwietnia 2001]. This development should also take into account environmental protection. Actions in favour of the environmental protection are more and more often treated by the enterprises not as the cost but as an investment for future. Amongst the benefits of improvement in the corporate image, a cost cutting of functioning of the enterprise by reducing the negative influence of the business activity to the environment, a height of the loyalty of customers and stakeholders are being exchanged. According to the European Commission, resource-efficient and effective economy is crucial for the growth of the economy, building employment, the increase in the competitiveness reducing the costs for businesses, important benefits to health and environment, lower energy bills and new opportunities for innovation and investment [Komunikat Komisji do Parlamentu Europejskiego 2013]. From this point of view, the priority seems to be green innovations, implementing the objectives of sustainable development by reducing the environmental impact and increase the resilience of the economy to changes within it, which are taking over more responsibility of the use of natural resources [European Commission 2011].

Green innovations are defined as entrepreneurial activities involving the design phase of the product and the integrated management of its life cycle, which contributes to the ecological modernization of the economy [Carley, Spapens 2010]. This concept is also understood as the implementation of the widespread use of new products, technologies and infrastructure equipment, whose purpose is to protect the elements of the environment: air, water, soil, landscape, flora and fauna, as well as a human related to the negative influence of economic activity [Białoń 2010]. The problem may be the use of different terminology, because in addition to green innovation such terms are used in literature: eco-innovation, green technologies, environmental technologies [Ziółkowski 2008].

Applying solutions of green innovations is supposed to manifest itself with increasing the environmental effectiveness by the reduction of energy consumption of the production which is supposed to influence the increasing of the cost

competitiveness of an enterprise [Strojny 2010]. Thus such innovations can be perceived as actions limiting the negative influence of economic processes to the natural environment and reducing the damage in the environment [Kanerva, Arundel, Kemp 2009]. Green innovation is therefore a combination of innovation with environmental sensitivity and ecological awareness [Węgrzyn 2013]. Green innovations influencing the growth in the economy in long-term action are treated as the factor stimulating the improvement in the productivity of the economy in using the available resources, creating new markets of the technology, goods and services, curbing the negative environmental impact and coming into existence of new places of employment. The positive dimension of these actions will be manifested in greater economic stability due to lower production costs achieved through the efficient and rational use of natural resources. The balance of ecosystems will be kept by limiting the influence of the activity of companies on the environment and lowering the risk of sudden, irreparable and expensive changes.

2. Green innovations

The concept of sustainable construction relies on energy-efficient buildings, waste recycling and water conservation, use of renewable energy, put on regional materials and raw materials, preferably recycled and manufactured in an environmentally friendly way, as well as promoting cycling and public transportation [*Green thinking*... 2011].

In the construction industry green certificates may also be considered: LEED (*Leadership in Energy and Environmental Design*), BREEAM (*Building Research Establishment Environmental Assessment Method)*, DGNB (*Deutsche Gesellschaft fur Nachaltiges Bauen*), CASBEE (*Comprehensive Assessment System for Built Environment Efficiency*) or Green Star. Investors in the property market can use, inter alia, the following solutions in the context of certificates: reduce the total energy consumption in the building by 25% of the national standards [Leadership in Energy... 2017], reduce pollution associated with construction works by controlling soil erosion and dust emissions, reduce the use of water during construction and operation building, as well as renewable and clean energy sources [Building Research Establishment... 2017], reduce greenhouse gas emissions through the installation of energy efficient refrigeration systems, reduce environmental pollution by shorter transport to the point of use [Institute for Building... 2017], improve indoor air quality by increasing access to natural light, use of modern technology, activate the local economy [Deutsche Gesellschaft... 2017]. These criteria are supposed to be achieved by an increase in supply on green buildings, increase in community awareness and market development for the creation of innovations that minimize the cost of construction. The growing interest in green construction results in an increase in the number of environmentally friendly buildings. It is worth highlighting good practices in the field of energy, materials, emissions, water and impact on the local

economy. Green innovation is becoming an area of activity of combining economic, environmental, scientific research, education, labour market and security.

To heat the building, among others, the passive solar energy, modern windows reflecting infrared radiation and heat storage stone walls are used [Szpor, Śniegocki 2012]. As many as 95% of the demand for light can be provided by solar radiation, and the rest by energy-saving and efficient lamps [von Weizsäcker, Lovins, Hunter Lovins 1999]. Due to the use of daylight, green composition (water reservoir, green garden), and natural ventilation, for example Kings Mill Hospital building during the reconstruction became healthier and more comfortable for patients and staff. Cooling and heating system of the building is based on the geothermal source in the form of a nearby lake, which saves electricity, gas, reducing carbon dioxide emissions. Through the use of environmentally-friendly fluorescent lamps, meters, motion sensors or sunlight, energy efficiency of the building is improved. In addition, the green roof filters of rainwater absorb CO2, insulate heat and sound, protect the building against the weather and UV radiation and reduce the outflow of rainwater. The walls of the building have been built with environmentally friendly materials (brick sludge), and rainwater is re-used. Local construction companies and geothermal energy companies were involved in the implementation of the investment, which had a positive effect on local economic development. During the construction, machines were muted and the demolition materials and other waste were subjected to recycling.

In Poland, as a good example of good practice of using eco-innovation is eg. residential complex located on the roof of Galeria Sfera in Bielsko-Biala, which has its own garden (2000 m^2) in the inner courtyard of the estate of space to rest and a place for the playground [*Zielone dachy i żyjące ściany*... 2017]. The concept of building apartments assumes care for the environment and reducing energy costs. The solutions provide the possibility of individual control of central heating, to optimize its use and easy settlement of heating costs whilst the garden is watered by an automatic system supplied from rainwater tanks [Drobniak, Janiszek, Plac 2016].

Durable and sustainable urban development can be amplified by the use of solutions in water management, waste management and the use of renewable energy sources. The demand for green products and services encourages companies to develop environmentally friendly technologies contributing to the local, regional, national and international sustainable development goals. Nevertheless, there is still lack of knowledge about the environmental costs of maintenance of the entities and the possibility of limiting the alternative is a significant barrier to implementing green innovations [Rzeńca 2015]. Therefore, in the sphere of education it is to provide customers and investors with data about the efficiencies and benefits of green products based on new technologies introduced to the market [Europejska Agencja Środowiska 2016] and comprehensive support to increase the availability of funding sources. In addition, further development of fiscal systems to encourage the development and implementation of eco-innovation may be important, as well as reducing the uncertainty about the rate of return on realized investments. In the

cities, simple economic efficiency of an expected better performance with similar expenditures is crucial. These solutions belong to this group for which the prospective benefits, the benefits calculated over a long period of time are essential. Note, however, that there are known such examples (Hammarby, Sweden), where green innovations became image-successive of the city allowing for the formation of a good brand for young households with children, but in the long term resulted in a significant increase in the cost of living green infrastructure, which charged a city.

3. Innovations in decision-making processes

In the process of preparing a local plan, there are two stages of participatory: collecting applications before starting the design (based on them the text and figure study or plan arises) and consultations lined to inspect the project along with the environmental impact assessment findings.

By public notes, advertisements in local newspapers and in the customary manner residents in the village are informed about the activities of a vogt, a mayor or a City President. It happens that the form of the document drafted is confusing to respondents because of the lack of the fundamental knowledge on the content of the plan, especially its purpose and scope. This results in inadequate plan proposals, e.g. related to the organization of traffic and speed limit. Another mistake may be the location of the consultation in the planning process and the choice of the place where the discussion will be taken, as it is usually the head of the office, not a building located in the area of the plan. The meeting takes place before 5 p.m., without the introduction of extensive information enriched with graphic materials and writings in non-specialist language.

Designers' vision is more often presented in the form of drawings, maps, plans and diagrams using GIS tools to visualize urban development, planning and architecture. Visualization of these takes the form of: perspective view, photomontage, a three-dimensional model, computer animation, interactive two-dimensional maps and three-dimensional digital terrain model [Klejnberg 2010].

The development of technology acquisition and processing of spatial information makes three-dimensional digital models are increasingly used to present an existing or planned landscaping in the subjects e.g. infrastructure management, spatial planning, public security, industry and tourism marketing. The sites with satellite images, aerial and three-dimensional data can be found on Google Earth, Microsoft Virtual Earth and NASA.

The process of changing land use planning, especially the public, needs to take actions to integrate the needs of public administration, public institutions, investors, property owners, as well as residents of the examined area. In the case of spatial policy of local government, restrictions may constitute the legal protection of property and the effects of regulation of financial solutions for private property. In addition, these actions can cause hidden spatial conflicts [Jaworski 2014].

Three-dimensional models of cities contain buildings' solids with a description of their functions, number of storeys or determination of the historic character that has the majority of metropolises, e.g. New York, Chicago, Delhi, Tokyo, Singapore, Beirut, Sydney, Adelaide, Sant Petersburg and Warsaw. According to the topology of Shiode'a [2001] three-dimensional models can be divided due to:

- detailed reflection of reality,
- the type of data used,
- functionality.

In order to sort out the level of details City GML scale [Kolbe, Groger, Plumer 2005] about five degrees of accuracy − LoD (Level of Details) is used based on ISO/OGC (GML3):

- LoD 0 − digital terrain model showing terrain, covered orthophotomap − suitable for the planning of the area and regional planning,
- LoD 1 – model of block buildings with flat roofs,
- LoD 2 − solids with textures, imposed images of facades, buildings fleshed lump roofs,
- LoD 3 − model faithfully devoted elevation, texture, high-resolution, putting each element of the building more than 0.5m, putting the shape and type of the roof,
- LoD 4 − model of the detailed subtleties of the building from the outside and inside.

Shooting from the ground, panoramic photos, aerial oblique photos, laser scanning and high satellite distribution may be included to the modern techniques of obtaining information and creating models. Using a pair of images obtained in this way by means of the software and the material forming, the three-dimensional model can be made. These models can be divided according to their use, the degree of usability and usefulness of analytical data:

- aesthetic models − for the purposes of presentation, having a small technical and analytical functionality,
- models showing the characteristics of the areas and buildings with a limited number of data,
- models allowing full spatial analysis (GIS in three dimensions),
- hybrid model, interactive (made e.g. of plastic).

These models are created using GIS tools which integrate spatial information with databases. Apart from the function of visual presentation, space can be used in other aspects.

4. Applying town

Presentation of the plan enriched with a third dimension can contribute to better assimilation of the objectives of the plan by the recipient participating in the planning process. However, this is only a tool to support traditional techniques (information and consultation) of social participation.

The models are used to strengthen social participation in projects related to land use. Mazowiecki Office of Regional Planning tool − Geo-Discussion Panel (GDP) [Andrzejewska, Baranowski, Rusztecka 2005] allowed residents of individual assessment of the plan, commenting and submitting proposals for amendments thereto. Available geospatial data on the Internet and registered users were able to use a web browser with the basic functions of GIS programs (adjustment of view, the content of maps and graphics, display information about the objects, database search by selected criteria). Residents had the opportunity to participate in a panel discussion, enrich it with geocomments (graphics and text), and then send them to the database. People engaged in consultations, analysed, collected and verified them. For Internet consultations application software GeoTools were developed. This tool is used for the presentation of the draft zoning and different variants of the effects of development on the environment. Geoconsultations allow to avoid the disturbed course of discussion contributing to greater transparency of the planning process, and office work. It is, however, quite expensive software, and depends on the quality and availability of geospatial data and requires adequate knowledge of workers. The three-dimensional digital models are used to improve the conditions for discussion and social participation, but very often take only a form of pilot or research.

The concept of e-participation [Gil-Garcia, Gonzalez-Miranda 2010] was determined to involve citizens in the public decision-making process via the Internet. Indicated channels for its development are: action taken outside the Internet (education, democracy at the municipal level), incentives for participation online (promotion of civil society), information for applicants (basic information about the work of the office and its employees), forums (exchange comments on selected topics of local politics), blogs (increasing awareness of the specific topics of spatial), chats, surveys (collecting people's views on the current policy), e-elections, the publication of the results of e-participation [Damurski 2011].

E-planning is a process assisted with information systems. It serves the flow of information between the users of the environment and the decision-making center which fulfils the tasks of planning with the principles of equality of stakeholders in decision-making space [International Journal… 2012]. E-planning should consider [Antunes et al. 2010]:

- perception − cognitive aspect of the decision-making processes,
- support − taking into account the past experience of individuals and organizations,
- surfacing − exchange of knowledge between the participants,
- diagnosis − accepting the terms of decisions,
- convergent/divergent models of work − the selection of the implementation strategy of flexible jobs
- task management − control tasks by decision-makers.

Applied tools and techniques of communication on the social order and ways to manage the city play an important role in modern urban development. Local digital

infrastructure is becoming more functional and useful for local authorities and residents. The use of information systems and communication tools of web planning is the foundation of the concept of the city 2.0 which integrates the ideas of Web 2.0. By using these assumptions residents have the opportunity to contribute to the city [Szelągowska 2014]. The aim of the idea of the city of 2.0 is the creation of the city with the use of new technologies contributing to the functional improvement to make transport friendlier and more efficient, reduce poverty and deepen social differences, order green space and improve residents' awareness in terms of quality of life and environmental protection.

The increase of the availability of Internet services is conducive to the implementation of innovative solutions in the management of cities. Digital information systems used to introduce, collect, process and visualize three-dimensional Geoinformation, are also used in the decision-making process. The most commonly used tools include geosurveys and geodiscussions. The first of them are interactive maps that allow to obtain spatial information directly from residents about the perception of their particular areas of cities and their preferences regarding changes in land use of the space. They are usually used before public debates on the proposals submitted solutions intended for spatial changes, while geodiscussions allow Internet users to point to an interactive map of the problem or suggest their own solution assigned to a specific location in space. These tools are used to improve the quality of life in the city and minimize conflicts in the urban public space. Created applications allow citizens to submit notification (e.g. defects in the road surface, tracks, unprotected sewage wells, broken street lighting, devastations, residual snow or a stray dog) containing the image with a description of the example to local government or any other institution. TripZoom application is intended to reduce congestion, protect the environment and improve safety as well as the well-being of European citizens.

These actions are expected to contribute to the active participation of citizens in political and social life of the city. Spatial systems are increasingly used for public consultation on the budget of the civic revitalization of neighbourhoods, streets and houses, increasing green spaces, transforming specific objects for other public purposes to improve the quality of life of residents.

5. Conclusions

Green innovations are activities that improve the efficiency of the use of natural resources in the economy to reduce the negative impact on the environment by strengthening the economy's resilience to environmental pressure. The positive dimension of these activities will be the creation of new markets for technology, goods and services and the creation of new jobs. Ecosystem balance will be maintained by reducing the environmental impact of businesses, reducing the risk of sudden, irreversible and costly changes through long-term and economically viable operations.

Sustainable local and regional development can be strengthened by the application of water management, waste management and the use of renewable energy sources. The demand for ecological products and services encourages companies to develop environmentally friendly technologies, contributing to the achievement of local, regional, national and international sustainability goals. The process of city management and its development should be supported by tools based on spatial information acquisition and processing technology. These activities should integrate the needs of public, private and local communities. Because enriched with the third dimension they contribute to better assimilation of local and regional development in cooperation with society.

References

Andrzejewska M., Baranowski M., Rusztecka M., 2005, *Geowizualizacja w procesie planowania przestrzennego*, Roczniki Geomatyki, vol. III, issue 4, http://ptip.org.pl/download/files/RG2005z4-Andrzejewska-inni.pdf (access 23.01.2017).

Antunes P., Sapateiro C., Zurita G., Baloian N., 2010, *Integrating spatial data and decision models in an e-planning tool*, [in:] G. Kolfschoten, T. Herrmann, S. Lukosch (eds), CRIWG, LNCS, vol. 6257, pp. 97-112.

Białoń L., 2010, *Zarządzanie działalnością innowacyjną*, Placet, Warszawa, p. 25.

Building Research Establishment Environmental Assessment Method, www.breeam.com (access 14.01.2017).

Carley M., Spapens P., 2010, *Dzielenie się światem*, Wyd. Instytutu na rzecz Ekorozwoju, Białystok–Warszawa.

Damurski Ł., 2011, *Internetowe narzędzia partycypacji społecznej w procesie planowania przestrzennego w Polsce*, Studia KPZK PAN, no 142/2011, http://skpzk.czasopisma.pan.pl/images/data/skpzk/wydania/No_142_2011/48_Internetowe_Narzedzia_Partycypacji_Spolecznej_W.pdf (access 25.01.2017).

Deutsche Gesellschaft fur Nachaltiges Bauen, www.dgnb.de (access 14.01.2017).

Drobniak A., Janiszek M., Plac K., 2016, *Zielona gospodarka i zielona infrastruktura jako mechanizmy wzmacniania gospodarczo-środowiskowego wymiaru prężności miejskiej*, [in:] A. Zakrzewska-Półtorak, P. Hajduga, M. Rogowska (eds.), *Gospodarka przestrzenna XXI wieku*, Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, Wyd. Uniwersytetu Ekonomicznego we Wrocławiu, no. 443, Wrocław, pp. 57-69

European Commission, 2011, Communication from the Commission. Innovation for a sustainable future – The Eco-innovation Action Plan (Eco-AP), Brussels, http://www.mos.gov.pl/g2/big/2014_01/cfaedfdcf2dcf1c98c72af9c3a79df3b.pdf (access 14.01.2017).

Europejska Agencja Środowiska, *Technologie ekologiczne*, 2016, http://www.eea.europa.eu/pl/themes/technology/about (access 14.01.2017).

Gil-Garcia J.R., Gonzalez-Miranda F., 2010, *E-government and Opportunities for Participation. The Case of the Mexican State Web Portals* [in:] C. Reddick (ed.), *Politics, democracy, and egovernment: Participation and service delivery*.

Green thinking. There's more to building a green society than just building, 2011, Skanska's Green Initiative, www.skanska.com (access: 14.01.2017).

Institute for Building Environment and Energy Conservation, www.ibec.or.jp (access 14.01.2017).

International Journal of E-Planning Research (IJEPR), 2012, http://www.igi-global.com/journal/international-journal-planning-research-ijepr/44994 (access 25.01.2017).

Jaworski P., 2014, *Partycypacja w planowaniu przestrzennym*, Podsumowanie sesji tematycznej w ramach Forum Praktyków Partycypacji 29-30 maja 2014 r., http://archiwum.partycypacjaobywatelska.pl/wp-content/uploads/2014/10/partycypacja-w-planowaniu-przestrzennym.pdf (access 14.01.2017).

Kanerva M., Arundel A., Kemp R., 2009, *Environmental innovation: Using qualitative models to identify indicator for policy*, United Nations University Working Papers Series, Maastricht.

Klejnberg H., 2010, *Zastosowanie trójwymiarowych wizualizacji planów zagospodarowania przestrzennego w konsultacjach społecznych*, Człowiek i Środowisko, no. 34(1-2), pp. 27-42.

Kolbe T.H., Groger G., Plumer L, 2005, *City GML*, Interoperable Access to 3D City Models Geo-Database Management Center, http://www.gdmc.nl/events/gi4dm/presentations/02-Kolbe.pdf (access 23.01.2017).

Komunikat Komisji do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego oraz Komitetu Regionów. Program prac Komisji na 2014 r., 2013, Bruksela, 22.10.2013, COM(2013), 739 final, http://ec.europa.eu/atwork/pdf/cwp_2014_pl.pdf (access 14.01.2017).

Leadership in Energy and Environmental Design, https://www.usgbc.org/ (access 14.01.2017).

Rzeńca A., 2015, *Ekoinnowacje polskich przedsiębiorstw: dobre praktyki na przykładzie projektu GreenEvo − Akcelerator zielonych technologii*, Acta Universitatis Lodziensis, Folia Oeconomica, no. 2 (313).

Shiode N., 2001, *3D urban models: Recent developments in the digital modelling of urban environments in three-dimensions*, GeoJournal, vol. 52, pp. 263-269.

Strojny J., 2010, *Wdrożenie systemu zarządzania potencjałem ekoinnowacyjnym w przedsiębiorstwie* [in:] L. Woźniak, J. Strojny, E. Wojnicka (eds.), *Jak budować przewagę konkurencyjną dzięki ekoinnowacyjności?*, Polska Agencja Rozwoju Przedsiębiorczości, Warszawa.

Szelągowska A., 2014, *Miasta 2.0 we współczesnej gospodarce*, Zarządzanie i Finanse, Journal of Management and Finance, vol. 12, no. 4/2014.

Szpor A., Śniegocki A., 2012, *Ekoinnowacje w Polsce. Stan obecny, bariery rozwoju, możliwości wsparcia*, Instytut Badań Strukturalnych, Warszawa.

Ustawa z dnia 27 kwietnia 2001 r. Prawo ochrony środowiska, Dz.U. nr 25, poz. 150, art. 3.

von Weizsäcker E.U., Lovins A.B., Hunter Lovins L., 1999, *Mnożnik cztery: podwojony dobrobyt – dwukrotnie mniejsze zużycie zasobów naturalnych*, Wyd. Rolewski, Toruń, pp. 26-31.

Węgrzyn G., 2013, *Ekoinnowacje w Polsce na tle krajów Unii Europejskiej*, Ekonomia i Środowisko, no. 3 (46).

Wieteska-Rosiak B., 2013, *Zrównoważony biznes na przykładzie zielonych inwestycji na rynku nieruchomości*, Ekonomia i Środowisko, no. 1 (44).

Zielone dachy i żyjące ściany – systemowe rozwiązania i przegląd inwestycji w polskich gminach, http://psdz.pl/publikacje/ZIELONE%20DACHY%20I%20ZYJACE%20SCIANY%20-%20SYSTEMOWE%20ROZWIAZANIA%20I%20PRZEGLAD%20INWESTYCJI%20W%20POLSKICH%20GMINACH.pdf (access 14.01.2017).

Ziółkowski B., 2008, *Znaczenie ekoinnowacji dla rozwojuprzedsiębiorstw* [in:] A. Graczyk (ed.), *Zrównoważony rozwój w teorii ekonomii i w praktyce*, Wyd. Akademii Ekonomicznej we Wrocławiu, Wrocław.