COMMODITY SCIENCE IN RESEARCH AND PRACTICE

TOWARDS SUSTAINABLE DEVELOPMENT

EDITED BY WACLAW ADAMCZYK

COMMODITY SCIENCE IN RESEARCH AND PRACTICE

TOWARDS SUSTAINABLE DEVELOPMENT

Edited by Wacław Adamczyk

Polish Society of Commodity Science

International Society of Commodity Science and Technology

Faculty of Commodity Science Cracow University of Economics

Editor: Wacław Adamczyk

All published papers have been reviewed before publishing

Reviewers of Commodity Science in Research and Practice series:
Jadwiga Adamczyk, Wacław Adamczyk, Andrzej Chochół,
Agnieszka Cholewa-Wójcik, Joanna Dziadkowiec, Tadeusz Fijał, Dariusz Firszt,
Andrzej Gajewski, Marta Gollinger-Tarajko, Łukasz Jabłoński, Piotr Kafel,
Agnieszka Kawecka, Małgorzata Lisińska-Kuśnierz, Małgorzata Miśniakiewicz,
Paweł Nowicki, Stanisław Popek, Anna Prusak, Joanna Ptasińska-Marcinkiewicz,
Renata Salerno-Kochan, Grzegorz Suwała, Jerzy Szakiel, Jarosław Świda,
Paweł Turek

The monograph has not been amended or proofread and editor is not responsible for the language used by chapter's Authors (in chapters).

Suggested citation:
Author A., 2014, Title of the paper, in: W. Adamczyk (ed.) Commodity Science in Research and Practice – Towards sustainable development, Foundation of the Cracow University of Economics, Cracow, pp. xx-xx. ISBN: 978-83-62511-38-9

The book was financed with subsidies of Ministry of Science and High Education for maintaining the research capacity granted to the Cracow University of Economics

ISBN 978-83-62511-38-9 (printed version)
ISBN 978-83-62511-04-4 (html)

Year of publishing: 2014
Number of pages: 246

Publisher
Foundation of the Cracow University of Economics
Rakowicka 27, 31-510 Cracow, Poland

Contents

Foreword

The necessity of economic arrangement according to the sustainable development rules has been recognised by the international community yet in 1992 in the *United Nations Conference on Environment and Development* held in Rio de Janeiro. Despite of objections resulting from a lack of understanding of this idea as well as anxiety about limitations, sustainable development became one of the principal paradigms of modern economy. The progress in seeking for reducing adverse environmental impacts, especially under condition of dynamic civilisation development, is still insufficient, while creating and preserving the image of a resource wasting man (*homo profusus*) in quest for profits. Although no balance between production and consumption has not been achieved yet it should be noted that there are more and more actions undertaken to approach to ecological stability of economy, while maintaining the needs of present and future generations.

This monograph covers a wide spectrum of items related to sustainable development realising. The included papers cannot cover such comprehensive multidimensional and complicated issues. However, they indicate directions of actions undertaken towards sustainable development.

Wacław Adamczyk

THE INTERRELATIONSHIP BETWEEN SUSTAINABLE DEVELOPMENT AND CORPORATE SOCIAL RESPONSIBILITY

Jadwiga Adamczyk

Department of Economics and Organization of Enterprises,
Faculty of Management, Cracow University of Economics,
jadwiga.adamczyk@uek.krakow.pl

Introduction

In the literature and business practice a relationship appears between the concept of sustainable development and corporate social responsibility. This problem refers especially to the enterprise level.

The essence of sustainable development is to connect economic and social development with environmental protection by providing an access to resources, while maintaining the quality of life in a clean environment. Sustainable development should stimulate economic growth necessary for building social welfare, while considering a social good, fairness, safety consciousness and environmental quality as a social good. The concept of sustainable development was developed at the macroeconomic level, but is completed also on a microeconomic scale.

Sustainable development at enterprise level refers to its activity by balancing the economic, ecological and social goals. Sustainable development of an enterprise shall be thought as a process where environmental resources are transformed into economically and socially efficient products.

Corporate social responsibility can be interpreted as an undertaking to run the business in a transparent and ethical way according to the sustainable development rules, striving for social welfare, while considering the stakeholders' expectations in compliance with laws and standards of behaviour. Social responsibility as defined by the European Commission is the concept whereby companies voluntarily integrate social and environmental concerns in their business operations beyond common regulatory and conventional requirements (Green Paper, 2001, p. 28).

An analysis of relationships between the concept of sustainable development and corporate social responsibility is the aim of this considerations.

The management of a company in compliance with the rules of sustainable development includes the achievement of social, ecological and social objectives, while ensuring that the stakeholders' expectations are fulfilled. Therefore, sustainable development is possible by obeying the rules of social responsibility.

Origins and development of the idea of social responsibility

The origins of social responsibility have its roots in ethics. Ethics as a science has existed for centuries, while business ethics that deals with morally good behaviours emerged in the 20th century. Some periods can be distinguished in the historical development of the concept of corporate social responsibility (Łukasiewicz-Kamińska, 2011, p. 16-17).

The first of them is the end of the 19th century, when public criticism of corporations has arise in the United States. In response to this phenomenon the enterprises began to manifest the taking responsibility in fear of introduction of federal regulation (Etyka biznesu, 2001, p. 186-187).

The next period of increased interest in the idea of social responsibility was the great global crisis in the years 1929-1933. Public opinion assigned the responsibility for crisis to corporations being beyond control of the government. At that time a series of economic and social reforms was introduced in the United States, including the act regulating the rules of fair competition and a number of regulations related to employees. In 1943 the president of Johnson&Jonhson specified company responsibility to customers, employees and society as the condition of return from their investments for shareholders (Martin, 2010, p. 58-65).

The next period of the development of the concept of business responsibility were the 1960s and 1970s in connection with activity of transnational corporations in developing countries and attempts to impose unified operating rules on them. An aversion of corporations to obligatory and enforced regulations turned them to undertaking business responsible activities on a voluntary basis (e.g. Guidelines for International Investments).

In 1976 the organisation for Economic Cooperation and Development (OECD) prepared and adopted the Guidelines for multinational enterprises, recommending a transparent information policy in R&D activities as well as in fiscal, ecological, competition, employee and consumer rights policies. These guidelines were an attempt to point out the directions of actions with respect to legal requirements applicable in the countries where international corporations operate. The guidelines are updated due to changes occurring in the international markets (OECD Guidelines, 2000).

In 1977 the corporations governing enterprises in the RSA introduced the principles of social and economic justice. These principle known as "Global Sullivan Principles" recommend (The Sullivan Foundation):

- observance of universal human rights,
- promotion of equal opp. ortunity for employees,
- respect for employees' voluntary freedom of association,
- providing employees with fair remuneration and the opp. ortunity to improve their qualifications,
- human health and environmental protection,
- promoting fair competition,
- work with governments and communities in countries where the companies do business,
- observance of the principle of equal trade opp. ortunities,
- introduction of the transparency principle.

An essential change in business responsibilities was introduced by provisions developed at the conference of global business representatives called the "Caux Round Table" which was held in 1994. The result of this conference is the idea of extending responsibility applying it not only to shareholders but also to stakeholders, observance of laws in the countries where the enterprises do business and, like in the OECD Guidelines, observance of the principles of fair competition and environmental protection (Caux Round Table). Alongside the general directions also detailed principles were adopted to specify relationships between enterprises and customers, investors, owners, employees, suppliers, competitors and local community.

In 2000 on the initiative of United Nations Secretary General Kofi Annan the UN Global Compact program containing a catalogue of good practices based on nine general principles resulting from the Universal Declaration of Human Rights, the Declaration of Fundamental Principles and Rights at Work of the International Labour Organization and the AGENDY 21 recommendations (Agenda 21, 1992). An access of an enterprise to the consists in respecting the principles of social responsibility (Global Compact).

In 2000 the European Union in the Lisbon Strategy specified that the European economy should be based on knowledge and sustainable economic growth, provide more and better jobs and greater social cohesion. In July 2001 the European Council published the Green Paper on Corporate Social Responsibility in which the concept of social responsibility was defined as a recommendation for voluntary including the care of social and environmental items and interests of business partners and all involved parties (Green Paper, 2001).

According to the EU documentation social responsibility occurs when the following three principles are followed:

– making decision of including it,
– interactions with stakeholders,
– including CSR into enterprise's strategy.

Decision making means that each entity decides individually on whether and when it includes social responsibility into its business activity. Social responsibility should be undertaken as a voluntary instrument for implementing positive actions and dialog with stakeholders according to equal and clear principles. Social responsibility should be included into the enterprise's strategy, that it should be taken into account in the mission and strategic goals and followed in everyday practice.

In May 2002 the European Parliament adopted a resolution on promoting responsible business in the EU Member States. The next document published by the Commission is the White Paper on CSR regarding business responsibility (Biała Księga, 2003). It contains the four areas of the EU activity goals: economic growth based on knowledge and full employment (Konkurencyjność..., 2005).

The implementation of the social responsibility rules depends on enterprise's specificity as well as on its environment. It is possible to facilitate this process due to the standards containing guidelines for interpretation of universal principles and provisions of codes of good practices and legal regulations. Corporate social responsibility refers to many areas, thus any attempt of implementation has a diversified nature. This includes both the area of responsibility to employees and to expectations of other stakeholders, but also indirectly the system standards related to the quality and relations of the enterprise with its environment.

The concept of corporate social responsibility was supported by the European Parliament resolution of 13 March 2007, where the following was emphasized among other things:

– assuming more responsibility for social and environmental protection items by enterprises is one of the fundamental components of the European sustainable development strategy,
– the need to expand enterprise activity onto new life areas such as permanent education, equal opp. ortunities, social cohesion,
– the relationship between social responsibility (including activities for eliminating inequalities, fair remuneration policy) and enterprise competitiveness.

Alongside the general directions of actions the OECD principles specifying in detail the enterprise's relations with customers, investors, owners, employees, suppliers, competitors and local community were also adopted.

The guideline principles create the criteria of corporate social responsibility measurement and assessment in rating systems (OECD Guidelines, 2000).

Genesis and essence of sustainable development

The origins of sustainable development come down from environmental protection. The concept of sustainable development was born in the early 1970s. On the one hand some problems with environmental contamination and deterioration occurred, while economic development was depended on availability of raw material resource. The economic pressure on the environment caused significant degradation and simultaneously reduced the availability of natural resources necessary for economic growth.

The report of U'Thant, UN Secretary General, announced in 1969 and entitled "Human and Environment" paid attention to the necessity to solve environmental problems. In turn the report of the Club of Rome indicated the danger resulting from depletion of natural resources.

The global nature of ecological hazards was appreciated by the international community by submitting the environmental protection problems at the UN Forum. In 1983 the United Nations set up the World Commission on Environment and Development under direction of G. Brundtland. In 1987 this Commission in the report entitled "Our common future" commonly known as the Brundtland Report, indicated for the first time that sustainable development is a way of harmonised development of communities without limiting for future generations the opp. ortunities to meet their development needs (Adamczyk, Nitkiewicz, 2007, p. 24-27).

As the result of discussions on the report the II Conference of the United Nations so called the "Earth Summit" was organised in Rio de Janeiro in 1992 where the sustainable development guidelines were unified. The two important documents were then adopted: Declaration on Environment and Development and the plan of so called Agenda 21. In 2002 during the Johanesburg Earth Summit the detailed plan of the implementation of Agenda 21 was agreed and some steps were taken to transform the ideas and principles of sustainable development in practice. In 2012 at the UN conference (Rio+20) the process of sustainable development implementation was assessed and appropriate further actions in this area were accepted.

During the "Earth Summit" the declaration specifying the rights and obligations related to sustainable development was formulated and a set of

more than 2,500 recommendations for sustainable development actions on a worldwide scale (Agenda 21) was indicated. The principles adopted then are developed in the areas covered by the concepts of sustainable development and social responsibility (e.g. environmental protection, human rights, participation of society in deciding on economic development).

The Agenda 21 recommendations became the basis for developing many programmes and guidelines related to sustainable development and social responsibility (e.g. OECD guidelines, Global Compact programme or GRI guidelines).

Sustainable development is that social and economic development in which political, economic and social activities are integrated with the maintenance of natural balance and durability of basic natural processes to guarantee an opp. ortunity for particular communities or citizens of the present and future generations to meet their fundamental needs (Prawo ochrony środowiska, 2008).

Sustainable development at an enterprise level applies to its functioning by integrating economic, ecological and social goals. It is based on the process of effective manufacturing of socially desired products and services, while limiting the use of natural resources and observing environmental protection and fulfilling the stakeholder's expectations. At the same time according to the concept of sustainable development an environmental interference is allowable (even a disturbance of its values) due to economic growth, that is due to business activity. Thus one may assume that in sustainable development the economic growth, i.e. achievement of economic targets by enterprises is strongly emphasized.

Enterprise governance according to the rules of sustainable development takes into account the interests of employees, local community as well as other groups interested in its activity and therefore is connected with social responsibility.

This is the concept of running business activity by building transparent, long-term and permanent relations with all groups directly or indirectly interested in enterprise functioning (Adamczyk, 2009, p. 89-96). Corporate social responsibility means on the one hand the necessity to take the consequences of undertaken actions and on the other hand to respond to the needs of specified people, social organisations and entities creating the enterprise environment. This includes all voluntary enterprise actions targeted at solving socially important problems (e.g. preservation of environmental values and quality of life, preventing unemployment, participation in cultural development, welfare).

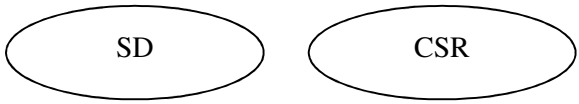
Bonding sustainable development with social responsibility

Both in theory and practice sustainable development and social responsibility are considered as separate, equivalent or correlated concepts (Fig. 1).

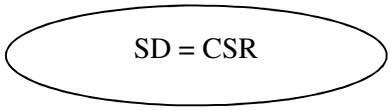
Sustainable development and corporate social responsibility were established as two independent concepts. However, in the development of social responsibility, especially in later standards and guidelines many principles and guidelines of sustainable development were used in CSR.

Despite of different origins of sustainable development and social responsibility, these two concepts are interrelated. These concepts are often exchangeable in publications. However, the use of "social responsibility" instead of sustainable development is unjustified.

a) independent concepts



b) synonymous concepts



c) interdependent concepts

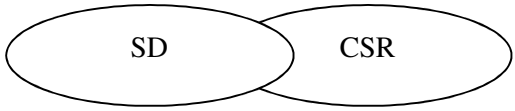


Figure 1. Relationship between of Sustainable Development and Corporate Social Responsibility

Source: Author.

However, the use of guidelines and standards from one of this areas in another one is permissible. This is most clearly visible in practice, as many enterprises when preparing sustainable development reports submit them to various social responsibility rankings.

The basic areas of sustainable development according to the GRI guidelines and social responsibility according to the Global Compact programme and ISO 26000 are presented in Table 1. There are guidelines and recommendations most often used in implementation and social assessment of corporate social responsibility.

Table 1. Areas of sustainable development and corporate social responsibility

Guidelines and standards	**Areas**
GRI guidelines	Economic results Environmental results Social results – employment related – human rights related – society related – product responsibility related
Global Compact programme	Human rights Labour standards Environment Corruption
Standard ISO 26000	Corporate order Human rights Labour process practices Environmental impacts Good practices to suppliers, competitors Consumer issues Community involvement

Source: own research based on Global Reporting Initiative 2006, Global Compact. ISO 26000, 2010.

The sustainability guidelines Global Reporting Initiative (GRI) belong to the basic CSR reporting systems. GRI established in 1997 as an joined project of the three organizations: the Coalition for Environmentally Responsible Economies, Tellus Institute and United Nations Environmental Protection Program. Currently, GRI is an independent organization with its seat in Amsterdam. The first GRI guidelines were issued in 2000, and in 2006 their third edition, so called G3, was published. In 2011 the work was commenced on the fourth integrated version G4. The main assumption of the GRI guidelines is transparency in economic, social and environmental effects as a fundamental component of effective relations with stakeholders, investment decisions and other market behaviours (Global Reporting Initiative, 2006).

The aim of the GRI guidelines is to measure, reveal economic, social and ecological results and report them to stakeholders. Sustainability reporting is sometimes used interchangeably with social responsibility reporting. This results from an interrelation between these concepts, since undertaking social responsibility by enterprises redounds to sustainable development.

GRI developed the basic reporting rules that specify the way how information related to sustainable development is presented. There are three types of normalized presentation of information related to:

- organizational strategy and profile (look at the idea of sustainable development from the perspective of the strategy being adopted),
- approach to management (enterprise's approach to economic, social and environmental results),
- performance indicators (seventy nine indicators have been proposed for assessing an enterprise for performance in achieving sustainable development).

The aim of the GRI guidelines is to establish a general commonly accepted framework for reporting the economic, social and environmental aspects of operation of any organization or sector of any size and location. The GRI guidelines contain no methods for computing individual indicators, but only variables to be measured are indicated. The following examples of indicators can be given (Oswald 2009, p. 110):

- Economic indicators, e.g. income, operating costs, employee remuneration, donations and other benefits to the community, retained profits, payments to capital owners and governmental institutions,
- Environmental indicators, e.g.: percentage of materials from recycling,
- Social indicators related to:
    A. Employment – e.g. supervisory board structure and workforce breakdown by gender, age etc.,
    B. Human rights – e.g. number of hours designed for employee training in human rights and percentage of trained employees,
    C. Society – e.g. percentage and number of business entities subject to analysis for corruption,
    D. Product responsibility – e.g. programs related to observance of laws, standards and marketing communication codes, advertising, promotion and sponsoring.

Before the report is completed and published, organizations should declare the level of application of the GRI framework rules. This allows evaluation of the extent to which the GRI guidelines and framework rules are considered in the report. The application levels are denoted by letters (C, B and A) according to increasing degree of application of GRI rules.

The main assumption of the GRI guidelines is transparency in economic, social and environmental effects as a fundamental component of effective relations with stakeholders, investment decisions and other market behaviours.

The Global Compact program provides the key rules that when are followed indicate corporate social responsibility (Table 2). The rules are adopted on a voluntary basis and its general nature does not allow an univocal assessment of the adopted responsibility level. If an enterprise fails to submit a report and does not explain a reason of such failure, then is voluntary joint to the program is cancelled.

Table 2. Basic social responsibility rules

Global Compact rules
Human rights 1. Supporting and obeying human rights adopted by the international community 2. The elimination of any cases of human rights breaches by the enterprise
Labour standards 3. Respect to freedom of association 4. The elimination of all forms of forced and compulsory labour 5. The abolition of child labour 6. The elimination of discrimination in respect of employment
Environment 7. Pre-cautionary approach to environmental protection 8. Promoting greater environmental responsibility 9. The use and development of environmentally friendly technologies
Corruption 10. Working against corruption in all its forms, including extortion and bribery.

Source: Global Compact.

The latest standard ISO 26000 (Table 3) has a higher operationalization level. According to ISO 26000 means responsibility for decision making and conducting the actions having an influence on society and environment and carried out by transparent and ethical behaviour in compliance with sustainable development and social welfare, while fulfilling stakeholders' expectations, and in accordance with laws and international codes of conduct (ISO 26000, 2010). ISO 26000 is a comprehensive standard but its general approach indicates the seven CSR areas.

The ISO 26000 standard was developed to achieve an international agreement of all CSR interested environments on (ISO 26000, 2010):

– social responsibility definitions and rules,
– identification of core subjects and issues of social responsibility,
– guidelines for including social responsibility into operational strategy of an organisation.

ISO 26000 is not subject to certification, but its purpose is to facilitate undertaking the actions within the scope of social responsibility. Multi-dimensional nature of the standard is connected with international norms related to human rights, social responsibility, environmental protection and countering corruption. The overarching objective of social responsibility recommendations contained in the standard is the action for sustainable development and social welfare.

Table 3. CSR areas and assessment criteria according to ISO 26000

Areas	**Criteria**
1. Governance	Implementation of management systems, structure and processes
2. Human rights	Respect for human right to life, liberty, labour, education, health etc.
3. Labour practices	Practices used at workplaces – working conditions, safety, employee development
4. The environment	Environmental impact – preventing contamination, reducing raw material use and energy consumption, climate change mitigation
5. Business practices	Good practices in relations with partners, suppliers, governmental agencies, competition
6. Consumer issues	Fair approach to consumers in providing products and services, marketing, information and contractual practices and safety
7.Societal engagement	Initiatives for the benefit of society and local community – education, development of employees and local community, social investment, wealth creation

Source: own research based on ISO 26000, 2010.

The following core subjects of CSR were indicated: relationship between social responsibility and organisational governance (organisational order), human rights, labour relations, environment, good practice in contacts with governmental agencies, business partners, suppliers, competitors, fair approach to consumers, social involvement and community development.

ISO 26000 encourages organizations to exercise CSR to a broader extent than legal norms by developing general interrelated principles that should be used consequently in policy, business activity and decision making. There are following principles:

1) law observance,
2) respect for international directives, declarations, resolutions, conventions and agreements,
3) identification of stakeholders' expectations,
4) responsibility,
5) transparency,
6) respect for fundamental human rights,
7) respect for diversity.

An attempt to bond corporate social responsibility with achievement of sustainable development is contained in ISO 26000. The aim of this standard is, among other things, to support various organizations in achieving sustainable development. ISO 26000 refers social responsibility to sustainable development to large extent and almost all seven chapters contain direct or indirect references to this concept. This is manifested at the level of definitions, principles, genesis and key social responsibility components. However, the lack of target operationalization does not allow the level of balancing the economic, ecological and social objectives to be determined univocally.

Conclusions

When comparing the GRI sustainability reporting guidelines with the Global Compact program and the ISO 26000 Guide one may conclude that the subjects related to human rights, society, labour practices as well in contacts with suppliers, competitors, customers and social involvement are taken into account to a comparable extent. However, environmental impact of a company, although is present in all of guidelines mentioned above, has the largest and most detailed extent in GRI. This undoubtedly results from establishing the concept of sustainable development as a countermeasure against worsening environmental quality and an expression of care for environmental protection. It should be emphasized that a great importance is assigned to economic achievements in the GRI guidelines, while these issues are omitted in other CSR standards. Therefore, it is possible to claim that the concept of sustainable development pays special attention to balancing economic, ecological and social objectives. Such approach is reasonable, because economic development is necessary for providing the quality of life.

An attempt to demonstrate interrelationships between sustainable development and corporate social responsibility is made in ISO 26000.

Social responsibility is defined as responsibility for consequences of decisions and actions having an effect on society and environment by using transparent and ethical behaviours that:

- contribute to sustainable development, including health care and social welfare,
- take into account expectations of interested parties,
- are consistent with applicable laws and international conduct norms,
- apply to the whole organization and its relations with other subjects (stakeholders).

It is stated in ISO 26000 that social responsibility and sustainable development are concepts close to each other and their interrelations occur in each of the seven areas. However, no relationship was found at the enterprise level, and quite contrary it was cited that sustainable development applies to society as a whole. This does not fit to economic practice where many enterprises formulate and implement the strategy of sustainable development.

In addition, the lack of proposed measures for assessing the actions undertaken in the mentioned areas of social responsibility gives enterprises a freedom in interpretation. Moreover, certification of declared CSR rule implementation levels is not required and therefore they might be used only for promoting enterprises. For these concerns the GRI guidelines for sustainable development are more credible, as they require the results to be measured according to measurable criteria and GRI approval. However, when considering the fact that ISO 26000 is the newest guide for corporate social responsibility implementation and assessment, there is hope that further research will be undertaken to certify enterprise achievements for enhanced reliability.

References

Adamczyk J., 2009, Społeczna odpowiedzialność przedsiębiorstw. Teoria i praktyka, PWE, Warszawa, (in Polish).

Adamczyk J., Nitkiewicz T., 2007, Programowanie zrównoważonego rozwoju przedsiębiorstw, PWE Warszawa, (in Polish).

Agenda 21, 1992, UN Conference on Environment and Development.

Biała Księga, 2003, część VI. Nowy model społeczny, praca zbiorowa pod red. I. Białeckiego, Z. Czepulis-Rutkowskiej, U. Sztanderskiej, I. Wójcickiej, Polskie Forum Strategii Lizbońskiej, Gdańsk-Warszawa, (in Polish).

Caux Round Table, http://www.cauxroundTable.org

Etyka biznesu w działaniu, 2001, praca zbiorowa pod red. W. Gasparskiego i J. Dietla, PWN Warszawa, (in Polish).

Global Compact, http://www.unglobalcompact.org.pl

Global Reporting Initiative, 2006, Sustainability Reporting Guidelines.

Green Paper, http://ec.europa.eu/employment_social/soc-dial/csr/greenpaper.htm.

ISO 26000, 2010, Guidance for Social Responsibility, International Organization for Standardization.

Konkurencyjność przedsiębiorstw w świetle Strategii Lizbońskiej, 2005, J. Bieliński (red.), CeDeWu, Warszawa, (in Polish).

Łukasiewicz-Kamińska A., 2011, Społeczna odpowiedzialność przedsiębiorstwa finansowego, Difin, Warszawa, (in Polish).

Martin R., 2010, The Age of Customer Capitalism, Harvard Busienss Review.

OECD Guidelines for international enterprises. Polish edition, Ministry of Economy, Warsaw.

Oswald D., 2009, Koncepcja odpowiedzialności biznesu w rachunkowości, [in:] Odpowiedzialność biznesu. Teoria i praktyka, N. C. Smith and G. Lenssen (red.), Wyd. Studio EMKA, Warszawa, (in Polish).

Prawo ochrony środowiska, 2008, Ustawa z dnia 27 kwietnia 2001 r. wraz ze zmianami (Dz. U. 2008, Nr 25, poz. 150).

The Sullivan Foundation, http://www.thesulivanfoundation.org.

GREEN PUBLIC PROCUREMENT IN STIMULATION OF THE SUSTAINABLE CONSUMPTION AND PRODUCTION PROCESS

Wacław Adamczyk

Department of Technology and Ecology of Products,
Faculty of Commodity Science, Cracow University of Economics,
waclaw.adamczyk@uek.krakow.pl

Introduction

The realization of the concept of sustainable development by sustainable production and consumption is reflected in Green Public Procurement. The present shape of the concept of sustainable development assumes an equilibrium between components of the triad of spheres: economic, ecological and social. In practice, the concept of sustainable development is realized by member states at various levels of social and economic development, thus at various levels of organizational culture and structure, and requires an uneven emphasis distribution. This is supported by the results of studies carried out at the Institute for App. lied Ecology in Frieburg, Germany, indicating differences in the results of substitution of conventional products by eco products developed in various countries (Dross et al., 2007).

The EU intensified activities related to sustainable development led to restoration of the Lisbon Strategy as well as the European Union Sustainable Development Strategy (Michnowski, 2008, p. 89). The modernization of these strategies was aimed at mitigation of discrepancies inherent to primordial assumptions of Sustainable Development and continuous improvement of quality of life for current and future generations, while observing environmental protection rules. The sustainable development strategy renewed by the EU assumes propagation of dynamic economy, while providing full employment and high education level for citizens as well health care, social and territorial cohesion, world peace, safety and respect for cultural diversity. The main direction adopted to achieve this goal is the sustainable production and consumption.

Consumption processes are embedded in lifestyles. The term “life style” is widely used in environmental and sustainability contexts. For sustainability, scientists and practitioners underline the need for changing our life style.

Environmental sociologists and psychologists have often looked at proenvironmental attitudes and behavior changes at the micro level of individuals and households. At the macro level of society as a whole lifestyle refers to typical behaviors and mentalities influenced by the network of social interaction and average living conditions e.g. technological infrastructures (Reusswig et al., 2004 and Uusitalo, 1996). At this level a significant role to fulfill green public procurement.

EU action plans for the sustainable production and consumption

The desire to achieve the sustainable production and consumption is presented in the Europe 2020 strategy where three priority areas are indicated (COM 2010):

- smart growth consisting in economic growth based on knowledge and innovations,
- sustainable growth achieved by a more competitive low-carbon economy that makes efficient use of resources,
- inclusive growth creating the conditions for social inclusion by rising employment rate and providing economic, social and territorial cohesion.

The progress in achieving this strategy by the EU Member States by 2020 will be assessed according to five criteria in the form of measurable main five objectives:

- ensuring employment rate at 75%,
- increasing investments into research and development up to 3% of GDP; an indicator of R&D activity and innovations will be developed by the European Commission,
- limiting greenhouse gas emissions by 20%; further reduction depends on the decision of non-EU countries, including developing ones,
- increasing education level up to 40% of 36-40-olds completing tertiary education,
- supporting social inclusion by activities for ensuring 20 million fewer citizens are in poverty.

To achieve the main objectives of the Strategy, that are highly interrelated, it is required to fulfill the guidelines set by the European Commission:

- To ensure the quality and stability of public finances.
- To solve the problem of macroeconomic inequality.
- To decrease the Eurozone income inequality.

- To optimize support for research and develop innovations, strengthen the knowledge triangle and release the potential of digital economy.
- To promote more effective use of resources and limiting greenhouse gas emissions.
- To improve both business and customer environments and modernization of industrial base for fully functioning internal market.
- To increase employment, reduce structural unemployment and promote employment quality.
- To develop qualified workforce resources fulfilling labor market needs and promote permanent education.
- To improve quality and efficiency of education and training systems at all levels and to increase the number of tertiary students.
- To promote social inclusion and poverty reduction.

Some of guidelines mentioned above are difficult to be achieved and generate contradictory effects, when considering that they are to be achieved together. This applies to employment growth, industrial development, thus also production growth, while implementing restrictive emission reductions and planned actions for sustainable consumption. It is difficult to claim whether R&D activities and eco-innovations are sufficient for balancing adverse effects that could accompany achieving this strategy or not (Adamczyk, 2012). These guidelines are, among other things, a basis for the EU Member States for developing National Action Plans (NAPs) on ecologization of public procurement as recommended by the European Commission in 2003 (GPPNAPs, 2013). As of the end of December 2013, from among 28 EU Member States only 6 (Croatia, Estonia, Greece, Hungary, Luxemburg, Romania) did not submit their own NAPs.

Positive effects related to the propagation of Green Public Procurement refer to political, social, economic and environmental aspects (Fig. 1).

Within environmental area GPP play an important role in sustainable forestry and agriculture, reducing greenhouse gas emissions, rationalizing water consumption, improving energy efficiency of machinery and equipment, reducing emissions of harmful substances and limiting the amount of generated wastes.

GPP affects the market, providing the society an example of ecologization of purchasing and related advantageous effects. In consequence it has an influence on the growth of ecological awareness by propagating knowledge of ecological products, changing consumer purchasing preferences and life style, and encourages for ecologization of procurements at private companies.

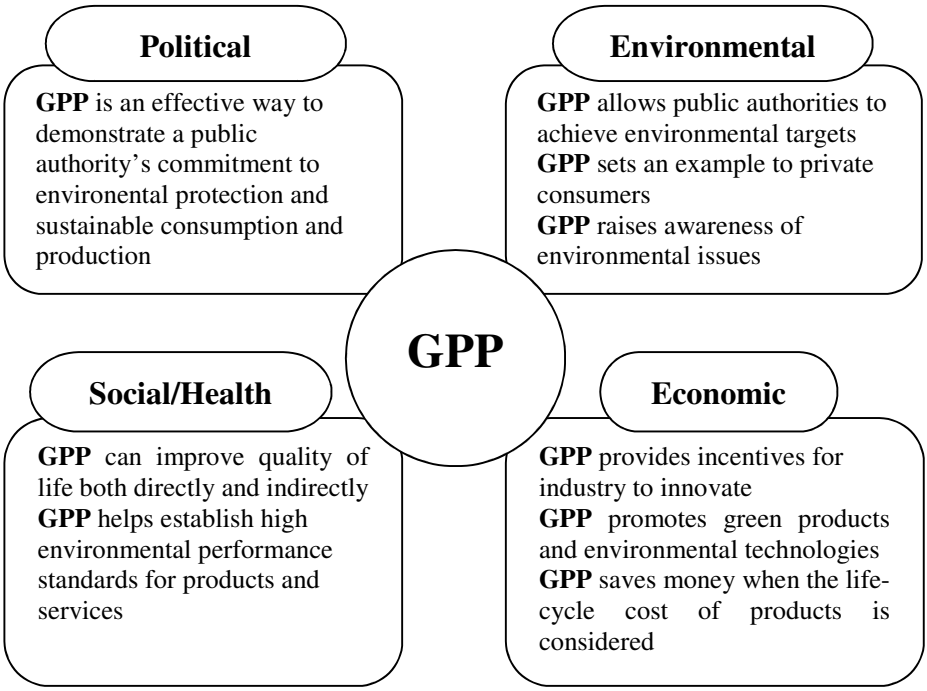


Figure 1. Benefits of Green Public Procurements

Source: Green Public Procurements Brochure 2010.

As regards to social benefits, achieving GPP purposes improves the quality of life, while having an advantageous effect, among other things, on transportation and work environment. The implementation of environmental requirements through GPP enhances the quality of products and services that become more popular among customers.

Within the economic area, GPP brings resource and monetary savings, especially due to comprehensiveness of life cycle thinking and the use of life cycle costing. GPPs are also eco-innovation stimulators. They stimulate also eco-technology competitiveness, thus leading to price reduction.

The government commitment in GPP, thus also in environmental protection and actions for the sustainable production and consumption being priorities resulting both from the country environmental policy and the EU, has a positive image of the governmental administration in their country and within the UE.

The role of GPP in shaping the sustainable production and consumption

Green Public Procurement plays a more and more important role in the desire for sustainable production and consumption. The European Commission develops and updates Green Public Procurement criteria within selected priority product groups, by recommending member states to use these criteria when specifying public procurements. So far 24 product groups were considered as priority groups due to its environmental impact and share in public procurement total value.

They include:

- plumbing fixtures,
- office IT equipment,
- construction,
- office buildings,
- electricity,
- waste water infrastructure,
- thermal insulation,
- furniture,
- windows,
- street lighting and traffic signals,
- indoor lighting,
- copying and graphic paper,
- wall panels,
- gardening products and services,
- combine heat and power,
- heating systems,
- cleaning products and services,
- mobile phones,
- toilets,
- transport,
- hard floor-coverings,
- textiles,
- food and catering services.

For procurement specification it is necessary to know ecological properties defined according to criteria included into product data sheet (GPP product criteria, 2014).

GPP criteria are developed based on the data from an evidence base, while using also eco-labeling criteria and information gathered from the industry, society and EU member states. The leading rule in data creation and interpretation is Life Cycle Thinking.

Green Public Procurement criteria include for each sector:

– basic criteria that may be commonly used by the purchasing institutions from all UE states, while considering major environmental impacts and its verification and costs are reduced to a minimum,
– comprehensive criteria used when purchasing the best ecological products available on the market may require an additional verification or a minute cost increase compared to products of the same functionality.

In addition, international, national and regional institutions have developed their own criteria for various product groups, sometimes close to those of the EU criteria.

The following criteria are most commonly used in GPP:

– energy saving,
– share of renewable, recycled and substituted raw materials,
– low emissivity, technical specifications may specify the kind of substance and allowable emission level,
– low level of generated wastes, sometimes with recycling requirements,
– specification of contractor environmental performance,
– completeness of technological solutions.

Ecological requirements are introduced into description of the subject of procurement by formulating technical specifications while considering eco-labeling and contractor's qualifications, environmental management means and standards and observing procurement getting and processing in compliance with the European Community legislation (Directive 2004/18/EC). The perception of product ecological features is facilitated by the eco-labeling system, although product groups covered by eco-labeling do not coincide with the GPP priority group. The use of advanced LCA and LCC techniques in the decision making process was also foreseen. The use of these techniques provides a real estimation of procurement costs throughout the life cycle that are usually higher than the offered price. The true operating costs are very often affected by costs related to the possibility and frequency of servicing, repairs, availability and prices of spare and complementary parts. The costs of product operating and waste management practically decide that ecological variant is more effective in the whole life cycle. As follows from the above, the price criterion without any reference to life cycle costs does not reflect the real price of the product. This is why the establishing and use of contact networks aimed at exchange of experiences from product use, bid procedures and spreading GPP good practices is of such high importance.

The value of public procurement market in the EU is approximately 2 bilion € annually, corresponding to 19% GDP of the European Community (What is GPP, 2014). Thus the use of GPP, thus also the value of bids proceeded in this mode is rising consecutively. The target share of GPP in public procurements within the EU member states should reach 75% by 2020 at central level and 50% at self-government level. In the future the rule of 100% GPP share within the priority goods as well as construction services and works should be used. This means that all purchases within these groups made by public institutions should fulfill the GPP criteria. In the years 2014 – 2020 GPPs will be integrated with the Structural Funds and Cohesion Funds, thus guaranteeing co-financing (EU GPP Public Consultation, 2012). This condition will not be extended into other financing sources such as LIFE+, CIP etc. (LIFE+, 2007). Although the use of GPP is voluntarily, the implementation of its rules creates an overall climate. The situation looks slightly different in the private sector, where so much depend on the level of environmental awareness like as in individual consumption, where the price criterion as quality synonym still predominates. The public-private partnership is a factor stimulating the private sector towards green procurements.

As indicated by researches carried out by the European Study Center on a sample of 850 public respondents from 26 EU Member States, the GPP share was 26%. The highest GPP level was reached in Belgium, Denmark, the Netherlands and Sweden where in 40 - 60% of cases all environmental criteria were used. However, in twelve EU member States, for example in Bulgaria, Estonia, Greece, Ireland, Poland and Portugal the use of environmental criteria was below 20% (Fig. 2).

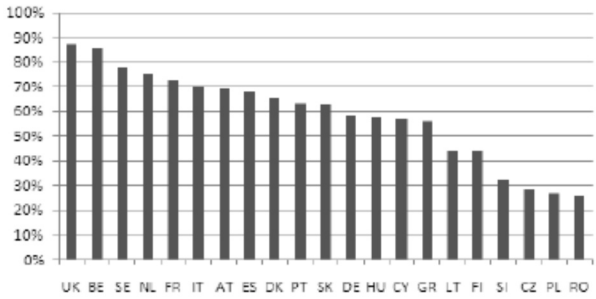


Figure 2. The level of considering any environmental criteria in the last GPP bid procedures in the EU Member States (studies completed on the EU order in 2012)

Source: Domestic Action Plan for sustainable public procurements for the years 2013-2016.

Poland reached 20th place in the ranking among EU Member States, where environmental criteria were applied. Any chosen environmental criterion in recent GPP was used by 28% of Polish public respondents (Krajowy Plan Działań, 2013). Also detailed studies indicate the GPP level in Poland is below the EU average. More than half of 29 respondents revealed an incidental nature of considering ecological criteria in public procurements and that up to 36% of respondents do not use environmental criteria.

Barriers to Eco-Innovations and Green Public Procurement – Developing preventive actions

When considering a significant role of GPP in shaping the sustainable production and consumption, its share in public procurements should be considered as unsatisfied both in Poland and in the EU, in general.

The introduction of environmental criteria into the bid processes has a positive effect on development of eco-innovations, which however may be a strengthened barrier to common use of GPP. Financial support oriented to eco-innovations indicates a diversified interest among potential beneficiaries.

This is caused, among other things, by the following:

- lack of effective ecological education and awareness,
- lack of highly qualified staff,
- legal and administrative barriers,
- high costs of eco-innovation solutions,
- high investment risk,
- lack of own financial contribution,
- lack of good practices related to eco-innovations.

Also conditions directly connected with GPP practices decide on the occurrence of difficulties in its common use. Beside exchange of good practices and information between public institutions at various level, insufficient knowledge of benefits resulting from ecological products should be emphasized. Also changeable and unclear public procurement laws create an atmosphere of uncertainty as to use of environmental criteria in requirement specifications. The barrier is also lack of knowledge on practical use of the LCA and LCC methods.

Beside institutional support and educational sphere also the incentive system for purchasing ecological products proposed by the EU plays an important role. The member states will exert an influence on consumers and producers to stimulate the sustainable production and consumption policy. An example of such proposal, are introduction of tax abatements and euro checks proportional to a product environmental quality measured by its

environmental impact. This will lead to "monetization" of environmental impact for a specified product life cycle as presented in (Clean Vehicle Directive, 2009; European strategy, COM 2010, 186). This incentive corresponds then the money value enabling adverse environmental impacts to be prevented. Other examples of diversified VAT rates depending on environmental impact, that is possible in the context of tax system reforms in the EU Member States as well as awards, e.g. EU Economic Award for best products granted based on an assessment of the degree of sustainability, eco-innovativeness and attractiveness. This allows to increase the demand for products of better ecological characteristics in chosen categories which have a significant environmental impact during its whole life cycle and for which ecological marking exists. Within this area the study of economization of behaviors allow to know mechanisms of relations between product environmental impacts and arising imperative to obey new social environmental standards. This requires coordinated cooperation of the EU Member State governments with self-government institutions, science sphere, industrial sector and media. Media and educational activity perform a significant role. For this purpose the member states are encouraged to introduce into education systems the subjects, methods and materials promoting sustainable consumption. The aim is to get awareness that welfare does not mean an excess of goods. Also national, regional and local initiatives for sustainable life style, in particular through financial programs, structural and cohesion funds, will be supported.

Conclusions

The problem is not undertaking ecological challenges being more and more complex global issue. The product price does not reflect losses related to its life cycle and costs borne to liquidate these losses are detached from the product. These costs are not borne by the manufacturer but become social costs. This leads to accumulation of environmental losses and related dangers. Undertaking production by using energy-saving materials and methods require higher expenditures carried onto the product price. Thus, a customer chooses a product of lower price but higher life cycle costs. At present ecological products are more expensive, but the crisis situation favors gradual abandoning subsidies as in the case of bio-fuels in Spain. Economic entities have no information on environmental benefits and business opp. ortunities. The solution is implementation of obligatory product pricing by considering costs related to adverse environmental impact during the whole life cycle, estimated by using the LCA and LCC methodology or an obligation to inform in detail about life cycle costs.

The actions undertaken by the EU as well as local initiatives of member states bring a noticeable improvement in GPP propagation. However, there is

still lack of imperative to undertake pro-environmental initiatives, GPP is used on a voluntary basis only and fulfilling NAP assumptions is difficult. Also unclear energetic situation in Europe is of great importance for implementation of eco-innovations and GPP.

References

Adamczyk W., 2012, Współczesne problemy zrównoważonej produkcji i zrównoważonej konsumpcji, [in:] Zarządzanie i Finanse, praca zbiorowa pod red. M. Wiśniewskiej, Vol. 10, no. 3, part 2, Gdańsk, p. 177 - 191, (in Polish).

CleanVehicle Directive, 2009; 33/EC.

COM (2010), Europa 2020, Strategia na rzecz inteligentnego i zrównoważonego rozwoju sprzyjającego włączeniu społecznemu, (in Polish).

COM (2008) 400; Public procurement for a better environment.

Dross.M. et al., 2007, Costs and benefits of Green Public Procurement in Europe, Ed. by Institute for App. lied Ecology, Freiburg.

Dyrektywa 2004/18/WE, Parlamentu Europejskiego i Rady w sprawie koordynacji procedur udzielania zamówień publicznych na roboty budowlane, dostawy i usługi, (in Polish).

EU Green Public Procurement, Public Consultations on Future GPP Policies (2012), 2/4/2012, http://ec.europa.eu

European strategy for clean and energy efficient vehicels, COM 2010, 186.

Green Public Procurement National Action Plans 2013, http://ec.europa.eu/environment/gpp. /action_plan_en.htm.

GPP product criteria, 2014, http://ec.europa.eu/environment/gpp. /pdf/.

Krajowy Plan Działań w zakresie zrównoważonych zamówień publicznych na lata 2013-2016, (2013),Urząd Zamówień Publicznych, Warszawa.(in Polish)

Reusswig F. et al., 2004,Lebensstile und globaler Energieverbrauch. Analyse und Strategieansatze zu einer nachhagtigen Energiestructur. Potsdam Institute for Climate Impact Research, PIK Report No 90.

LIFE+, Instrument finansowy na rzecz ochrony środowiska, 2007, Rozporządzenie WE no. 614/2007, (in Polish).

Michniowski L., 2008, Odnowiona Strategia Trwałego Rozwoju Unii Europejskiej, Problemy Ekorozwoju, Vol. 3, No 2, (in Polish).

Uusitalo L., 1986, Environmental impacts of consumption patterns. Gower, Aldershot.

What is GPP, 2014, http://ec.europa.eu/environment/gpp. /what_en.htm.

THE EUROPEAN ECOLABEL FOR TOURIST ACCOMMODATION IN ITALY: AN EXPLORATORY STUDY

Barbara Campisi[*], Caterina Castiglione[**], Paola Masotti[***]

[*]*Department of Economics, Business, Mathematics and Statistics, University of Trieste,*
barbara.campisi@deams.units.it
[**]*University of Trieste*
[***]*Department of Economics and Management, University of Trento*

Introduction

Environmental quality has been now more and more considered a strong point for the tourist attractiveness of an area; that's why public administrations and companies operating in the tourism sector are increasingly integrating environmental aspects in their policies and in their business logic (United Nations World Tourism Organization, 2002) . It is clear that the environmental quality and natural resource protection are necessary to maintain the competitive advantage of a tourist site, and this explains the interest of public authorities and industry to promote and adopt virtuous systemic approaches, designed to stimulate continuous improvement of environmental performances (Buckley, 2002). Systemic approaches, structured on the basis of voluntary environmental standards such as ISO 14001, the EMAS Regulation and eco-label certifications of products and services, that, once verified by third-party entities (verifiers or certifiers), communicate to the stakeholders the commitment and achievements for environmental management, bearing the recognition (certificate or label).

Amongst the voluntary initiatives involving the development of environmental labelling standards based on life cycle considerations. These third party ecolabelling schemes were firstly introduced by national standards, such as the German Blue Angel and the Nordic Swan. Only in 1992 an European Regulation was issued to introduce the so-called "EU Ecolabel", on which this paper is focused on, lastly revised in 2009 (The European Parliament and the Council of European Community, 2010). The EU Ecolabel scheme is part of the sustainable consumption and production policy of the

European Community, and it is aimed at reducing the negative impact of consumption and production on the environment, health, climate and natural resources through the promotion of the use of the EU Ecolabel logo (the Flower) for environmentally sound and high performance products. Currently, the European scheme covers 33 product groups (European Commission, 2014), including tourist accommodation and camp services and according to the statistics the European Flower is in full bloom. Between 2000 and 2010 the number of licenses was multiplied by a factor of more than 20, and this result was due to the tourism accommodation service sector particularly, where the number of licenses are still increasing rapidly (Eurostat, 2011). Thanks to a lot of promotion and communication initiatives carried out at a regional level, Italy is the country with the major percentage of Ecolabel holders (31% of the European total number) and the greatest number of holders in the tourist accommodation product group (Institute for Environmental Protection and Research, 2009). Given the role played by the tourist sector in the diffusion of the EU Ecolabel in Italy, this paper is addresses the perception issue about the advantages driven by the award of the Community eco-label to tourist accommodation service and the main difficulties encountered by the Italian applicants. After having evaluated the participation experience in the EU Ecolabel scheme in a specific context of tourist infrastructure – the mountain huts – in a previous paper (Campisi, Marinatto & Bogoni), here the analysis was referred to all the tourist accommodation services.

Materials and methods

This exploratory study was based on the analysis of data results obtained through the submission of an online survey entitled "EU Ecolabel for Tourism Accommodation Service". This survey was based on a semi-structured questionnaire involving 1 open question for the geographical identification of the respondent, 10 semi-closed questions, 21 closed questions and a final open section to give the respondents a chance to voice comments additionally. The questionnaire design was intended to gather a mix of qualitative and quantitative information about the perception of the experience, the benefits and difficulties related to the EU Ecolabel, along with practices adopted for the environmental management and external communication. The invitation to participate to the survey was sent by email to all the EU Ecolabel awarded tourist accommodation services in Italy. For their identification was used the National Register updated by the Institute for Environmental Protection and Research (ISPRA) for the Italian Competent Body 'Comitato Ecolabel-Ecoaudit' and available on the ISPRA website (http://www.isprambiente.gov.it/). All the respondents who took the "EU Ecolabel for Tourism Accommodation Service" survey accessed the questionnaire via a link

included in the invitation mail. The "Module" instrument contained in Google services suite was used to build the questionnaire and collect data, the answers were included in a Table on a case-by-case basis when questionnaires were sent. Subsequently, all received data have been checked and sorted so that they look better at charting. For semi-enclosed questions, providing a pre-coded response mode and an open mode ("other") to be specified, the answers were interpreted and classified, making sure if they could stay among the alternatives proposed, or if it was vice versa necessary to add a new category. For data analysis and graphics the Microsoft Excel spreadsheet and the statistical R programming language have been used.

Results and discussion

The data analysis here reported was intended to highlight some peculiar aspects concerning the opinions about the ecolabelling experience of the Italian tourism accommodation services involved in EU Ecolabel scheme. For this purpose a questionnaire was designed and submitted to gather a mix of qualitative and quantitative information. The questionnaire was divided into five sections: Section A. intended to gather data about the reasons that led to the decision for the EU Ecolabel application and details on the certification project; section B. aimed at identifying the difficulties encountered in ecolabelling implementation and the perceived advantages derived from the EU Ecolabel award; section C. with questions concerned the maintenance process of the certification; section D. referred to the external communication practices and the environmental awareness/knowledge, particularly of the EU Ecolabel, among the guests; section E. aimed to obtain details about the best practices adopted for the environmental management, the environmental education and communication to the guest and other stakeholders. Here following, some aspects of most relevance based on the data analysis will be introduced and discussed.

Out of a total of 181 accommodation services only 59 (33%) participated in the survey, of which 2 are no longer in possession of the eco-label. The number of participants was in line with expectations, nevertheless, for the purposes of this analysis the final sample may not be representative. Those who agreed to collaborate are probably the ones who more than others have an interest in sharing their opinions, maybe because very satisfied or disappointed. The answers classified by geographic location have highlighted the participation of all regions with at least one structure answering (Figure 1). Outside of Abruzzo and Lazio, in possession of, respectively, 1 and 2 certifications, all of the certified structures in regions with a number higher than 2 did not participate. In addition, for the two regions that currently hold the largest number of certified EU Ecolabel for tourist accommodation

services, Trentino-Alto Adige and Puglia, unfortunately it is registered the lowest rate of respondents (respectively 33% and 12%).

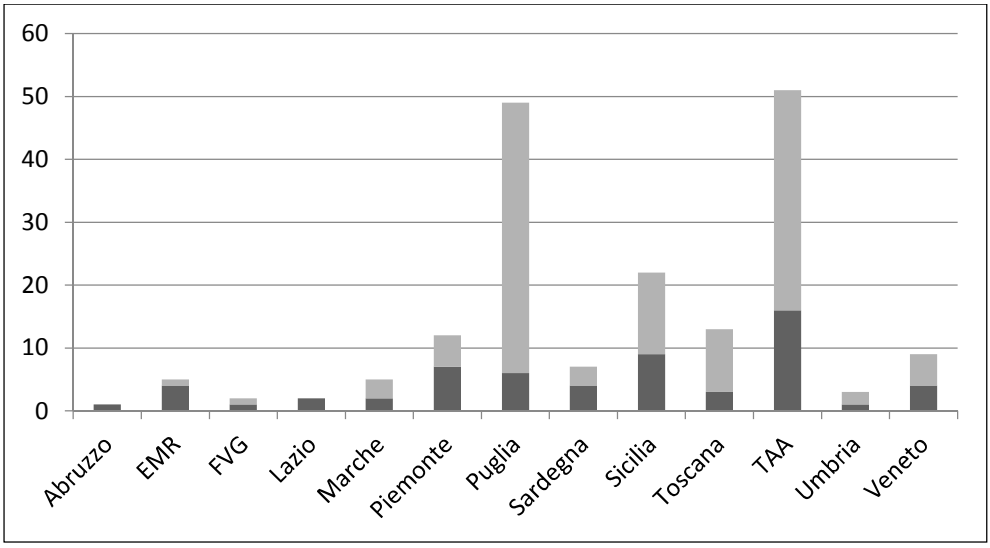


Figure 1. Number of respondents for region (in dark grey color) out of the total number of questionnaires (EMR stands for Emilia Romagna whereas TAA stands for Trentino Alto Adige)

Source: own research.

EU Ecolabel Motivations and some elements of the certification project

Among the reasons that led the respondent structures to undertake the eco-label choice, it is evident that most of these have acted on their own initiative (56%), while the rest are left to steer projects organized at various levels or even driven by the needs of the area. The data collected showed evident the important role of institutions, although the decision to undertake the certification goal of improving environmental performance is defined by 64% of respondents as very important. It is precisely in those regions where there is a very limited number of certifications (1 to 5) that the intervention of public bodies would be totally absent.

Another element that testifies the existence of local authorities activities is given by the allocation of public funding and incentive, that somehow can motivate the various structures in the area to undertake this initiative. 58% of respondents claimed to have used only its own resources, while a good percentage (42%) used forms of provincial and regional co-financing (20% e 22%) (Figure 3). A comparison of the two graphs (Figures 2 and 3) shows an almost perfect overlap between those who have independently chosen to

undertake certification and those who have only used their own resources. This probably shows that for those who have acted on their own initiative, the decision to undertake the Ecolabel certification process is only one way to further specify and declare a commitment to the environment, already in place prior to certification. For those who have been referred to this path by a third party, however, you can presume that the environmental certification choice is responding to external reasons.

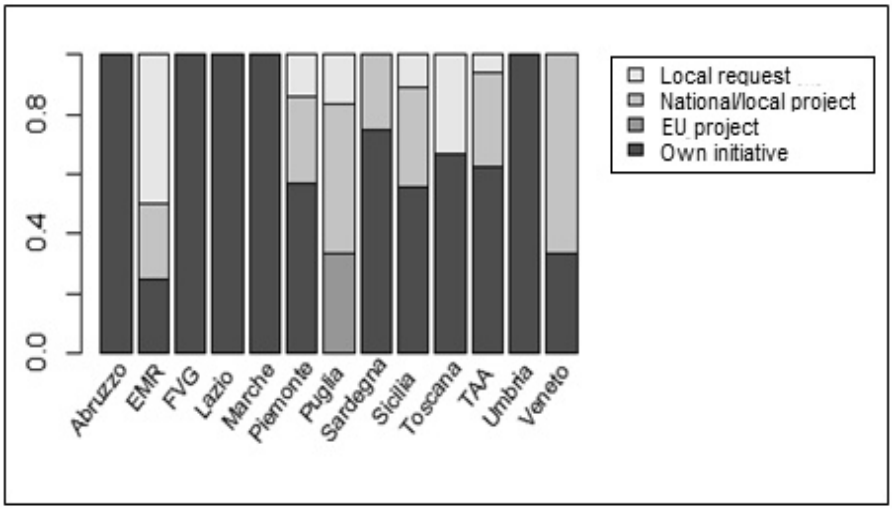


Figure 2. Reasons for the EU Ecolabel application

Source: own research.

Through the questionnaire we wanted to also investigate how it was perceived the process of obtaining certification, from the phase of information and preparation of the structure and the documents, to the one that led to the final result, that is the granting of the ecolabel. The timing of obtaining the ecolabel, for example, is average long: very few structures reported that they had obtained the certification in three months (Figure 4). This data is fully in line with expectations: the period of 3 months is the maximum time that may elapse between the submission of the application and licensing of the trademark, which means that those who have been successful (9%) were already able to meet the requirements without having had to resort to specific adaptations.

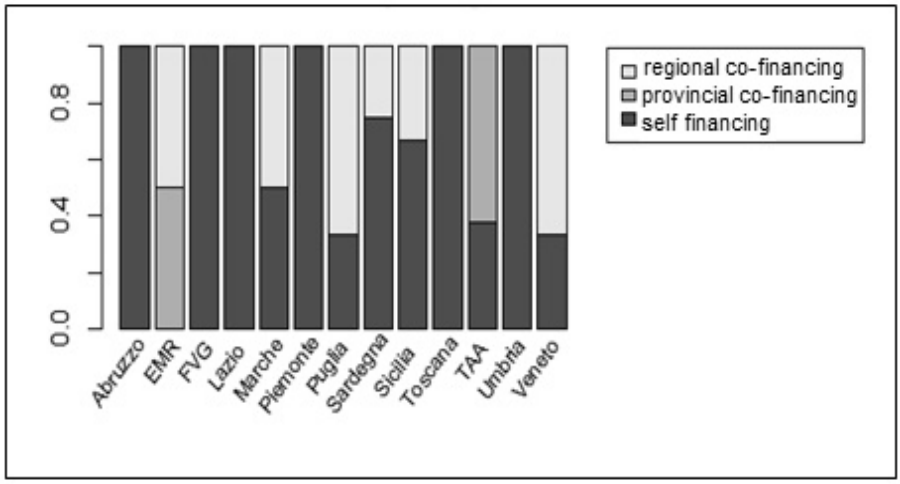


Figure 3. Financing sources for certification according to regions

Source: own research.

Main difficulties and perceived advantages for attaining the EU Ecolabel

To assess the difficulties perceived by respondents to ensure the compliance to the EU Ecolabel standard an evaluation grid was adopted (where 1 = "no problems" and 5 = "maximum difficulty") of the difficulties encountered in relation to: understanding of the Regulation; definition of environmental Policy; identification of environmental impacts; adaptation to environmental legislation; obtaining financing; staff training; internal and external communication. To summarize graphically the results obtained a box plot was used, that allows you to show various information about the data distribution. Centrality index is used as the median (represented by the thicker bar inside the box), which is optimal in the treatment of categorical and quantitative data. The sides of the box indicate, instead, the first and third quartile.

By analyzing the graph (Figure 5) it is possible to note that almost all aspects show a median equal to the central value and an absolutely symmetrical distribution. It is therefore possible to say that the respondents have found, in general, a medium difficulty and probably this is due to the fact that 70% of the structures said to have turned to third parties (consulting firms and other bodies) for the processing of the relevant practices. The only exceptions are those for "identification of environmental aspects", considered one of the simplest elements to be observed, probably because the environmental aspects are in fact already identified by the Ecolabel requirements (Commission of the European Communities, 2009), and

"funding", which is found to be an element a bit more critical, consistent with what has already emerged.

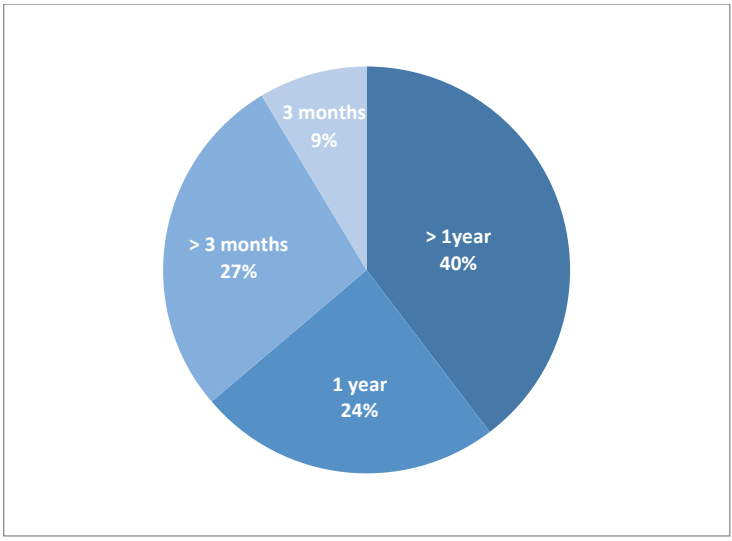


Figure 4. Time needed for obtaining the EU Ecolabel award

Source: own research.

Also with regard to the fulfillment of the requirements it was asked to express a judgment, in terms of time, effort and resources required, assessable from 1 to 5 (where 1 = minimal effort and 5 = maximum effort) (Figure 6). Again the medians are concentrated in the central value, although in this case the distributions are unbalanced to the right, especially regarding the "Energy" and "General Management" for which was then declared the need for a greater effort. Among the advantages attainable through the certification, there are certainly those referring to the reduction of environmental ordinary costs that the structure must inevitably bear for its business. It has therefore been asked to express reductions, measured as a percentage, subsequently found to obtain certification in the various areas of cost, divided into the same sections provided by the Ecolabel requirements (Figure 4.). Much of the respondents reported a percentage of improvement between 20% and 60% for almost all sections. Those for which a low improvement is highlighted are energy, where the answers are more concentrated in the midrange with less variability upward, and other services, for which the center of the distribution is only 30%. It is interesting to note that in some cases it has been declared a cost reduction of up to 100%

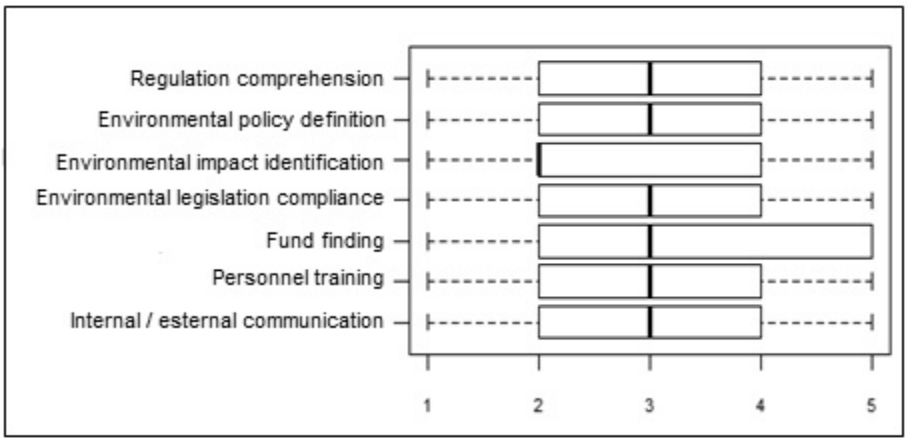


Figure 5. Perceived difficulty of the main aspects that precede or are contextual to the obtaining of the label

Source: own research.

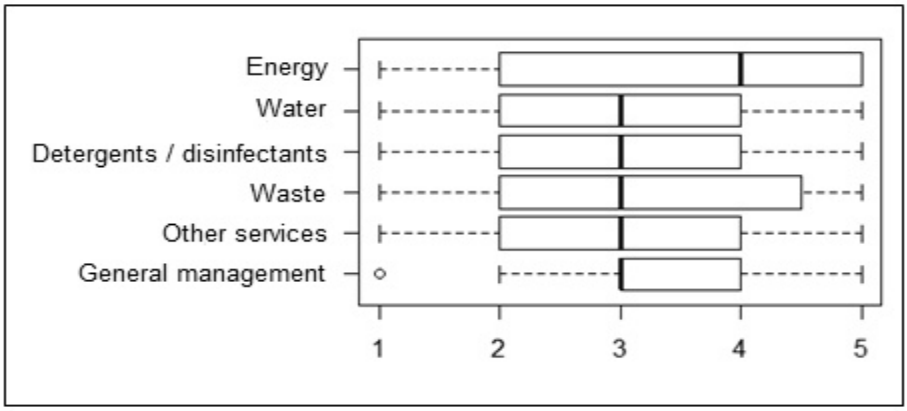


Figure 6. Perception of effort in terms of time and money with regard to the mandatory requirements

Source: own research.

External communication practices and environmental awareness/knowledge, among the guests

Once obtained the certification, it is possible to show in all communication channels the goal achieved through the Ecolabel, without circumventing the rules imposed. All the respondents recognized the importance of the Flower shown as European hallmark. However, to explore how the structures believe that their customers are informed Ecolabel, they were asked to express, based on their experience, a judgment on the matter. It was found that none of the respondents believes that the customer is very

informed, but which in most cases is poorly informed (22%) and that only 7% of the sample believes that the customer has no interest in this initiative (Figure 8). A result confirmed also by the Eurobarometer on "European's attitude towards the issue of the sustainable consumption and production". The awareness of the EU Ecolabel and its Flower logo particularly in Italy is one of the lowest along UK and Sweden in Europe (The European Commissione, 2009).

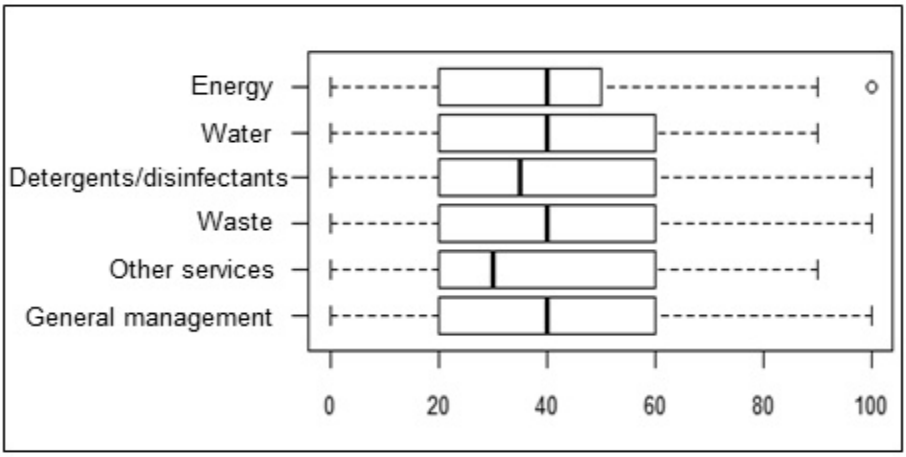


Figure 7. Savings in the various areas of cost recognized by the respondents after obtaining certification

Source: own research.

According to the information gathered, we can say that, since the little knowledge of the Ecolabel, if you want to obtain good results for its development it is needed a greater action by the institutions in particular, which should educate the public to respect and protect the environment. About what it can be done to improve this aspect, it has been asked participants to suggest potentially effective forms of support for the development and dissemination of the project Ecolabel (Table 1) and the one most commonly referred to is the training and awareness-raising about the tools for the environmental certification and eco-labeling.

At the end of the questionnaire it was given the opp. ortunity to leave, in a special section, any comments and/or reports related to the experience. The comments collected in this way were not entirely positive as the most recurring themes were:

– The high bureaucracy,
– The lack of environmental awareness of the public,
– The limited activity of the territory,
– The failure to satisfy the expectations.

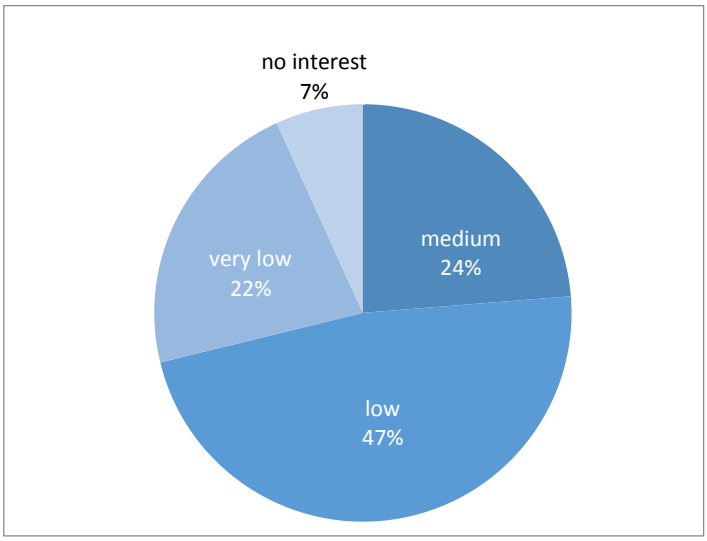


Figure 8. Perception of customer knowledge about the Ecolabel

Source: own research.

Table 1. Possible forms of support to the development of Ecolabel

Types of support	
Training and awareness on tools of environmental certification and eco-labeling	29%
Increased publicity of incentives available for the development of Ecolabel	24%
Involvement of the Ecolabel structures in sharing their experience	19%
Guidelines / manuals and brochures	10%

Source: own research.

The process of obtaining and preparing the documentation was, in fact, judged excessively long and complex and the training of applicants totally absent, although institutions as ISPRA and regional and provincial environment agencies indicate appropriate annual courses. Often the structures that require this certification are small hotels, B&Bs or family-run farms, where the owners are not always so inclined to administrative efforts and maybe do not even have the proper knowledge to be able to address these issues on their own. For this, they need outside help or advice, which, unfortunately, does not always come from the public bodies and therefore they are often forced to bear the costs for the administrative process. From the data analysis it was found that out of 70% of respondents who benefited from

external assistance, as much as 73% turned to studies or private companies and only the remaining 27% addressed to public bodies. In general, this path can be considered particularly onerous, especially for the ones who need a total renovation of the structure to homologate the requirements. Only those who, at the beginning of the certification, had an already "ready" structure considered the certification achievement relatively undemanding. Several respondents also perceive the territory and citizens still too far away from a culture aimed at safeguarding the environment, unlike the foreign customers much closer to environmental issues. Their experience has shown that the initiatives for the creation of an environmental culture are still limited and that the customer does not care about environmental measures to be taken in this type of structure: the search for an overnight stay which has all the comforts mostly prevails on environmental through the small steps required. Finally, in addition to the return of the image and saving management costs that few have pointed out, for so many expectations have not been met. Who always was concerned to operate in an environmentally friendly way, and continues to do so, considers this certification as unnecessary and inconvenient, especially in terms of time and money.

Conclusions

To summarize what are the results of the data collected on the basis of the final sample of respondents, it is possible to show that the achievement of the Ecolabel is perceived as a result from which benefits in terms of saving, image and awareness of environmental derive. The common feeling, however, is that these benefits could grow further if greater publicity of tools to promote effective environmental policy were guaranteed, and in particular the spread of a culture that cares about the environment in the national context.

The data collected about the communication with the customers and the perception of how much eco-label is known in the various geographic levels bring out, in fact, that the mark is known to a few and mostly to foreigners. Probably the only promotion of the Ecolabel is not sufficient to support this initiative because, at least with regard to Italy, the population is still not very sensitive to environmental issues. Unfortunately there is still no real environmental education of the public, a key element for the promotion of an environmental sustainability of consumptions and, in general, a change in attitudes in individual and collective behavior.

References

Buckley R., 2002, Tourism ecolabels. Annals of Tourism Research, 29 (1), 183-208.

Campisi B., Marinatto F., Bogoni P., 2014, The European Ecolabel in the Tourist Sector: An Analysis of the Italian Experience of Mountain Huts, [in:] Salomone R. Saija G. (eds.), Pathways to Environmental Sustainability, Springer, pp. 257-266.

Commission of the European Communities, 2009, Commission Decision of 2009/578/EC of 9 July 2009 establishing the ecological criteria for the award of the Community eco-label for tourist accommodation service. OJ L 198/57, 30.7.2009.

European Commission, 2009, Europeans' attitudes towards the issue of sustainable consumption and production. Analytical Report. Flasheurobarometer 256, July 2009.

European Commission, 2014, EU Ecolabel News Alert, Issue n. 93, First quarter 2014.

European Parliament and the Council of European Community, 2010, Regulation (EC) No. 66/2010 of 25 November 2009 on the EU Ecolabel. OJ L 27/1, 30.1.2010.

Eurostat, 2011, Sustainable development in the European Union. 2011 monitoring report of the EU sustainable development strategy. European Union, Luxembourg.

Institute for Environmental Protection and Research (ISPRA), 2009, Tourism accommodation and camp site services EU eco-label award scheme. Final activity report to criteria revision camp site service and tourism accommodation service.

Institute for Environmental Protection and Research (ISPRA) Database, Ecolabel Certification, http:// www.isprambiente.gov.it/ it/ certificazioni/ ecolabel-ue/servizi-certificati, accessed January 10, 2014.

United Nations World Tourism Organization (UNWTO), 2002, Voluntary Initiatives for Sustainable Tourism. UNWTO, Madrid.

WIND ENERGY IN EU IN 2020 AND DEMAND FOR RARE EARTHS METALS: A PRELIMINARY ASSESSMENT

Alfredo Ernesto Di Noia, Giuseppe Martino Nicoletti

CeSETEA, Department of Economics,
University of Foggia,
alfredo.dinoia@unifg.it

Introduction

Many of the energy scenarios elaborated in recent years agree in predicting further increases in global energy demand, up to over 40% compared to that of 2011, with fossil fuels that represent the 80% of the energy mix used, and coal is the first source with 29%, followed by oil (27%) and natural gas (23%). This will result in an increase in carbon dioxide emissions by about 40% (IEA, 2013b).

As confirmed by the fifth IPCC report (IPCC, 2013), a radical change in energy policies becomes increasingly urgent. These policies must be oriented to principles of sustainability, and the "decarbonisation" of the economy is the first road to be taken.

This objective is achieved with a careful attention to energy efficiency and by facilitating the spreading of renewable energy sources (RES) (UNEP, 2011). If you plan to hold the atmospheric concentration of CO_2 below 450 pp. m requires that, by 2035, the share of RES reaches at least 26% in total energy demand (compared to 13% in 2011) (IEA, 2013b)

The European Union has among its primary goals the activation of policies that strengthen the security of energy supply. "Europe 2020 Strategy" (EC, 2010) includes specific policies for management of issues relating to climate and energy, indicated in Directive 2009/28/EC (European Parliament and Council, 2009). It has many binding targets. As regards RES the main aim is to achieve by 2020 the production of energy from RES equal to a 20% share of the EU's energy mix. EU has constrained every Member State to adopt a "National Renewable Energy Action Plan" (NREAP) to monitor the achievement of this target. These documents are characterized by a massive production of electricity from wind power. The NREAPs expect to achieve, by 2020, a total installed capacity of 214 GW (currently installed capacity is

approximately 117 GW). (EC, 2014; Beurskens, Hekkenberg & Vethman, 2011).

The interest for wind energy is founded on the following elements:

– after about 25 years since the start of the exploitation of wind energy (from 4 GW of installed capacity in the world in 1990 to 434 GW in 2011), there are still ample opp. ortunities for growth of the installations, both globally and in Europe, raising the contribution of wind energy to electricity generation to 50% of that produced by all of the RES (excluding hydroelectric) (IEA, 2013b);
– the cost of generating electricity from wind has dropp. ed significantly, so much so that today it is often competitive with the cost per kWh produced by fossil fuels (IEA, 2013a; Lantz, Wiser & Hand, 2012);
– the technology of wind turbines is still not fully mature, and therefore are expected further increases of productivity (kWh produced/kW installated).

Currently, the technology that seems to have the best requirements, allowing the realization of more powerful machines, uses "Direct Drive Turbines" (DDT) employing "Permanent Magnet Synchronous Generator" (PMSG) for the conversion of mechanical energy into electricity. (Moss, Tzimas, Kara, Willis & Kooroshy, 2013; Anon, 2012) The peculiarities of these wind turbines are represented by the use of permanent magnet (PM) and the absence of the gearbox. The nacelle, therefore, turns out to be smaller and lighter, and the number of moving mechanical parts is significantly lower. This allows it to build machines more powerful (studies suggest 20 MW offshore wind turbines could be in use by 2020) (Schüler, Buchert, Liu, Dittrich & Merz, 2011; Lantz, Wiser & Hand, 2012; Anon, 2011; Fichaux, Beurskens, Jensen & Wilkes, 2011).

The peculiar features presented by the latest generation of PM are related to the particular composition of the alloy of which consist of: iron (67.4% - 72.4%), boron (1%), a mixture of rare earth group metals (REMs) (neodymium (Nd), dysprosium (Dy), praseodymium (Pr), and any small amounts of other elements including terbium, for a total of between 26.7% and 31.6%) (Ayres, Villalba Mendez & Talens Peiro, 2011). At the moment REMs are difficult to replace in this application (please note that PM with similar composition are used in applications in many other strategic areas: defense, medical diagnostics, healthcare, ICT, electrical traction systems etc.). In 2007, it was estimated that the PM used in wind turbine accounted for 15% of those present in the market (Du & Graedel, 2011).

REMs are currently produced almost exclusively in China, despite being relatively widespread on the planet. REMs have assumed the role of "strategic materials" for the economies of developed countries, as this situation will remain unchanged for several years (also for China's intention consolidation

of restrict exports) (Erdmann & Graedel, 2011; Di Noia & Nicoletti, 2011; Di Noia & Nicoletti, 2012; Massari & Ruberti, 2013; WTO, 2014). All this imposes the obligation to assess carefully the intent expressed in NREAPs about strong expansion of the wind energy plants. How many power capacity will be possible to install in Europe? The principal problem is that the wind industry, even on medium term, will totally dependent by imports of PMs or REMs.

In the present work, taking into account the objectives set out in NREAPs of the EU's Member States relating to the development of wind plants installations, and the technologies currently employed (and those being tested), an estimate is made of the demand, annual and cumulative, until to 2020, of Nd and Dy used in DDT technology with PMSG.

The interest in these two metals is due to the fact that the first is massively present in magnetic alloy (often combined with praseodymium) (Moss, Tzimas, Kara, Willis & Kooroshy, 2013), the second belongs to the group of REMs classified as “heavy”, for which a serious risk of a supply shortfall is highly probable (Di Noia & Nicoletti, 2011; Mackowski, 2012).

Definition of PMs composition and weight in wind turbines

The estimate of the amount of Nd and Dy request for the production of PMs has been done considering aspects:

– wind power capacity installed annually, as indicated by the NREAPs of the EU's Member States,
– the market share of DDT with PMSG,
– the amount of Dy and Nd request to installed wind power units (kg/MW) (Di Noia & Nicoletti, 2014).

In relation to the first parameter, we used the wind power capacity quantity to install related to commitments the NREAPs by Member States in the period 2015-2020 (EC, 2014).

Table 1 shows the values taken from the literature connected to the market shares from 2015 to 2020 of the wind turbines which adopt the technology examined in this study. Almost all studies contemplate two possibilities (prudent, ambitious) of technology's diffusion. The value used to calculate the demand for Nd and Dy is the average between the minimum value and the maximum value for the given year (17% for 2015, 42% in 2020). The increase of the coefficient of penetration in the market of DDT with PMSG in period 2015 - 2020 has a CAGR of 20%.

Table 1. Market shares of direct drive turbines with permanent magnet synchronous generator

Source	Market shares (%) of DDT with PMSG			
	2015		2020	
	Prudent scenario	Ambitious scenario	Prudent scenario	Ambitious scenario
(Di Noia & Nicoletti, 2014)	25		40	
(Buchert 2011)	15	25	15	40
(Hoenderdaal, Tercero Espinoza, Marscheider-Weidemann & Graus, 2013)	20	25		30
(Constantinides, 2011) (a)	/		75	
(Constantinides, 2012) (a)	/	15		20
(Moss, Tzimas, Kara, Willis & Kooroshy, 2011)	/	10		20
(Moss, Tzimas, Kara, Willis & Kooroshy, 2013)	/	27		27
(Zimmermann, Rehberger & Gößling-Reisemann, 2013) (b)	/		10	
(Kara, Chapman, Crichton, Willis & Morley, 2010)	20		20	
(Bauer, Diamond, Li, Sandalow, Telleen & Wanner, 2010)	10	25 (onshore) 75 (c) (offshore)	10	47 (d)
(Bauer, Diamond, Li, McKittrick, Sandalow, Telleen & Wanner, 2011)	15 (onshore) 25 (offshore)	75 (e) (onshore) 75 (c) (offshore)	15 (onshore) 25 (onshore)	75 (f)
(Hykawy, 2010)	20 (g)		/	
(Chan & Ke, 2011)	20		20	
Assumed hypothesis				
Range (%)	10	25	10	75
Average Value (%)	17		42	

(a) Data are estimated for the European countries and also include new medium-speed hybrid-drive turbines.

(b) The Figure refers to installed capacity to 2025 in Germany.
(c) The Figure is not taken into consideration because the estimates of its installed capacity in 2013 of DDT with PMSG is only the 1.5% (Corbetta, Pineda & Moccia 2014). So it's unlikely that in two years will increase to 75% of capacity installed.
(d) We use the same hypothesis (f) and calculate the weighted average of the estimates envisaged (25% for onshore and 75% for offshore) compared to onshore and offshore defined in NREAPs (6.7 GW for onshore and 8.6 GW for offshore).
(e) The Figure is not taken into consideration because it refers to world market, which is very different from the European market.
(f) The data assume a more rapid adoption of both turbines that employ PM manufactured in China and new medium-speed hybrid-drive turbines.
(g) The Figure relates to all types of turbines that use rare earth magnet.

The third parameter depends on composition of PM and on amount of the magnets used to MW installed capacity (Table 2).

We observe a significant variability both in terms of the percentage of the two metals used in the magnet, and as regards its weight. It can be argued that these two parameters belong to the category of "industrial secrets", because a different percentage of use of REMs allows to obtain different performances, such as an increased corrosion resistance and an improved magnetic properties (Di Noia & Nicoletti, 2011). The range of Nd is between 21.8% and 31%, that of Dy between 1.2% to 9.8%. The range of magnet's weight between 250 kg/MW and 1,000 MW/kg.

The values reported in the Table 2 were downsized, in order to simulate probable technological improvements of the near future. The following improvement factors were assumed:

– 10% reduction compared to values of the ranges from 2015 until 2019, and 20% in 2020 (Janssen, Lacal Arántegui, Brøndsted, Gimondo, Klimpel, Johansen & Thibaux, 2012);
– 30% reduction of PM weight compared to range's values in 2016, which remains constant until 2020 (Di Noia & Nicoletti, 2014).

Table 3 presents the results of our estimation of demand for Dy and Nd contained in PMSG employed in DDT, in the 2015-2020 period. It is observed that the demand for Nd and Dy grows at a CAGR of 14%. The results are compared to that of Moss (Moss, Tzimas, Kara, Willis & Kooroshy, 2013), assuming the composition of didymium is: 75% Nd, 25% Pr (Kara, Chapman, Crichton, Willis & Morley, 2010).

Table 2. Weight's estimates of PM (for MW of installed capacity) and intensity of neodymium (Nd) and dysprosium (Dy) employed in PMSG of DDT

Source	PM Weight (kg/MW)	Nd (%)	Dy (%)
(Bauer, Diamond, Li, Sandalow, Telleen & Wanner, 2010)	400 - 600	31	5.5
(Bauer, Diamond, Li, McKittrick, Sandalow, Telleen & Wanner, 2011)	200 (a) - 600	31	2 - 4
(Constantinides, 2011; Constantinides,2012)	600 (b) 400 (c)	27.5	4.1
(Janssen, Lacal Arántegui, Brøndsted, Gimondo, Klimpel, Johansen & Thibaux, 2012)	650 (d)	31	2.3
(Lifton, 2009)	700 - 1000	/	/
(Lifton, 2010)	/	28	2
(Hatch, 2008)	571	/	/
(Seaman, 2010)	667	30	/
(Gutfleisch, Willard, Brück, Chen, Sankar & Ping Liu, 2011)	500	21.8	9.8
(Schüler, Buchert, Liu, Dittrich & Merz, 2011)	400	26	/
(Hoenderdaal, Tercero Espinoza, Marscheider-Weidemann & Graus, 2013)	600 - 642	30	4 – 4.5
(Kara, Chapman, Crichton, Willis & Morley, 2010)	700	29	3
(Xu & Peng, 2009) (e)	/	22.5 – 29.7	1.2
(Kleijn & van der Voet, 2010)	550	27.3	/
(Zimmermann, Rehberger & Gößling-Reisemann, 2013)	600	/	/
(Chan & Ke, 2011)	250	/	/
(Bubar, 2011)	500 - 750	/	/
(Kollenbach, 2011) (f)	250	/	/
(Polinder, van der Pijl, de Vilder & Tavner, 2006)	567	/	/
(Bartos, 2011)	650	/	/

(a) The date relates to hybrid turbines which contain a lesser amount of PM.
(b) Average weight of Nd magnet estimated in 2010.

(c) Average weight of Nd magnet estimated in 2020.
(d) Weight of the magnets contained in the direct drive generators, low-speed of 3 MW of capacity in low-speed case.
(e) The data relate to the chemical composition of solid wastes of Nd magnet.
(f) The data do not regard only the DDT technology with PMSG.

Table 3. Estimate of the amount of Dy and Nd present in PM of DDT in the EU-28 according to the commitments of the NREAPs

Description	2015		2020			Cumulative 2015-2020		2020 (Moss)
Annual installed capacity (GW)	12		15			83		14
Market shares of DDT with PMSG (*)	17 (%)		42 (%)			/		27 (%)
	Min	Max	Min	Max	Average	Min	Max	
Estimation of Nd (t)	104	590	197	1122	659	860	4894	634
Estimation of Dy (t)	6	186	11	355	183	47	1547	58

(*) From Table 1.

In the period 2015-2020, for the Nd we observe a maximum demand much bigger than the minimum level calculated (860 t vs. 4,894 t), while for the Dy the maximum amount represents more than 30 times the minimum (1,547 t vs. 47 t). The demand for Nd calculated for the full period represents the 4% (minimum demand) - 24% (maximum demand) of world production in 2010 (20,000 t), and that of Dy is estimated in a range between 3% (minimum demand) and over 90% (maximum demand) of its production in 2010 (1,600 t). In particular, the estimated demand for Nd and Dy in the year 2020 will represent, respectively, 1% - 6% and 1% - 22% of the global production in 2010 (Bauer, Diamond, Li, McKittrick, Sandalow, Telleen & Wanner, 2011).

If you compare the average values of the range estimated in the present study in 2020 with the demand presented by Moss, we note a slight positive difference for Nd (4%), while for the Dy our estimate is significantly higher. This result requires to consider more carefully the risks associated with high demand of Dy in relation to the potential shortage scenarios (Di Noia & Nicoletti, 2011; Mackowski, 2012).

Conclusions

The increase in the spread of wind energy in the process of "decarbonisation" of the EU economy may be less significant if the REMs market becomes more risky from the point of view of supply.

The study's results highlight that demand for Nd and Dy in 2020, to enable the achievement of wind energy targets set in NREAPs of EU Member States, is incompatible with current level of REMs supply.

If you consider that REMs are essentials in a great number of applications in civil and defense sectors, it becomes necessary, and urgent, undertake new projects in the mining field and in the context of recovery and recycling from Waste Electrical and Electronic Equipment, to raise supply of REMs.

Acknowledgments

The present work, although the result of the shared thoughts of the authors, is due in particular to G. M. Nicoletti in the planning stage/setting of the research with suggestions of supplementary revision of the text and for the "Introduction" and A. E. Di Noia for the paragraph "Definition of PMs and weight in wind turbines" and "Conclusion". The literature search was carried out jointly.

References

Anon, 2011, Turbina senza moltiplicatore di giri, La Chimica e L'Industria, 4, 44.

Anon, 2012, Whitepaper Wing Generator Technology. Eclareon, Copyright© European Copp. er Institute. www.leonardo-energy.org/node/156615, accessed 25 March 2014.

Ayres R. U., Villalba Mendez G., Talens Peiro L., 2011, Rare and Critical Metals as By-products and the Implications for Future Supply, 2011/129/EPS/TOM/ISIC. www.insead.edu/facultyresearch/research/details_ papers.cfm?id=29826, accessed 25 March 2014.

Bartos F. J., 2011, Direct-Drive Wind Turbines Flex Muscles, CFE Media, LLC. http://www.controleng.com/industry-news/single-article/direct-drive-wind-turbines-flex-muscles/4be132ffb0.html, accessed 6 April 2014.

Bauer D., Diamond D., Li J., Sandalow D., Telleen P., Wanner B., 2010, Critical Materials Strategy, U.S. Department of energy. http://energy.gov/ sites/prod/files/piprod/documents/cms_dec_17_full_web.pdf, accessed 6 April 2014.

Bauer D., Diamond D., Li J., McKittrick M., Sandalow D., Telleen P., Wanner B., 2011, Critical Materials Strategy, U.S Department of Energy.

http://energy.gov/sites/prod/files/DOE_CMS2011_FINAL_Full.pdf, accessed 5 April 2014.

Beurskens L. W. M., Hekkenberg M., Vethman P., 2011, Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States. Summary report, ECN-E--10-069. https://www.ecn.nl/projects/nreap/2010/reports/, accessed 25 March 2014.

Bubar D., 2011, Proactive InvestorsOne2One Investor Forum, © Proactiveinvestors.com.www.proactiveinvestors.com/genera/files/companies/proactive_presentation_11_01_18__avalon. Pdf, accessed 6 April 2014.

Buchert M., 2011, Rare Earths - a Bottleneck for future Wind Turbine Technologies?, http://www.oeko.de/oekodoc/1296/2011-421-en.pdf, accessed 4 April 2014.

Chan V., Ke L., 2011, Baotou Rare Earth, Credit Suisse, https://doc.research-and-analytics.csfb.com/docView?language=ENG&source=ulg&format=PDF&document_id=874941241&serialid=E%2B8amvjKRSHLU5SHITQXkcjT1xpXUbJJPoRtZVmJl3s%3D, accessed 6 April 2014.

Constantinides S., 2011, Rare Earth Materials Update – May 2011, © 2014 Arnold Magnetic Technologies Corp. http://www.arnoldmagnetics.com/WorkArea/DownloadAsset.aspx?id=5379, accessed 5 April 2014.

Constantinides S., 2012, Material Matters, http://www.northeastern.edu/nanomagnetism/downloads/EAM%202012%20-%20Arnold_120711_mod120802.pdf, accessed 4 April 2014.

Corbetta G., Pineda I., Moccia J., 2014, The European offshore wind industry - key trends and statistics 2013 EWEA. January 2014, © European Wind Energy Association – EWEA. http://www.ewea.org/fileadmin/files/library/publications/statistics/European_offshore_statistics_2013.pdf, accessed 6 April 2014.

Di Noia A. E., Nicoletti G. M., 2011, Terre rare e sviluppo dell'eolico, in: Revelling in Reference: XXV Congresso Nazionale di Scienze Merceologiche, 26 – 28 Settembre, AISME, Trieste-Udine, Italy, pp. 637-643.

Di Noia, A. E., Nicoletti G. M., 2012, Primary Evaluation of the Commercial Quality of Rare Earth Deposits, in: Revelling in Reference: XVIII Symposium of International Association of Science of Commodity and Technology, 24 – 28 Settembre, IGWT, Rome, Italy.

Di Noia A. E., Nicoletti G. M., 2014, Eolico in Italia e domanda di Terre Rare al 2020, in: Revelling in Reference: XXVI Congresso Nazionale di Scienze Merceologiche, 13-15 febbraio, AISME, Pisa, pp. 279-289.

Du X., Graedel T. E., 2011, Global Rare Earth In-Use Stocks in NdFeB Permanent Magnets, Journal of Industrial Ecology, 15 (6), 836-843.

Erdmann L., Graedel T. E., 2011, Criticality of Non-Fuel Minerals: A Review of Major App. roaches and Analyses, Environmental Science & Technology, 45, 7620-7630.

European Commission (EC), 2010, EUROPE 2020. A strategy for smart, sustainable and inclusive growth. http://eur-lex.europa.eu/LexUriServ/ LexUriServ.do?uri=COM:2010:2020: FIN:EN:PDF, accessed 25 March 2014.

European Commission (EC), 2014, National renewable energy action plans. http://ec.europa.eu/energy/renewables/action_plan_en.htm, accessed 25 March 2014.

European Parliament and Council, 2009, 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 and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1395746260935&uri=CELEX:020 0 9L0028 -20130701, accessed 25 March 2014.

Fichaux N., Beurskens J., Jensen P. H., Wilkes J., 2011, UpWind. Design limits and solutions for very large wind turbines. http://www.upwind.eu/~/ media/UpWind/Documents/Home/21895_UpWind_Report_low_web.ashx.

Gutfleisch O., Willard M. A., Brück E., Chen C. H., Sankar S. G., Ping Liu J., 2011, Magnetic Materials and Devices for the 21st Century: Stronger, Lighter, and More Energy Efficient, Advanced Materials, 23(7), 821-842.

Hatch G. P., 2008, Going Green: The Growing Role of Permanent Magnets in Renewable Energy Production and Environmental Protection, © 2009 - 2010 Gareth Hatch. http://www.terramagnetica.com/papers/Hatch-Magnetics-2008.pdf, accessed 6 April 2014.

Hoenderdaal S., Tercero Espinoza, L., Marscheider-Weidemann F., Graus W., 2013, Can a dysprosium shortage threaten green energy technologies?, Energy, 49, 344–355.

Hykawy J., 2010, The Rare Earths. Pick Your Spots CAREFULLY, © Byron Capital Markets Ltd. http://www.byroncapitalmarkets.com/the-rare-earths-pick-your-spots-carefully/, accessed 6 April 2014.

International Energy Agency (IEA), 2013a, Medium-Term Renewable Energy Market Report 2013. Market trends and projections to 2018, © OECD/IEA. http://www.iea.org/w/bookshop/add.aspx?id=453, accessed 25 March 2014.

International Energy Agency (IEA), 2013b, World Energy Outlook 2013, © OECD/IEA. http://www.iea.org/W/bookshop/add.aspx?id=455, accessed 25 March 2014.

Intergovernmental Panel on Climate Change (IPCC), 2013, Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, © Intergovernmental Panel on Climate Change 2013. http://www.ipcc.ch/ report/ar5/wg1/, accessed 11 April 2014.

Janssen L. G. J., Lacal Arántegui R., Brøndsted P., Gimondo P., Klimpel A., Johansen B.B., Thibaux P., 2012, Scientific Assessment in support of the Materials Roadmap enabling Low Carbon Energy Technologies. Wind Energy, © European Union. http://publications.jrc.ec.europa.eu/repository/

bitstream/111111111/26289/1/reqno_jrc68191_set-plan%20materials% 20pdf. pdf, accessed 6 April 2014.

Kara H., Chapman A., Crichton T., Willis P., Morley N., 2010, Lanthanide Resources and Alternatives, © Oakdene Hollins Ltd. www.oakdenehollins.co. uk/pdf/lanthanide_resources_and_alternatives_may_2010.pdf, accessed 5 April 2014.

Kleijn R., van der Voet E., 2010, Resource constraints in a hydrogen economy based on renewable energy sources: An exploration, Renewable and Sustainable Energy Reviews, 14, 2784–2795.

Kollenbach U., 2011, Superconductors Solve Rare Earth Element Problem for Wind Power, © Amazon Web Services. http://s3.amazonaws.com/zanran_ storage/www.zenergypower.com/ContentPages/2476294541.pdf, accessed 6 April 2014.

Lantz E., Wiser R., Hand M., 2012, IEA Wind Task 26: The Past And Future Cost Of Wind Energy. WP2, http://www.nrel.gov/docs/fy12osti/53510.pdf, accessed 25 March 2014.

Lifton J., 2009, On the rare earth crisis of 2009, © Seeking Alpha. http://seekingalpha.com/article/178225-on-the-rare-earth-crisis-of-2009, accessed 6 April 2014.

Lifton J., 2010, The Green Revolution in China, © Technology Metals Research, LLC. http://www.techmetalsresearch.com/2010/08/the-green-revolution-in-china/, accessed 6 April 2014.

Mackowski S., 2012, Why is the Supply Side of Dysprosium Not Keeping Pace with Demand?, REE World Report. http://myemail.constantcontact.com/REE-World-Report--Political-Squeeze-Play-and-the-Rare-Earth-Revolution.html? soid=1101929135265&aid=cJ7wsRNp8ag, accessed 25 March 2014.

Massari S., Ruberti M., 2013, Rare earth elements as critical raw materials: Focus on international markets and future strategies, Resources Policy, 38, pp. 36-43.

Moss R. L. Tzimas E., Kara H., Willis P., Kooroshy J., 2011, Critical Metals in Strategic Energy Technologies. Assessing Rare Metals as Supply-Chain Bottlenecks in Low-Carbon Energy Technologies, © European Union. http://setis.ec.europa.eu /publications/jrc-setis-reports/critical-metals-strategic-energy-technologies, accessed 25 March 2014.

Moss R. L. Tzimas E., Kara H., Willis P., Kooroshy J., 2013, Critical Metals in the Path towards the Decarbonisation of the EU Energy Sector, © European Union. http://setis.ec.europa.eu/publications/jrc-setis-reports/jrc-report-critical-metals-energy-sector, accessed 25 March 2014.

Polinder H., van der Pijl F. F. A., de Vilder G-J., Tavner P. J., 2006, Comparison of direct-drive and geared generator concepts for wind turbines, IEEE transactions on energy conversion., 21 (3), 725-733.

Schüler D., Buchert M., Liu R., Dittrich S., Merz C., 2011, Study on Rare Earths and Their Recycling, www.oeko.de/oekodoc/1112/2011-003-en.pdf, accessed 25 March 2014.

Seaman J., 2010, Rare Earths and Clean Energy: Analyzing China's Upp. er Hand, LOVENLY © 2009-2014. www.ifri.org/downloads/noteenergieseaman. pdf, accessed 6 April 2014.

UNEP, 2011, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. www.unep.org/greeneconomy, ISBN: 978-92-807-3143-9, accessed 25 March 2014.

World Trade Organization (WTO), 2014, "China – Measures related to the exportation ff Rare Earths, Tungsten, and Molybdenum. Reports of the panel", http://www.wto.org/english/news_e/news14_e/431_432_433r_e.htm, accessed 03 April 2014.

Xu T., Peng H., 2009, Formation cause, composition analysis and comprehensive utilization of rare earth solid wastes, JOURNAL OF RARE EARTHS, 27 (6), 1096-1102.

Zimmermann T., Rehberger M., Gößling-Reisemann S., 2013, Material Flows Resulting from Large Scale Deployment of Wind Energy in Germany, Resources, 2, 303-334.

INNOVATIVE ACTIVITY AND ECO-INNOVATIONS IN THE LIGHT OF PRO-ENVIRONMENTAL STRATEGIES

Tadeusz Fijał

Department of Technology and Ecology of Products,
Faculty of Commodity Science, Cracow University of Economics,
fijalt@uek.krakow.pl

Introduction

Economic entities more often conduct innovative activities. Due to aiming at various improvements and novelties, enterprises may gain numerous economic advantages, including at first place the maintenance of its market position and competitiveness (Działalność innowacyjna..., 2012). Implementation of new, essentially improved products, processes and methods in enterprises is a key of increasing efficiency and creating new jobs and building competitive advantage as a solid foundation of permanent development.

The rate of implementation of new innovative products is a function of enterprise's ability to manage, keep and create knowledge. Creation of innovations depends also on proper functioning of the system of innovation exchange. Innovations are rarely an isolate event, are rather an effect of highly interactive cooperation processes in an increasing and differentiated stockholder network (Nauka i technika..., 2012).

National and international economic entities, R&D institutions as well as public sector more and more intensively participate in knowledge creation and exchange. Such cooperation becomes a mean for extending the range of innovative development projects and a way of competence supplementation.

The basic Polish legal act related to supporting innovative activities is the Act of 30 May 2008 on some forms of supporting innovative activities. This Act defines the rules of supporting innovative activities by: granting a technological credit by credit banks and technological premium by the Bank Gospodarstwa Krajowego and granting a company the status of R&D centre (Ustawa..., 2008).

The development of civilisation connected with technical progress and the use of new and new techniques and manufacturing technologies and the volume of global good and service production causes an increasing environmental impact of manufacturing processes and produced goods. The necessity to reduce this adverse impact was expressed in the concept of sustainable development (eco-development) commonly adopted and accepted worldwide proposed by the United Nations, assuming among other things implementation of eco-innovative material- and energy- saving manufacturing technologies, minimising amount of generated waste, its recovery and recycling, product life cycle analysis, product marking and promotion of environmentally friendly products as well as natural resource preservation for future generations. Eco-innovativeness is also an important component of the EU ecological policy realized in the EU Sustainable Development Strategy.

Eco-innovativeness based on extensive scientific researches, especially in modern disciplines of knowledge, is a key factor determining economic growth. It is also an important element of ecological policy conducted within the scope of numerous pro-environmental global and EU strategies such as "Europe 2020 - A strategy for smart, sustainable and inclusive growth", "OECD Green Growth Strategy – GGS", "Global Green New Deal – GGND" and "Strategy for Environmental Technologies".

The aim of this paper is to demonstrate a stimulating role of these strategies in the process of implementing eco-innovative technical, technological, marketing and organizational undertakings to develop environmentally friendly processes and products.

Innovative activity and eco-innovations

Innovative activity covers all scientific, technical, organisational, financial and commercial operations intended to innovation implementation. Some of these activities are innovative, while the others cannot be a novelty, but are necessary for innovation implementation. Innovative activity includes also R&D that is not directly related to creation of a particular innovation.

The term "innovation" is understood as the implementation of a new or essentially improved product (good, service) or process, new organizational method or new marketing method in economic practices, workplace organization or relations with the environment (Działalność innowacyjna..., 2010).

A new or essentially improved products become implemented when are launched on the market, while new processes, organizational methods or marketing methods become implemented when are actually used in company activities.

The product, processes and organizational and marketing methods should not be a novelty on the market where a company is operating but must be a novelty for a company at least.

Besides, the products, processes and methods should not be developed by a company, but may be developed by another company or organization of quite other type (e.g. university, R&D institute, R&D centre).

Innovative enterprise – an enterprise that launched on the market within a specified period at least one of the following:

– Process innovation (new or essentially improved process), or
– Product innovation (new or essentially improved product).

Process innovation – the implementation of new or essentially improved production and distribution methods and supporting product- and service-related activities. Process innovations include also new or essentially techniques, devices and software in auxiliary activities such as logistics, accountancy, IT service and maintenance (Działalność innowacyjna..., 2010).

Product innovation – the launching on the market a product or service that is new or essentially improved with respect to its features or applications. For services product innovations consist in the implementation of significant improvements in service rendering but adding new functions or features to the existing services or the implementation of quite new services (Działalność innowacyjna..., 2010).

Innovative activity of each organization is related to foreseeability. Such foreseeability is considered as the basic source of economic efficiency. Thus, it can be concluded that innovativeness is based on forecasting, out of touch with reality and building scenarios of future events.

Eco-innovations are a particular case. This term means any innovation (new technology, product, process or service) that may participate in environmental protection or more effective and rational use of resources.

Eco-innovation applies to all innovation forms – technical and extra technical, new products and services and new business practices, which give a chance for a company and provide environmental advantages, preventing or reducing adverse environmental impacts or optimizing resource utilization (including energy consumption). Eco-innovativeness is closely connected with the development and application of environmental technologies as well with the concept of effectiveness and eco-industry. The general objective is to enable creation of models for more sustainable production and consumption (Ekoinnowacje, 2009).

Practical examples of eco-innovations are as follows:

– recovery of useful substances from waste or sewage,
– manufacturing construction materials from recycled waste,

– improving energy efficiency by using energy-saving devices,
– use of heavy-duty co-generating plants and renewable energy sources in power engineering,
– use of environmentally friendly packaging,
– implementation of technologies of environmentally friendly product manufacturing, and
– use of new management methods.

Eco-innovations bring not only environmental advantages. Each year the world market of environmental products and services increasingly develops. Due to its strong position on this market, Europe plays the role of a leader in application of eco-innovations to cope with nowadays environmental challenges, and is given an unique chance of investment growth in this relatively new sector.

Europe 2020

Innovativeness is an important part of development of the EU Member States, including Poland. In European Commission Communication "Europe 2020 – A strategy for smart, sustainable and inclusive growth" published in March 2010, a new long-term programme of EU social and economic growth that in practice replaced the Lisbon Strategy is identified and the growth based on knowledge and innovations is one of three key priorities.

The "Europe 2020" Strategy includes the three interrelated priorities subject priorities (Komunikat Komisji..., 2010): smart growth (economic growth based on knowledge and innovations), sustainable growth (fostering more resource efficient production) and inclusive growth (economic growth at high employment rate).

In Communication "Europe 2020" the European Commission presented seven 'flagship initiatives' which should ensure progress in each subject priority. Three of them are directly connected with eco-innovativeness. They include (Komunikat Komisji..., 2010):

– "Innovation Union" – aims to improve framework conditions and access to finances for research and innovations, so that innovative ideas can be turned into new products (goods and services) and thereby creating economic growth, investment level increase and new jobs;
– "Resource-efficient Europe" – aims to decouple economic growth from the use of resources, supporting low-carbon emission economy, an increased use of renewable energy sources, the modernisation of transport sector and promotion of energy efficiency;

– "An industrial policy for thee globalisation era" – aims to improve the business environment, especially for SMEs and supporting the development of a strong and sustainable industrial base able to compete on world market.

The "Europe 2020" strategy is foreseen for the years 2010-2020 and is a response of the European Union to increasing phenomena and newly arising challenges, for example increasing competitiveness of arising economies such as India and China. The document presents a vision of social market economy based on smart growth, sustainable growth and inclusive growth. This means in practice fostering innovations and knowledge development, effective resource use, competitiveness and environmental protection and supporting employment and social and territorial cohesion (Wskaźniki zrównoważonego rozwoju..., 2011).

The goals of the "Europe 2020" strategy should be achieved by flagship initiatives proposed by the European Commission. "Innovation union" aimed at solving the most important social and economic problems indicated in the strategy is a key driver in the context of economic growth based on knowledge (Komunikat Komisji do Parlamentu Europejskiego..., 2010).

"Innovation union" has been proposed to set a vision, plan, tasks and procedures for monitoring the innovation development. The main goal is to support activities aimed at accomplishing the "Europe 2020" strategy objectives, at first place by enhancing access to finance for scientific research and innovation, thus enabling innovative ideas to be turned into new products more effectively, that in turn should promote inclusive growth. As indicated in Commission Communicate related to "Innovation union" it is estimated that if 3% of the EU GDP will be assigned to R&D before 2020, then about 3.7 million jobs can be created up to 2025, while GDP may rise to about € 800 milliard (*US billion*) annually. Thus, it is not to be wondered that the planned budget o scientific research and innovations for the years 2014-2020 - Horizon 2020 – was fixed at the level of € 80 milliard (Działalność innowacyjna..., 2012).

The European Commission proposed in the "Europe 2020" strategy five measurable goals for the EU to be achieved by 2020, that set the course for its growth and were converted into national targets. These targets include: employment, research and development, climate changes and energy, education and the fight against poverty. They indicate the direction towards which the European Union should go. The aims of the "Europe 2020" strategy related to eco-innovativeness for the EU are presented in Table 1.

The assumed and adopted by the European Union the goal of increasing expenses for scientific researches and innovations up to 3% GDP in 2020 (Table 1), could increase accessibility to environmental technologies and

possibility to use them in economic activities as well as possibility to open the leading world market to European eco-innovative products and processes.

Table 1. Eco-innovativeness goals of the "Europe 2020" strategy for 2020 and selected Member States

EU goals Member States	R&D investments [% GDP]	CO2 emission reduction [%]	Renewable energy use [%]	Energy efficiency (energy consumption limitation) [Mtoe]
Main goal of the EU (27)	3%	-20% (against 1990 levels)	20%	Energy efficiency increase by 20%
Estimation at the EU level	2.69	-20	20	206.9
Germany	3.0	-14	18	38.30
France	3.0	-14	23	34.00
Sweden	4.0	-17	49	12.80
Denmark	3.0	-20	30	0.83
Austria	3.76	-16	34	7.16
Hungary	1.8	10	14.65	2.96
Slovakia	1.0	13	14	1.65
Lithuania	1.9	15	23	1.14
Poland	1.7	14	15.48	14.00

Source: Author's own elaboration based on: "Europe 2020" strategy targets, 2011, EU European Commission - Europe 2020, http://ec.europa.eu/europe2020/pdf/targets_pl.pdf

Innovative policy should take into account the changes observed in world economy and transformations in the innovation processes. As regards to innovativeness the European Union falls behind its main world rivals, i.e. the USA and Japan. Although promising tendencies (despite of economic crisis) can be observed in most of Member Countries, advances in this area are not sufficiently rapid. Though the supremacy of the European Union over raising economies such as India and Russia is still clear, in the case of Brazil becomes smaller and smaller, while China catches up the Union very rapidly. Within the EU the most impressive results in innovations are recorded in Denmark, Finland, Germany and Sweden, that is in countries achieving the results considerably above the mean for UE-27 (Nowa unijna tablica wyników, 2011).

OECD Green Growth Strategy

Another strategic initiative related to eco-innovativeness is the OECD Green Growth Strategy (GGS) adopted on 26 May 2011 at the OECD Ministerial Council meeting, an organisation that dealt with environmental degradation and climate change from economic point of view for many years.

This strategy assumes achieving eco-innovative activities to restore environmental equilibrium and prevent climatic crisis that threatened world. It also assumes the necessity of undertaking innovative activities for green investments and rational resource use, especially related to investments in infrastructure and new power technologies being key drivers of low-coal economic growth.

By proposing such strategic initiative the OECD points out the need for a broad and integrated strategy that uses a number of market mechanisms to achieve "green growth". They include: making prices more realistic, encouraging investments in "green" eco-innovative technologies and eliminating ineffective tools such as fossil fuel subsidies.

"Green growth" is understood as an action towards economic growth, while preventing environmental degradation, maintaining biodiversity and use of natural resources without affecting environmental equilibrium. The GGS strategy provides a framework ensuring such policy that enables closer economic integration and changes in production and consumption standards leading to rational use of limited natural resources (Wskaźniki zrównoważonego rozwoju..., 2011).

"Green growth" is based on initiatives promoting sustainable development existing in many countries and is aimed at identification of "clean" sources of economic growth, including the development of new "green" industrial sectors, "green" workplaces and "green" technologies. At the same time it provides better management of structural changes related to transition into "green" economy (Sprawozdanie..., 2010).

The "Green growth strategy" adopted by the OECD contains practical tool for a policy allowing safe transition into more pro-environmental economy both at national and international levels. The main concept of this strategy is to provide a response to economic crisis challenges and to develop sustainable manufacturing processes as well as customer behaviour. The GGS shall guarantee an integrity of economic, environmental and social justice policies in the OECD member states (Uwagi GCPL..., 2011).

The "Green growth" proposed in this strategy is a new pathway to social and economic development that accomplishes the goals of sustainable development in a more effective way. In contrast to the present model based to large extent on the use of fossil fuels and other non-renewable raw materials, green economy should derive from experience of environmental

economy and provide appropriate relations between the economy and eco-systems. So called "the greening of the economy" is considered on many planes and includes a series of narrower items such as the development of eco-innovative clean technologies, the use of renewable energy sources, the improvement of energy and material efficiency, turning the consumption and production model into more sustainable integrated product policy, green public orders, green workplaces or environmental tax reform (Zielona gospodarka, 2011).

Global Green New Deal

The need for turning the present economic growth model into more sustainable one has been also considered as one of priority areas by the United Nations that proposed its own strategic initiative in green economy and eco-innovativeness development.

In March 2009 the United Nations Environment Programme (UNEP) published the report entitled the Global Green New Deal (GGND) in which governments should strengthen collaboration in supporting economic transformation.

The UNEP presented a vision of economy animation and employment increase, while accelerating mitigation and adaptation actions to cope with climate changes, environmental degradation and to reduce poverty. In the GGND report an increase of "green" economy investments up to 1% of global GDP is foreseen by rising expenditures incurred by the G20 members - the richest countries and most responsible for climate change. In addition to financial expenditures the UNEP recommends a number of political reforms such as liquidation of subsidies on environmentally harmful activities, environmental tax reform as well an new regulation tools (Szanse i zagrożenia..., 2009).

The "Global Green New Deal" identities six sectors of the highest potential in the transformation process and key drivers for "green" economy development. They include (Zielona gospodarka na forum ONZ 2011): clean energy and new cleaner technologies; energy in rural areas, including renewable energy; sustainable agriculture, including ecological farming; infrastructure for using ecosystem resources, reducing carbon dioxide emissions to reduce the greenhouse effect and sustainable cities, including land-use planning, urban transport and sustainable building.

In November 2011 the UNEP published a comprehensive report entitled "Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication", where an assessment of the current state of "green" economy and its prospects in the main fields of activities related to: investments in natural capital, investments in energy sector, and mechanisms

supporting activities enabling the transition to a global green economy (Towards a Green Economy..., 2011).

The report indicates that ecological economics should not be an obstacle for economic growth. Quite the contrary, a "green" economy has a high potential and can be a growth driver generating new jobs. The report is also aimed at encouraging decision makers to create appropriate conditions for eco-innovativeness development and pro-environmental investments allowing the transition to a "green" economy.

EU Environmental Technology Strategy

Another strategic initiative closely connected with eco-innovativeness is the EU "Environmental Technology Strategy" being a key element of strengthening ecological and innovation policy to use the eco-innovation potential to cope with environmental challenges, maintain the economic growth rate and increase competitiveness.

In January 2004 The Commission Communication for the Council and the European Parliament on "Stimulating technologies for sustainable development – Environmental Technologies Action Plan for the European Union" (ETAP) was published. (Komunikat Komisji Wspólnot Europejskich..., 2004) This action plan gained support from governments of Member States during the EU Council summit held in Brussels in March 2004.

Environmental Technologies Action Plan for the European Union is an EU strategic initiative intended to activate technological potential so far not been fully used, enabling environmental improvement and increase of European economy competitiveness as well as promoting choice of environmentally advanced technologies in all investment and trade decisions.

The general objective of the ETAP is effective use of the technological innovation potential for achieving environmental and economic goals.

As defined by the European Commission, environmental technologies are understood as technologies (activities) being relatively less environmentally arduous compared to other competitive technologies (activities).

There are technologies that protect the environment as a whole, generate less pollutants, use resources in a rational way, manufacture environmentally friendly products and assure reuse of waste and its rational neutralisation.

The process of implementation of environmental technologies in Poland is running based on the document of the Ministry of the Environment of 16 February 2006 entitled "Road map for implementation of Environmental Technologies Action Plan in Poland" (Mapa drogowa..., 2006).

The "Road map" is the National Environmental Technologies Action Plan (KETAP). In this plan the main actions undertaken in Poland in the field of environmental technologies and eco-innovativeness are set and methods for action completion and coordination as well as information flow are specified.

The KETAP covers the following areas of activities connected with implementation of environmental technologies:

- the environmental technologies research and implementation and eco-innovation development system (R&D area),
- environmental technologies verification,
- financing research on environmental technologies,
- economic instruments (market),
- ecologization of public orders,
- educational and promotional actions for spreading environmental technologies,
- global actions,
- supporting and coordinating actions.

The most developed area of activities in the KETAP the environmental technologies research and implementation and eco-innovation development system functioning in Poland and including such entities as (Fijał, 2008): main R&D centres working on environmental technologies, perfection centres, advance technologies centres, technological parks, technology transfer parks, technological incubators, technological platforms and research networks.

According to the National Programme Foresight "Poland 2020" the main actions related to eco-innovations currently carried out by units participating in the environmental technologies research, development and implementation system are connected with implementation of the following priority technologies groups (Priorytetowe technologie..., 2009): technologies for manufacturing modern construction and functional materials (advanced materials and technologies), technologies for gaining and using raw materials and technologies of renewable and alternative energy sources, environmental protection technologies and advanced methods and technologies for forming competitiveness of the economy.

Among the selected thematic priority technologies groups a particular role was assigned to eco-innovative power engineering technologies, energy-saving construction technologies, "Polish speciality" applied to manufacture of test and research equipment and unique technological devices as well as the items related to knowledge transformation and advanced technology transfer considering them as a key drivers for effective implementation and commercialization of scientific solutions.

Conclusions

Eco-innovative economy is a key element of global and European Union environmental policy. An important instrument of this policy that stimulates eco-innovation solutions are pro-environmental strategies such as "Europe 2020 – A strategy for smart, sustainable and inclusive growth", OECD "Green Growth Strategy", UNEP "Global Green New Deal" and EU "Strategy for Environmental Technologies".

An analysis of assumptions and objectives of the presented strategies allows us to conclude that eco-innovations become the centre of attention in all these strategies due to the fact that implementation of essentially improved products, processes, methods and procedure is a key to the growth based on knowledge, increased performance and creating new jobs.

Eco-innovativeness is necessary to prosper in the currently highly competitive world economy, where the need for undertaking innovative activities for pro-environmental investments and rational use of natural resources is the order of time, enabling transition to a "green economy".

The "Environmental technologies strategy" being implemented on a large scale in Poland is carried out in almost all economy sectors, e.g. pollution control, water and waste management and power engineering. These technologies allow emissions to be reduced, generate less waste and have a lesser impact on human health and biodiversity, and enable also manufacturing costs to be reduced and company competitiveness to be increased.

The main area of activities carried out within the framework of the National Environmental Technologies Action Plan in Poland is the environmental technologies research and implementation system, involving many units engaged in the KETAP. This area is of utmost importance for realising full potential of booming eco-industrial sector and for stimulating eco-innovations and creating new jobs.

The implementation of new eco-innovative solutions and its commercial application encounter many obstacles. To enable its application on a large scale it is necessary to remove economic and legal barriers and to promote eco-innovative "green" investments as well to increase society awareness in this area.

References

Cele w ramach strategii "Europa 2020", 2011, Komisja Europejska UE - Europa 2020, http://ec.europa.eu/europe2020/pdf/targets_pl.pdf

Działalność innowacyjna przedsiębiorstw w latach 2006-2009, 2010, GUS, Warszawa, p. 6.

Działalność innowacyjna przedsiębiorstw w latach 2009-2011, 2012, GUS, Warszawa, p. 13.

Ekoinnowacje, 2009, Komisja Europejska UE - Środowisko, http://ec.europa.eu/environment/pubs/pdf/factsheets/eco_innovation/pl.pdf

Fijał T., 2008, Implementation of the Environmental Technologies Action Plan in Poland, Proceedings of the 16th IGWT Symposium: Achieving Commodity & Service Excellence in the Age of Digital Convergence, Suwon (Korea), vol. I, s. 280.

Komunikat Komisji COM(2010)2020: "Europa 2020 - Strategia na rzecz inteligentnego i zrównoważonego rozwoju sprzyjającego włączeniu społecznemu", Komisja Europejska, Bruksela, 3 marca 2010 r., p. 5.

Komunikat Komisji do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego oraz Komitetu Regionów COM(2010)546: "Projekt przewodni strategii Europa 2020 - Unia innowacji", Komisja Europejska, Bruksela, 6 października 2010 r.

Komunikat Komisji Wspólnot Europejskich dla Rady i Parlamentu Europejskiego COM(2004)38: Stymulowanie technologii w kierunku zrównoważonego rozwoju – Plan Działań Unii Europejskiej na rzecz Technologii Środowiskowych, Bruksela, 28 stycznia 2004 r.

Mapa drogowa wdrażania Planu Działań na rzecz Technologii Środowiskowych w Polsce, 2006, Ministerstwo Środowiska, Warszawa.

Nauka i technika w 2010 r., 2012, GUS, Warszawa, p. 3.

Nowa unijna tablica wyników innowacyjności. UE wciąż za najważniejszymi rywalami pomimo postępów w wielu państwach członkowskich, 2011, European Commission - IP/11/114, Bruksela, 1 lutego 2011 r.

Priorytetowe technologie dla zrównoważonego rozwoju Polski, 2009, Narodowy Program Foresight "Polska 2020", Warszawa.

Sprawozdanie dotyczące przygotowania Strategii "Zielonego" Wzrostu: Realizacja naszego zaangażowania na rzecz zrównoważonej przyszłości, 2010, OECD, Paryż..

Szanse i zagrożenia dla przemysłu związanego z rozwojem "zielonej gospodarki" - Ekspertyza, 2009, Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Kraków, pp. 5-6.

Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, 2011, UNEP, Nairobi.

Ustawa z dnia 30 maja 2008 r. o niektórych formach wspierania działalności innowacyjnej, Dz. U. 2008, nr 116, poz. 730.

Uwagi GCPL do "Strategii zielonego wzrostu" OECD, 2011, Green Cross Poland, Warszawa.

Wskaźniki zrównoważonego rozwoju Polski, 2011, GUS, Katowice, p. 6.

Zielona gospodarka na forum ONZ, 2011, Ministerstwo Gospodarki, http://www.mg.gov.pl/node/12521

Zielona gospodarka, 2011, Ministerstwo Gospodarki, http://www.mg.gov.pl/Wspieranie+przedsiebiorczosci/Zrownowazony+rozwoj/Zielona+gospodarka

LIFE CYCLE INVENTORY ASPECTS OF INTERNAL TRANSPORT – OPERATION OF THE FORKLIFTS FITTED WITH INTERNAL COMBUSTION ENGINES

Pawel Fuc[*], Przemyslaw Kurczewski[*], Anna Lewandowska[**], Jerzy Merkisz[*], Ewa Nowak[***], Andrzej Ziolkowski[*]

[*]*Faculty of Machines and Transportation, Poznan University of Technology*
[**]*Faculty of Commodity Science, Poznan University of Economics, anna.lewandowska@ue.poznan.pl*
[***]*Faculty of Chemical Technology, Poznan University of Technology*

Introduction

The internal transport is an important element of companies' activity. It relates not only to production plants, but also to service and sales companies and it includes the following operations: displacing (transferring, transporting, carrying), reloading (loading and unloading) and arranging, fastening, measuring (Fijałkowski, 2003; Jacyna, 2009). The internal transport can be performed by using various means of transport like forklift trucks, cranes, conveyors, manipulators and industrial robots. There are two main sorts of internal transportation activity made by the companies: the transport related to the production/technological processes and the transport oriented to service/storing/warehousing operations (Urbanczyk-Piecuch, 2010). The large plants can use, apart from the short distance means of transport, also long distance means of transport like railway rolling stock and the trucks.

The internal transport, as many others areas of companies' activity, can impact on the environment. The economic costs of use of internal transport are the typical component of the companies' accounting, whereas the environmental consequences associated with it are often underestimated or even disregarded. According to Polish law (Environmental Protection Act, 2001) the companies are obligated to pay the environmental fees due to use of the environment resulting from emissions of gases or dusts to the air, introduction of sewage to the water or the soil, consumption of surface- and groundwater, storage of waste. There is a list of enumerated exemptions, but it should be – in principle – assumed, that everyone who uses the environment should calculate a fee and pay it in accordance with the statutory requirements

(Jóźwiak, 2011). The internal transport, especially if performed by using of internal combustion vehicles and working machines, impacts on the environment by emitting of exhaust gases and should be take into account during the calculation of the environmental fees. The environmental fees can be calculated on the basis of fuel consumption (a sort and an amount of this fuel consumed by the engine) or emissions to the air (a sort and an amount of the substances emitted to the air).

However the interest of the companies in the environmental consequences of the transportation processes can go beyond the obligatory law regulations. One of the potential reasons is having of the environmental management system (EMS) implemented. The companies with EMS can make a reduction of the negative impacts on environment caused by internal transport as one of the environmental goals and as an important element of their environmental policy. In such situations, the companies should have an access to proper information concerning not only operation (the fuel consumption and exhaust gases emissions), but also exploitation (repairs and renovations, an exchange of the spare parts and the exploitation fluids) and even the whole life cycle of the vehicles and transport equipment (production of the vehicles and their final disposal).

Material and methods

Life Cycle Assessment (LCA) can be used in order to assess the environmental aspects and potential impacts on the environment (Adamczyk, 2004; ISO 14040, 2006; ISO 14044, 2006; Kowalski et al., 2007; Nitkiewicz, 2011) caused by the transportation processes. There are many examples of using LCA in transport sector (Amatayakul and Ramnas, 2001; Schmidt and Butt, 2006; Finkbeiner et al., 2006; Chester et al., 2010; Sathaye et al., 2010; Howe et al., 2013; Bartolozzi et. al., 2013, Patterson et. al., 2013). In most cases, however, they relate to the external transport, not internal. Only single examples of LCA studies relating to the means of internal transport have been identified (Takehisa, 2002; Toyota, 2003; Jungheinrich, 2010). They are made by the forklifts' producers and used rather for internal companies' purposes. The most popular European LCA database (ecoinvent database v.3; ELCD) include inventory data relating to some off-road vehicles like excavators, loaders and diggers, but the lack of data relating to the forklifts has been identified. For this reason, the research on gathering inventory data connecting with the operation of forklift trucks – as the most popular means of internal transport - has been initiated. The inventory results for internal combustion trucks' operation are presented in this paper while the full LCA results related to different sorts of forklifts can be found in (Merkisz et al., 2014).

There are two main inventory elements related to internal combustion forklifts' operation: a fuel consumption and the exhaust gases' emission. The emission standards for the combustion engines for off-road vehicles (Stage I, Stage II, Stage IIIA, Stage IIIB, Stage IV) (DIRECTIVE 97/68/EC; DIRECTIVE 2002/88/EC; DIRECTIVE 2004/26/EC; COMMISSION DIRECTIVE 2010/26/EU; COMMISSION DIRECTIVE 2012/46/EU) provide the reference values for the exhaust gases emissions, but the emissions levels are expressed in units which are difficult to apply in LCA (g/kWh). Moreover, these values are derived from the measurements made on the engine test stand in the conditions of static engine exploitation (in accordance with the guidelines of the ISO group 8178s). In case of LCA, where the calculations are usually related to the function and the functional unit, the fuel consumption and exhaust gases emissions should reflect the real conditions of forklifts' use and should be related to the working cycles made by the vehicles. For this reason in our study the inventory data were gathered for the functional unit defined as *the transport payload of 1 tonne on the distance of 1 km* for loaded drives and as *1 km distance with no vehicle load* for empty drives (Merkisz et al., 2014).

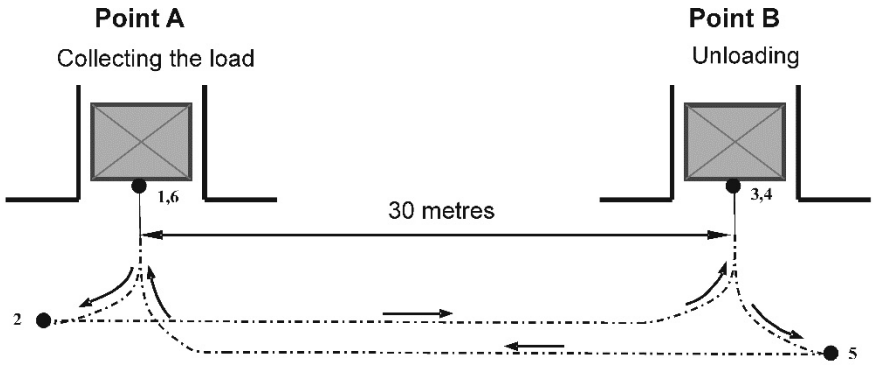


Figure 1. The scheme of the working cycle used in the presented study

Source: own research, Merkisz et al., 2014.

The inventory data was measured in relation to the strictly defined working cycle. It was assumed that one working cycle consists of two main phases: transporting the load and an empty drive. The working cycle begins with a lift to the height of 1 metre and lowering the load in the first bay. Then the driver leaves the bay with the load and drives a distance of 30 metres to the second bay. In the second bay the driver removes the load, backs up the forklift and returns without the load, following the same way, to the first bay (Figure 1) (Merkisz et al., 2014). Such working cycle reflects the typical procedure of loading/unloading performed by the forklifts.

The analysis was made within the scope of "well – to – wheels", which means that included were the processes of production and transport of the fuel ("well – to – tank") and the environmental aspects directly connected to the fuel consumption ("tank – to – wheels").

For the measurement of harmful exhaust gases the mobile device SEMTECH DS was used. It belongs to the PEMS group (PorTable Emissions Measurement System), which allows measuring the concentration of carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx = NO + NO2), total hydrocarbons (THC), and oxygen (O2) (Figure 2).

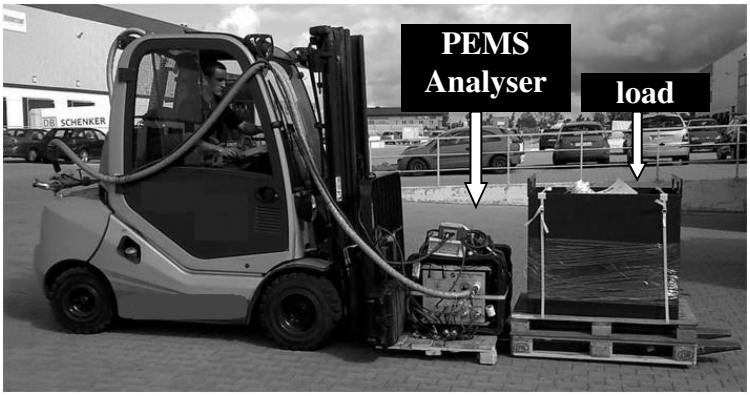


Figure 2. The installation of the measuring equipment on a forklift truck

Source: own research, Merkisz et al., 2014.

The measurement of CO and CO2 is carried out with the use of NDIR (Non-Dispersive Infrared) analyser, NOx are measured with NDUV (Non-Dispersive Ultraviolet), THC is measured by FID (Flame Ionization Detector), and O2 is measured by electromechanical sensor. Measuring ranges for the analysers are as follows: CO2 – 0-20% (accuracy ±3%), CO – 0-10% (accuracy ±3%), NOx – 0-3000 pp. m (accuracy ±3%), THC – 0-10 000 pp. m (accuracy ±2,5%), and O2 – 0-20% (accuracy ±1%). The device has own meteorological station allowing for measuring pressure, temperature and air humidity. It is also equipped in GPS (Global Positioning System) module and allows for communication with the vehicle's diagnostic system. The measurement of the mass flow of the exhaust gases is performed with the use of flowmeter, which operates on the same principle as the Pitot tube (Merkisz et al., 2014).

For the analysis 7 forklifts were selected with the internal combustion engines where 4 powered by LPG and 3 powered by diesel (Merkisz et al., 2014). All analysed forklifts showed a similar lifting height of 3,000 mm and a 150mm full free lift. The forklifts selected were with 1.6 t capacity (types named as: LPG2, LPG3, LPG4) and 3.0 t (types named as: LPG1, DSL1,

DSL2, DSL3), because the vehicles of such parameters are most widely used in Polish businesses (Widlak List, 2013). All analysed forklifts were brand new vehicles, produced by three leading manufacturers on the global market, whose total share on the Polish forklift market in 2012 was 40% for new vehicles and 33.5% for the used vehicles (Widlak List, 2013). More technical information related to the selected forklift trucks can be found in (Merkisz et al., 2014).

Results and discussion

Table 1 presents the inventory results for LPG forklifts' operation. It includes the use of oxygen from the air, LPG consumption and emissions of carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx), and hydrocarbons (THC).

Table 1. The inventory results for operation of four selected LPG forklifts, based on SEMTECH DS measurements (for drive with load [per 1 tkm] and for drive without load [per 1 km])

INVENTORY POINTS		LPG1		LPG2		LPG3		LPG4	
		drive with load [per1tkm]	drive without load [per 1km]	drive with load [per1tkm]	drive without load [per 1km]	drive with load [per1tkm]	drive without load [per 1km]	drive with load [per1tkm]	drive without load [per 1km]
INPUTS FROM NATURE									
oxygen, in air	g	98.14	64.81	226.40	80.24	170.30	68.17	199.92	42.82
INPUTS FROM TECHNOSPHERE									
LPG	dm^3	1.85	1.21	3.72	1.36	2.53	1.05	3.39	0.73
OUTPUTS TO NATURE (EMISSIONS TO THE AIR)									
carbon dioxide	g	2,959.57	1,935.16	6,023.32	2,161.19	4,036.34	1,678.83	5,166.63	1,104.07
carbon monoxide	g	27.04	13.36	38.04	2.44	20.04	9.46	181.62	47.49
nitrogen oxides	g	19.63	13.90	42.23	20.07	56.05	28.11	56.27	12.86
total hydrocarbons	g	3.06	1.51	4.03	2.04	15.73	6.72	19.96	3.93
where:									
aliphatic alkanes	*g*	*1.75*	*0.86*	*2.30*	*1.16*	*8.96*	*3.83*	*11.37*	*2.24*
aliphatic alkenes	*g*	*0.46*	*0.23*	*0.60*	*0.31*	*2.36*	*1.01*	*2.99*	*0.59*
aromatic hydrocarbons	*g*	*0.80*	*0.39*	*1.05*	*0.53*	*4.09*	*1.75*	*5.19*	*1.02*
acetylenes	*g*	*0.06*	*0.03*	*0.08*	*0.04*	*0.31*	*0.13*	*0.40*	*0.08*

Source: own research, Merkisz et al., 2014.

Because the mobile device SEMTECH DS allows for measuring the hydrocarbons in general (total hydrocarbons), in relation to the LPG engines the average composition of hydrocarbons emissions was assumed: aliphatic alkanes 57%, aliphatic alkenes 15%, aromatic hydrocarbons 26% and acetylenes 2% (Merkisz and Kozak, 2002).

The analogical inventory results for DISEL forklifts' operation presented in Table 2. In this case, the average composition of hydrocarbons emissions was assumed as following: aliphatic alkanes 61%, aliphatic alkenes 18.1%, aromatic hydrocarbons 17.8% and acetylenes 3.1% (Carey and Cohen, 1980; Hammerle et al., 1994).

In both Tables the results are related to the drive with and without load. In the first case, the oxygen and fuel consumption and the exhaust gases emission have been measured for the functional unit defined as the transport payload of 1 tonne on the distance of 1 km [per 1 tkm]. In a case of empty drive the functional unit is 1 km distance with no vehicle load [per 1 km].

The presented inventory data can be regarded as high-quality information. The data was acquired with the use of the latest technology of measurements for the emission of harmful exhaust gases made in the real operating conditions, i.e. in the place and time of implementation of the analysed transport processes. The measurements were made in several weeks' intervals (September/October 2013) in comparable weather conditions and while maintaining the identical operating cycles. Table 1 and Table 2 present the values of arithmetical mean of each inventory point (the measurements were made in 10 repeating cycles).

Table 2. The inventory results for operation of three selected DIESEL forklifts, based on SEMTECH DS measurements (for drive with load [per 1 tkm] and for drive without load [per 1 km])

INVENTORY POINTS		DSL1		DSL2		DSL3	
		drive with load [per1tkm]	drive without load [per 1km]	drive with load [per1tkm]	drive without load [per 1km]	drive with load [per1tkm]	drive without load [per 1km]
INPUTS FROM NATURE							
oxygen, in air	g	256.02	124.86	225.13	180.75	159.03	122.13
INPUTS FROM TECHNOSPHERE							
diesel oil	dm^3	0.83	0.40	0.97	0.81	0.64	0.51
OUTPUTS TO NATURE (EMISSIONS TO THE AIR)							
carbon dioxide	g	2,152.85	1,036.92	2,556.34	2,143.57	1,681.15	1,352.01
carbon monoxide	g	15.62	7.12	3.01	2.08	3.22	2.32
nitrogen oxides	g	19.53	9.42	32.63	27.15	8.31	6.41
total hydrocarbons	g	3.05	1.52	1.35	1.03	0.90	0.69
where:							
aliphatic alkanes	*g*	*1.86*	*0.93*	*0.83*	*0.63*	*0.55*	*0.42*
aliphatic alkenes	*g*	*0.55*	*0.28*	*0.24*	*0.19*	*0.16*	*0.13*
aromatic hydrocarbons	*g*	*0.54*	*0.27*	*0.24*	*0.18*	*0.16*	*0.12*
acetylenes	*g*	*0.09*	*0.05*	*0.04*	*0.03*	*0.03*	*0.02*

Source: own research, Merkisz et al., 2014.

The results presented in Table 1 and Table 2 used to define the average inventory data for two types of forklifts' (LPG and diesel) operation (Table 3). LCA practitioners can use the data to perform the LCA studies for transportation processes performed by using the internal combustion forklift trucks. It is worth mentioning that the inventory results presented in the paper relate to the new vehicles produced in 2012/2013 years. The analogical measurements for older vehicles are assumed and will be the subject of our work in the near future.

Table 3. The average inventory results for LPG and DIESEL forklifts' operation, based on SEMTECH DS measurements (for drive with load [per 1 tkm] and for drive without load [per 1 km])

INVENTORY POINTS		LPG *average* drive with load [per1tkm]	LPG *average* drive without load [per 1km]	DSL *average* drive without load [per 1km]	DSL *average* drive without load [per 1km]
INPUTS FROM NATURE					
oxygen, in air	g	173.69	64.01	213.39	142.58
INPUTS FROM TECHNOSPHERE					
LPG	dm^3	2.87	1.46	-	-
diesel oil	dm^3	-	-	0.81	0.57
OUTPUTS TO NATURE (EMISSIONS TO THE AIR)					
carbon dioxide	g	4,546.47	2,309.19	2,130.11	1,510.83
carbon monoxide	g	66.68	18.19	7.28	3.84
nitrogen oxides	g	43.55	25.72	20.16	14.33
total hydrocarbons *where:*	g	10.69	5.80	1.77	1.08
aliphatic alkanes	*g*	*6.10*	*3.31*	*1.08*	*0.66*
aliphatic alkenes	*g*	*1.60*	*0.87*	*0.32*	*0.20*
aromatic	*g*	*2.78*	*1.51*	*0.31*	*0.19*
acetylenes	*g*	*0.21*	*0.12*	*0.05*	*0.03*

Source: own research, Merkisz et al., 2014.

Conclusions

The transportation processes are inherent element of the life cycle of all products and services. It concerns not only the long-distance external transport performed during upstream stages (between the companies in the supply chain) and downstream stages (after sale), but it should concern also the short-distance internal transport realized in the organizations' boundaries.

In the context of the increasing interest in LCA (the work of European Commission on the environmental/carbon footprints of products and organizations), the gathering specific and high quality inventory data concerning the internal transport can be seen as urgent issue. The presented results are the initial step of our project. The works towards collecting the inventory data related to other exploitation aspects (replacement of fluids and parts, repair and maintenance), as well as production and utilisation of the same vehicles are planned as continuation of this research, which is to be carried out in the next years.

Acknowledgments

The authors wish to thank the logistics portal log4.pl for advice and organisational support, and the businesses who agreed to lend the selected forklifts for measuring the emissions.

References

Adamczyk W., 2004, Products Ecology, PWE, pp. 241, (in Polish).

Amatayakul W., Ramnas O., 2001, Life cycle assessment of a catalytic converter for passenger cars; J Clean Prod; 9: 395-403.

Bartolozzi I., Rizzi F., Frey M., 2013, Comparison between hydrogen and electric vehicles by life cycle assessment: A case study in Tuscany, Italy, App. lied Energy, 101, 103-111.

Chester M.V., Horvath A., Madanat S., 2010, Comparison of life-cycle energy and emissions footprints of passenger transportation in metropolitan regions, Atmospheric Environment, 44, 1071-1079.

DIRECTIVE 2010/26/EU of 31 March 2010 amending Directive 97/68/EC of the European Parliament and of the Council on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:086:0029:0047:EN:PDF accessed 14 April 2014.

DIRECTIVE 2012/46/EU of 6 December 2012 amending Directive 97/68/EC of the European Parliament and of the Council on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:353:0080:0127:EN:PDF accessed 14 April 2014.

DIRECTIVE 97/68/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 1997 on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants

from internal combustion engines to be installed in non-road mobile machinery http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri= CONSLEG:1997L0068:20130110:EN:PDF accessed 14 April 2014.

DIRECTIVE 2002/88/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 December 2002 amending Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery http://eur-lex.europa.eu/LexUriServ/ LexUriServ.do?uri=OJ:L:2003:035:0028:0081:EN:PDF accessed 14 April 2014.

DIRECTIVE 2004/26/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 April 2004 amending Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery http://eur-lex.europa.eu/LexUriServ/LexUriServ.do ?uri=OJ:L:2004:146:0001:0107:EN:PDF accessed 14 April 2014.

Ecoinvent, www.ecoinvent.ch accessed 14 April 2014.

ELCD, http://elcd.jrc.ec.europa.eu/ELCD3/processSearch.xhtml accessed 14 April 2014.

Environmental Protection Act as of 27 April 2001, Journal of Laws No. 62, item 627 (in Polish).

Fijałkowski J., 2003, The internal transport in logistic systems, OWPW, Warszawa (in Polish).

Finkbeiner M., Hoffmann R., Ruhland K., Liebhart D., Stark B., 2006, App. lication of Life Cycle Assessment for the Environmental Certificate of the Mercedes-Benz S-Class, Int J Life Cycle Assess, 11(4), 240-246.

Howe S., Kolios A.J., Brennan F.P., 2013, Environmental life cycle assessment of commercial passenger jet airlines, Transportation Research Part D-Transport And Environment, 19, 34-41.

ISO 14040, 2006, Environmental management – Life cycle assessment – Principles and framework CEN, Brussels, 2006.

ISO 14044, 2006, Environmental management – Life cycle assessment – Requirements and guidelines, CEN, Brussels, 2006.

Jacyna I., 2009, The role of transport in the logistic processes realized in the companies, Prace naukowe Politechniki Warszawskiej, 29, 54-63, (in Polish).

Jóźwiak M., 2011, Environmental fee – legal obligation or conscious duty, Monitoring Środowiska Przyrodniczego, 12, 147-153.

Kowalski Z., Kulczycka J., Góralczyk M., 2007, Environmental assessment of the manufacturing processes - LCA, PWN, pp. 204, (in Polish).

Merkisz J., Fuc P., Kurczewski P., Lewandowska A., Nowak E., Ziolkowski A., 2014, Environmental life cycle assessment of forklifts' operation – well-to-wheels analysis, Transportation Research Part D-Transport And Environment (in review).

Nitkiewicz T., 2011, The use of life-cycle assessment for supporting decision-making of wooden caskets producer and its customers, [in]: Current trends in commodity science. Environmental and Market Research, Zeszyty Naukowe UEP, 216, 66-78. .

Patterson T., Esteves S., Dinsdale R., Guwy A., Maddy J., 2013, Life cycle assessment of biohydrogen and biomethane production and utilisation as a vehicle fuel, Bioresource Technology, 131, 235-245.

Sathaye N., Horvath A., Madanat S., 2010, Unintended impacts of increased truck loads on pavement supply-chain emissions, Transportation Research Part A, 44, 1-15.

Schmidt W.P., Butt F., 2006, Life Cycle Tools within Ford of Europe's Product Sustainability Index. Case Study Ford S-MAX & Ford Galaxy, Int J Life Cycle Assess, 11(5), 315-322.

Urbanczyk-Piecuch B., 2010, The transportation system in a production company, http://www.publikacje.edu.pl/pdf/7919.pdf, accessed 14 April 2014, (in Polish).

Widlak List, 2012, Forklifts in Poland – annual market report prepared by Log4.pl; RANDS Andrzej Szymkiewicz, (in Polish). .

ECO-INNOVATIONS FOR SUSTAINABLE DEVELOPMENT OF CITIES AND HUMAN SETTLEMENTS

Marta Gollinger-Tarajko[*], Justyna Tarajko-Kowalska[**]

[*]*Faculty of Commodity Science, Cracow University of Economic, gollingm@uek.krakow.pl*
[**]*Faculty of Architecture, Cracow University of Technology, justarajko@tlen.pl*

Introduction

Planning and achieving the principles of sustainable development in the territorial system of a city is a huge challenge, that requires detailed analyses of development factors and conditionings. This requires programming and implementing such mechanisms that improve the living environment for a local community and ensure sustainable development of a city both at a local (within the city limits) and regional scale (influence area, region). The developed design solutions are based on theoretical assumptions and observation of solutions being currently completed successfully. They are most often presented in the form of so called models of sustainable development. Urban sustainable development comprises both the areas of social and economic as well as spatial activities. This can be carried out in a qualitative as well as quantitative terms (Mierzejewska, 2008). Therefore the mean tasks facing the designers is to create such concepts of dwelling development that enable the main goal of sustainable development, i.e. improvement of the quality of human life to be achieved. In selected cases of design solutions for sustainable cities and human settlements the ten guiding principles of the One Planet Living program are combined with the One Planet Communities program used to achieve the spatial order in conformity with the concept of sustainable development.

Urban sustainable development programmes and principles

To demonstrate capabilities in designing new cities and human settlements in compliance with the principles of sustainable development the One Planet Living and One Planet Communities programmes developed and

recommended by the WWF were used. In these programmes some principles are stipulated that when followed enable the Ecological Footprint (EF) to be reduced and the Human Development Index (HDI) to be balanced. Both these indices being determined by the UN agencies indicate the direction of development for particular regions at the local, national and global levels. The aggregated Ecological Footprint measured in global hectares (gda) quantifies the human pressure on the environment by the use of natural resources and waste generation with waste assimilation capabilities. The published reports (e.g. Living Planet Report, 2012) containing global indicators indicate progressively increasing disadvantageous trends in human environmental pressure observed both in developing and highly developed countries. It follows from the forecasts made that sustainable development can be achieved in a long-term perspective at the HDI above 0.8 and the EF smaller than 1.8 gha per capita. According to the WWF these indices for Poland are as follows: the EF is 3.6 gda, while the HDI is 0.81 (www.footprintnetwork.org).

In the WWF One Planet Living programme (www.oneplanetliving.org) the 10 principles of sustainable living used also, among other things, in the One Planet Communities programme in designing, building and long-term project management (www.oneplanetcommunities.org) are stipulated. They include:

- CO_2 emissions of zero (Zero carbon) – improving energy efficiency in buildings, deriving as much energy as possibly from renewable sources,
- Zero waste – reducing waste generation, recycling, reducing waste flow to landfill to minimum,
- Sustainable transport – promoting low-emission modes of transport, creating spatial solutions reducing the need to travel,
- Local and sustainable materials – using energy-saving and local materials (shortening the supply chain) made from renewable or waste resources,
- Local and sustainable food – choosing local, season and organic diet, while reducing food waste;
- Sustainable water – using water efficiently in buildings, tackling local flooding and water course contamination,
- Natural habitats and Wildlife – protecting and restoring biodiversity and natural habitats through appropriate land use and integration into the built environment,
- Culture and Heritage – reviving local identity, supporting and participating in the arts,
- Equity and Local Economy – supporting regional economies, increasing the share of local production and self-sufficiency of settlement units;

– Health and Happiness– encouraging active healthy lives to promote good health and well being according to the model of life worth living and carrying out various educational actions for sustainable life style (Wehle-Strzelecka, 2008).

The above mentioned principles are consistent at many points with the principles of sustainable urban development derived from an analysis of models of sustainable development. These principles include, among other things, (Tarajko-Kowalska, 2012):

– the effective use of space and land (preventing so called urban sprawl),
– high quality of life through creating attractive architecture and town planning;
– multifunctional space (enabling people to live, work and relax in close vicinity),
– deriving energy from renewable sources;
– waste segregation – waste recycling and utilization,
– restricting vehicle traffic and enhancing efficient public transport and walking and biking as a priority;
– ecological construction materials – maximizing the use of construction materials locally/regionally available,
– efficient water use - sewage treatment, recycling of so called "greywater"; efficient water use in landscape and irrigation systems based on reuse of water resources,
– maintaining biodiversity,
– care about cultural heritage preservation and creating a city's identity.

Connecting these principles poses difficult requirements for designers. They become a specific challenge for innovative urban solutions. They are used, for example, to develop pilot projects that through the special approval process indicate the most valuable eco-innovative solutions. BioRegional – an organisation established in 1992 to promote and implement pro-environmental solutions for sustainability is authorised to endorse such projects. The accepted units so called Endorsed Communities are given not only theoretical but also practical support from BioRegional. For each of selected projects a stringent One Planet Action Plan has been developed. This plan comprises goals and strategies for achieving the 10 One Planet Living principles. Each of selected and implemented units is being monitored by 2020 for achieving the EF at the One Planet level and reducing CO2 emission almost to zero.

An example of Endorsed Communities according to One Planet Living principles

To assess eco-innovative settlement units developed according to the One Planet Living principles BedZed and One Brighton communities in the United Kingdom were chosen. The One Planet Living principles mentioned above were implemented when building and developing these pilot projects. They may be model solutions both for newly designed communities as well as for revitalisation of the existing ones.

BedZed (Beddington Zero Energy Development) was completed in 2002 in Wallington, the London Borough of Sutton. It was designed in partnership with BioRegional Development Group, Peabody Trust, Bill Dunster Architects, Arup and others, as home to 220 residents consisting of 82 houses, 17 apartments and around 1,500 m^2 of commercial space. Currently this is the UK's largest near zero CO_2 emission housing and one of the few of such developments in this country. The Ecological Footprint computed per capita for a BedZed resident is 2.4 gda compared to the UK average of 6.19 gda (www.oneplanetcommunities.org/communities/bedzed).

One Brighton is an award-winning building complex erected in Brighton on the south coast of England in 2010. The development comprising 172 apartments, offices and community space was designed by BioRegional Quintain & Crest Nicholson. The completion of this project proves that it is possible to achieve the quality of life consistent with the sustainable development principles at typical construction costs (www.onebrighton.net).

Based on these two chosen communities the actions undertaken by designers to fulfil the One Planet Living programme principles are presented.

The first principle applies to energy: improving energy efficiency of buildings, minimising energy consumption and using energy renewable sources to reduce CO_2emissions. Energy efficiency is a key component of the EU energy strategy and should be increased by 20% by 2020 (UE L315/1, 2012). According to the Energy Performance of Buildings Directive (EPBD) all buildings built after 31 December 2020 will have to meet high standards of energy savings and the use of energy from renewable sources. At the same time the solutions for decentralised power supply, central heating and cooling systems are recommended (Directive 2010/31/UE). Energy for BedZed was initially produced by the CHP (*Combined Heat and Power Plant*) where all the hot water through a district system was provided. Unfortunately these experimental biomass CHP plant was not successful because its scale was too small to run technically and financially. There are now plans to replace this with a wood-fired boiler. An additional source of heat and electricity is 777m^2 of solar photovoltaic panels and burning biomass from tree surgery waste. The Photovoltaics have been very successful (although expensive) generating

about 19% of total electricity requirements. Due to innovative recuperation technologies the heat for building heating comes also from occupants and everyday activities they carry out, e.g. cooking. At One Brighton 50% of energy requirements are met by alternative solutions. A 500 kW biomass boiler provides energy for room heating and hot water. Also photovoltaic panels with 9.52 kW in peak power are installed and have generated more than 7,000 kWh of electricity during the first year since commissioning. The remaining energy is purchased in bulk from certified renewable sources by Energy Services Company (ESCO) established for community energy provision.

The principle of solid waste reduction, segregation and recycling to reach 2% sent to landfill by 2020 is also implemented in these developments. Besides segregated recycling bins for the four types of waste: glass, paper, plastic and metal at BedZed the Big Hanna composter was installed to handle organic waste on site.

The problem of low emission transport, promotion of public transport, prioritising pedestrians and cyclists, while restricting car traffic was solved at BedZed through the Green Transport Plan. Moving on foot, bike and public transport is promoted. The number of traditionally powered vehicles was reduced in favour of electric cars for which special electric charge points are available. One Brighton is located close to a railway station, thus enabling the use of public transport. To restrict car traffic the number of parking spaces was reduced radically. The residents use car- club cars through a car-share scheme. At the same time a large bicycle storage space was provided.

The principle of construction materials used for building purposes indicates energy efficient locally sourced materials derived from renewable or recycled materials. In fact, only a few of materials meet all the criteria mentioned above. In particular, possibility of reuse, recovery or recycling is often ignored despite of its significant importance to its meaningful importance for general costs of materials and final product. Ecodesign being already at the conceptual design stage assumes “design for recycling” and is currently a global tendency, and the contemporary ecological methods use this principle as a basis. At BedZed substantial amounts of reclaimed materials were used. These materials were delivered from sources located within 56km from the construction site, thus reducing transportation and in consequence, CO_2 emission too. Timber used for construction purposes comes from environmentally friendly sources certified by Forest Stewardship Council A.C. The construction materials used at One Brighton were chosen due to its durability, manufacturing method and transport route. In prestressed concrete frame construction 50% Granulated Ground Blast furnace Slag (GGBS), a steel industry by-product, used as a cement replacement, thus reducing carbon dioxide emissions. In addition breathable clay blocks and wood fibre

insulation were used. All timber used in construction is FSC or PEFC certified. In total 47% of construction materials were reclaimed.

The fifth principle of sustainable construction applies to efficient and effective use of water, proper management of on-site water resources, the use of so called "greywater" and rainwater, efficient water use in landscaping and construction of irrigation systems with reuse of water resources (Tarajko-Kowalska, 2012). Rational water and sewage management is useful both in water savings and reuse. At BedZe most rainwater is collected on site and reused. In each apartment at One Brighton dual flush toilets, water meters and water efficient showers and washing machines were installed. In addition underground rainwater containers were installed and used for irrigating gardens.

The next principle is protecting and restoring biodiversity and natural habitats. Proper nature management and integration with built-up areas is carried out both in whole-city scale (gardens, parks, ecological corridors) and in quarters and housing estates. This includes also such architectonic solutions as green roofs and facades. At BedZed sky gardens were implemented because of high density development. However, at One Brighton an ecological assessment was undertaken by qualified consultants before construction was started. The green gardens planted with native plant species were installed, thus reducing significantly the greens maintenance costs and in addition allows local populations of insects and fungi etc. to be preserved.

The superior principle of sustainable development is to improve resident's quality of life. This principle is applied in sustainable construction. Through attractive alternative solutions implemented in developments under consideration, adjusted to diversified resident's needs the desired effects have been achieved. High quality architecture and urban spaces as well as multifunctional and diversified urban structure provide mixed residential, shop and office functions. This diversify also apartment types, size and price availability adjusted to all resident groups. These principles are followed both at BedZed and One Brighton.

One Brighton's Life Cycle Assessment

The presented developments and implemented eco-innovative solutions may be model solutions for newly designed and revived settlement units. Further case studies are carried out at BedZed and One Brighton to improve the One Planet Living programme indicators. In this chapter the results of Life Cycle Assessment for One Brighton carried out in March 2014 are presented (Hermon, Haynes, Desai, 2014). The effects of work undertaken to meet the One Planet Living requirements are shown. In this assessment (for future design solutions) the records of the two UE legal documents, namely REGO

(Renewable Energy of Origin) (https://www.ofgem.gov.uk/environ-mental-programmes/renewable-energy-guarantees-origin-rego) and PAS2050 (Publicly Available Specification for the assessment of the life cycle greenhouse gas emissions of goods and services), (http://www.sgs.pl/pl-PL/Sustainability/Environment/Carbon-Services/Greenhouse-Gas-Emissions-and-Lifecycle-Assessment/PAS-2050-Carbon-Footprint.aspx) were used. PAS 2050 builds on existing methods established through BS EN ISO 14040 (Environmental Management. Life Cycle Assessment. Principles and Framework) and BS EN ISO 14044 (Environmental Management. Life Cycle Assessment. Requirements and Guidelines).

The standard ISO/TS 14067:2013 specifies principles, requirements and guidelines for the quantification and communication of the carbon footprint of a product (CFP). The text of ISO/TS 14067:2013 has been prepared by Technical Committee ISO/TC 207 "Environmental management" of the International Organization for Standardization (ISO) based on the PAS 2050 guidelines.

One Brighton's Life Cycle Assessment was carried out by an eTool Office's interdisciplinary team (Hermon, Haynes, Desai, 2014).

The aim of this assessment was:

- to determine greenhouse gas emissions for buildings located at One Brighton, in the CO_2 equivalent in tonnes;
- to present possible CO_2 emission reduction by energy eco-innovations in designs and plans for One Brighton;
- to compare various constructional solutions by using the REGO and PAS2050 programs and evaluation;
- to make possible comparison of greenhouse gas emission (GHG) of One Brighton with typical buildings in the United Kingdom.

The data included into Life Cycle Assessment of Brighton are listed in Table 1. About 600 construction components composed of different raw materials were assessed. The emissions related to extraction, processing, manufacture and transportation of construction components and erection of building facilities were determined. It was assumed that facilities will stand for 100 years. The building repairs by finishing both facades and interior wall claddings were also taken into account. Reduction of greenhouse gas emissions can be achieved by lowering repair frequency, using substitutes of most energy-consuming materials and waste materials (e.g. concrete described above). The "operational" emission related to the use of buildings at One Brighton is of considerably less importance. The biomass and gas fired boilers using biomass derived from wooden pallets are used heating and hot water supply. The planned proportion changes in favour of biomass (up to 90%) allow CO_2 emission to be reduced almost to zero. For typical housing

these proportions are reversed. The use of standard buildings is a source of significant GHG emissions. This results from its high demand for electricity and heat derived from fossil fuels for heating, hot water supply and lighting etc.The results of LCA for CO_2 emission index expressed in kg/occupant/year for variant solutions used at One Brighton indicate 60% reduction of greenhouse gas emission compared to typical existing housing. At predicted 90% biomass use and 10% gas used as fuels at One Brighton a 78% GHG reduction is forecast compared to standard housing.

Table 1. Summary of impacts in and out of scope of LCA

Category	**In Scope**		**Out Scope**
Materials	Floors, Walls, Roof, Internal Finish, External Finish, Services, Fittings		Fitting Landscaping
Assembly	Site Preparation and Earthmoving, Assembly Energy associated with all materials		Assembly energy associated with all materials categories listed out scope above
Recurring	Replacement of Materials, Maintenance of Materials, Recurring assembly with main impacts associated with maintaining and replacing building component.		Any recurring impacts associated with out of scope materials or assembly.
Transport and Travel	Transport of Materials with all materials categories, Transport of equipment and trade staff associated, Transport associated with recurring impacts,		Travel of building occupants after construction Transport impacts associated with out of scope materials, assembly of recurring Embodied impact of transport methods (trade staff vehicles)
Operational	Thermal Control, Hot water, Refrigeration, Lighting, Cooking and other kitchen appliances, Laundry appliances, Entertainment and Communications Workshop and garage	Domestic water supply, domestic water treatment, water pumps and bores, small scale energy generation, Office / Work Stations, Personnel or Service Lift / Elevator	Operational Transport Energy, Occupant consumption food, goods and services Occupant waste
End of Life	Deconstruction / Demolition Transport and waste processing Disposal, Reuse, Recovery, Recycling		

Source: One Brighton's LCA Report, 2014.

In Table 2 the data on total CO_2 emission for typical existing housing, One Brighton eco-development and design scenarios based on the REGO and PAS2050 programs for this development are listed.

Table 2. Absolute CO_2e Figures for each model (kg/occupant/year)

Kg CO_2 per Occupant per Year				
		Embodies/assembly Impacts	Operational Impacts	Total
B/mark AVg	Existing Stock	512	2436	2948
	Building 2006	512	1662	2174
	Building 2013	512	1364	1876
One Brighton designed	REGO	382	188	569
	PAS2050	382	1051	1433
One Brighton as Built	REGO	382	812	1194
	PAS2050	382	1904	2286
	REGO 90%Biomass	382	264	645
	PAS2050 90%Biomass	382	1355	1737

Source: One Brighton Life Cycle Assessment, 2014.

Conclusions

In summary one can conclude that LCA covering greenhouse gas emission index only as CO_2 equivalent for One Brighton and comparing it with typical housing is fully reasonable. This results from the One Planet Living and One Planet Communities programmes that require from all EU member states CO_2 emissions to be reduced almost to zero by 2020. The described eco-innovations implemented in two developments presented above may be an example of standard solutions for newly built houses, housing estates and other public facilities in Poland and other UE member states. The stringent requirements for greenhouse gas emission reduction contained in EU directives supported by One Planet Living and Living Planet Communities programmes may improve with time the quality of life of residents, especially in large urban agglomerations. Despite of imperfections and many factors omitted in Life Cycle Assessment this lies a foundation for regular environmental impact assessments for newly built facilities confirmed with an obligatory certificate.

References

Directive 2010/31/UE of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, Dz. U. 153 of 18.06.2010, pp. 13-35.

Directive 2012/27/UE of the European Parliament and of the Council of 5 October 2012 on energy efficiency, Official Journal of the UE L315/1 of 14 November 2012.

Harmon P., Hayes R., Desai P.,2014, One Brighton: Lifecycle Assessment Report, www.onebrighton.net, accessed 20 April 2014.

http://www.sgs.pl/pl-PL/Sustainability/Environment/Carbon-Services/Greenhouse-Gas-Emissions-and-Lifecycle-Assessment/PAS-2050-Carbon-Footprint.aspx, accessed 10.01.2014.

https://www.ofgem.gov.uk/environmental-programmes/renewable-energy-guarantees-origin-rego, accessed 10.01.2014.

Living Planet Report. Biodiversity, biocapacity, and better choices, 2012, pp. 1-80, http://awsassets.wwfpl.panda.org/downloads/lpr_2012_as_printed.pdf, accessed 15.04.2013.

Mierzejewska L., 2008, Zrównoważony rozwój miasta-aspekty planistyczne, [in:] Parysek J., Tolle A. (ed.) Wybrane problemy rozwoju i rewitalizacji miast: aspekty poznawcze i praktyczne, Biuletyn Uniwersytetu im. Adama Mickiewicza w Poznaniu, Seria: Rozwój Regionalny i Polityka Regionalna nr 5, Wydawnictwo Naukowe Poznań, (in Polish).

Tarajko-Kowalska J., 2012, Eko-architektura i Eko-urbanistyka- czyli zrównoważone kształtowanie współczesnej przestrzeni miejskiej w aspekcie idei ekologii miast, [in:] Adamczyk W. (ed) Wybrane aspekty budownictwa zrównoważonego, University of Economic, Cracow, pp. 5-11, (in Polish).

Wehle-Strzelecka J., 2008, Współczesne tendencje w przekształceniu terenów miejskich w aspekcie ekologii miasta, in: Czasopismo techniczne, z.4-A/2008, pp. 249-255, (in Polish).

www.footprintnetwork.org, accessed 10.01.2012.

www.onebrighton.net, accessed 10.01.2012.

www.oneplanetcommunities.org/communities/bedzed, accessed 10.01.2012.

www.oneplanetliving.org, accessed 12.01.2012.

BIODEGRADATION OF STARCH AND POLY(ε-CAPROLACTONE) MODIFIED BY STARCH IN NATURAL FRESH WATER (POND) AND SEA WATER

Aleksandra Heimowska, Maria Rutkowska

Department of Chemistry and Commodity Industrial Science,
Gdynia Maritime University,
a.heimowska@wpit.am.gdynia.pl

Introduction

Thousand tones of plastics have been reported to be discarded into marine environment and river, lake and pond every year. It has been estimated that one million animals are killed every year either by choking on floating plastic items or by becoming entangled in plastic debris. Natural water environment is a unique ecosystem with very different microbially activity and sensitivity to pollution. The development of biodegradable polymers is the key to solving the problems caused by plastic debris (Doi, Kanesawa, Tanahashi, Kumagai, 1992).

Biodegradation process is based on the fact that microorganisms available in the environment, i.e. bacteria, fungi and algae recognize biodegradable plastics as a source of nutrients and consume and digest them. Biodegradation includes different parallel or subsequent abiotic and biotic steps and must include the step of mineralization. The first step of biodegradation is fragmentation (depolymerization) which is followed by mineralization (conversion of the organic carbon into the inorganic carbon) (Krzan, 2013).

The susceptibility of a polymer material to biodegradation depends on its chemical structure. Whether the polymer is made of renewable resources (biomass) for example starch or made of non renewable resources(fossil) for example poly(ε-caprolactone) is irrelevant to biodegradability (Krzan, 2013).

Starch is a hydrocolloid biopolymer (formed by one branched (Amylopectin) and one linear polymer (Amylose) found in a variety of plants including wheat, corn, rice, beans and potatoes. The bioplastics from starch are used mainly in the packaging sector, in catering, the agrarian sector,

gardening and landscaping but also for personal hygiene articles, textiles and medical technology (http://www.bio-plastics.org/).

Starch is a degraded material by different microorganisms like yeast, fungus and bacteria or enzymes: α-amylase, β-amylase or glucoamylase. This natural material may be incorporated as a filler into synthetic plastic matrices, like poly(ε-caprolactone), as a rapidly biodegradable component (Mucha, 2002; Rutkowska, Heimowska, 2008).

Poly(ε-caprolactone) is an important member of the aliphatic polyester family known as susceptible to biological degradation. Poly(ε-caprolactone) is degradable in several biotic environments like compost or sewage sludge. It has been reported that esterase and other kinds of lipase could degrade poly(ε-caprolactone). Degradation of aliphatic polyesters in living environments can result from enzymatic attack or from simple hydrolysis of ester bonds or both (Albertsson, Renstad, Erlandsson, Eldsater, Karlsson, 1998; Darvis, Mitomo, Enjoji, Yoshii, Makuuchi, 1998; Doi, 1990; Jarrett, Benedict, Bell, Cameron, Huang, 1991; Li, Vert, 1995; Park, Shalaby, Park, 1993; Pettigrew, Reece, Smith, King, 1995; Rutkowska, Krasowska, Heimowska, Steinka, Janik, Haponiuk, Karlsson, 2002; Tokiwa, Suzuki, Takeda, 1998; Woodward, Brewer, Moatmed, 1985).

In PCL containing starch, the starch is "complexed" with variable quantities of biodegradable polymeric complexing agents to create a variety of molecular superstructures with a wide range of properties that can be put to many different uses. It is a material to a wide range of manufacturers, which use it to make items such as bags, mulching film, disposable Tableware, accessories, packaging and more (http://novamont.com/).

The aim of this study is the estimation of sea water and fresh water (pond) influence on degradation process of starch and poly(ε-caprolactone) modified by starch.

Experimental

Material

Starch samples containing 80% of thermoplastic starch were received from Natura Packaging – Germany (http://www.bio-plastics.org/).

Poly(ε-caprolactone) samples modified by starch in amount 45% were received from Novamont - Italy (Moore, Saunders, 1997).

Polymer films were cut into 15 x 2 cm rectangles. After incubation in water environments, the samples were left at room temperature and then were taken to investigations.

Environment

Incubation of starch and poly(ε-caprolactone) modified by starch samples took place in the following environments:

– The Baltic Sea water – under natural conditions,
– sea water with sodium azide (NaN_3) – under laboratory conditions,
– fresh water (pond) – under natural conditions.

The incubation of polymer samples in The Baltic Sea water took place in Gdynia Harbour. The samples were located in the special basket at 2 meters depth under the water surface, near a ship of Polish Ship Salvage Company (Rutkowska, Heimowska, 2008; Rutkowska, Krasowska, Heimowska, Steinka, 2002; Rutkowska, Krasowska, Heimowska, Steinka, Janik, Haponiuk, Karlsson, 2002).

For comparison the degradation of polymer samples also took place in sea water with NaN_3 (0,195g/l) in laboratory. The sodium azide was added to sea water for the purpose of excluding the activity of microorganisms and to evaluate the resistance of the polymers to hydrolysis (Albertson, Berenstedt, Karlsson, 1994).

The incubation of polymer samples in fresh water took place in Rumia's ponds in a special basket at 2 meters depth under the water surface.

Methods

After incubation the starch and poly(ε-caprolactone) modified by starch were taken out from all environments and washed with distilled water. Then they were dried at room temperature to a constant weight. The changes in weight and surface morphology of polymer films were tested during the experiment.

– *Weight changes [%]* – were determined using a Gibertini E 42s electronic balance. The weight of clean and dried polymer samples after biodegradation was compared with that before biodegradation. Weight loss was calculated and expressed in a percentage [%]. The average from 3-5 polymer samples was the final result of the investigation.
– *Macroscopic observations of polymer surface* – were analysed organoleptic with a "Konica" camera. The macrographs were analyzed before and after biodegradation.
– *Microscopic observation of polymer surface and structure* – were analysed with the methalographic microscope ALPHAPHOT-2YS2-H linked to a Casio QV-2900UX camera. The micrographs were analyzed before and after biodegradation.

Results and discussion

Environmental parameters

The characteristic parameters of natural fresh water (pond) and sea water under natural and laboratory conditions are presented in Table 1.

Looking at the parameters of each environments in summer months (July, August) we can state that the average temperature 18-23°C was slightly lower than that preferred for enzymatic degradation, which is in the range 20-60°C (Lenz, 1993).

The average value of pH in sea water was alkaline 8.0-8.6 and was higher than that preferred for enzymatic degradation 5-8 (Lenz, 1993).

The incubation process of polymer samples in fresh water (pond) lasted longer than in sea water, so the parameters were measured up to the winter months. The temperature was lower and pH was higher than that preferred for enzymatic degradation.

Table 1. Characteristic parameters of fresh water, The Baltic Sea water and laboratory sea water

Incubation time [months]	Fresh water		Sea water with NaN_3		The Baltic Sea water*				
	Temp. [°C]	pH	Temp. [°C]	pH	Temp. [°C]	pH	Cl^- content [g/kg]	Oxygen content [cm^3/dm^3]	Salt content [pp. t]
July	19.3	8.6	18.0	8.0	19.5	8.2	3.6	7.6	6.4
August	18.5	8.4	23.0	8.0	20.1	8.2	3.3	6.5	6.1
September	12.3	8.5	-	-	-	-	-	-	-
October	10.0	7.7	-	-	-	-	-	-	-
November	7.0	9.0	-	-	-	-	-	-	-
December	3.8	8.3	-	-	-	-	-	-	-

* The Baltic Sea water parameters received from Gdynia Management and Meteorology Institute.

Source: own research.

Abiotic parameters have an influence on development of biotic parameters. Under marine conditions the development of psychrotropic and mesophilic bacteria is observed. Algae, heterotrophic and epilitic bacteria are presented in fresh water (pond) (Rutkowska, Heimowska, 2008; Rutkowska, Krasowska, Heimowska, Steinka, 2002; Rutkowska, Krasowska, Heimowska, Steinka, Janik, Haponiuk, Karlsson, 2002).

Biotic and abiotic parameters should have an influence on the biodegradation process of incubated polymers such as starch or poly(ε-caprolactone) modified by starch.

Weight changes of polymers during biodegradation process

The weight changes of starch and poly(ε-caprolactone) modified by starch after incubation in fresh water (pond), The Baltic Sea water and sea water with NaN_3 are presented in Table 2 and Figure 1, 2.

Looking at the results in Table 2 we can compare the weight changes of starch and poly(ε-caprolactone) modified by starch in three different water environments.

Table 2. Weight changes [%] of starch and poly(ε-caprolactone) modified by starch samples after degradation in different water environments.

Incubation time [weeks]	Starch [S]			Poly(ε-caprolactone) modified by starch [PCL+S]		
	Fresh water	The Baltic Sea water	Sea water with NaN_3	Fresh water	The Baltic Sea water	Sea water with NaN_3
1	-8.9	-4.3	-	-7.7	-4.0	-1.1
2	-9.9	-4.7	-4.0	-7.9	-9.8	-1.2
3	-10.1	-4.9	-4.5	-9.1	-20.8	-1.1
4	-11.1	-5.0	-4.8	-9.1	-89.6	-1.2
5	-11.5	-5.1	-5.1	-10.2	destroyed	-1.2
6	-11.5	-5.5	-5.4	-10.4	-	-
7	-11.6	-5.8	-5.6	-11.9	-	-
8	-12.2	-6.4	-5.8	-12.7	-	-
9	-12.9	-	-	-14.4	-	-
10	-12.8	-	-	-15.1	-	-
11	-13.4	-	-	-16.2	-	-
12	-13.6	-	-	-16.8	-	-
13	-13.5	-	-	-18.0	-	-
14	-13.5	-	-	-18.3	-	-
15	-13.6	-	-	-20.0	-	-3.3
18	-13.9	-	-	-	-	-
32	-63.4	-	-	-	-	-

Source: own research.

During all incubation times the weight changes of starch (polysaccharides) samples were higher in fresh water (pond) than in The Baltic Sea and sea water with sodium azide.

After 8 weeks of incubation the weight loss of starch samples were 12,2% in fresh water (pond) and 6.4% in The Baltic Sea. This was probably a reason of the small activity of enzymes in The Baltic Sea water, when presence of psychrotrophic and mesophilic bacteria could be expected (Rutkowska, Heimowska, 2008).

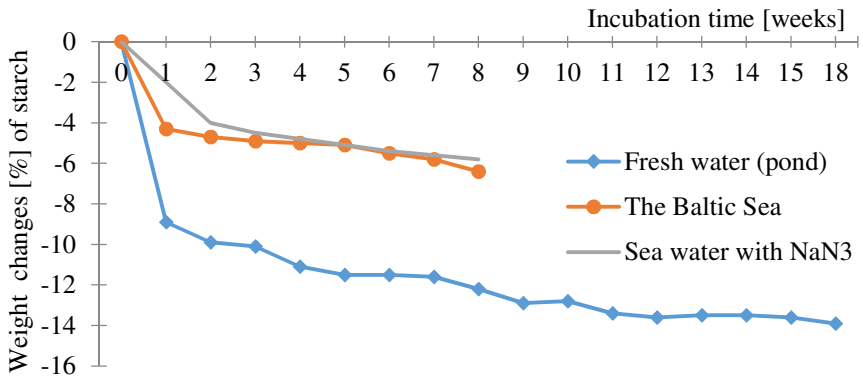


Figure 1. Weight changes [%] of starch samples after degradation in different water environments

Source: own research.

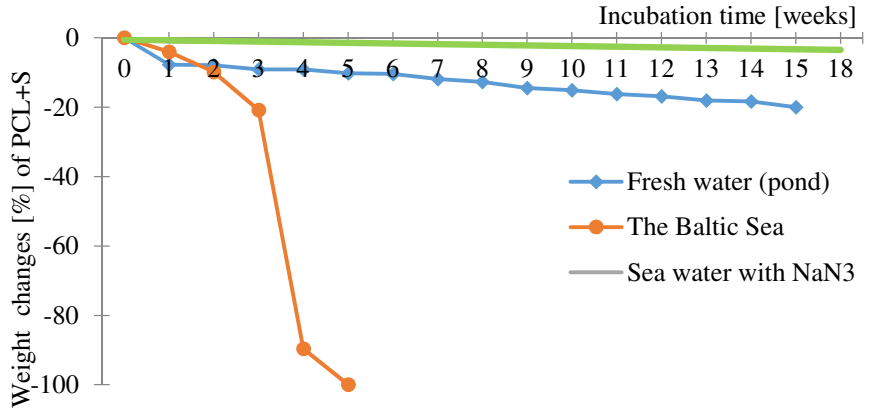


Figure 2. Weight changes [%] of poly(ε-caprolactone) modified by starch samples after degradation in different water environments

Source: own research.

The different phenomenon we can observe in case of poly(ε-caprolactone) modified by starch in that three environments. The weight changes of poly(ε-caprolactone) samples were higher than in the case of starch samples. The weight loss was higher in The Baltic Sea than in fresh water (pond) or in sea water with sodium azide.

After 5 weeks of incubation the samples of poly(ε-caprolactone) modified by starch was completely destroyed in The Baltic Sea, but the weight loss was 10.2% in fresh water (pond) and 1.2% in sea water in laboratory. The present of ephilitic microorganisms in The Baltic Sea water, salinity and water undulation had an influence on degradability of poly(ε-caprolactone) modified by starch (Brzeska, Heimowska, Rutkowska, 2004; Heimowska, Krasowska, Rutkowska, 2011; Rutkowska, Krasowska, Heimowska, Steinka, Janik, Haponiuk, Karlsson, 2002).

Degradation process in Sea water with sodium azide might be explained by no enzymatic hydrolytic ester cleavage. The hydrolysis was much slower than enzymatic degradation of all polymer samples in microbially active environments like fresh water and Baltic sea water (Rutkowska, Krasowska, Heimowska, Steinka, Janik, Haponiuk, Karlsson, 2002).

Macroscopic observations of the surface of polymers during biodegradation process

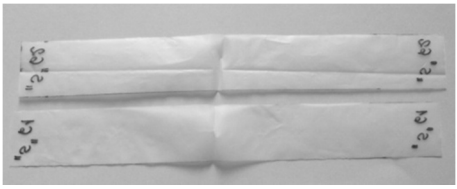
The macroscopic observations were in good agreement with changes of weight of polymer samples.

The macroscopic changes on the surface of starch samples after incubation in natural fresh water (pond) and sea water indicate on their enzymatic degradation (Figure 3). After first weeks incubation in fresh water (pond) the white tarnished places on the starch surface could be observed, which were become more visible after longer incubation time. The first holes were noticed after 15 weeks biodegradation in fresh water. After 32 weeks of incubation in fresh water the starch samples were break up into pieces.

The starch samples got twisted after incubation in The Baltic Sea water. Samples edges became more thin and led to disruption. There were dark brown places on the surface of starch samples, which are a consequence of microorganisms activity.

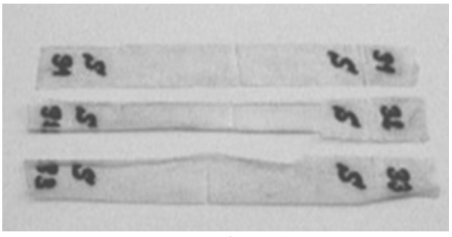
No visible changes in surface of starch samples after incubation in sea water with sodium azide in laboratory could be observed (Rutkowska, Heimowska, 2008).

Macroscopic observation of poly(ε-caprolactone) modified by starch are presented on Figure 4. Biodegradation process of that samples was very fast in The Baltic Sea. After 3 weeks of incubation the dark brown places on



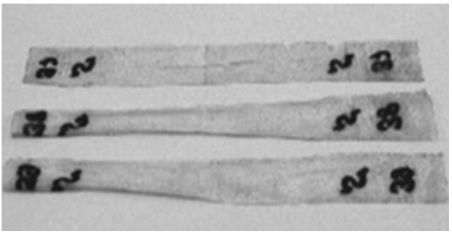
blank

fresh water 6 weeks

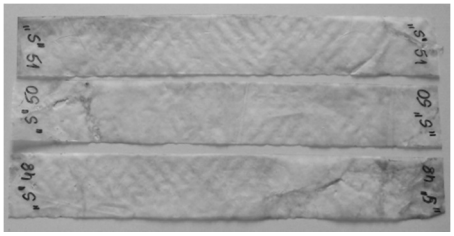


sea water 6 weeks

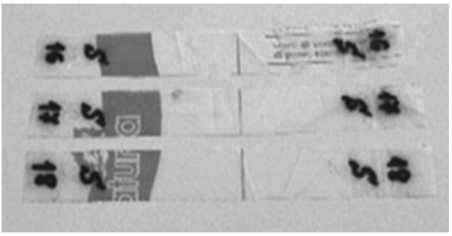
fresh water 8 weeks



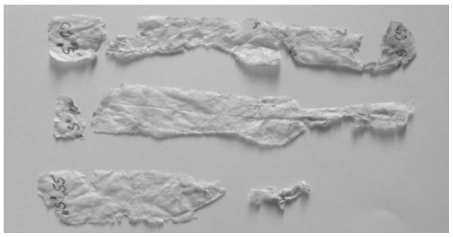
sea water 8 weeks



fresh water 15 weeks



sea water + NaN_3 8 weeks



fresh water 32 weeks

Figure 3. Macroscopic observations of the surface of starch samples after degradation in different water environments

Source: own research.

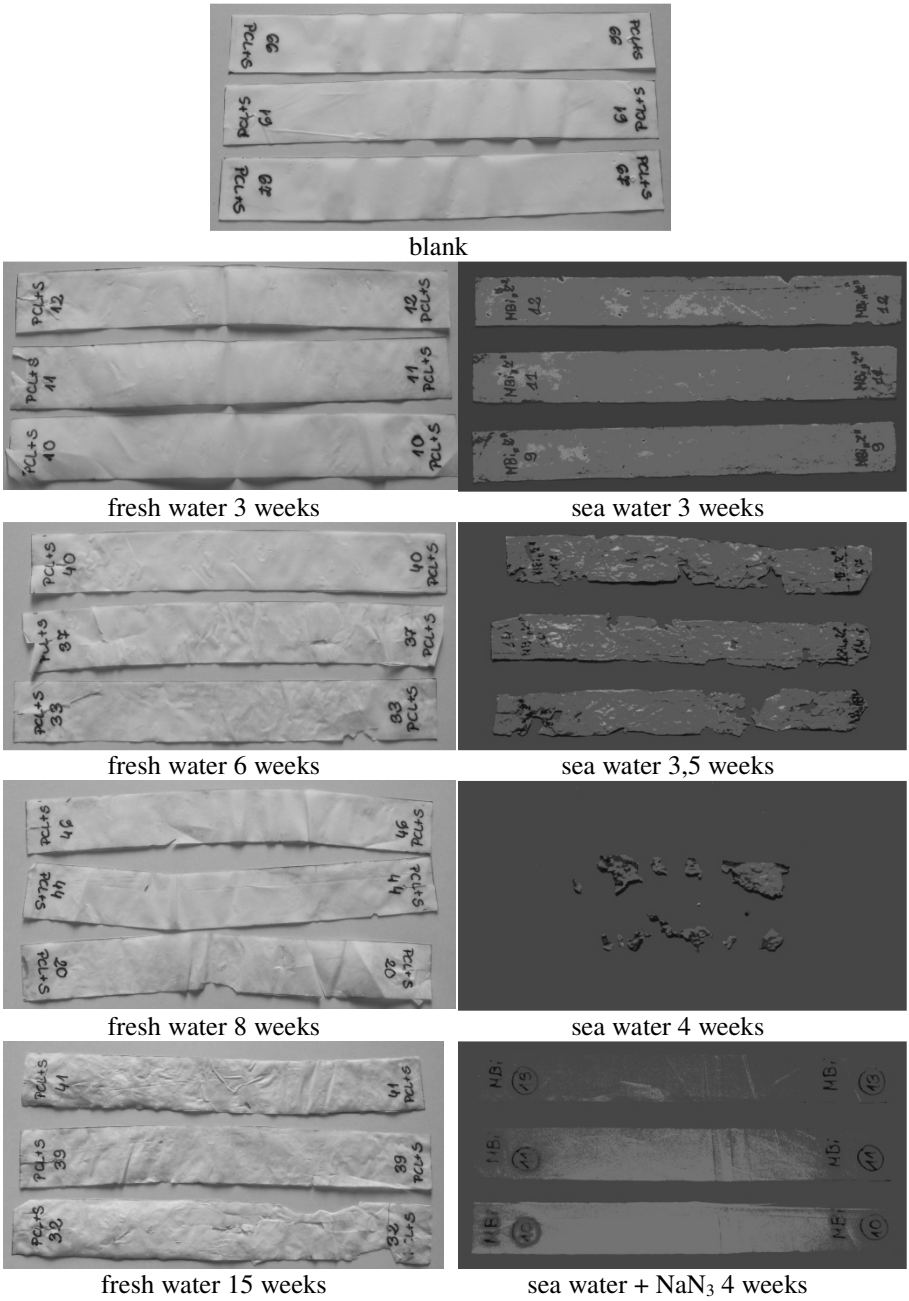
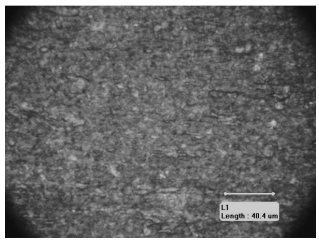
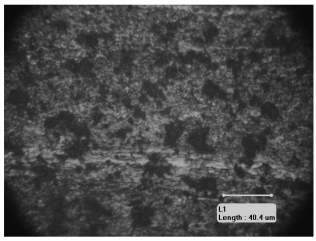


Figure 4. Macroscopic observations of the surface of poly(ε-caprolactone) modified by starch samples after degradation in different water environments

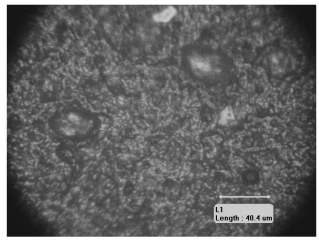
Source: own research.



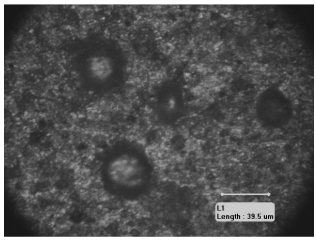
blank



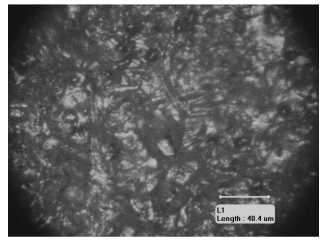
fresh water 6 weeks



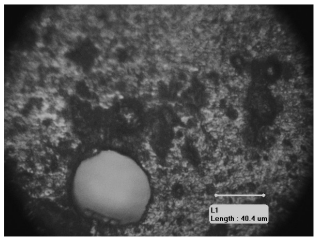
sea water 6 weeks



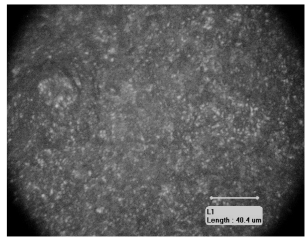
fresh water 8 weeks



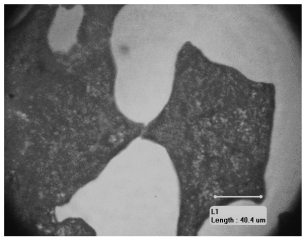
sea water 8 weeks



fresh water 15 weeks



sea water + NaN_3 8 weeks



fresh water 32 weeks

Figure 5. Microscopic observations of the surface of starch samples after degradation in different water environments

Source: own research.

poly(ε-caprolactone) surface could be noticed. After 3.5 weeks the samples had a lot of holes and after 4 weeks the samples were completely decayed.

The poly(ε-caprolactone) modified by starch samples got first small holes after 6 weeks of incubation in fresh water (pond) and after 15 weeks of incubation the first signs of disintegration were visible.

Because of the absence of microorganisms in sea water in laboratory after 4 weeks incubation the samples were in good condition. Only chemical hydrolysis could be expected.

Microscopic observations of the surface of polymers during biodegradation process

Studying the biotic degradation of starch and poly(ε-caprolactone) modified by starch we observed that under natural water conditions the samples could degrade enzymatically, leading to polymer surface erosion.

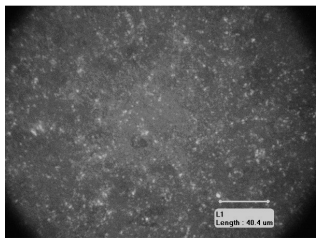
The microscopic changes on the surface of starch samples after incubation in natural fresh water (pond) and sea water are presented in Figure 5.

The surface of blank starch sample, when observed under metallographic microscope, consisted of two phases (bright – crystalline and dark - amorphous). After 6 weeks incubation in fresh water we observed an increase of crystalline phase (the amorphous phase was degraded first) and dark places, which might be an evidence of presence the microorganism agglomerations. The activity of microorganisms led to slowly destruction of starch samples and after 15 weeks of incubation in fresh water (pond) we observed first holes on the polymer film. The connection of holes to each other brought to fragmentation of starch samples.

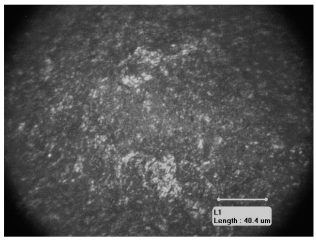
Biodegradation process of starch samples in The Baltic Sea water was more slowly. The increase in crystallinity of starch samples was more visible after 8 weeks of incubation in natural sea water. There were not any holes on the polymer film. There were no evident changes on surface of starch samples after incubation in sea water with sodium azide, which indicate only on chemical hydrolysis.

The microscopic changes on the surface of poly(ε-caprolactone) modified by starch after incubation in natural fresh water (pond) and sea water are presented in Figure 6. After incubation in natural environments the samples were not homogeusly destroyed and there were different images depending on where the picture was taken.

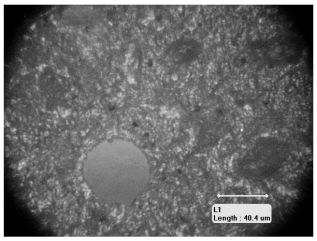
The surface of blank PCL sample consisted of two phases: crystalline and amorphous. After 3 weeks of incubation in The Baltic Sea we observed an increase in crystallinity.



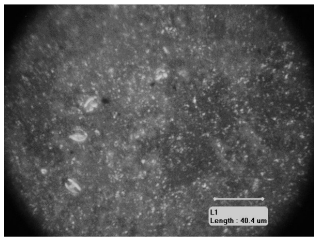
blank



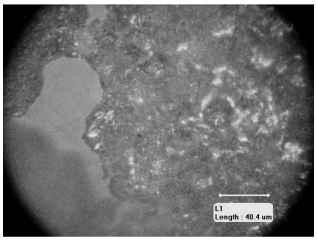
fresh water 6 weeks



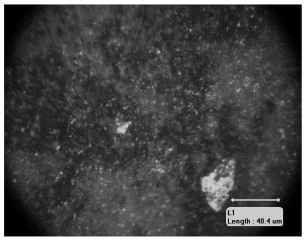
sea water 3 weeks



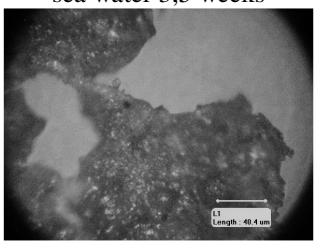
fresh water 8 weeks



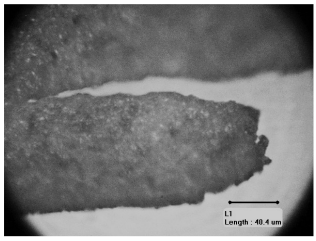
sea water 3,5 weeks



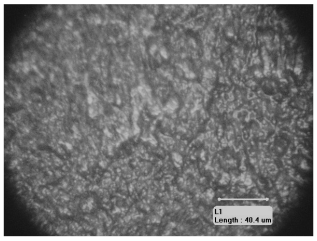
fresh water 13 weeks



sea water 4 weeks



fresh water 15 weeks



sea water + NaN_3 15 weeks

Figure 6. Microscopic observations of the surface of poly (ε-caprolactone) modified by starch samples after degradation in different water environments

Source: own research.

According to literature semicrystallinity of PCL plays a critical role in degradation phenomena, because the amorphous phase is degraded first and as a result an increase in crystallinity of polymers occurs. When most of the amorphous phase is degraded, subsequently the crystalline phase is degraded (Carter, Wilkes, 1984; Fredericks, Melveger, Dolegiewtz, 1984; Jarrett, Benedict, Bell, Cameron, Huang, 1991; Pitt, Gu, 1987).

The microscopic observations confirmed that the amorphous phase was degraded first. After 4 weeks of experiment the decrease of birefringent element was observed, crystalline phase began to degrade. There were black areas on the surface of samples, which represented an agglomeration of microorganisms (there were psychrotropic and mesophilic bacteria under marine condition). Because the biodegradation process of poly(ε-caprolactone) modified by starch was very fast, we could observed holes on polymer film during all incubation stage in The Baltic Sea.

Biodegradation process of poly(ε-caprolactone) modified by starch in fresh water (pond) was more slowly. The increase in crystallinity of PCL samples we observed after 6 weeks of incubation in natural fresh water (pond). After 8 and 13 weeks we noticed less birefringence elements – degradation of crystalline phase and black areas, which is as a result of microorganisms activity (the algae, heterotrophic and epilitic bacteria were developed in the pond). There were holes on the polymer film after 15 weeks of incubation in fresh water (pond).

There were no evident changes on surface of starch samples after incubation in sea water with sodium azide, which indicate only on chemical hydrolysis.

Conclusion

Abiotic parameters (temperature, pH, salinity) and biotic parameters (algae, bacteria) had an influence on the biodegradation process. Different kind of microorganisms in three water environments differently influenced on the degradation process.

Biodegradation of poly(ε-caprolactone) modified by starch in The Baltic Sea was faster than starch samples. The samples were completely assimilated after 5 weeks of incubation. Natural fresh water (pond) was more favorable environment for biological degradation of starch. During degradation process, changes observed for starch and poly(ε-caprolactone) modified by starch in both natural environment (fresh water and salt water) were as a result of an enzymatic hydrolysis, but in sea water in laboratory there were only chemical hydrolysis. The obtained results indicate that poly(ε-caprolactone) modified

by starch was sensitive to enzymatic attack of microorganisms in natural environment and rather resistant to chemical hydrolysis.

Microscopic observations of the surface of starch and poly(ε-caprolactone) modified by starch incubated in natural environments lead to conclusion that the biodegradation this polymers occurred in two stages. The first stage consisted of the degradation of amorphous phase, resulting in an increase in crystallinity of the polymer. The second stage started, when most of the amorphous regions were degraded – next, the crystalline phase was degraded. The polymers became prone to fragmentation and enzymatic surface erosion proceeded.

References

Albertson A.C., Berenstedt C., Karlsson S., 1994, J. App. l. Polym. Sci., 51, 1097.

Albertsson A.C., Renstad R., Erlandsson B., Eldsater C., Karlsson S., 1998, J. App. l. Polym. Sci., 70, 61.

Brzeska J., Heimowska A., Rutkowska M., 2004, Biodegradation of polymers in sea water as a way to utilize packaging materials, Proceedings of 3rd Central-European Conferance Plastics Recycling Science-Industry, Krynica, 81-82.

Carter B.K., Wilkes G.L.,1984, Polymers as Biomaterials, Plenum Press, New York, 67.

Darvis D., Mitomo H., Enjoji T., Yoshii E., Makuuchi K., 1998, Polym. Deg. & Stab., 62, 256.

Doi Y., 1990, Microbial Polyesters, VCH Publishers, New York.

Doi Y., Kanesawa Y., Tanahashi N., Kumagai Y., 1992, Polym. Degrad. Stab., 36, 173.

Fredericks R.J., Melveger A.J., Dolegiewtz L.J., 1984, J. Polym. Sci.: Polym. Phys. Ed., 22, 57.

Heimowska A., Krasowska K., Rutkowska M., 2011, Degradability of different packaging polymeric materials In sea water, The 12th Annual General Assembly of IAMU Green ships, eco shipping, clean seas, International Association of Maritime University, 153-163.

Jarrett P., Benedict C.V., Bell J.P., Cameron J.A. Huang S.J., 1991, in Polymers as Biomaterials, Plenum Press, New York, 181.

Krzan A., 2013, Bioplastics – Opp. ortunity for the Future, Plastice Project.

Lenz W.R., 1993, Advances in Polymer Science, 107, Berlin, 1-40.

Li S., Vert M., 1995, Biodegradation of Aliphatic Polyesters, Degradable Polymers, Chapman and Hall, Chap.4, London.

Moore G.F., Saunders S.M., 1997, Advances in Biodegradable Polymers, Rapra Review Reports, vol. 9, nr 2, 24.

Mucha M., 2002, Polimery a ekologia, Wydawnictwo Politechniki Łódzkiej, Łódź.

Park K., Shalaby W.S., Park H., 1993, Biodegradable Hydrogels for Drug Delivery, Technomic, Lancaster, PA, 26.

Pettigrew C.A., Reece G.A., Smith M.C., King L.W., 1995, J. Macromol. Sci., Pure App. l. Chem., A32, 811.

Pitt C.G., Gu Z.W., 1987, J. Control. Rel., 4, 283.

Rutkowska M., Heimowska A., 2008, Degradacja materiałów polimerowych pochodzenia naturalnego w środowisku wody morskiej, Polimery, 53, nr 11-12, 854-864.

Rutkowska M., Krasowska K., Heimowska A., Steinka I., 2002, Wpływ modyfikacji poli(ε-kaprolaktonu) na jego biodegradację w warunkach naturalnych, Polimery, 47, nr 4, 262-268.

Rutkowska M., Krasowska K., Heimowska A., Steinka I., Janik H., Haponiuk J., Karlsson S., 2002, Biodegradation of Modified Poly(ε-caprolactone) in Different Environments, Polish Journal of Environmental Studies, Vol.11, No. 4, 413-420.

Tokiwa Y., Suzuki T., Takeda K., 1998, Agric. Biol. Chem., 52.

Woodward S.C., Brewer P.S., Moatmed F., 1985, J. Biomed. Mater. Res., 19, 437.

http://novamont.com/

http://www.bio-plastics.org/

SUSTAINABILITY LABELS ON PRODUCTS: CONSUMER UNDERSTANDING AND USE IN BULGARIA

Daniela Ivanova, Elka Vasileva, Stiliyan Stefanov, Nina Tipova

Department of Natural Resources Economics,
University of National and World Economy,
danielai@unwe.bg

Introduction

In the recent years there has been a growth of labels relating to the promotion of ideas of sustainable development (Boer, 2003; Horne, 2009). The labels of sustainability awarded by the respective certification schemes aim to identify the "ideals" to which consumers should aspire (e.g. energy efficiency, recycling, etc.) and/or the significant "evils" that must be avoided (e.g. use of chemical fertilizers and pesticides, unhealthy and unsafe working conditions, child labour, etc.) (Horne, 2009). Using this type of certification schemes illustrates one of the ways in which social effects can interact with market forces to outline the information medium for provision of products and services.

Environmental and ethical labels are part of the tools of policies related to sustainable consumption and production that emphasize disclosure of information for environmentally friendly activities and socially responsible behaviour by companies. Manufacturers through labelling supply the information sought by consumers about the environmental impact of products and thus meet their needs (Stern, 1999). In this way information asymmetries between producers and consumers is reduced in relation to sustainable product characteristics.

Despite the clear statutory relationships and motives environmental and ethical labels do not always increase the demand for products. Many studies have found that among them there are those who do not provide the necessary message and users are not sure of the added value and that leads to confusion and inadequate recognition of products (Delmas & Grant, 2010; Delmas & Lessem, 2012; Dietz & Stern, 2002). Proliferation of numerous sustainable labels that currently exist in the world is another big problem for consumers (Koos, 2011). According to Koos the reason for this is that separate labelling

cannot obtain significant recognition among competing labels on products and thus it is difficult to optimize its role (Koos, 2011).

Unfortunately, there are a very limited number of studies on this problem in Bulgaria (Vasileva, Ivanova, Stefanov & Tipova 2012; Nikolov, Vassileva & Ivanova, 2010). Attempts to explore consumer knowledge and identification of environmental and ethical labels are sporadic and limited in scope.

The purpose of this study is to explore the understanding of Bulgarian consumers of environmental and ethical labels and their attitudes to the consumption of products labelled with them.

Material and methods

Information was collected through direct personal interviews with persons who fall within the scope of the surveyed population through two-stage random cluster sampling based on electoral rolls. The survey was conducted during the month of April - May 2013; it involved 1011 adult citizens of the Republic of Bulgaria.

The study was conducted through a questionnaire organized logically in order to gather accurate and objective information about: understanding of Bulgarian consumers of environmental and ethical labels on products; attitudes to consumption of products with environmental and ethical labels; the social and demographic characteristics of respondents.

Results and discussion

The survey collected information about the respondents' environmental knowledge related to their perception of the various labels used to indicate environmental products and services on the one hand and on the other - the extent to which these labels are recognized and understood. The results indicate the need for more information on the topic and the difficulties both in the identification and orientation in the various labels and in the choice of the labelled products.

Almost all study participants (about 90%) agree that citizens in general and they personally need information about the importance of these specific labels. Three out of four respondents adhere to the view that environmental labels are difficult to understand and that respectively difficult is the choice of products marked with such labels. About 77% of the respondents identify the goods marked with environmental labels as too expensive in relation to their income (Figure 1. Respondents' opinion about environmental labels and products marked with them).

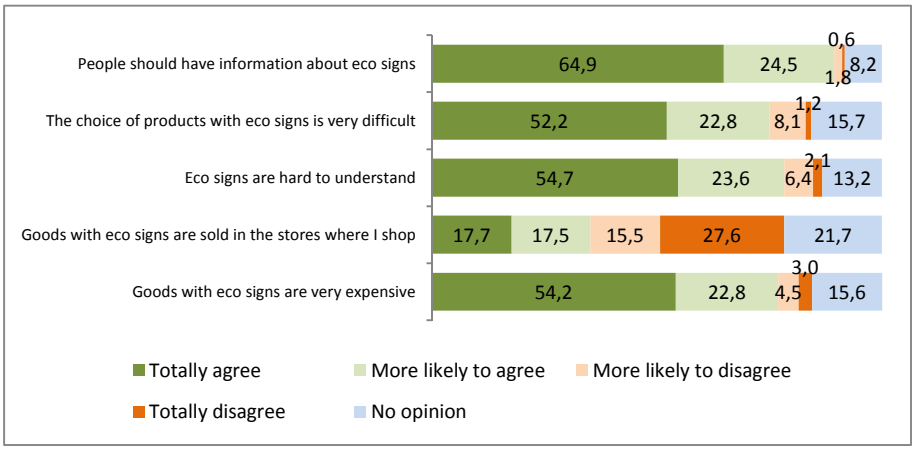


Figure 1. Respondents' opinion about environmental labels and products marked with them (% respondents)

Source: Own research.

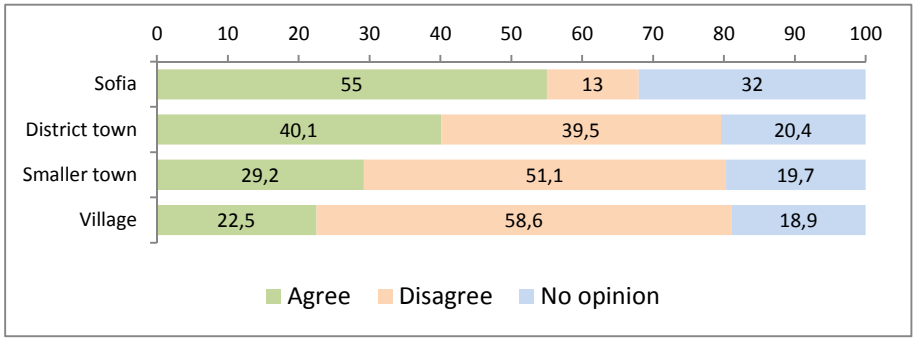


Figure 2. Correlation between the availability of products with environmental signs and the place of residence

Source: Own research.

The analysis of the collected information indicates an uneven distribution of the products with environmental labels in the country (Figure 2. Correlation between the availability of products with environmental signs and the place of residence). They can be found in large urban centres and are virtually absent in smaller places of residence. Only a quarter of the residents of small places (towns and villages) can find products marked with an environmental label in the stores where they shop. In the district towns the share of these answers is about 40%, and in Sofia - about 55%.

Consumer understanding of nine environmental and ethical labels on products

Table 1. Nine signs which meaning they had to recognize

Sign 1	**Sign 2**	**Sign 3**
 EU Organic production	 EU Ecolabel	 Fair Trade
Sign 4	**Sign 5**	**Sign 6**
 FSC certification	 Protected geographical indication	 Protected designation of origin
Sign 7	**Sign 8**	**Sign 9**
 Traditional speciality guaranteed	 Energy label	 The product is obtained by recycling or can be recycled

Results show that the majority of the respondents are poorly informed about the importance of signs and do not recognize them. One sign stands out among the others and is considerably ahead of them because of the extent to which it is recognizable and correctly interpreted by the respondents. This is Sign "*Energy label*" – 43% of the respondents know it and know its meaning (Figure 3. Awareness of the importance of environmental and ethical signs). Another relatively well recognized sign is Sign "*The product is obtained by recycling or can be recycled*", and about a quarter of the respondents were aware of its importance (Figure 3. Awareness of the importance of environmental and ethical signs).

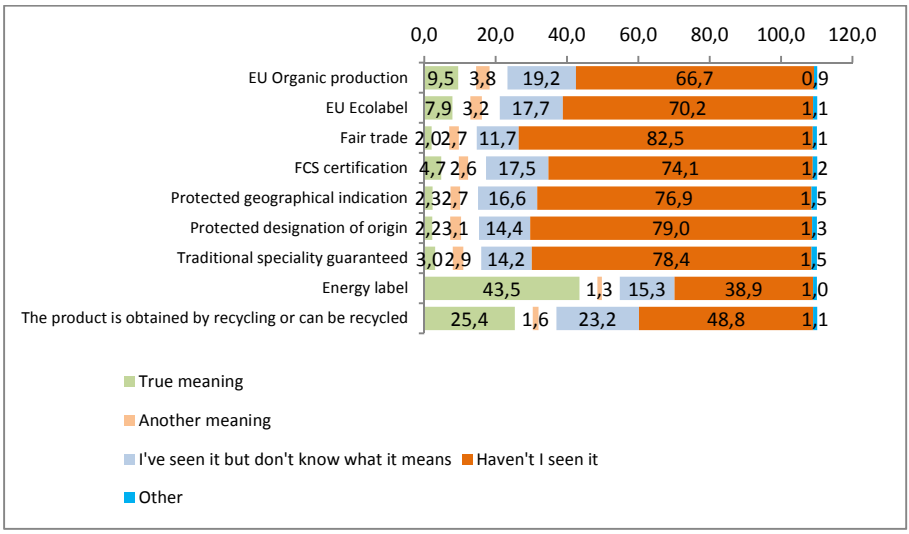


Figure 3. Awareness of the importance of environmental and ethical signs (% respondents)

Source: Own research.

All other seven signs are poorly or very poorly known. About 9% of the respondents understand Sign "EU Organic production" and Sign "EU Ecolabel". The other five signs are recognized by a very small number of respondents (less than 5% of the participants) (Figure 3. Awareness of the importance of environmental and ethical signs).

The study found a strong correlation between information about the labels and the main socio-demographic characteristic of participants - education. While for respondents with higher education the share of those who know "Energy label" sign is about 64% for people with lower levels of education it is only about 16% (Figure 4. Recognition of Sign "Energy label" according to the education of the respondents).

Similar are the results for the Sign "The product is produced by recycling or can be recycled". Almost half of university graduates properly identify the meaning of the label, while among those with the lowest level of education - only about 4% of the participants.

The higher levels of education are generally associated with higher income and that means more personal experience in the purchase of certain types of goods including those marked with the respective labels (e.g. certain types of more expensive appliances on which the sign of energy efficiency is usually placed - refrigerators, stoves, washing machines, television sets). A quarter of university graduates say they have never seen the sign "Energy label" and among people with the lowest education about 70% indicate that answer.

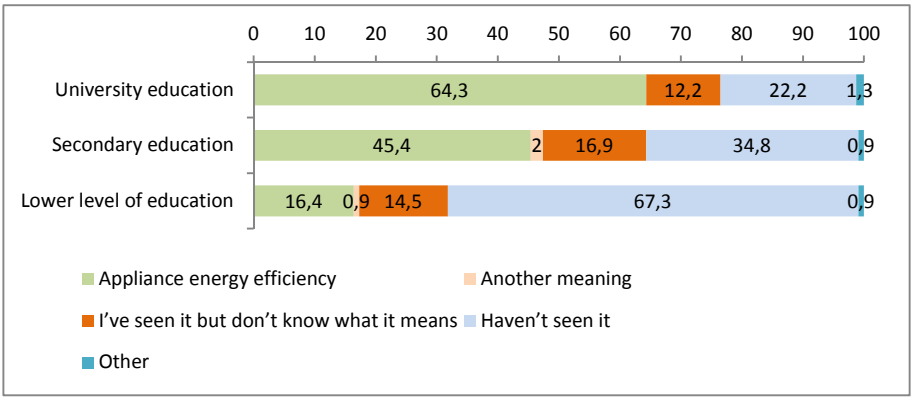


Figure 4. Recognition of Sign "Energy label" according to the education of the respondents (% respondents)

Source: Own research.

The data gathered on the opinions and estimates of the respondents allows to make a kind of a "user profile" for each of the nine labels suggested for recognition.

Interesting are the results for the four signs which can be said to be relatively familiar to the respondents: "*Energy label*" Sign, "*The product is obtained by recycling or can be recycled*" Sign, "*EU Organic production*" Sign and "*EU Ecolabel*" Sign. The opinions of the respondents are presented in Table 2.

What is interesting is that the profiles of the two best known labels ("*Energy label*" and "*The product is obtained by recycling or can be recycled*") are very close. About 50% have bought recently a product labelled with the respective sign. For both signs the respondents are the least informed about the extent to which the relevant product actually possesses the qualities that the label certifies, whether the use of the label is subject to any rules and whether it is subject to any control. More often respondents specifically collected information about the meaning of the label "*Energy label*" (about 64% of those who recognize the sign), and more rarely about the label "*The product is obtained by recycling or can be recycled*" (about 47% of those who recognize the sign) which is understandable since energy consumption is directly related afterwards to the costs and to the household budget. Respondents slightly more often regarded as clear the sign of energy efficiency (about 73% versus about 64% for the recycling symbol).

The profiles of the other two labels (recognized by about 10% of the respondents) - "*EU Organic production*" and "*EU Ecolabel*" also show such similarity. Here the three obscure factors for the respondents are: the extent to which the product complies with the content of the label, the availability of rules for the use of the label and control options. Two out of three people who

recognized the signs (between 60 and 70%) stated that greater awareness of the label would lead to greater interest in the product on their part.

Table 2. Opinion of Consumers who know the meaning of the signs: "Energy label", "The product is obtained by recycling or can be recycled", "EU Organic production" and "EU Ecolabel", (% positive answers)

Sign / Question	Energy label	The product is obtained by recycling or can be recycled	EU Organic production	EU Ecolabel
I have recently bought a product with this sign	51.9	48.8	48.4	35.1
I know the sign because I was particularly interested	63.9	47.0	54.7	54.5
By the look of this sign it is immediately clear what it means	73.5	64.3	43.2	63.6
Products with this sign are really such	76.9	64.9	56.8	53.2
There are rules in which cases the sign can be used	64.8	63.7	58.5	72.7
The use of the sign is controlled	62.2	61.0	51.1	67.5
If I know more about the sign I would be more interested in the product	70.6	70.2	61.7	66.2

Source: own research.

Conclusions

For consumers it is difficult to estimate the impact of the products they consume on the environment or society. Their environmental and ethical characteristics turn them into products of confidence. Certification by a third party and the corresponding labelling can provide the necessary information.

Environmental and ethical labels reduce the costs of information search when consumers understand their messages.

The study of consumer knowledge of the quality of products gained from the existing certification schemes (with a focus on environmental and ethical characteristics) showed that very limited number of such schemes are recognized in our country. It was found that Bulgarian consumers need more information about the labels, the methods of production and processing, the standards, the certification schemes and control. The presence of information asymmetry, in turn, hinders the development of market for products with environmental and ethical characteristics in the country. The limited market penetration of environmental products, coupled with the poor knowledge of Bulgarian consumers opened the door to the emergence of unregulated eco labels. This can create further confusion and lack of confidence among consumers.

In this regard, the role of stakeholders, including government institutions, NGOs, business organizations and others is crucial for the impact of information and the creation of trust in environmental and ethical product labelling.

Acknowledgments

The financial support provided by the National Science Fund and the Ministry of Education and Science for the Project "Sustainable Consumption in Bulgaria – changing patterns" is gratefully acknowledged.

References

Boer J., 2003, Sustainability Labelling Schemes: the Logic of Their Claims and Their Functions for Stakeholders, Business Strategy and the Environment, 12 (4), 254 - 264.

Delmas M., Lessem N., 2012, Eco Premium or Eco Penalty? Eco labels and quality in the organic wine market, Publishing Institute of Environment and Sustainability, http://www.environment.ucla.edu/media/files/Delmas-Lessem-WINE-2012-va-uft.pdf, accessed 21 April 2014.

Delmas M., Grant L., 2010, Eco-labeling Strategies and Price-Premium: The Wine Industry Puzzle, Publishing Institute of Environment and Sustainability, http://www.environment.ucla.edu/perch/resources/delmas-grant-bas.pdf, accessed 21 April 2014.

Dietz, T., Stern P., 2002, Exploring New Tools for Environmental Protection, [in:] T. Dietz, & P. Stern (Eds.) New Tools for Environmental Protection: Education, information and Voluntary Measures, National Academies Press, pp. 3 - 15.

Horne R. E., 2009, Limits to Labels: The Role of Eco-labels in the Assessment of Product Sustainability and Routes to Sustainable Consumption, International Journal of Consumer Studies, 33 (2), 175 - 182.

Koos S., 2011, Varieties of Environmental Labelling, Market Structures, and Sustainable Consumption Across Europe: A Comparative Analysis of Organizational and Market Supply Determinants of Environmental-Labelled Goods, Journal of Consumer Policy, 34, 127 - 151.

Nikolov B., Vassileva E., Ivanova D., 2010, Quality labeling and information asymmetry: Identification of quality labeling certification schemes in Bulgaria, 17th IGWT Symposium, "Facing the Challenges of the Future: Excellence in Business and Commodity Science", Bucharest, Romania, 21st – 25th September 2010, Proceeding of Symposium, Volume I, pp. 83 - 92, Special issue of the Romanian Journal "Quality – access to success", Year 11, No 116, September 2010.

Stern P. 1999, Information, Incentives, and Proenvironmental Consumer Behavior, Journal of Consumer Policy, 22, 461 - 478.

Vasileva E., Ivanova D., Stefanov S., Tipova N., 2012, Eco-labelling and Information Asymmetry: Independent Consumer Information through Eco-labels in Bulgaria, [in:] Corson, M.S., van der Werf, H.M.G. (Eds.), Proceedings of the 8th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2012), 1 - 4 October 2012, Saint Malo, France. INRA, Rennes, France, pp. 171.

INTEGRATING ENVIRONMENTAL AND ECONOMIC LIFE CYCLE ANALYSIS IN BUILDING INDUSTRY

Katarzyna Joachimiak-Lechman

Faculty of Commodity Science, Poznan University of Economics, katarzyna.joachimiak-lechman@ue.poznan.pl

Introduction

Sustainable development comprises one of the most important challenges of the modern world and sets priorities of the European Union at the same time. The concept is reflected both in micro-scale and in the perspective of single products and services and also in sectoral analyses that is in the context of individual economic sectors, within which rules of sustainable development, such as building industry, transportation, energy etc. are implemented.

Lately, it is observed that construction industry increasingly represents thinking in terms of a life cycle category and involves the idea of sustainable development into this area. Sustainable building industry consists in designing, erecting and using or knocking down buildings following the 4R principle (Adamczyk & Dylewski, 2011):

1) Reduce – smaller use of natural resources, energy and construction materials for construction of a building;
2) Reuse – using construction materials again where it is possible;
3) Recycle – recovery and recycling of materials used in erection of buildings as well as designing with the purpose of recovery;
4) Renewable – making building components from renewable resources and using energy coming from natural resources, however, merely renewable carriers.

The concept of the sustainable building consists in integrated evaluation of environmental, economic and social aspects of the building project perceived by the prism of the whole life cycle (Yongtao et al., 2011). Life Cycle Assessment (LCA) is an environmental management technique, which has been frequently used in the construction business (for example

Kofoworola & Gheewala, 2008; Blengini & Carlo, 2010; Ortiz-Rodríguez et al., 2010; Bribián et al., 2011; Lewandowska et al., 2012). Reference books distinguish two approaches to the problem, namely: bottom-up, in which the research comprises building materials or particular modules of a building and top down, where the whole building and its whole life cycle is analyzed (Erlandsson & Borg, 2003). Economic consequences related to the efficiency of building projects are of no less importance than environmental effects. A technique which enables cost assessment to be made over a specified period of time is Life Cycle Costing (LCC).

Building industry applies normalized methodology of cost calculation basing on particular life cycle stages (ISO 21929-1:2011) and it is the building sector for which the models of incorporating life cycle costs into the financial feasibility analysis were elaborated first (Langdon, 2007). Three basic purposes of the cost analysis of the life cycle in this sector can be identified, in particular: support of the decision-making process – choice among alternative scenarios of the best solution in the context of building materials, technology etc., improvement of the process of cost management – planning the structure and cost level considering the quality and functionality of individual modules in the whole life cycle and prediction of operating costs (Bakis el al. 2003)

From a user perspective it seems to be a good idea to implement environmental issues in building investments decision. The main objective of this paper is to present the economic and environmental dimension of chosen life cycles phases of two residential buildings that differ from one another in the technology used for their erection and the energy standards met. It is demonstrated, how important in decision- making context is to link environmental impacts and costs generated by building's life cycle processes.

Material and methods

In fact, traditional LCC and LCA, beyond being based on the perspective of the life cycle (Life Cycle) and functioning as a tool supporting decision-making processes, have not much in common (Norris 2001). Therefore, in the view of numerous divergences occurring in the same environmental perspective and economic life cycle, for the purposes of efficient correlation of LCA with a cost analysis, a new tool called environmental life cycle of the product so called *environmental LCC* (e-LCC), also referred to as *LCA-based LCC* (Kloepffer 2008) was developed. The integration of LCA and LCC life cycle techniques requires defining a coherent target and scope of the research. It is also important to maintain identical (or equivalent) limits of the system and determination of analogue functional unit (Swarr el al., 2011).

Research object

The present analysis, basing on the research work of the Wood Technology Institute in Poznań (Lewandowska et al., 2012), chose two model detached houses with the area of 98.04 m2, that differ from one another in material structure, technology used and the energy standards applied. One of the buildings was designed in a brick technology with the application of a conventional heating system in the form of central heating with a gas boiler, complying with requirements for thermal insulation binding currently in Poland (indicator of energy demand necessary for heating 123 Kwh/m2a), while the other, in the wood technology as a passive building (indicator of energy demand necessary for heating 15 Kwh/m2a) with the heating system in the form of a ground source heat pump of vertical position of a collector and efficiency index equalling 4.

Function, functional unit, reference flow

Buildings perform a number of functions, from the point of view of conducted researches, the useful and wrapper functions are the most important. In connection with the above, the functional unit was defined as: *ensuring 98.04 m2 of the useful floor and ensuring the users protection against harmful effects of external factors for a period of 30 years.* Time horizon of the research was determined by taking into account declared by the manufacturer life of the system using renewable energy sources, assuming that analysed buildings treated as a whole possess the same lifetime (contrary to comparable heating systems), the reference stream was defined as 1 building performed in a given variant.

System boundary

Building life cycle presented according to the norm ISO 21931-1 consists of stages *before the handover of the building* (production of building materials and construction process*), after the handover of the building* (use and maintenance, operation of the building) and *end-of-life stage* (ISO 21931-1: 2010). Due to complexity of processes of the building life cycle, processes which are potentially a source of key environmental and economic aspects and differentiate analysed buildings the most were decided to become the scope of the research. In connection with the above, the analysis covered production of building materials, the assembly of the heating system, use of the building (including the use, renewal and maintenance, exchange, renovation and final management of waste arising at this stage) and final management of demolition waste.

Life Cycle Inventory- general assumptions

Another step of the integrated LCA/LCC analysis consists in identification of all material and energetic flows within a given system of the product and allocating the costs. In this way each input and output referring to individual unit processes and attributed to the functional unit shall be presented both in physical and monetary quantity. However, the realisation of the assumed functional unit also requires incurring additional costs which do not have direct reference in the environmental analysis. Due to complexity of research objects however, it was decided to limit cost estimation of identified environmental interventions with the exception of the installation of the system for which calculations of labour costs were identified. This way a cost system adjusted to requires of LCA methodology and in accordance with assumptions of ecological bookkeeping is made (Kowalski el al., 2007).

Costs of the life cycle of individual stages are estimated on the basis of the rates applied during research conduct (2012/2013). The stage which at maintaining proper practices generates advantages (both environmental and economic ones) is the stage of final waste management. The material recycling benefits were determined according to the rates of a particular recycling centre. For most of the wastes the basis of the calculation was a direct purchase of wastes from owners of the buildings by businesses dealing with this type of activity. In case of wastes that require earlier dismantling/ removal and for those that are not purchased from individual parties (concrete debris, polystyrene insulation) the calculations included dealers of segregated waste collection and household waste treatment systems. Benefits from energy recycling were identified with the rates offered to regular clients by cement plants for high energy wastes designed for alternative fuel (Joachimiak-Lechman & Zarebska).

Economic data for most analysed stages of the life cycle was taken from the research project realised by Institute of Wood Technology in Poznań (Lewandowska el al., 2012). Their basic source was architectural projects of considered buildings. Technical parameters of the system using renewable energy sources and information concerning the installation of heating systems were gained from the manufacturer and in the department of sanitary system. Thermal energy consumption was estimated on the basis of data obtained from calculations in accordance with methodology of energy performance certificates, while other media consumption was estimated on the basis of available statistics.

In the 30-year period the use of a residential building, double replacement of gas furnace (on the basis declared by the food manufacturer) was planned. Moreover, the following frequency of renewals and maintenance was assumed: painting the walls every 5 years, painting the external doors every 10 years, painting internal doors every 15 years, painting external elevation

every 25 years, painting window frames (only building B) every 5 years, lacquering the floor (only building B) every 25 years.

Particular waste fractions were linked with the commonly applied nowadays practices of the final building waste disposal/management. The assignment of the final method development for various construction waste was made on the basis of data obtained from operating in Poland waste management plant (Joachimiak-Lechman & Zarebska)

Life Cycle Impact Assessment and Cost Calculation- general information

The LCIA analysis was made in the SimaPro Analyst 7.3 Program with the Impact 2002+ method. The results were presented on the most cumulated level, where the environmental impact Figure is expressed with the eco indicator value (LCA Indicator) and measured in environmental points [pt]. The highest the positive Figure of the indicator, the bigger the negative environmental impact; the negative value is understood as environmental benefit.

The cost indicator (LCC Indicator) is a measure of the costs and revenues generated during the 30 years of building life cycle, discounted to present value. A financial analysis relies on real prices at the discount rate of 5%. Positive economic indicator means cost, the negative means revenue and is shown in the European value [Euro]

Results and discussion

Environmental impact and economic assessment

On the basis of the conducted integrated LCA/LCC analysis it was considered that both in environmental and economic point of view, a passive building made in the wood technology is a more favourable version of the building. As indicated above (Table 1, Figure 1 and 2), the life cycle of the building in the passive variant generates negative impact on the environment equalling 38.39 pt, while discounted costs of the life cycle equal Euro 53.066. This means that in relation to a traditional building there was the decrease in analysed indicators of the life cycle by 47.43% and 23.54%, respectively.

Considering the environmental dimension it is necessary to notice that the use is definitely the decisive stage of the life cycle both of a traditional and passive building. In case of the first one, the most environmental impact is generated by the use of the thermal energy (on the basis of the natural gas). This aspect has been assigned the value of the eco-indicator at the level of 37.56 points which constitutes 62% of the impact of the use stage and over 50% of the whole life cycle burden.

Table 1. Comparison of environmental impact and costs of the life cycle of two model residential buildings

Life Cycle Stages	Masonry traditional				Wooden passive			
	LCA-Indicator	%	LCC-Indicator	%	LCA-Indicator	%	LCC-Indicator	%
Building materials production	16,13	22,09	31 831	45,86	12,95	33,73	30 942	58,31
Heating Installation (including materials)	0,71	0,98	8 630	12,43	1,07	2,77	11 376	21,44
Use	60,67	83,07	29 808	42,95	33,55	87,41	11 725	22,1
Demolition	-4,48	-6,13	-863	-1,24	-9,18	-23,91	-976	-1,84
TOTAL	**73,03**	**100**	**69 405**	**100**	**38,39**	**100**	**53 066**	**100**

Source: own research based on (Lewandowska el al., 2012; Joachimiak-Lechman el al., 2013, Joachimiak-Lechman & Zarebska).

In case of a passive building, the strongest environmental impact was revealed for the consumption of electricity for living purposes (lighting, household appliances and TV) which is characterised by the eco-indicator value at the level of 17.55 points. Heating processes are also realised with the use of electricity and generate environmental impact at the level of 10.76 points. Such a considerable decrease in the impact of this aspect (as of the whole life cycle) was obtained owing to the design of the building so that it ensures the low indicator of the demand for electricity and system using renewable sources of energy on the basis of the heat pump of high efficiency.

Passive building is marked with high degree of insulation which is potentially translated into a number of building materials. However, the analysed building made in the passive version is considerably "lighter" than a conventional equivalent which is influenced by its material structure – high share of wood, wood-based materials and foam glass (foundation/floor). In case of a passive building, lower value of the eco-indicator of the production stage of building materials (decrease in relation to the traditional version by 20%) is influenced by favourable wood carbon footprint which by "catching" carbon dioxide from the atmosphere contributes to limitation of the greenhouse effect

(Lewandowska el al., 2012). The material structure also decides about the environmental impact of the management stage of demolition waste. Higher benefit for this reason was revealed for a passive building, which is connected with the weight and type of waste intended for material recycling and energy recovery (Joachimiak-Lechman & Zarebska).

The only stage of the life cycle of a traditional building which is better than of a passive building is the heating installation system. These aspects were on purpose presented separately in order to reveal that unjustified solutions at this stage often turn out to be much more beneficial in a comprehensive approach. The increase in environmental impact generated during the considered stage of the life cycle is caused by a different

construction of heating appliances, installation of an alternative system (necessity of trenching) and fill of the collector. Comparison of individual stages of the life cycle of analysed buildings is presented in the graph below.

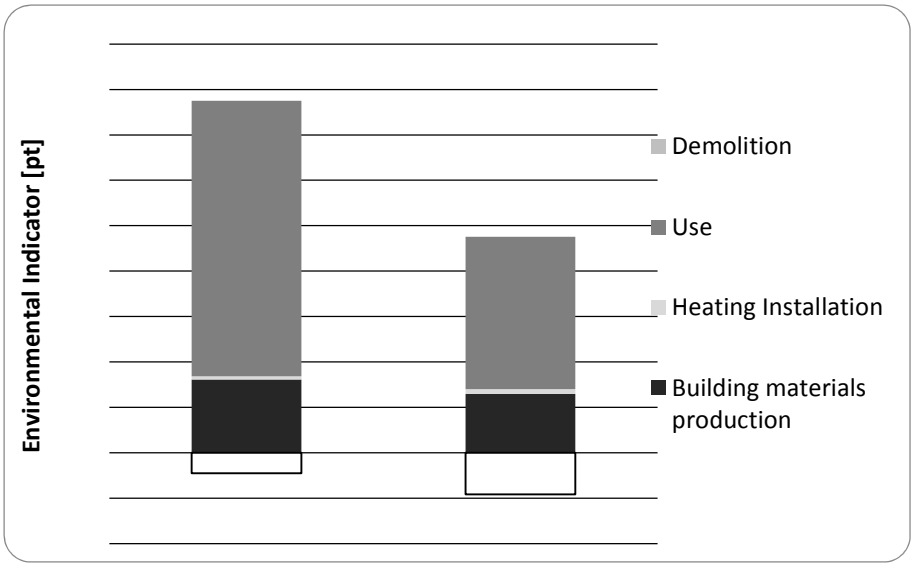


Figure 1. Comparison of environmental impact of the life cycle of two model residential buildings

Source: author's own research based on (Lewandowska el al., 2012).

When considering costs of the life cycle it was recognised that independently on the analysed building, production of building materials (Table 1 and Figure 2) is a domineering stage in this respect. In case of a conventional building, its use is placed in the second place (almost 43%), and followed by the installation of the heating system (12.43%). The percentage share of operating costs and system installation for a passive building is placed at the similar level and equals about 22%.

The consumption of thermal energy (almost 60% of costs at this stage and 25% of costs of the life cycle) is the greatest cost driver for the use of a traditional house. When comparing costs of the life cycle of analysed buildings, the most important differences were recorded for this aspect. The cost of implementation of heating processes in a passive building is almost 60% lower than in a conventional building which as a result contributes to the fact that a passive building is characterised by a lower indicator of life cycle costs.

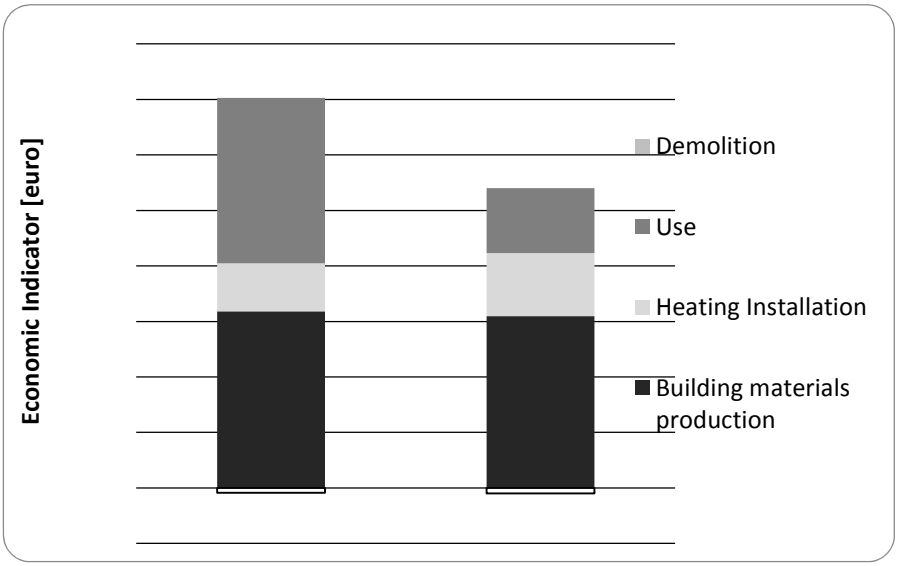


Figure 2. Comparison of economic impact of the life cycle of two model residential buildings

Source: author's own research based on (Joachimiak-Lechman el al., 2013, Joachimiak-Lechman & Zarebska).

Likewise in case of environmental analysis, the stage of alternative system installation is characterised by higher indicator of cost effectiveness than the typical gas system. Especially, it is apparent in the context of investment outlays (the heat pump is more expensive than the gas boiler; there is a necessity of the purchase of the system additional parts– the collector and the fill) and in the context of assembly works, the system of the lower source has the greatest impact on the costs.

Discussion

In many sectors of the economy, environmental evaluations such LCA are of particular importance. One of them is the power industry. The applications of LCA in assessing energy generation systems have been shown in, among others, a report of the World Energy Council, which demonstrated the benefits of using life-cycle analysis in this field. In Poland, the application of LCA in the energy industry has long been the focus of studies by the Cracow Institute of Mineral Resource and Energy Management (Kulczycka & Pietrzyk-Sokulska, 2012). Findings from such studies show a need to persevere in initiatives to assess the environmental potential of renewables.

The key issue deciding on the reduction of the negative environmental baggage of a passive building in relation to a conventional one is the implementation of heating processes. When comparing these aspects, a clear decrease in the value of an eco-indicator for such environmental categories as: natural resources and climate changes was noted. Basically, this is connected with two environmental interventions: decrease in the consumption of non-renewable fuel – natural gas and reduction of heating emissions – mainly CO2. What is worth to indicate, as shown in the technological scenario for Poland provided in the ecoinvent database, the environmental loads of producing 1 kWh of electricity is greater than that of generating 1 kWh of heat from natural gas. The environmental impact of electricity is more than 5.3 greater than that of an equivalent amount of heat. However, very high efficiency of a heating appliance along with the proper insulation causes relatively low consumption of electricity in relation to the gained warmth which is the cause of reduction of the overall LCA indicator observed for a passive building.

Low pricing model of a passive building can be explained likewise. The cost of gaining one unit of electricity is relatively high in relation to natural gas. Despite this, it was shown that the total cost of maintenance of a passive building is lower than of a traditional one. The result was achieved owing to the design of a building which guarantees minimum heat loss and application of the system using renewable energy sources.

It is also worth mentioning that when comparing discounted costs of the life cycle of a considered building, smaller disparities than in case of environmental indicators were noticed between them. It can be assumed that one of the reasons of such a situation is the fact of incomplete internalisation of environmental costs due to the emissions released into the air from boilers fired with gaseous fuel, however in accordance with the provisions of the Polish law, natural persons not being entrepreneurs are exempt from fees for economic use of the environment.

Integration of life cycle techniques in the building industry – methodical aspects

Traditional LCC is a type of investment calculus used to rank different investment alternatives. The main feature of this approach is that LCC has a extended life cycle perspective, and thus considers not only investment costs, but also operating costs during the product's estimated life-time (Gluch & Baumann, 2004). However, such an expansion of the system boundaries does not include all environmental costs, especially external costs. In this context, among other things, it is important to integrate LCA and LCC in decision-making process. Extend the system boundaries by complementing LCA with

costs calculations in case of construction is suggested by several researches (for example: Mora el al., 2011; Sterner 2002; Aye el al., 2000)

When considering the integration of life cycle techniques in the building context, it is worth to refer briefly to methodical aspects of such an approach. Traditionally, it is considered that the LCC indicator is a sum of discounted costs of the life cycle which means the necessity of determining the current value of costs occurring in the future. In case of LCA analyses there are attempts of discounting environmental damages noted, however validity and ethical considerations of such proceedings arouse a number of controversies (Hellweg el al., 2003). In the literature on the subject there are statements that when correlating LCA and LCC techniques it is necessary to conduct an economic analysis of steady state type. However, most specialists are in favour of discounting LCC indicators, especially for objects of long life cycles, despite the fact that it causes some methodical inconsistency (Swarr el al., 2011).

Another important issue from the point of view of cost calculations is including the residual value (if exists) of analysed objects at the moment of their liquidation. It is particularly important in a situation of comparing building modules of considerably different service life. Therefore, the problem constitutes coherent approach to these issues. In other words, in the context of LCA, it is necessary to offer a solution within the estimation of environmental impact of the final management which would effectively reduce non-equivalence in the aspect of life cycle length.

Conclusions

On the basis of the conducted LCA and LCC comparative analysis it was considered both in environmental and economic terms, a passive building made in wood technology is presented more beneficially. Environmental indicator of the life cycle of the building, in relation to a traditional equivalent, decreased by 47.43%, while discounted costs decreased by 23.54%. The result was achieved due to the application of the system using renewable energy sources and also the insulation of the building which guarantees minimum heat losses. Used building materials and their susceptibility to recycling is also not without significance. Additional environmental baggage and higher investment outlays connected with the assembly of the alternative system are compensated over the life cycle of the analysed building. It is necessary to be clearly emphasised that the stated results are representative only for analysed building projects and accepted manner of their maintenance, at the assumed economic and technological conditions.

References

Adamczyk J., Dylewski R., 2011, Recycling of Construction Waste in Terms of Sustainable Building (in Polish), Problems of sustainable development, Vol. 5, No. 2, pp. 125-131.

Yongtao T., Liyin S., Hong Y., 2011, Sustainable construction practice and contractors' competitiveness: A preliminary study, Habitat International, Vol. 35, No. 2, pp. 225-230.

Kofoworola O.F., Gheewala S.H., 2008, Environmental life cycle assessment of a commercial office building in Thailand; International Journal of Life Cycle Assessment, Vol. 13, No. 6, pp. 498-511.

Blengini G.A., Carlo T.D., 2010, Energy-saving policies and low-energy residential buildings: an LCA case study to support decision makers; International Journal of Life Cycle Assessment, Vol. 15, No. 7, pp. 652-665.

Ortiz-Rodríguez O., Castells F., Sonnemann G., 2010, Life cycle assessment of two dwellings: One in Spain, a developed country, and one in Colombia, a country under development, Science of the Total Environment, Vol. 408, pp. 2435–2443.

Bribián I.Z., Capilla A.V., Usón A. A., 2011, Life cycle assessment of building materials: Comparative analysis of energy and environmental impacts and evaluation of the eco-efficiency improvement potential, Building and Environment, Vol. 46, pp. 1133-1140.

Lewandowska A., Noskowiak A., Pajchrowski G., Strykowski W., Witczak A., 2012, The environmental life cycle assessment of the model residential buildings constructed in masonry technology and wood technology - as an example of LCA application (in Polish), Final report from research project N N309078138 financed by the Polish Ministry of Science and Higher Education, Wood Technology Institute, Poznań, Poland.

Erlandsson M., Borg M., 2003, Generic LCA- methodology applicable for buildings, constructions and operation services – today practice and development needs, Building and Environment, Vol. 38, pp. 919-938.

ISO 21929-1:2011, Sustainability in building construction - Sustainability indicators -Part 1: Framework for the development of indicators for buildings.

Langdon D., 2007, Towards a Common European Methodology for Life Cycle Costing (LCC) - literature review http://ec.europa.eu/enterprise/sectors/construction/files/compet/life_cycle_costing/literat_review_en.pdf; [Accessed 8.03.2014].

Bakis, N., Amaratunga R.D.G., Kagioglou M., Aouad G., 2003, An integrated environment for life cycle costing in construction , [in:] 20th CIB W78 Conference: IT in Construction, 2003, New Zealand.

http://itc.scix.net/paper w 78-2003-15.content [Accessed 10.03.2014].

ISO 21931-1:2010, Sustainability in building construction -Framework for methods of assessment of the environmental performance of construction works - Part 1: Buildings.

Norris G.A., 2001, Integrating life cycle cost analysis and LCA, The International Journal of Life Cycle Assessment, Vol. 6, No. 2, pp. 118-120.

Kloepffer W., 2008, Life Cycle Sustainability Assessement of Products, The International Journal of Life Cycle Assessment, Vol. 13, No. 2, pp. 89-95.

Swarr T.E., Hunkeler D., Klopffer W., Pesonen H-L., Ciroth A., Brent A.C., Pagan R., 2011, Environmental Life Cycle Costing: A Code of Practice, SETAC, New York, USA.

Kowalski Z., Kulczycka J., Góralczyk M., 2007, Ecological evaluations of the life cycle of manufacturing processes (Polish), PWN, Warsaw, Poland

Joachimiak-Lechman K ., Borkowska J., Kowalewska A., Pajchrowski G., 2013,Sustainable development-evaluation of sustainable construction (in Polish), Clean Energy, No. 2 (138), pp. 36-37.

Joachimiak-Lechman K., Zarebska J., Economic and environmental consequences of building waste treatment – the examples of four residential buildings; Journal of Material Cycles and Waste Management (in review).

Kulczycka J., Pietrzyk-Sokulska E. (ed.) 2012, Evaluation of the energy sector in Poland (in Polish), IGSMiE PAN, Krakow, Poland.

Gluch P., Baumann H., 2004, The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision making; Building and Environment, Vol. 39, pp. 571-580.

Mora R., Bitsuamlak G., Horvat M., 2011, Integrated life-cycle design of building enclosures, Building and Environment, Vol. 46, No. 7, pp. 1469-1479.

Sterner E., 2002, Green procurement of buildings: estimation of environmental impact and life-cycle cost and environmental impacts, Ph.D. dissertation thesis, Department of Mining Engineering, Lulea University of Technology, http://epubl.ltu.se/1402-1544/2002/09/ [Accessed 10.03.2014].

Aye L., Bamford N., Charters B., Robinson J., 2000, Environmentally sustainable development: a life cycle costing approach for a commercial office building in Melbourne, Australia, Construction Management and Economics, No. 18, pp. 927-34.

Hellweg S., Hofstetter T.B., Hungerbühler K.,2003, Discounting and the Environment, The International Journal of Life Cycle Assessment, Vol. 8, No.1, pp. 8-18.

SUSTAINABILITY CRITERIA AND CERTIFICATION SCHEMES OF BIOFUELS IN THE EUROPEAN UNION

Mariarosaria Lombardi[*], Roberto Rana[*], Caterina Tricase[*], Carlo Ingrao[**]

*[*]Department of Economics, STAR*AgroEnergy Research Group, University of Foggia*
*[**]STAR*AgroEnergy Research Group, University of Foggia,*
mariarosaria.lombardi@unifg.it

Introduction

The growing demand for energy from fossil fuels has generated an increase in price and in the atmospheric emissions of greenhouse gases (GHGs) and pollutants. For example, global CO_2 emissions (93% of the total anthropogenic GHGs) were equal to 31.3 Gt in 2011 with an average annual growth of 2.7%. Energy production and transport were the main sectors responsible for CO_2 emissions, with respectively 42% and 22% of the total (IEA (a), 2013). In particular, road transport accounted for about 75% (almost 920 $MtCO_2$) of the total transport emissions, increasing its value by 52% since 1990 and in 2011 (European Commission, 2013).

To reduce these effects, many countries have undertaken to promote the production and use of biofuels, which are more sustainable than traditional energy sources. They are considered an efficient/effective option for decreasing the above-mentioned emissions and energy dependency, as well as providing an opp. ortunity for rural development, especially in developing countries.

Even if liquid biofuels currently represent only about 3% of global road transport fuel (REN21, 2013), scientific studies have shown that 1st generation biofuels, obtained by energy crops, cause evident environmental and socio-economic impact (Lombardi, Rana & Tricase, 2009). They are a great source of debate regarding their real role in slowing down climate change and possible competition with food production, which significantly affect food security and prices of raw materials.

In the long run, especially with regard to first-generation biofuels, the feasibility of their production is influenced by several factors such as fossil

fuel and energy prices, agricultural commodities cost and so on (FAO, 2013). According to the FAO, the cultivation of energy crops may limit the possession of the small landowners land in favour of the agro-food multinational corporations, which buy vast areas of land in order to produce biofuels. This phenomenon, called "land grabbing", is particularly evident in Africa, where entire regions, due to the absence of a land register, are leased or sold to outside investors, including corporations and governments. In this way the local communities lose their ability to produce food for their own subsistence. Therefore, it is necessary to respect some restrictions in order to guarantee both environmental and social-economic sustainability.

In light of these considerations, it might be useful to introduce a certification system based on specific criteria in order to safeguard the environment and to attest farmers' rights, especially those in developing countries. Currently there are no standardized procedures or parameters: each country, indeed, has adopted its own certification schemes. This has created problems of consistency, transparency or comparison and generated confusion and perplexity on the part of economic operators.

The European Union, through the Directive 2009/28/EC (Renewable Energy Directive – RED), has established a number of specific criteria and recognized 15 different certification systems so far – at both national and international level using voluntary and mandatory approaches.

The growing number of "validated" systems, within the EU, has certainly stimulated competitiveness, expanded the regulatory framework and developed tools of checking and monitoring; but the aforementioned problems had not yet been solved. In this context, the present work aims to carry out an analysis of these aspects, highlighting critical issues and potentiality.

Biofuel production and sustainability: the Directive 2009/28/EC

World biofuel production has increased sevenfold since 2000, but still meets only 2.3% of final liquid fuel demand. It grew in fact from 16 billion litres globally in 2000 to an estimated 110 billion litres in 2012 (including bioethanol and biodiesel –). In particular, in the United States of America (USA) 52 billion litres of biofuels were produced (47% of world production), in Brazil 23.5 billion litres (21.3% of the total) and 14.3 billion litres (13%) in the European Union (Flach, Bendz, Krautgartner & Lieberz, 2013; Barros, 2013; USDA, 2013) (Figure 1). In 2012, global biofuel production was sTable: higher feedstock prices and lower production volumes in key producing regions, due principally to extreme weather conditions, have caused this static situation (IEA (b), 2013). Specifically, in the USA, bioethanol obtained mainly from cornstarch kernels accounted for 94% of all biofuel production in 2012: the remainder was biodiesel, derived from vegeTable oils as well as

animal fats, waste oils, and grease (USDA, 2013). In Brazil, bioethanol represented 88.5% of the total biofuel production and it was obtained from sugar cane (Barros, 2013).

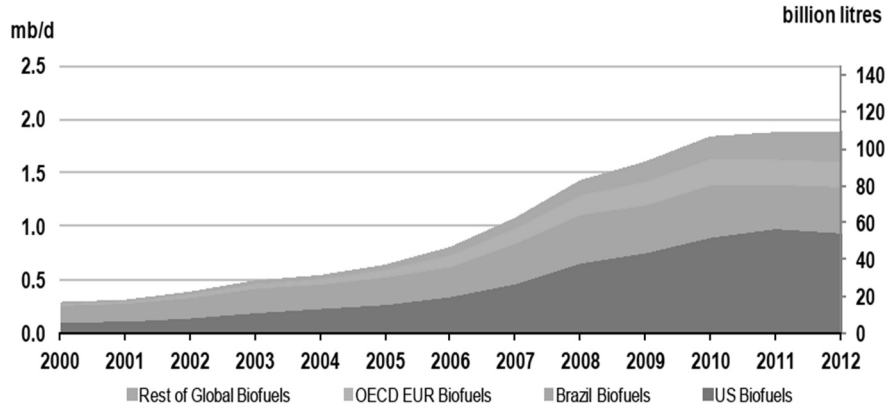


Figure 1. Global biofuel supply 2000-2012

Source: IEA (b), 2013.

Analysing the EU-27 production, biodiesel was the main fuel, with 9.7 billion litres in 2012 and the whole trend consumption slows down, over the last two years: indeed, it increased only by 2.9% compared to 2011 while, between 2010 and 2011, by 3.1%. The sluggish growth has been caused by the economic crisis that has forced some importing countries to decrease the biofuel level used and incorporated into their transport sector, and by uncertainty about future European Union legislation that has slowed the market. Italy is the fourth Member States of EU-27 for final consumption, representing 8.5% of the total in 2012 (EurObserv'er, 2013; EurObserv'er, 2012).

The geographical distribution of biofuel supply reflects the greater availability of raw materials in some regions (sugar cane in Brazil and corn in the USA) but also legislative choices made in the past. The European Union, indeed, only began to regulate this sector more recently, with the Directive 2003/30/EC promoting the use of biofuels or other renewable fuels for transport. It established, for 2010, the target of 5.75% for the market share of biofuels on the basis of their energy content, providing an intermediate value for the year 2005 equal to 2%. In the same year, to facilitate biofuel production, the Directive 2003/96/EC was issued in order to restructure the Community framework to grant tax reductions or exemptions for producers of biofuels, thereby contributing to the better functioning of the internal market (Tricase & Lombardi, 2008).

The European Union has reaffirmed its commitment with the approval, in April 2009, of the Directive 2009/28/EC, which states that 10% of energy consumption, in the transport sector, must come from renewable sources by 2020. As result, each Member State should have already put in place National Renewable Energy Action Plan (NREAP) in order to make the binding for fossil fuel suppliers obligatory. In some cases, the suppliers are required to blend their fuels with a minimum proportion of biofuel, thereby establishing minimum requirements for diesel and gasoline. However, in some countries, the implementation of biofuel blending mandates are combined with tax incentives that could actually limit market prospects. Every year, each country has revised the mandates according to their production and consumption capacity (Cansinon, del P Pablo-Romero, Roman & Yniguez, 2012). From 2005 to 2012, the biofuel incorporation rate (given by the ratio between the biofuel and fuel consumption) in the EU transport sector rose significantly from 1.03% to 4.7% (EurObserv'er, 2013; Johnson, Pacini & Smeets, 2012).

The aforementioned blending mandates and targets do not guarantee biofuel sustainability. Specifically, they don't assure promotion and respect for human rights, diversity between populations and maintaining of right integrity to health and safety (*social sustainability*); maintaining sufficient profitability by preventing any possible risks (*economic sustainability*); and, last but not least, preservation of environment and maintaining adequate capital in terms of natural resources, climate and biodiversity (*environmental sustainability*) (FAO, 2013).

To assess these aspects it is necessary to identify appropriate indicators that are universally valid. Currently, most of the criteria used are applicable only at a local level and their effects are difficult to measure and quantify, without considering the implications and correlations between the various factors analysed.

So, government policy measures must be geared to promoting sustainable performance, for example through mandated minimum GHG savings or financial support linked to life-cycle CO_2 emission reductions. At a national and regional level, such policies are currently quite limited.

Thanks to the EU RED, minimum sustainability criteria have been imposed in order to contribute to binding national targets (10%) for renewable energy deployment. The fulfilment of these objectives gives not only an environmental but also an economic advantage because the biofuels can be sold onto the market at a higher price.

Article 17, in particular, identifies five criteria that must be met: 1. reduction of greenhouse gas emissions by at least 35%, and 50% in 2017, compared with fossil fuels; 2. protection of biodiversity; 3. protection of land with high carbon stock; 4. protection of un-drained soil; 5. guarantee of good agricultural and environmental conditions.

These are part of a larger context that is the achievement of improved energy conversion efficiency of the entire production process. The method, identified by the RED Directive to assess the performance in terms of greenhouse gas emissions released with agro-energy sources, is the assessment of the life cycle (Life Cycle Assessment) following precisely the energy chain from the source to the energy/final products.

However, because these sustainability criteria do not currently include emissions from Indirect Land-Use Change (ILUC) the European Commission, in October 2012, presented a proposal for a Directive to amend part of the regulatory framework. In September 2013, the European Parliament voted in favour of accounting for ILUC, postponing the measure until after 2020, and adopted an amendment of Directive 2009/28/EC to impose a national cap of 6% on biofuels produced from food crops or from crops grown on land that was previously occupied by other vegetation (other crops, meadows or forests) (European Parliament, 2013).

Certification schemes approved in the European Union

The verification of the requirements of the EU RED, in order to signal to European countries that they must fulfill the minimum sustainability criteria, can be made on the basis of voluntary sustainability standards and certification schemes, recognized as a qualifying standard by the European Union.

The processes, concerning the formulation of certification schemes, have been developed by diverse organizations representing different stakeholders, while the European Commission has marked a series of actions which are listed below.

In June 2010, one Decision and two Communications were adopted in order to help Member States to implement sustainability schemes which meet the requirements and could then be approved by the Commission.

The Communication 2010/C 160/01 has illustrated the ways in which the Commission may decide if the voluntary schemes or bilateral and multilateral agreements, concluded by the EU, contain accurate data about the sustainability criteria and if they can add default values for new production methods of biofuels/bioliquids or update existing values. This starts a process of evaluation of the voluntary system, in compliance with the sustainability criteria set out in the Directive. If the evaluation is positive, the Commission begins the procedure for the adoption of a decision to publish in the Official Journal, which indicates the validity of the system (in general, for a maximum period capacity of 5 years) and which part, or parts, of the sustainability criteria of Directive they fall within.

In order to facilitate the consistent application of sustainability criteria, the Commission has adopted the Communication 2010/C 160/02 on the

practical implementation of the sustainability scheme and on counting rules. The calculation of GHG emissions must be made on the basis of actual or standard values (permitted by the Directive).

The Commission also published its Decision 2010/335/EU containing the guidelines for the calculation of land carbon stocks in the soil, completing the rules laid down in Annex V to Directive 2009/28/EC.

The implementation of sustainability criteria is provided in the context of national law, but this has not yet begub in all Member States.

The adoption of these criteria in the EU could be a tool to push biofuels producers to adopt environmentally responsible modes of production. In fact, only recognized sustainable biofuels can be considered valid for the purposes of achieving the percentage at Community levels by the Member States. They can also benefit from tax incentives or receive financial support that the Member States have introduced and, finally, they be counted towards the GHG emission reductions target in the Fuel Quality Directive.

In order to demonstrate sustainability criteria to the authorities of Member States of the consignments of biofuels, the economic operators (organizations with responsibility for one or more steps in the supply chain) have to adhere to: a national certification system in which biofuels and bioliquids are only recognised internally; or voluntary national or international schemes recognized by all Member States; or bilateral or multilateral agreements with third countries, approved by the European Commission under Directives 2009/28/EC and 2009/30/EC (Johnson, Pacini & Smeets, 2012).

There are currently different types of certification, made by public or private entities, each with its own scope, which can be regarded as a significant instruments for promoting and developing more sustainable production practices.

These voluntary certification schemes can be divided into three categories:

a) roundTable initiatives which are characterised by a large number of economic operators or organizations directly involved in the process certification which address concerns about the sustainability of a crop (e.g. oil palm, sugar) or whole biofuels sector, examples include Bonsucro, RoundTable on Responsible Soy (RTRS), RoundTable on Sustainable Biofuels (RSB);
b) industry schemes based on supply chains proposed by specific trade groups such as 2BSvs, RSBA/Abengoa and Greenergy;
c) government-financed schemes involving research institutions, industries and NGOs (Johnson, Pacini & Smeets 2012).

Voluntary scheme		Scope					Demonstrates compliance with Articles:					Updated scheme documents checked for still adequately covering the sustainability criteria for which the scheme is recognised (cf. Art. 2(1), 2nd and 3rd sentence of the respective Decision)
Name	Version recognised	Date Commision Decision	Feedstock type	Feedstock origin	Biofuel production geography	Extent of supply chain covered	17(2) GHG through	17(3) High biodiversity value	17(4) High Carbon Stock	17(5) Peatlands	18(1) mass balance system	
International Sustainability and Carbon Certification (ISCC)	See scheme documents on http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm	19 July 2011	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes	Yes	Yes	Yes	
Bonsucro EU		19 July 2011	Sugar cane	Global	Global	Full supply chain	Default only	Yes, except 17(3)(c)	Yes	Yes	Yes	
Round Table on Responsible Soy EU RED (RTRS EU RED)		19 July 2011	Soy	Global	Global	Full supply chain	Default or actual	Yes	Yes	Yes	Yes	RTRS EU RED Compliance Requirements for Producers 3.0_ENG, available via: http://www.responsiblesoy.org/
Roundtable on Sustainable Biofuels EU RED (RSB EU RED)		19 July 2011	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes	Yes	Yes	Yes	RSB standard for EU market access version 2.1, available via: rsb@epfl.ch
Biomass Biofuels voluntary scheme (2BSvs)		19 July 2011	Feedstocks for which there are default values	Global	Global	Full supply chain	Default or actual	Yes, except 17(3)(c)	Yes	Yes	Yes	2BSvs-PRO- 03 Rev: V 1.8 En, 2BSvs-PRO-02 Rev. :V 1.8 EN, 2BSvs-PRO-01 Rev. :V 1.8 EN available via: http://en.2bsvs.org/
Abengoa RED Bioenergy Sustainability Assurance (RBSA)		19 July 2011	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes	Yes	Yes	Yes	
Greenergy Brazilian Bioethanol verification programme (Greenergy)		19 July 2011	Sugar cane	Brazil	Brazil	Full supply chain	Default only	Yes, except 17(3)(c)	Yes	Yes	Yes	
Ensus Voluntary Scheme under RED for Ensus Bioethanol Production (Ensus)		23 April 2012	Feed wheat	EU	Ensus One plant	From the first feedstock delivery point to the Ensus One bioethanol storage	Actual or combination	Yes*	Yes*	Yes*	Yes	
Red Tractor Farm Assurance Combinable Crops & Sugar Beet (Red Tractor)		16 July 2012	Cereals, oilseeds, sugar beet	UK	n/a	Until the first feedstock delivery point	**	Yes	Yes	Yes	Yes	
Scottish Quality Farm Assured Combinable Crops Limited (SQC)		24 July 2012	Winter wheat, maize, oilseed rape	North Great Britain	n/a	Until the first feedstock delivery point	**	Yes	Yes	Yes	Yes	
Roundtable on Sustainable Palm Oil RED		23 November 2012	Palm oil	Global	Global	Full supply chain	Default; or actual following recognised tool	Yes	Yes	Yes	Yes	
REDcert		24 July 2012	Wide range of feedstocks	Europe	Europe	Full supply chain	Default or actual	Yes	Yes	Yes	Yes	
NTA 8080		31 July 2012	Wide range of feedstocks	Global	Global	Full supply chain	Default or actual	Yes, except 17(3)(c)	Yes	Yes	Yes	
Biograce GHG calculation tool		30 May 2013	Wide range of feedstocks	Global	Global	Supply chain not covered	Actual***	No	No	No	No	
HVO Renewable Diesel Scheme for Verification of Compliance with the RED sustainability criteria for biofuels		09 January 2014	All feedstocks suitable for HVO-type biodiesel	Global	Global	From the producer of HVO-type renewable diesel	Default or actual	Yes*	Yes*	Yes*	Yes	

* The scheme relies for this on other recognised schemes.
** Only recognised for accurate data that land use change emissions (e_l) referred to in point 1 of part C of Annex V are equal to zero, and on the appropriate geographic area referred to in point 6 of part C of Annex V (NUTS-2 region).
*** The scheme is a non-typical voluntary scheme that covers only assessment of greenhouse gas savings. Voluntary schemes using the tool need to ensure that it is applied appropriately and that adequate standards of reliability, transparency and independent auditing are met.

Table 2. Biofuel certification schemes (2011-2014)

Source: European Commission, 2014.

From July 2011 to May 2014, the European Commission has recognized 15 voluntary systems, which apply in all 27 Member States.

Table 2 provides a list of schemes, which can be identified at global and regional (EU) levels. Schemes are applicable to different feedstock (forests,

agricultural crops), bioenergy products (wood chips, pellets, ethanol, biodiesel, electricity) and segments of or entire supply chains.

The certification schemes differ in origin, in coverage of the supply chain, methodologies (criteria, indicators), stringency and costs. They contain principles and criteria for biofuel production and verification and certification procedures. Therefore the implementation and the quality of the certification control schemes, through proper enforcement and verification mechanisms, are of great importance.

On overview shows that is difficult to make a comparative assessment due to wide differences with regard to sustainability principles established in the EU RED; in fact these certification systems include environmental, economic and social aspects with different approaches and methodologies (German& Schonevald, 2012; Scarlat & Dallemand, 2011).

Conclusions

The expansion of the market for biofuels put the agricultural sector and the environment in general under pressure - not only ecological but also socio-economic. The concerns derive from the improper use and management of resources (water and soil), but also the effect on markets for agricultural commodities, their intended use, and their impact on the rural population

In the last few years, lively debate on the rigor, impartiality, transparency and accessibility of the schemes, associated with the sustainability standards, has been highlighted. The proliferation of these schemes, non-harmonized with different methodologies and standards, underlines the need for harmonization and coordination through the formulation of criteria and more widely shared definitions, in order to make them truly comparable and more effective. Is also vital to avoid uncertainty and confusion among all stakeholders.

Certainly sustainability schemes have led to greater credibility, accountability and transparency to supply chains but there is no comprehensive information about the actual impact of the schemes on the practices referred to in the standards. It is also important to emphasize that uniform and standardized assessment as well as accreditation processes could result very useful in view of the huge economic interests related.

It should be noted that the area of sustainability certification is an emerging business and there are strong interrelations with climate change policies in International Agreements on Climate Change or WTO negotiation that must be considered in order to implement a common shared environmental policy.

Acknowledgments

STAR*AgroEnergy Research Group is a scientific network promoted by the University of Foggia in the European project STAR*AgroEnergy (Strategic & Technological Advancement in Research on AgroEnergy). The project is funded by the European Commission, Directorate-General for Research & Innovation, SP4 – Capacities, Coordination and Support Action, Seventh Framework Programme (FP7), Regpot 2011-1. Grant Agreement N° 286269.

Logo space

References

Barros S., Agricultural Specialist Agricultural Trade Office, Sao Paulo, Brazil Biofuels Annual Report 2013, Date: 9/12/2013 GAIN Report Number: BR13005. http://gain.fas.usda.gov/, accessed 26 November 2013.

Cansinon J.M., Pablo-Romero M. del P., Roman R., Yniguez R., 2012, Promotion of biofuel consumption in the transport sector: An EU-27 perspective, Renewable and Sustainable Energy Reviews, (16), 6013-6021.

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 and amending and subsequently repealing Directives 2001/77/EC and 2003/ 30/EC, Brussels, Official Journal L 140, 5.6.2009, pp. 16.

EurObserv'ER, 2012, The state of renewable energies in Europe, 12th EuObserver'ER Report, http://www.energies-renouvelables.org/observ-er/stat_baro/barobilan/barobilan12.pdf, accessed 8 September 2013.

EurObserv'ER, 2013, Biofuels Barometer, Systèmes Solaires, Le journal des energies renouvables, July (216), 49-63, http://www.energiesrenouvelables.org/observer/stat_baro/observ/baro216_en.pdf, accessed 8 September 2013.

European Commission, 2013, Greenhouse gas emissions by sector, http://eppeurostat.ec.europa.eu/portal/page/portal/statistics/search_database, accessed 13 December 2013.

European Parliament, 2013, Environment Committee advocates promoting advanced biofuels, European Parliament: Press release 11-07-2013. Biofuel sustainability and the Directive 2009/28/EC.

FAO (Food and Agriculture Organization), 2013, Biofuels and sustainability challenge: a global assessment of sustainability issues, trends and policies for biofuels and related feedstocks, http://www.fao.org/docrep/017/i3126e/i3126e.pdf, accessed 15 September 2013.

Flach B., Bendz, K. Krautgartner R. and Lieberz S., 2013, EU-27 Biofuels Annual 2013, Date: 8/13/2013 GAIN Report Number: NL3034. http://gain.fas.usda.gov/, accessed 26 November 2013.

German L., Schonevald G., 2012, A review of social sustainability considerations among EU-approved voluntary schemes for biofuels, with implications for rural livelihoods, Energy Policy, 51, 765-778.

IEA (a) (International Energy Agency), 2013, CO2 emissions from fuel combustion – Highlights, OECD/IEA, 2013. http://www.iea.org, accessed 4 November 2013.

IEA (b) (International Energy Agency), 2013, Tracking Clean Energy Progress 2013, IEA Input to the Clean Energy Ministerial, 9 rue de la Fédération 75739 Paris Cedex 15, France, OECD/IEA, 2013. http://www.iea.org, accessed 15 January 2014.

Johnson F. X., Pacini H., Smeets E., 2012, Transformations in EU biofuels markets under the Renewable Energy Directive and the implications for land use, trade and forests, Occasional Paper 78, Center for International Forestry Research (CIFOR), ISBN 978-602-8693-81-3.

Lombardi M., Rana. R., Tricase C., 2009, La produzione degli "agrofuels": aspetti ecologici, sociali ed economici, Atti del XXIV Congresso Nazionale delle Scienze Merceologiche, Ambiente, Internazionalizzazione, Sistema, Energia (AISME), 23-25 giugno 2009, Università di Torino, CELID, Torino, 1169- 1176, ISBN 978-88-7661-873-4.

REN21, 2013, Renewables 2013 Global Status Report, Ren21 c/o UNEP, 15, Rue de Milan, F-75441, Paris, France. http://www.ren21.net/Portals/0/documents/Resources/GSR/2013/GSR2013_lowres.pdf, accessed 5 February 2014.

Scarlat N., Dallemand JF., 2011, Recent development of biofuels/bioenergy sustainability certification: a global overview, Energy Policy, 39, 1630-1646.

Schlamann I., Wieler B., Fleckenstein M., Walther-Thoß J., Haase N., Mathe L., 2013, Searching for sustainability Comparative analysis of certification schemes for biomass used for the production of biofuels, WWF Deutschland, Druckstudio GmbH, Dusseldorf (Germany), http://awsassets.panda.org/downloads/wwf_searching_for_sustainability_2013_2.pdf, accessed 10 February 2014.

Tricase C., Lombardi M., 2008, Il ruolo degli "agrofuels" nella politica energetica europea, La Rivista dei Combustibili, 62, (I), 53-62, ISSN 1972-0122.

United States Department of Agriculture Economic Research Service, 2013, U.S. Bioenergy Statistics, http://www.ers.usda.gov/data-products/us-bioenergy-statistics.aspx#.UpSLmmrEKHM, accessed 26 November 2013.

Vergano P.R., Laurenza E., 2012, Fossil fuel "grading" and sustainability criteria for biofuels and bioliquids under the EU Fuel Quality and Renewable Energy Directives: implications for international trade, Global Trade and Customs Journal, 7, (3), 92-102.

European Commission, 2014, Biofuels - Sustainability schemes, http://ec.europa.eu/energy/renewables/biofuels/sustainability_schemes_en.htm, accessed 10 February 2014.

CONTRIBUTION OF GEOGRAPHIC INFORMATION SYSTEMS (GISS) TO DETERMINE PROFILES OF PACKAGING WASTE MIX GENERATION. A LITERATURE REVIEW AND ITS VALIDATION

Maria Claudia Lucchetti[*], Claudia Aglietti[**]

[*]*Department of Management, Sapienza University, Rome,*
m.lucchett@uniroma3.it
[**]*Department of Business Studies, RomaTre University, Rome,*
claudia.aglietti@uniroma1.it

Introduction

This paper has the aim to bare the utility of a geographic information system (GIS) as an instrument that allows to perform a sort of complementary analysis which may confirm or disprove assumptions in literature, in order to explain with a new perspective a phenomenon that entail spatial/geographical components.

In this case, the geographic information system has been used to analyze, through cartography, a phenomenon that had been previously analyzed without considering the spatial element but merely comparing data, Tables and diagrams pursuant to the most recent literature. The phenomenon at issue is the composition of Municipal Solid Waste (MSW) and packaging waste produced in one area, and the impact that specific characteristics of the area may have on it.

The amount of expected waste, including packaging waste and in particular, its breakdown in components of different materials, depends on the specific configuration and the structural characteristics of the area, with particular regards to:

- size of the area (small, medium or big Municipalities),
- geographical location (north, centre, south),
- vocation of the area (agricultural, industry, tertiary, tourism),
- type of settlement (densely populated areas, not densely populated areas),
- seasonal fluctuation (high season, low season).

In reality, these variables entail different levels of correlation: the type of settlement is generally related to the size of the territory, while the fluctuation is related to the vocation of the site.

The present work aims to combine data at municipal level and the potentiality of a geographic information system in order to check consistency of facts and Figures traceable in the most recent literature on the topic. The check will be performed comparing Tables and numbers shown in the literature with results found through an analysis carried out using a GIS.

Materials and Methods

The territorial configuration and the management schemes for MSW generally differ from one Country to one other. Thus, we chose to focus on one particular Member State, Italy, and to rely on documents, studies and literature released by national public research centers and committed authors on this topic.

Actually, studies that focus on MSW composition and on the relationship between MSW composition and the type of dimensional and functional urban context are not much available or common. This is mainly because Municipalities do not divulge data on generated urban waste composition, except in a few cases. This complicates the effort to represent the phenomenon and to identify a model replicable in several urban contexts with different characteristics.

According to the literature released so far, there are a few variables to take into account in order to explain expected Municipal Solid Waste and its components of different materials in one specific area. Those variables are:

- size of the area (small, medium or big Municipalities),
- geographical location (north, centre, south),
- vocation of the area (agricultural, industry, tertiary, tourism),
- type of settlement (densely populated areas, not densely populated areas),
- seasonal fluctuation (high season, low season).

The interaction among those variables defines the peculiar configuration of one area, a specific result strongly related to its own characteristics, that is crucial in order to forecast profiles of MSW production, and to understand how components of different materials may impacts on the total (in percentage) – especially paper and cardboard, plastic, metal and glass.

As anticipated, Municipalities are the territorial units chosen for this analysis, as their authorities are the ones eligible for the management of MSW and packaging waste at the initial phase of waste treatment, namely the collection. Particularly, the present work focuses on a specific territorial area,

the Veneto Region, which is among the few ones that provides detailed data on generated municipal waste and packaging waste, broken down by components of different materials.

It is possible to set up methods that allow identifying components of different materials of MSW in order to predict quality and quantity for the future and construct a management system for it - in terms of both collection service and final treatment - starting from the characteristics and requirements of the territory.

Being this preliminary part of a wider study still in progress, only a part of our results will be shown, related to the following two structural variables:

- size of the area (small, medium or big Municipalities),
- geographical location (north, centre, south).

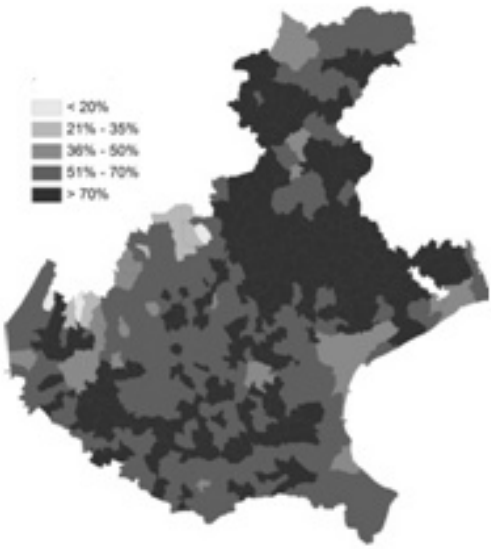


Figure 1. Percentage of Separate Collection in Veneto, per Municipality, year 2012

Source: my elaboration on ISTAT data ISPRA and Veneto.

Before proceeding with any type of analysis, we should specify that data here used refer not to the total amount of MSW produced, but to that collected by separate collection systems according to the percentages shown in the Figure above (Figure 1.) that include both household waste and assimilated waste.

Results and Discussion

A first branch of literature on the topic dating back to 2004, provide guidance on the possible ranges of percentage composition of MSW in relation to the different materials. This study has been released in 2004 by the Institute for Environmental Protection and Research, within "Waste Report 2004", whose proposed composition breakdown is shown in the following Table as an average of data recorded at Regional level.

In reality, ranges between MIN and MAX in the list are too much amp and a MSW management system could be arduously set up on their bases.

Moreover, by comparing these data with the percentages traceable in the breakdown of Veneto recent and real data, it can be seen how the reference literature, even if equipped with wide ranges, seems to be distant from the real percentage of the analyzed context, except for the fraction organic/green, whose joint analysis alters the reliability of data. Paper, cardboard, and plastic are extremely overestimated.

Table 1. MSW components break down% on total MSW

COMPONENTS	MIN	MAX	VENETO
Organic E Green	25%	40%	29.20%
Paper E Cardboard	20%	30%	13.09%
Plastic	10%	14%	1.14%
Glass	7%	10%	5.44%
Metals	4%	6%	0.02%
Multimaterial	-	-	8.38%
Other	18%	19%	5.20%
Tot Sc	-	-	62.47%
Other Waste	23%		37.53%

Source: APAT - ONR. Waste Report 2004.

De Feo and others propose an alternative hypothetical breakdown of municipal solid waste and packaging waste that depends on the propensity for recycling of separated materials. The same authors stressed that proposed data must be understood as indicative average values that oscillate around real data. Even in this case, except for the green and the residue, which obviously absorbs the percentage unexplained, almost all other components of different materials appear to be overestimated by the literature.

A further study by Regional Agency Prevention and Environment of Emilia-Romagna, based on data supplied by the National Packaging Consortium (CONAI), shows the average breakdown of municipal waste for

the year 2009 in that Region, estimated using data from detailed waste analysis carried out between the 2007 and 2008.

Table 2. Example of a hypothetical breakdown of MSW

COMPONENTS		THEORY	VENETO
ComposTable (40%)	Organic	37%	16.8%
	Green	3%	12.4%
Recyclable (48%)	Paper e Cardboard	25%	13.09%
	Plastic	9%	1.14%
	Glass	8%	5.44%
	Metals	4%	0.02%
	Wood	1%	-
	Texture	1%	-
Bulky materials and durable goods		2%	-
Dangerous Urban Waste		0.05%	-
Residual		~ 10	37.53%
Total		100%	

Source: modified starting from De Feo, 2008.

Table 3. Breakdown of MSW in Emilia-Romagna (2007-2008)

COMPONENT	EMILIA	VENETO
Organic	15%	16.8%
Green	15%	12.4%
Paper and cardboard	25%	13.1%
Plastic	12%	1.1%
Glass	6%	5.4%
Metals	3%	0.02%
Multimaterial	-	8.4%
Wood	5%	-
Intert waste	3%	-
Other	16%	-
Totale	100%	

Source: elaboration by Arpa Emilia-Romagna.

This breakdown is shown in the Table. The fractions quantitatively predominant are organic household waste and green (which alone accounts for almost one third of the total production), followed by paper and cardboard (25%), and plastic (12%); significantly lower is the presence of glass, wood, metals (including aluminum) and other fractions.

In this case, there is a consistency between Emilia Romagna and Veneto, concerning organic, green and glass. While paper is widely overestimated.

As stated by the authors themselves, a generalized analysis is not sufficient; percentages shown in the Table are approximate values that may vary according to the characteristics of the assessed area: geography, urban structure, demographics, social characteristics, economic characteristics.

It is necessary to individuate various sources of information that provide assistive knowledge with greater punctuality, particularly with regard to dimensional and functional characterization of the contexts served.

Being one of the above listed variables, the size of the context served may have an important impact on the breakdown of MSW in its principal components of different materials. Hence the need to distinguish between large, medium and small Municipalities. In this specific context of waste management and according to definition provided by ANPCI (National Association of Small Towns of Italy):

- a small Municipality is one city with less than 5,000 inhabitants,
- a big Municipality is one city with more than 50,000 inhabitants ,
- a medium-small Municipality is one with a population between 5,000 and 15,000 inhabitants,
- a medium-large Municipality is one with population between 30,000 and 50,000 inhabitants,
- a medium Municipality is one with populations between 15,000 and 30,000 inhabitants.

Generally, the size class of a Municipality, expressed in terms of population, changes the composition of the waste produced, following those pathway:

- higher production of green and metals is common for small and medium cities,
- higher production of paper and plastic is common for larger Municipalities.

With regard to the first point, the increased production of green waste is linked to the urban configuration of the Municipality. Small and medium ones are generally characterized by the presence of numerous green spaces and gardens, both public and private, and the consequent production of green waste. The large amounts of paper and plastic waste that is found in large and

medium-large Municipalities is attribuTable to the vocation of the context; generally these classes of Municipalities have greater presence of commercial settlements, and users of the service sector characterized by professional studios, offices, institutions, schools and libraries, restaurant.

That view is supported by analysis conducted on real data from De Feo and others. The authors argue that smaller Municipalities have a stronger rural vocation, compared to the larger ones; they report a lower percentage of recyclable materials, particularly paper and cardboard, to the advantage, however, of the kitchen remains and of cuttings and branches (green). In the graph below, the authors propose a comparison between a hypothetical production of MSW of a small town and the corresponding production of a large city.

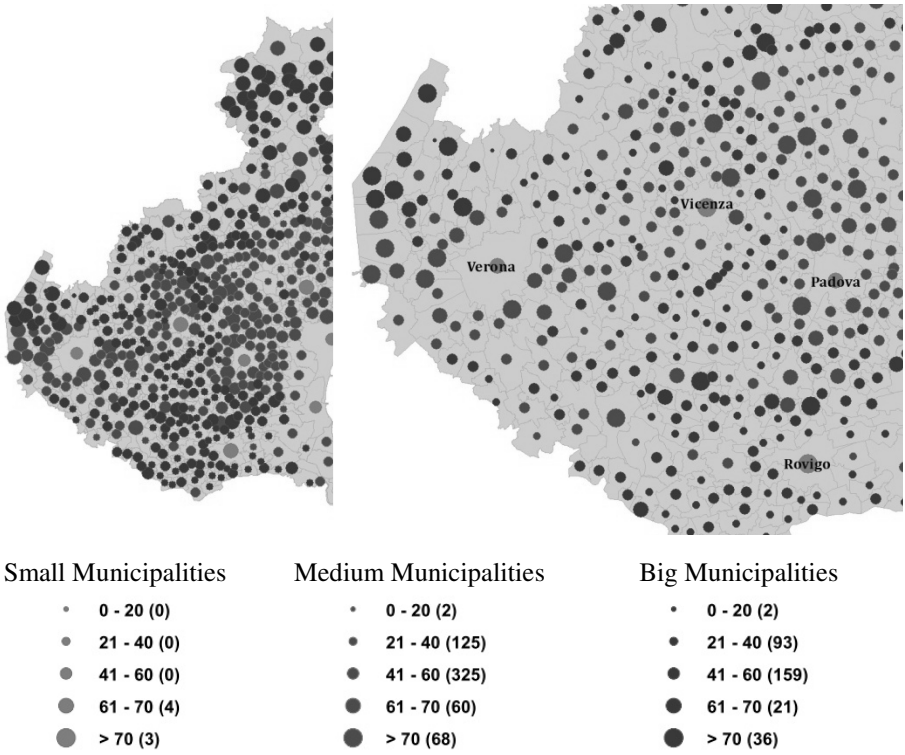


Figure 2. Focus on commodity PAPER fraction, an initial analysis based on per capita Figures

Source: my elaboration on ISTAT data ISPRA and Veneto.

Below we introduce a first contribution from a geographic information system. Starting from data of produced Municipal Solid Waste, broken down

by commodity fraction, the intent in this case is to determine whether, by isolating small towns (population <5,000), the results shows a trend that made it possible to associate the size of the Municipality the with the impact paper and cardboard have on total MSW.

The maps above (Figure 2) show the visualization of per capita production of paper registered in the Municipalities of Veneto in 2012. It interesting to note that there is a real trend towards per capita production as we move from areas with small size cities to area with more populous cities. Moreover, what emerges is a picture that seems to show a marked influence based on spatial proximity, which also coincides with a similar morphology of the territory. Aspects related to interaction given by the proximity and altitude will be discussed in an additional development of this study.

The same is evident from the next Figure (Figure 3). It does not report data for the production of paper and paperboard per capita but shows the percentage of the component material in question on the total waste produced. Two observations can be made from the visulaisation of this map :

- 470 Municipalities out of 508 have a value ranging 9-17%,
- the distribution of the mode seems to be not randomly distributed in the area, both for lower percentages than for higher values.

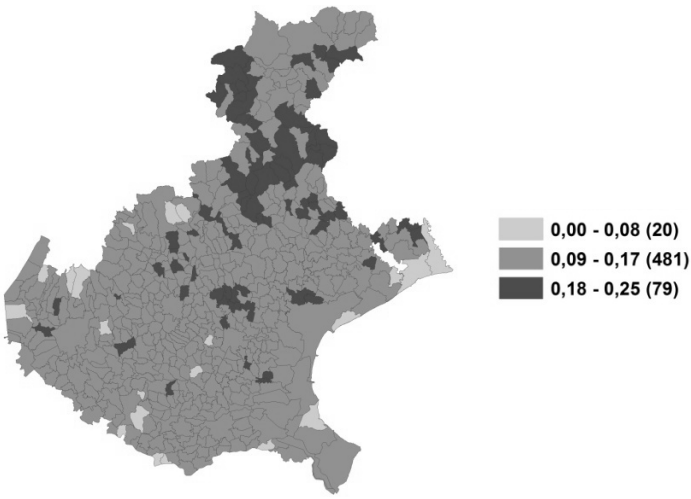


Figure 3. PAPER E CARDBOARD incidence on total MSW

Source: my elaboration on ISTAT data ISPRA and Veneto.

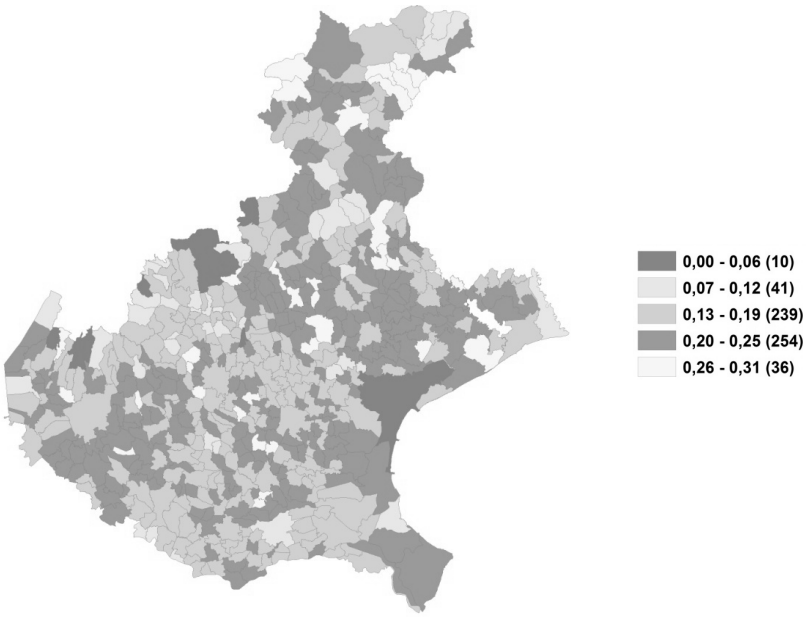


Figure 4. ORGANIC incidence in percentage of total MSW

Source: my elaboration on ISTAT data ISPRA and Veneto.

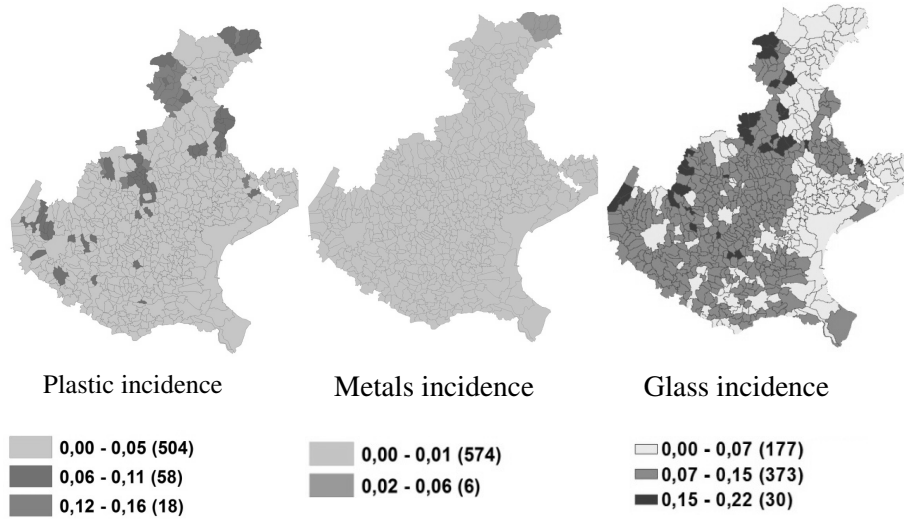


Figure 5. Comparison of incidence by type locality PLASTIC, METALS e GLASS

Source: my elaboration on ISTAT data ISPRA and Veneto.

Similar conclusions can not be drawn regarding the Organic component (Fig. 4) , the incidence of which is distributed in a more irregular way in the area. To overcome this evidence, we tried to increase the number of classes but the result is not suiTable to deduct any generalization.

The incidence of plastic (Fig. 5) oscillates around 5% for most of Municipalities; this confirms that predictions are overestimated in the reference literature. Similarly, as for metals, this recorded an incidence that ranges around 1% for most of the areas examined and between 7 and 15% for glass.

Conclusions

The Table below summarizes and compares incidence rate related to the impact different components have on total MSW, these values coming from both the reference literature and a series of preliminary results of the analysis carried out on Veneto data and based on the use and contribution of a geographic information system.

For the two following variables that follow:

- size class of the population,
- geographical location.

It is found that incidence rates provided by literature, net of the amount intercepted by recycling, overestimate the contribution of each fraction presenting the highest percentage for paper and cardboard, plastics, glass and metals intercepted and too law maximum percentage of glass intercepted.

Table 4. Compared rates and percentages taken from literature data of Veneto

COMPONENTS	DATA LITERATURE		DATA VENETO	
	MIN	MAX	MIN	MAX
Organic	15.00%	37.00%	13.00%	25.00%
Paper and Cardboard	20.00%	30.00%	9.00%	31.00%
Plastic	10.00%	14.00%	1.00%	16.00%
Metals	2.00%	6.00%	1.00%	6.00%
Glass	6.00%	10.00%	1.00%	22.00%

Source: my elaboration on ARPA VENETO data, 2012.

The work presented was aimed to show the contribution that geographic information system could provide as an instrument capable of operating an

additional level of analysis that allows validating or disproving theories commonly found in literature.

Working on data relating to the Veneto Region, we found that literature tends to overestimate. From the analyzes carried out interesting facts have emerged in terms of concentration phenomena to certain geographic areas, which leaves room for subsequent in-depth analysis one can always run through geographic information systems.

However, it would be appropriate to conduct the same type of analysis to other Italian regions before we can identify generalizable results. In addition, the hope is to be able to have access to detailed data as soon as possible and homogenized at the national level and European level.

References

ARPA EMILIA ROMAGNA, Piano Provinciale Dei Rifiuti, Emilia Romagna, 2008.

De Feo G., De Gisi G., Galasso M., 2012, "Solid Waste", Flaccovio Editore, Rome.

Environmental Agency of the Region Veneto, 2007-2012, Regional Observatory Waste, Environmental Indicators Http://Www.Arpa.Veneto.It/Temi-Ambientali/Rifiuti.

Environmental Agency of the Region Emilia Romagna, 2007-2012, Regional Observatory Waste, Environmental Indicators.

Institute For Environmental Protection And Research, ISPRA, 2004, Waste Report, Rome.

Institute for Environmental Protection and Research, ISPRA, 2013, Waste Report, Rome.

Federambiente, 2013, "Analysis of the Costs of Waste Collection", Bain & Company, Rome.

Hendrix W. G., Buckley D. J. A., 1992. Use of a Geographic Information System for Selection of Sites for Land App. lication of Sewage Waste. Journal of Soil and Water Conservation (May-June): 271-5.

Hendrix W.G., Fabos J.G., Price J.E., 1988. An Ecological App. roach to Landscape Planning Using Geographic Information System Technology, Landscape and Urban Planning 15: 2 1 1-25.

Lunkapis G. J., 2004. GIS As Decision Support Tool for Landfills Siting [in:] Map Asia.

Massarutto A., De Carli A., Graffi M., 2010, La Gestione Integrata Dei Rifiuti Urbani: Analisi Economica Di Scenari Alternativi, Research Report, IEFE Conference 2004.

Ogra A.,2003. Logistic Management and Spatial Planning For Solid Waste Management, Systems Using Geographical Information System [in: Map Asia 2003 India.

A SOCIO-ECOLOGICAL STUDY ON PLASMA DISPLAY PANEL TVS

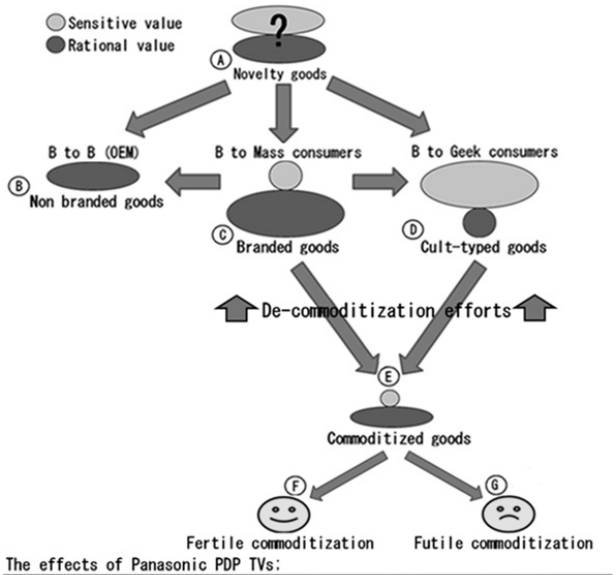
Mitsuharu Mitsui

Faculty of Business Administration,
Okayama University of Commerce,
mitsui_mitsuharu@yahoo.co.jp

Introduction

My academic life work is practically to observe socio-ecological developments of commoditization and de-commoditization discovered among such consumer durable products as electrical and electronic appliances, home appliances, clothing, accessories, toys, cosmetics, automobiles, furniture, etc. under the affluent (supply>demand) society (Figure 1). Commoditization, which tends to weaken consumers' loyalty toward particular corporate brands, is a result of consistently rigorous price-reduction competitions among many strong rivals (D'Aveni, 2010). Decommoditization is very much related to corporate tactful efforts hopefully to escape from the trap of unfavorable business losses. Usually, novelty (new) consumer durables have 1) some perceptually rational value derived from economic attributes and 2) other sensitive value mainly based on aesthetic meanings in order to attract enough number of buyers at the introductory stage of markets. For example, PDP TVs have been

Figure 1 Socio-ecological studies of consumer durables



providing much more spectacular and dynamic picture quality than LCT TVs mechanically in general. However, the share of PDP TVs in the whole markets of Flat Panel TVs has been falling down and down because of 1) their higher retail prices at the time of purchase and also 2) more electric energy consumption during the time of usage (maintenance). The most significant weak point of PDP TVs is that their picture quality has been considerably spoiled 1) in the dazzlingly bright show-rooms of gigantic electrical and electronic appliances retail stores and also 2) in the bright and narrow living-cum-dining rooms of such Japanese houses and apartments in urban areas.

I enjoyed KURO meaning black-color, which was a technologically advanced model (Full HD KRP-500A) of Pioneer PDP TV sold at the retail price of 670,000 Japanese yen in November of 2008. At the beginning of 2009 Pioneer entirely abandoned the production of PDP TVs, although KURO convinced quite a number of geek consumers of its uniquely sensitive functions. It turned out soon that KURO had generated no business profit for Pioneer, as its market volume was not big enough. I remember that Pioneer boasted its excellent picture and sound quality confirmed through a series of blind tests taken by many European geek consumers, then. Panasonic succeeded the intellectual properties of Pioneer, and made a lot more efforts to sharpen the competitive edge of sensitive value under the brand name of VIERA. I purchased a popular model of VIERA (TH-P502T5) at the retail price of 169,500 Japanese yen, while taking advantage of the present day's business phenomenon of commoditization in June of 2013. At that time Panasonic already suggested in public that it would be seceding itself from the production and sale businesses of PDP TVs soon. Its Korean formidable rivals of SAMSUNG and LG were supplying physically bigger and economically cheaper PDP TVs in the markets of America and China. The whole Japanese geek consumers have come to lose the opp. ortunity to buy any of new Panasonic PDP TVs in the future. They have not been able to support its niche-typed market with their purchasing power. In the case of the American rich consumers, on the other hand, they will be able to buy elaborated PDP TVs provided by SAMSUNG or LG at least for a while in the future, if they sincerely like.

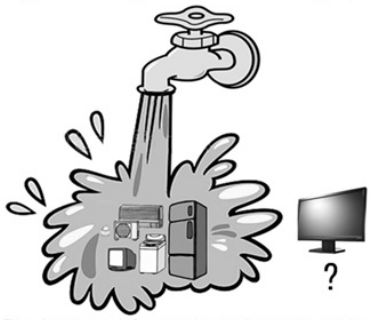
It is said that Panasonic is rapidly shifting its Flat Panel TVs business domain from 1) picture display to 2) information display in order to solve a serious corporate problem of its red-ink consolidated accounts. As you know, the American business and academic leaders have been focusing on information display from the beginning stage of Flat Panel TVs' R&D. The Society for Information Display (SID) is more than 50-year old by now.

I dare say that Panasonic capitulated to the dominant power of SID. Picture display may appeal some sensitive value especially to geek consumers. Information display, contrarily, will focus entirely on rational value to attract

a big mass of ordinary consumers. Generally speaking, consumer durables have two streams of 1) fertile commoditization and 2) futile commoditization as a result of rigorous price-reduction competitions. Fertile commoditization generates big chances for mass consumers continuously to buy cheaper products and services. Conversely, futile commoditization brings boringly homogenized (undifferentiated) living and working scenes throughout the world, in which calculative data are always favored by the authorities in business and politics (Moon, 2010). As a commodity scientist, I would like to contribute to some industrial designs to find fertile commoditization under the social media age, while gathering a number of prosumers associated with passionately environment-conscious geek consumers (Toffler, 1980).

Transience of Panasonic's corporate philosophy

Figure 2 Tap Water Philosophy



The founder of Panasonic declared in 1960s that consumer durables should be sold as cheaply as tap water.

Konosuke Matsushita, the founder of Panasonic is still famous for "Tap Water Philosophy (Figure 2)" in the field of the Japanese business schools. It was based on his conviction that common people must enjoy more comforTable lives, while utilizing various electrical and electronic appliances that were produced in mass quantity and sold to them as cheaply as tap water. In 1960s his company's engineers copied far-advanced electrical appliances of General Electric in America and Philips in the Netherlands as many as possible. Actually he changed his mind around 1970, when his company was already well-prepared for the globalization of free market economy. In America and Europe the presence of Panasonic brand name became conspicuous with its cheap but relatively trustworthy TVs, refrigerators, washing machines, air-conditioners and so on.

I think that Panasonic might have never imagined the world-wide phenomenon of commoditization of its branded goods in the future. However, the so-called white goods (large household electrical appliances) usually have very little sensitive value. Almost all of consumers focus on rational value, comparing the economic benefits with the real prices mainly consisting of retail prices and maintenance costs of their purchases. Flat Panel TVs are now becoming like such fast moving consumer disposable goods as daily necessaries or conveniences. Ironically this is what Konosuke Matsushita expected once in his golden age. As long as Panasonic runs its global manufacturing businesses, Panasonic needs to keep competing with its domestic and overseas followers. I am curious about its future, wondering

whether it is neglecting sensitive value of its consumer durables all in all. Is it a fate of supra-national corporations or not?

Table 1 The consolidated accounts of Panasonic

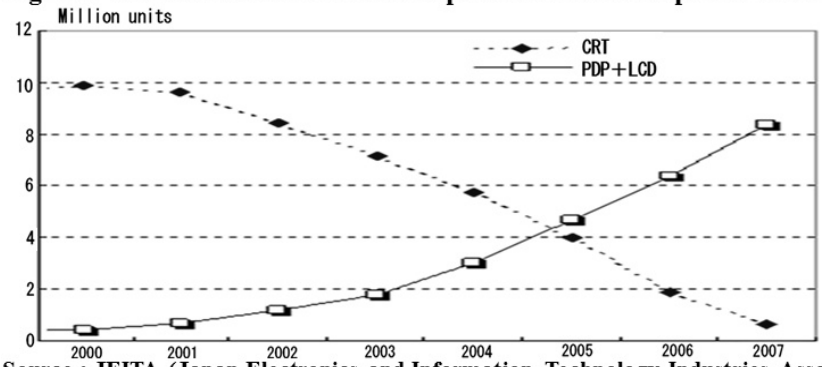
Billion yen — Closing month, March

Accounting period	(A) Sales	(B) Operating Profit	Ordinary profit	Net income	(B)/(A), %
2012	7,303	161	-398	-754	2.2
2011	7,846	44	-813	-772	0.6
2010	8,693	305	179	74	3.5
2009	7,418	190	-29	-103	2.6
2008	7,766	73	-383	-379	0.9
2007	9,069	519	435	282	5.7
2006	9,108	460	439	217	5.1
2005	8,894	414	371	154	4.7
2004	8,714	308	247	58	3.5
2003	7,480	195	171	42	2.6

Source : Yahoo Finance Analyst Reports

Panasonic was sunk in its unprecedentedly hard, tough and frustrating businesses over the past 10 years (Table 1). It is very often told that the most serious management mistake was to keep its lonely integrated manufacturing of costly PDP TVs too long. Panasonic leaders declared many times that PDP TVs were the most strategic items to represent its whole lines of consumer-oriented products. American supranational manufacturing corporations are rarely involved in such a long-time low profit businesses, as they have to please their shareholders with favourable black-ink consolidated accounts. Panasonic, on the other hand, patiently maintained the factory production of PDPs and their finished products for a long time. There is still a difference of corporate mentality between America and Japan. It is also part of my socio-ecological studies (Drucker 1993). Panasonic hired 384, 586 employees in March of 2010, and reduced them to 285,817 employees in December of 2013. This is a big dismal impact of the global zero-sum business games to the Japanese society. JEITA (Japan Electronics and Information Technology Industries Association) is one of the corporate-Japan-typed organizations to lead the industrial goals under the central governmental surveillance and guidance. In accordance with the world-wide digital revolution in 2000s Japan rapidly replaced Cathode Ray Tube (CRT) TVs with Flat Panel TVs in order to vitalize the Japanese economy with some monetary stimulants (subsidies to both the consumers and the manufacturers). However, such governmental domestic policies didn't work well, because the globalization of economy was always influencing the whole supply chains of materials and products of Flat Panel TVs. SONY was secluded from the main group of Panasonic, HITACHI, Toshiba, Pioneer, FUJITSU, SHARP and so on. SONY decided to favour the international collaboration to produce LCDs and to assemble their final products with SAMSUNG in Korea in 2005. Many of other Japanese manufacturers found some supplying sources of cheaper LCDs in China, Taiwan and Korea, too. Panasonic expanded its domestic production sites of PDP TVs even under the vividly declining trend of consumers' demands shown to their final products in 2006 and 2007 (Figure 3). Panasonic tried to improve their sensitive value of PDP TVs. It was a kind of over-shooting, which was technologically designated by Clayton Christensen (Christensen,

Figure 3 The historical trend of the Japanese domestic shipment of TVs

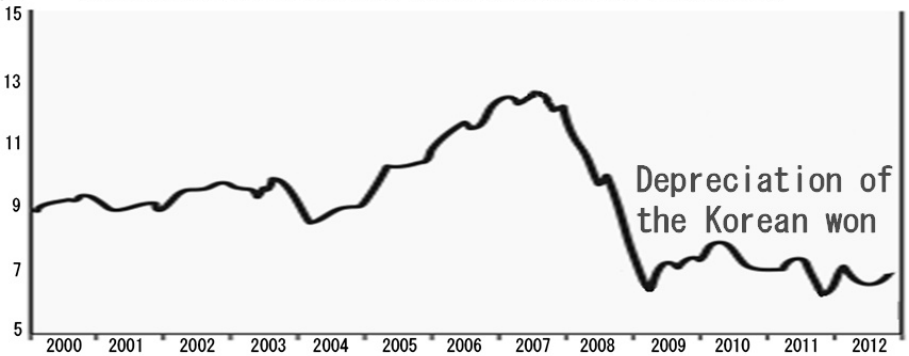


Source : JEITA (Japan Electronics and Information Technology Industries Association)

1997), when looking back into the past. Most of the ordinary consumers could not install such sophisticated PDP TVs in fully spacious and reasonably dark rooms of their houses or apartments.

Now import and export businesses of big manufacturing corporations are considerably swayed by the capricious international exchange rates (Figure 4). As App. le, for example, has neither capital- nor labour-intensive factory for itself, it can change the procuring quantity of materials and the ordering amount of products rather freely and quickly departing from the various business risks of exchange rates. However, Panasonic has its major production and assembling sites still in Japan. The Japanese yen's appreciation (the Korean won's depreciation, in other words) during the period ranging from 2007 through 2012 damaged Panasonic PDP TVs' competitiveness in the American and Chinese markets, where SAMSUNG and LG supplied their cheaper and almost-equal-quality products. As you know, the present matured markets are rapidly seized by a few of oligopolized corporations, which exhibit just one conspicuously attractive point in any attribute to a mass of coolheaded consumers. Panasonic lost its market share inevitably because of

Figure 4 The historical trend of 100 won
—the exchange rate between the Japanese yen and the Korean won—

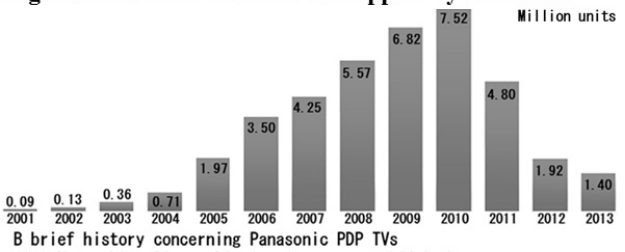


Source : Bank of Korea

its surely expensive retail prices. The long-time yen's strong appreciation was bad luck for Panasonic to maintain its international trade businesses of PDP TVs. At any rate this socio-ecological lesson was uncomfortably experienced by General Electric and Philips 60 years ago. And, SAMSUNG and LG followed 50-year-before's Tap Water Philosophy of Panasonic more tactfully.

The American-typed rationalism has been always encouraging business people so that they can keep the slogan of "Get big, or get out". in the radical market economy (Collins, 2001). Untill 2010 Panasonic had increased the annual shipment volume of PDP TVs under the strongly appreciated exchange rate of the Japanese yen year after year. I don't think that so many manufacturing corporations could bear aloofness against such whimsically fluctuating market conditions in the world. Over the past 3 years Panasonic has been quite a lot agonized by the unexperienced humiliating processes to withdraw itself from the businesses of PDP TVs (Figure 5). It seems to me that Panasonic is trying to become an astute corporation so that it can smoothly adjust to the present violent globalization based on economic supremacy. I bravely assume that Panasonic's long-time traditional Japanese business sense will be fading away, and that it will transform itself into an Amercian-typed supranational corporation in the future. May Panasonic's loyal geek customers expect no extraordinary sensitive value derived from craftmanship in its aesthetically designed durable goods? The most critical matter in the modern global marketing of both 1) B to B and 2) B to C businesses is that industries (sellers) should convince markets (buyers) of rational value in their branded products.

Figure 5 The units of PDP TVs shipped by Panasonic



B brief history concerning Panasonic PDP TVs
2000 Matsushita Plasma Display Co. was established.
2001 Shang Hai Matsushita Plasma Display Co. was established.
2003 VIERA TH-500X20 was released. The retail price was set at 1.1 million Japanese yen.
2005 SONY and SAMSUNG started the international collaboration of building and operating gigantic factories of LCD Panels.
2006 VIERA TH-P103PZ600 was released. The initial market price of World Largest Full HD Plasma was around 6 million yen.
2008 The corporate name was changed from Matsushita to Panasonic.
2009 Almost all of PDP front-line engineers of Pioneer and HITACHI joined in the PDP R&D team of Panasonic.
2010 The order-made VIERA TH-152UX1 (World Largest Full HD 3D Plasma) was publicized. The estimated price was about 30 million yen.
2013 Panasonic ceased all of the factory production of PDPs.
2014 Panasonic is scheduling to stop all of the sales of consumer-use PDP TVs.

Source : Panasonic http://panasonic.co.jp/index3.html

Transience of PDP TVs' marketability

Around 2000 many of Japanese people were fascinated by the concept of the High Definition (HD) wall-mounted TVs, which had been demonstrated through various media by many of Japanese innately competitiveness-oriented

electrical and electronic appliances manufacturers. Like cherry flowers, they burst into full bloom almost all at once, and then pass away soon. Most of the Japanese obedient consumers just accept a package of gifts (benefits of rational value and sensitive value in popular durable products) brought by two or three remaining players in the markets. For the past 50 years or so those remaining players were always SONY, Panasonic, SHARP or other world famous brands of Japanese corporations. I very often expected to install a thin paper-sheet-typed PDP TV on the wall of my small living room. At the present time, as of March of 2014, SAMSUNG and LG in Korea are demonstrating such innovative models of Flat Panel TVs in the international expositions and the consumer electronics shows. In the domestic and overseas markets of PDP TVs SAMSUNG and LG are remaining players by now. By the way, I am not a sentimentally ethnocentric person with regard to electronic information instruments and devices. I am using GALAXCY S SC-02C, which is a rather new model of smartphone provided by SAMSUNG. My wife is, too.

When looking back into the past 10 years or so, my academic friends (university colleagues) and I very often discussed about the superiority and inferiority of LCD TVs and PDP TVs including those structural difference (Figure 6). We were more sympathized with the PDP TVs manufactures than with the LCD TVs manufactures. Panasonic became very lonely in 2009 in maintaining its largely integrated manufacturing system from parts of PDPs through to finished PDP TVs. Panasonic needed a huge amount of monetary investment in order to supply and demand a variety of high quality (free of curves or distortions) glass tubes like CRT TVs in those days. And also, Panasonic required many craftsmen's miracle hands to adhere the front substrate to the rear substrate in assembling large-sized PDPs precisely one by one even in the most modern automated and robotized factories situated inside Japan.

The discussion about Flat Panel TVs was a good topic for us to keep a peaceful atmosphere, especially when we were eating out together in the evening. As long as people are rich enough and prefer to live in big spacious houses or apartments, they will favour PDP TVs. I sincerely envy their freedom of choice (Iyengar 2011). When people are not rich, they had better buy smaller LCD TVs without any hesitation. Although I have been living in a tiny apartment in downtown of Kobe for more than 20 years, I decided to buy KURO first, and then VIERA next in order to keep my snobbish dignity as a semi-professional photographer. I am fond of blackness of pictures shown on the 50-inch-sized PDP TVs. When I watch television at home, I always darken the narrow living room with thick curtains. I don't think that I am a typical Japanese consumer in many respects.

It is a smart way for Japanese price-conscious consumers to visit the web-sites of kakaku.com in Japan before they go shopp. ing. They can easily find

the lowest retail price and the way to get a convenient access to its outlets (retail stores) or auctioneers. Price in English is associated with kakaku in Japanese. As a Japanese consumer scientist, I very often visit kakaku.com/kaden to check the already-well-known phenomenon of commoditization found in the Japan-made electrical and electronic products. TH-65PF10KR is the legendary model of Panasonic PDP TV. It still has a semantic meaning favoured by a handful of fervent admirers as one of the cult-typed goods. Therefore, its auction price is very high even 6 years after its launch date (Table 2). I own TH-P502T5. I was a lucky person, as I bought it at the time, when the retail price was the lowest. Even now this model is on sale at many of kaden (electrical and electronic appliances in Japanese) retail stores. As Panasonic is stopp. ing the production soon, the retail price is higher than before. TH-P65VT60 is the most luxurious model of Panasonic PDP TVs in the Japanese domestic market. Its beautiful blackness of pictures and dynamic sounds of music really knock my socks off, if I imitate the American expressive way of complimenting (Zemke, Anderson, 1997). However, it is too big for my apartment. All in all, you can say that Panasonic PDP TVs have exhibited its outstanding sensitive value only to some of elegant and/or snobbish residents so far.

There are quite a lot of talkative prosumers at this moment, who can technically and technologically evaluate many of highly sophisticated consumer durables in the world. They dispute and argue with one another about their interesting matters openly on the various social media. This trend is deeply and widely connected with commoditization of electronic and information instruments and devices in the present day's competitive matured and/or declining markets. In the case of Flat Panel TVs I very often look into the evaluations given by valueelectronics.com. One of my two impressive points is that those audience and experts give almost the same scores to each model. Another is that PN64F8500 of SAMSUNG gets the highest score from both those audience and experts even on Day Mode (High Ambient Light), which they say has been the weakest point of PDP TVs (Table 3).

In the latter half of 1960s (my undergraduate university days) I fought consistently with the technical term of "value in use" especially in both economics and commodity science. Now I simply describe it as follows; Commodities sold and consumed in the olden poor society gave everyone almost the same rational value in use. On the other hand, well-known branded goods and cult-typed goods in the present affluent society are convincing a particular segment of people of their relatively varying sensitive value in use, which is dependent on their inward and outward circumstances.

PDP TVs are generally better in reference to picture quality than LCD TVs. It is because PDP TVs show us various moving images in a wider Human Eyes Visible Range (HEVR). However, their full performance must not be

expected in the brighter room (Figure 7). PDP TV's sensitive value in use is seriously damaged there. LCD TVs are more flexible to the change of brightness or darkness. This ubiquitous characteristic is part of LCD TVs' rational value in use. Most of the Japanese people watch television in their brighter space of cramped living-cum-dining rooms. While having meals in the morning and/or in the evening, they routinely turn on TVs. The majority of Japanese fathers in 30s and 40s don't have their exclusive-use rooms at home in order to take care of their teen-aged children who would like to study and sleep respectively in their own rooms Even when they know how to enjoy gorgeous PDP TVs, they have to give up their private leisure time for 10 through 20 years. Such poor Japanese housing conditions have been obliterating PDP TVs in the markets, if I exaggeratingly speak a bit.

I have some friends in Olympia of the State of Washington. They are enjoying elbowroom in many ways. In May of 2013 I discovered that the best performing model of Panasonic PDP TV was TC-P65ZT60, and it was available only outside Japan. One of my old friends brags that its direct colour filters are perfectly functioning 1) to show him black-colour as ink on its display, and 2) to give him the feeling of being at various live music clubs and playhouses, when sitting in his huge darker recreation room. As he can accommodate around 20 people at one time there, its wide viewing angle is very helpful for all of them to follow spectacular scenes of movies equally. Panasonic knew the importance of presence as part of sensitive value for the American geek consumers, but neglected the delicate interest of the Japanese geek consumers, who Panasonic might have thought were too few to engage itself in very costly marketing in the declining stage of PDP TV production and sale businesses. I learned a new lesson of the true capitalist society there (Figure 8). Panasonic is still cool as an extraordinary smart merchant in search of turning anything to its corporate business profits as a result. I don't think that Panasonic will become like Kodak, which was cohesive to its silver halide film businesses too long. However, I really wonder if Panasonic may appeal its excellence of electrical and electronic products to the long-time loyal customers as the corporate personnel consisting of 1) brave entrepreneurs, 2) charismatic managers, 3) visionary technologists and 4) warm-hearted craftsmen. Without craftsmanship in product designing Panasonic will not be able to capture the attention of so many geek consumers.

Conclusion

In the first half of 2000s PDP TVs were expensive objects envied by many of reasonably rich families in the affluent society. However, they were drastically replaced by LCD TVs in the latter half of 2000s. Comparatively speaking, PDPs have been under the closed business architecture based on the integral division of labor. Panasonic became only the main supplier of PDPs

during the period from 2009 through 2013 in Japan. On the other hand, LCDs have been under the open business architecture based on the horizontal division of labor. Various-typed LCDs were world-widely ordered and supplied among many manufactures of electronics and information instruments and devices including personal computers and mobile phones in the world. Therefore, LCDs have surpassed PDPs in the markeTable scale of economy. Under the rapid commoditization (mainly, the phenomenon of going down of retail prices) of Flat Panel TVs on the whole, LCD TVs have become surely superior to PDP TVs with regard to 1) costs in purchase and maintenance and 2) convenience and comfort in the stage of real usage for a mass of consumers.

Philip Kotler, who had been "Guru" in the American modern marketing for 40 years or so, published "Marketing 3.0" in 2010 together with his two Indonesian subordinates (Kotler, Kartajaya, Setiawan, 2010). This book completely denies the long-time traditional American rationalism and economic supremacy, and surprisingly promotes a more comforTable environment-conscious concept for common and business people in mind, heart and spirit on the basis of social value, which should be co-created between industries (sellers) and markets (buyers) world-widely. Under the traditional relationship of B to C, the corporate attitude of looking down upon consumers must receive a great revenge in the future. The most striking point is that Philip Kotler suggests globally active corporate business people to respect even their vexatious competitors. Therefore, B with C is not enough in the present social media age. The new relationship of B with B and C in equal manners is definitely welcome from the viewpoint of universalism in the future (Figure 9). The future fertile globalization of B with B and C shall bring about a new concept of wellbeing in the world.

Until the beginning of 1990s many of Japanese industries were notorious for "Corporate Japan" in the world. It was because they ruthlessly obliterated overseas competitors with their competitiveness power of 1) production costs and 2) sale prices. Since then, they have been involved in such American-typed phrases as "Economy was a peace-time war." and "Business was warfare acknowledged by everybody." Under the strong appreciation of the Japanese yen, the whole Japanese industrial structure has been considerably damaged. Under the long-time economic recession the solidarity of "Corporate Japan" has been seriously weakened. These unfavourable results could be associated with the past futile globalization. Actually the corporate image of Panasonic has grown stale along with many times of the red-ink consolidated accounts in 2008, 2009, 2010 and 2012. I think that the fundamental cause of its managerial failure is derived from lack of communicative competence which should be shared with its management class and engineering people. They don't get enough support from passionate

prosumers and cooperative business partners, who are imperative stakeholders in the context of marketing 3.0.

Panasonic does not give up all of Flat Panel TVs businesses. It is rather expanding its LCD TVs' production and sale businesses in the manners of B to B and B to C. It is said that 4K HD Smart VIERA series of its LCD TVs are popular in the domestic and overseas markets at this moment. However, 1) the extreme of picture quality in connection with sensitive value to please the Japanese quiet geek consumers with jet-black-colour of images, an amazingly wide viewing angle and no motion blur on its displays, and 2) Tap Water Philosophy to demonstrate rational value not in the poor society but in the affluent society have not been realized yet. Is Panasonic indifferent to these corporate commitments, which were promised in public before? If so, Panasonic will not be a gay player but a dismal player in the global markets. I believe that technological innovations come out of these paradoxical business conditions.

References:

D'Aveni R. A., 2010, Beating the Commodity Trap (1st ed.), Harvard Business School Press, Boston USA.

Moon Y., 2010, Different (1st ed.), Crown Business, New York USA.

Toffler A., 1980, The Third Wave (1st ed.), Bantam Books, New York USA.

Drucker P. F., 1993, The Ecological Vision (1st ed.), Transaction Publishers, New Jersey USA and London the Great Britain.

Christensen C.M., 1997, The Innovator's Dilemma (1st ed.), Harvard Business School Press, Boston USA.

Collins J., 2001, Good to Great (1st ed.), Harper Business, New York USA.

Iyengar S., 2011, The Art of Choosing (1st ed.), Grand Central Publishing, New York USA.

Zemke R, Anderson K., 1997, Coaching Knock Your Socks Off Service (1st ed.), Amacom, New York USA.

Kotler P., Kartajaya H., Setiawan. I., 2010, Marketing 3.0 (1st ed.), John Wiley & Sons, New Jersey USA.

PRODUCT LIFE CYCLE THEORY IN THE CONTEXT OF ECOLOGICAL ASSESSMENT METHODS

Tomasz Nitkiewicz

Department of Technology and Ecology of Products,
Cracow University of Economics,
nitkiewt@uek.krakow.pl

Introduction

The product life cycle (PLC) is an important theory in the fields of management and marketing. The commencement of the study of the product life cycle can be traced back to the 1950s, which was an effort to account for predictability of the life cycle of a product from introduction to withdrawal from the market (Yang & Zhao, 2010). Hedden proposes that the life cycle is characterized by a curve that can be separated into four distinct phases: introduction, growth, maturity, and decline. The study is purposed to achieve product's maximal value and profitability at each stage. It is principally deemed a marketing theory (Hedden, 1997). Cyert and March (1992) relate the product life cycle concept to the organizational context and use it as a background for development of behavioral theory of a firm. Van de Ven and Poole (2005) refer to product life cycle concept as a major approach for organizational change.

The management of product life cycle entails knowhow of a large number of professional disciplines, and a good command of techniques and skills and tools related to commerce and production. As the study developed, it became an independent discipline, called Product Life Cycle Management (PLCM), gradually involving nearly every yield of economy, from the light industry such as apparel & footwear, chemicals, plastic fabrication, and food & beverage to the heavy industries like building materials, industrial equipment, machinery, and metal fabrication, from electrical and electronic industry to such as automotive, communications, financial services, healthcare, hi-tech, insurance, information, and aerospace.

Technological discontinuities cause a period of ferment in which alternative product forms compete for dominance due to the large amount of market and technological uncertainty that exist following a technological discontinuity. New firms enter the market and competition focuses on product

innovation. Eventually, however, the process of experimentation between the firm and the users of the product leads to the appearance of a dominant design where standardized parts, software, and manufacturing equipment appear (Funk, 2004, p. 142)

Product life cycle describes the stages a product goes through from beginning to end. It is generic description of the way a product behaves in the market. In its classical version product life cycle is divided into four stages: introduction, growth, maturity, and decline (Wang, Guo, & Liang, 2009). Figure 1 illustrates the product life cycle. It is defined as markeTable product life cycle.

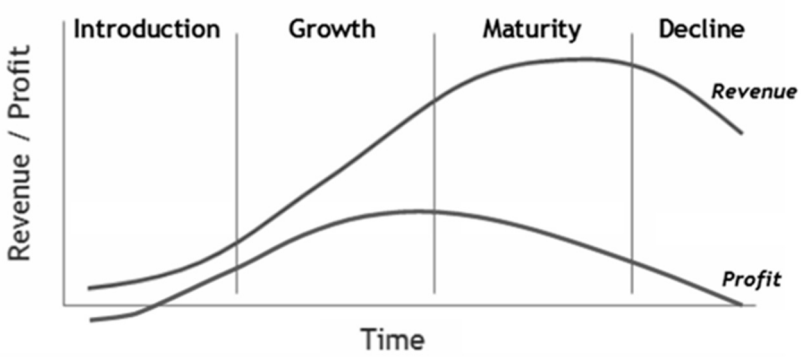


Figure 1. Schematic presentation of product life cycle phases

Source: http://www.mrdashboard.com/Product_Life_Cycle.html (accessed on March, 2014).

This approach to define product life cycle phases is a subject to many developments and expansions but also criticism. Despite the direct neglecting of product life cycle concept by some authors (see Field, 1971; Jaman, 2012), in general these efforts do not question product life cycle concept itself, but have a different view on its course, time span, phases and factors determining the switches between them (see Kotler and Philip, 1991; Klepper, 1997; Che, 2009). The key parameters determining the life cycle of the product include: technical readiness to enter the market, product relevance to consumers needs, volume of sale, potential product innovation and improvement, available marketing strategies (Kotler and Philip, 1991).

It should be underlined that the real potential of PLC concept does not lie in the area of prediction of product market performance but rather in new product designing and planning, product research, innovation management, designing marketing strategies and optimizing product portfolio.

The second item included in the analysis is life cycle assessment (LCA) method – one of the environmental management tools. The roots of LCA are often placed in 1970s and the emerging pressure on the economy to mitigate

environmental impacts and natural resources use and to develop the instruments to measure and monitor their effects, their short- and long-term impacts and project possible changes (Meadows et al., 1972). LCA has been designed as one of the techniques to measure the environmental pressures or impacts of goods. LCA has been introduced for products cycles analysis in order to determine material and energy quantities used during its production, exploitation, end-use together with identifying its environmental impact of its processing on every stage mentioned (ISO, 2006).

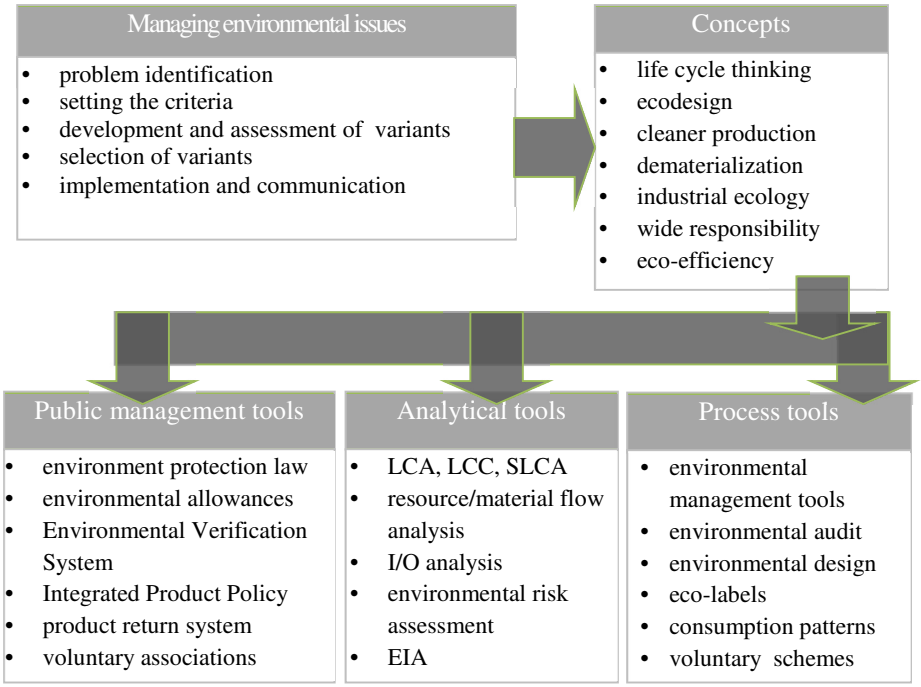


Figure 2. Life-cycle assessment position in the classification of environmental management tools

Source: based on Nitkiewicz, 2010a.

Figure 2 positions the LCA originating methods in general classification of environmental management tools. LCA concept constitutes an important group of methods based on life cycle concept. Together with life cycle costing and social life cycle assessment, as well as with I/O based method they are classified to the group of analytical tools. Analytical tools of environmental management serve for the purpose of supporting decision making process with specific information on environmental impacts of products, processes, investments and etc.

Primarily, LCA was dedicated to assess environmental impact of goods, but its capacity and flexible structure has significantly enlarged its possible use. Today, LCA is used not only for assessment of products but also processes organizations, technologies or strategies. LCA is becoming recognized more as one of environmental and resource-based management tools (Bajdur et al., 2010). The widening LCA use is closely connected to process of evolution of these tools in the direction of becoming more complex in assessing production processes. The basis for this evolution has been established by reference not only to production phase but also to the pre- and post-production phases that are very often indirectly connected to the product itself.

A simplified scheme of the product life concept is presented at Figure 3. Scheme content as presented here is usually referred to as a "life cycle" as it includes loops between the several life phases. Examples of such loops are the reuse and recycling of post-consumer products (originating in the end-of-life phase) or recycling of production scrap. The full arrows represent material and energy flows, while the dashed arrows represent information flows.

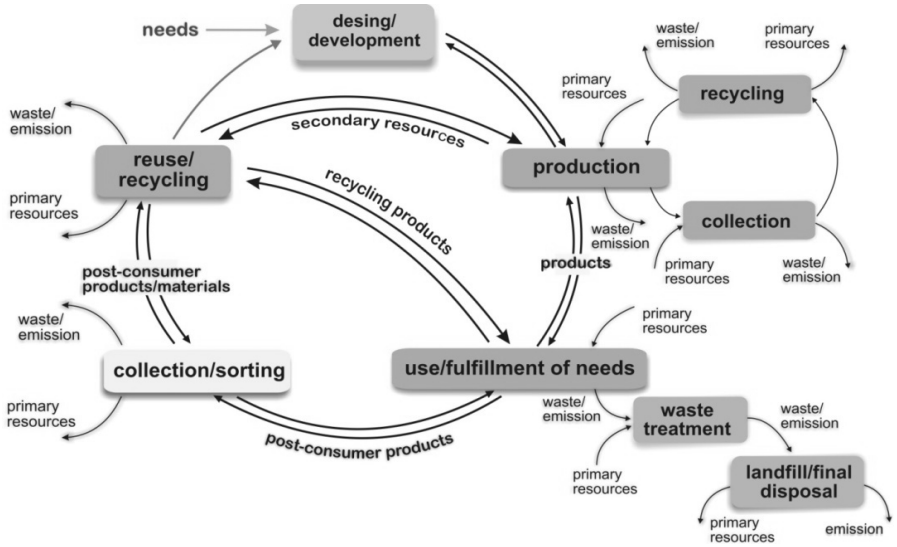


Figure 3. Schematic representation of a generic life cycle of a product

Source: Rebitzer et al., 2000; Nitkiewicz, 2010a.

Life cycle assessment is a methodological framework for estimating and assessing the environmental impacts attribuTable to the life cycle of a product, such as climate change, stratospheric ozone depletion, tropospheric ozone (smog) creation, eutrophication, acidification, toxicological stress on human

health and ecosystems, the depletion of resources, water use, land use, and noise – and others (Rebitzer et al., 2004).

Complexity of LCA is dependent on the number of life-cycle phases and their mutual relationships. These relationships were shown on the scheme presented on Fig. 3. Despite the fact that LCA is not yet methodologically unified its implementation is made with 4 phases (ISO, 2006; Kowalski et al., 2007):

- defining range and scope,
- inventory analysis,
- impact assessment,
- interpretation.

Each one of aforementioned stages is realized through chronological sequence of decisions and operations. Simplified scheme of LCA procedure is presented on Fig. 4.

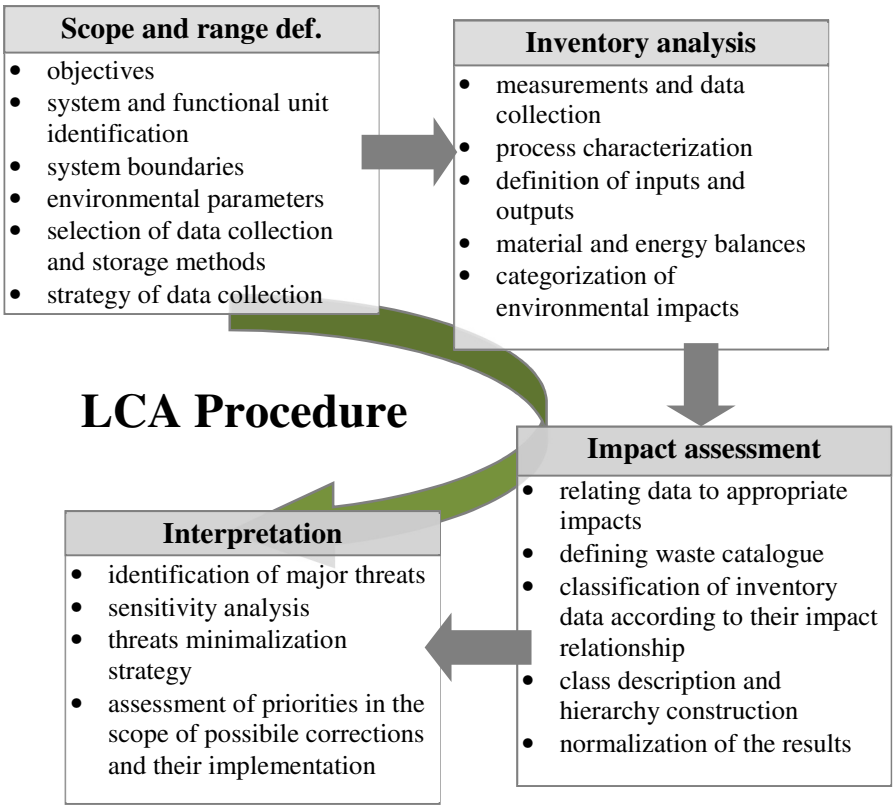


Figure 4. LCA implementation procedure

Source: based on Nitkiewicz, 2010b.

Major problem connected to LCA use is the consistency of data. Different institutions have tried to standardize the methodology so as to ensure comparability of the results obtained by different practitioners and they have admitted the possibility of streamlining LCA so as to make it applicable to a greater number of companies. However, carrying out LCA is already quite a difficult project for companies, because it requires investing time and resources along with in-depth environmental knowledge. Masoni et al. (2000) identified the following as the main difficulties for applying LCA to enterprises: scarcity of data (due to the non existence of measurement instruments), lack of awareness, restrictions in time and specific resources for environmental issues and low levels of training. These limitations can even lead to inconsistent results when applying traditional methods and software in this type of companies, since unavailable data are usually estimated according to averaged values or similar activities or processes which not always reflect exactly the company's under study situation (González et al., 2002). Another issue within LCA use that should be addressed is the actual use of its results in decision-making process. There are many different types of indicators originating from LCA i.e. KEA, ecological points, MIPS, Eco-indicator or CML just to name a few of them (for detail characteristics of LCA impact assessment methods see Nitkiewicz, 2013). Each one of them is different in calculation methodology used, types of impact categories included and number of results. Therefore, it is very often the case that decision-makers are unable to find out the clear message incorporated into LCA indicators.

Market life cycle of a product has been a milestone for the development of product strategy, orientate product research and consumer preferences. Its background relates the phases of product life cycle to its market performance and its recognition from the perspective of actual and potential consumers. The concept of ecological life cycle is evidently based on product life cycle theory but it uses different approach to define life cycle phases. These phases are modeled in a way that encompass their total environmental burden but do not relate them to their market performance and perception. This slight difference in defining life cycle is responsible for major difference in practical application of both concepts. Product life cycle research needs market based information, mostly from use phase, while life cycle assessment relies on design originated information.

Material and methods

Since the LCA use is an attribute of ecologically aware firms, the interrelation between PLC and LCA concepts is investigated in the sample of firms that have introduced some proecological initiatives in their activities and management practices. The sample was investigated through the survey made within the project titled "Ecological product policies of companies" that was

realized by Department of Product Technology and Ecology of Cracow University of Economics in the years 2011-2013 (Adamczyk, 2013). Survey results are adopted in order to provide some insights into PLC and LCA interrelations. The surveyed sample consisted of 61 manufacturing companies located in śląskie and małopolskie voivodships. The sample was profiled in a way of featuring firms with some experiences in undertaking proecological activities. The structure of the sample with regard to the size of the firms included is presented in Tab. 1. Since the survey was designed for the qualitative research its representativeness is limited to certain geographical area (śląskie and małopolskie voivodships) and to certain profile of companies (declared or proved environmental engagement). The survey was made in a form of computer assisted web-based interview (CAWI). The respondents of the interview were recruited from managerial staff, production management and environmental departments employees in firms.

Table 1. The structure of the sample of surveyed firms

Size of the firm	Number of employees	Number of firms
Micro	from1 to 9	8
Small	from 10 to 50	12
Medium	from 51 to 250	20
Large	above 250	21
Total		61

Source: own work on the basis of survey results.

In order to analyze PLC and LCA interrelations the Analytic Hierarchy Process (AHP) method is used. AHP method belong to the group of multi-criteria decision support instruments and serves for solving complex decision problems. According to its creator, Saaty (1980), AHP procedure includes building decision model on the basis of assumed major goal, decision criteria and sub-criteria and decision alternatives being the actions undertaken to solve decision problem. Major objective is settled at the top of hierarchy while the alternatives establish its bottom. Between the objective and the alternatives the decision criteria and their subcriteria are placed. Solving the decision problem is based on pairwise assessment of the importance of decision criteria and sub-criteria with relation to the element on the higher level of the hierarchy. The comparative assessment is made by the experts in the discipline or the decision makers themselves (Saaty, 2004). The AHP procedure enables the participation of not limited number of experts in the assessment and it extrapolates the results. The assessment is based on verbal opinion on given pair of criteria or sub-criteria in reference to the decision objective. The

opinions are expressed in Saaty's fundamental scale that describes the dominance of one element over another according to the assessments of experts. The scale is reversible and dominance of one element over another is automatically transferred into subordination of second element to the first one. Basing on the pairwise comparison the values of local and global priorities are calculated and prescribed to the alternatives, representing the solution of decision problem, as well as to decision criteria, indicating their importance in the decision making process. The detailed procedure of calculating priorities is presented in Saaty (2001), Gręda (2013) and Nitkiewicz (2013).

Results and discussion

The decision problem is formulated as: the optimization of production processes in a firm and is established as a major goal of AHP model. The decision problem is relevant to PLC and LCA concepts since both of them provide appropriate information for retrospective and prospective assessment of production processes, its effects and its possible upgrades. Basing on the survey results 7 alternative directions of changes in firms are identified. This set includes the following decision alternative areas of changes:

- products/services,
- packaging,
- technological processes,
- machines and equipment,
- supply, internal transport and distribution systems,
- communication systems,
- management and organization.

The decision problem is supported with major decision criteria set that consists of the following issues: economic, market, marketing, technological, ecological, personnel, legal.

In order to get some insights into decision making process major criteria are complemented with the set sub-criteria that is identical for each criterion. The justification of using the same set of sub-criteria for each criterion is based on the assumption that major criteria are very capacious notions that should be described in details with less comprehensive arguments. The set of sub-criteria includes the following: availability, costs, functionality, efficiency, quality and marketing potential. Diversifying criteria and sub-criteria was made on the assumption of gradualism of decision making process. Unfolding the gradualism assumption leads to defining 3 step approach to decision making while optimizing the firm. The first step is the identification of major functioning parameter to be improved, the second step is defining the way to

do it, while the third step relates it to the appropriate function of the firm or its attributes.

Figure 4 presents AHP model with its hierarchy and indicates also the two perspectives resulting from PLC and LCA approaches to optimization process of a firm. PLC is focused on market performance of the product and marketing activities needed to keep it on the high return phases. LCA perspective concentrates on environmental issues and possible actions that could mitigate possible ecological pressures. It is important to mention that other criteria would be also participating in both perspectives but the only the dominant ones are illustrated.

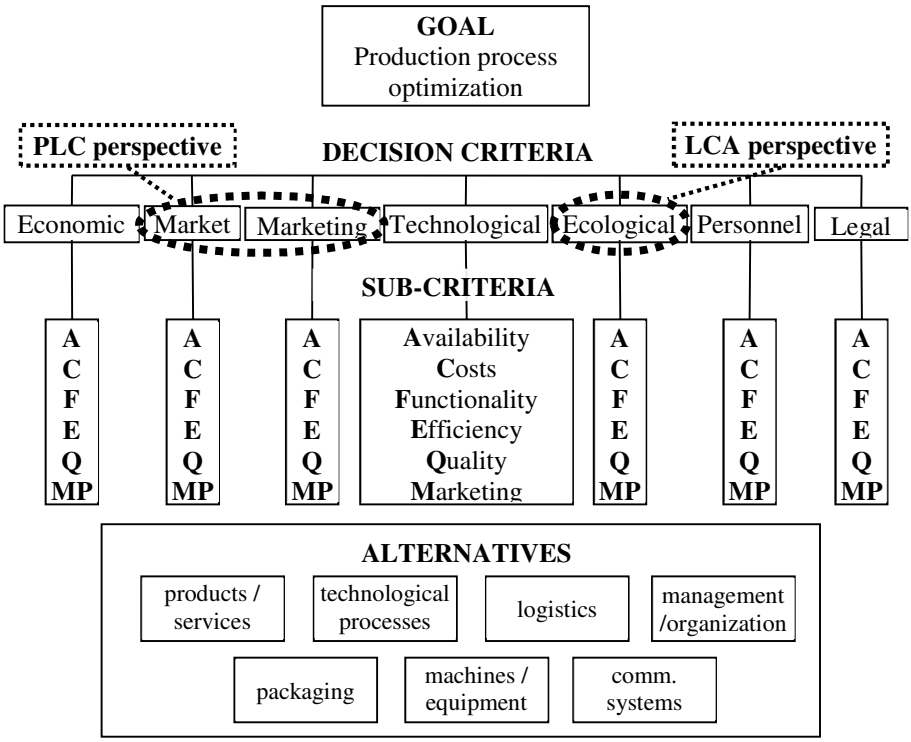


Figure 5. Schematic presentation of AHP production optimization model

Source: own work.

Solving the decision problem with AHP modeling leads to the identification of key alternatives, which is not crucial issue from the point of view of paper objectives, but also enables the assessment of decision criteria importance. Tab. 2 presents the values of global priorities for PLC (market and marketing) and LCA (ecological) decision criteria with values of global and local priorities for respective subcriteria sets. PLC related criteria have much higher value of global priority mainly due to high importance of market

criteria in decision making. Ecological criteria have only a supplementary role in decision process. Finding that PLC perspective is more commonly used to optimize production processes is rather no surprise. On the other hand, finding ecological criteria slightly more important than marketing criteria indicates that production optimization issue is related to environmental issues and they are also included in the decision making process on a similar basis to other supporting issues.

Table 2. Priority values for PLC and LCA criteria and subcriteria

Sub-criteria	Decision criteria (gobal priority value)		
	Market (0,068)	Marketing (0,021)	Ecological (0,023)
	Local and global priority values		
Availability	0.128 (0.009)	0.138 (0.003)	0.127 (0.003)
Costs	0.220 (0.015)	0.218 (0.004)	0.236 (0.006)
Efficiency	0.184 (0.012)	0.189 (0.004)	0.185 (0.004)
Functionality	0.172 (0.011)	0.167 (0.003)	0.189 (0.004)
Marketing potential	0.066 (0.004)	0.082 (0.001)	0.049 (0.001)
Quality	0.230 (0.016)	0.207 (0.004)	0.214 (0.005)

Source: own work.

There is no surprise finding that costs and quality are most important sub-criteria no matter which one of the two perspectives is used. It is worth to mention that considering sub-criteria set for market criterion quality has even higher significance than costs. Investigation of ecological sub-criteria set leads to observation that functionality is higher valued than efficiency which is opp. osite to both PLC criteria: market and marketing.

Conclusions

Comparing PLC and LCA frameworks led to identifying both the similarities and differences. Summarizing the comparison the following findings could be brought out:

1. PLC concept is focused on market life cycle while LCA concerns physical life time of a product. Because of that, life cycle phases are defined differently in both approaches. In PLC perspective life cycle phases are identified on the basis of finally designed and complex product and its sale volume on the market. In LCA approach life cycle phases come across its market life cycle and are defined in reference to its development

stadium. LCA includes the following phases of product life cycle: designing, manufacturing, using and end-of-life scenario. Despite the similarities and common genesis of the two concepts, the division of life cycle phases is made on the different assumptions and there is no possibility to directly transfer them between the two concepts.

2. PLC presents the product from the perspective of its consumer, his needs and demand, and producer, while LCA adopts the designer perspective and presents its cycle irrespectively to consumer and producer (life cycle phases included in LCA are typically serviced by different actors, such as suppliers, manufacturers, users, waste management operators). LCA perspective is obviously focused on environmental impacts in whole life cycle of a product and these impacts have many stakeholders interested in it, including not only life cycle actors but many more people and units.
3. PLC takes into account the volume of product that could be sold in given time (that could not be measured precisely) and accepts product modifications of any kind that could improve its market performance. On the other hand, LCA concerns single variant of a product but precisely defined in every one of its life cycle phases.
4. Referring to empirical evidence from AHP model solving PLC approach has much higher impact on decision making within manufacturing firms optimization framework. LCA perspective has a minor impact on decision making process even if already environmentally aware firms are investigated.

References

Adamczyk W. (ed.), 2013, Działania ekologiczne w polityce produktowej przedsiębiorstw, Wyd. Naukowe "Akapit", Kraków.

Bajdur W., Idzikowski A., Salamon S., 2010, Możliwości zastosowania ekologicznej oceny cyklu życia procesów wytwórczych w projektowaniu systemów zarządzania ochroną środowiska, [in:] Komputerowo zintegrowane zarządzanie, ed. R. Knosala, T.1., Ofic. Wyd. Polskiego Towarzystwa Zarządzania Produkcją, Opole.

Che Z.H., 2009, Pricing strategy and reserved capacity plan based on product life cycle and production function on LCD TV manufacturer, Expert Systems with Applications 36 (2009), 2048-2061.

Cyert R., March J., 1992, A Behavioral Theory of the Firm (2nd ed.) Wiley-Blackwell.

Field G.A., 1971, Do Products Really Have Life Cycles?, California Management Review, Fall 1971, Vol. 14, Issue 1, pp. 92-95.

González B., Adenso-Díaz B., González-Torre P.L., 2002, A fuzzy logic approach for the impact assessment in LCA, Resources, Conservation and Recycling 37 (2002), pp. 61-/79.

Gręda A., 2010, Wybór efektywnego systemu zarządzania jakością w przedsiębiorstwach na przykładzie przemysłu spożywczego. Zarządzanie Przedsiębiorstwem (2), pp. 21-32.

Gręda A., 2013, Wielokryterialne problemy decyzyjne w proekologicznych działaniach produktowych przedsiębiorstw, [in:] W. Adamczyk (red.), Działania ekologiczne w polityce produktowej przedsiębiorstw, Wyd. Naukowe "Akapit", Kraków.

Hedden C., 1997, From Launch to Relaunch: The Secret to Product Longevity Lies in Using the Right Strategy for Each Stage of the Life Cycle, [in:] Marketing Tools. Penton Business Media, Inc.

http://www.mrdashboard.com/Product_Life_Cycle.html (accessed on March, 2014).

ISO, 2006, ISO 14044: Environmental Management - Life Cycle Assessment - Requirements and Guidelines. International Organization for Standardization.

Jaman M., 2012, Critical Analysis of Segmentation Strategy For Potential Product Launch - Mapping The Customers, International Journal of Scientific & Technology Research, Dec 2012, Vol. 1, Issue 11, pp. 62-69.

Klepper S., 1997, Industry life cycles, Industrial and Corporate Change 6, 145-181.

Kotler L., Philip J., 1991, Marketing management-analysis, planning, implementation and control. Englewood Cliffs: Prentice-Hall.

Kowalski Z., Kulczycka J., Góralczyk M., 2007, Ekologiczna ocena cyklu życia procesów wytwórczych (LCA), Warszawa, Wyd. Naukowe PWN.

Masoni P., Scimia E., Balázs S., 2000, VerdEE – a new tool for the adoption of Life Cycle Assessment in Small and Medium-sized enterprises, Gupta S.M. (ed.), Environmentally Conscious Manuf., Proc. of SPIE, vol. 4193, Boston.

Meadows D.H., Meadows D.I., Randers J., Behrens III W.W., 1972, The Limits to Growth. Report to Club of Rome.

Nitkiewicz T., 2010a, The Conditions of Life Cycle Assessment App. lication in Business Sector, [in:] Modern Company Management. Monograph, Ed. Iwona Otola, Wyd.WZPCzęst. Częstochowa 2010, pp. 66-82.

Nitkiewicz T., 2010b, Using LCA Indicators in DEA Model - Variables Selection Algorithm, [in:] Technological and Socio-Economical Aspects of Environmental Protection in Industry. Monograph, Ed. Wioletta M. Bajdur, Wyd.WZPCzęst. Częstochowa, pp. 62-80.

Rebitzer G., Ekvall T., Frischknecht R., Hunkeler D., Norris G., Rydberg T., Schmidt W.-P., Suh S., Weidema B.P., Pennington D.W., 2004, Life cycle assessment Part 1: Framework, goal and scope definition, inventory analysis, and applications, Environment International 30 (2004), pp. 701-720.

Rebitzer G., Schiller U., Schmidt W.P., 2000, Methode euroMat'98—Grundprinzipien und Gesamtmethode, [in:] Fleischer et al. (Eds.), Eco-Design – Effiziente Entwicklung nachhaltiger Produkte mit euroMat, Springer, Berlin, pp. 4-22.

Saaty T.L., 1980, Multicriteria Decision Making: The Analytic Hierarchy Process. New York, McGraw-Hill.

Saaty T.L., 2004, The analytic hierarchy and analytic network processes for the measurement of intangibles and for decision making, [in:] J. Figueira & S. Greco (ed.), Multiple Criteria Decision Analysis: The State of the Art Surveys, Dordrecht, Kluwer Academic Publishers.

Saaty T.L., 2001, Decision Making for Leaders. The Analytic Hierarchy Process for Decisions in a Complex World. Pittsburgh, PA: RWS Publications.

Van de Ven, A.H., Poole, M.S., 2005, Alternative App. roaches for Studying Organizational Change, Organization Studies, September 2005, vol. 26, no. 9, pp. 1377-1404.

INCLUDING EXTERNAL COSTS IN ENERGY SECTOR WOULD THEY CHANGE COST-COMPETITIVENESS OF DIFFERENT ENERGY SOURCES?

Matevz Obrecht, Matjaz Denac

Faculty of Logistics, University of Maribor,
Faculty of Economics and Business, University of Maribor,
matevz.obrecht@fl.uni-mb.si

Introduction

Environmental pollution and increasing energy demand are two main issues of global energy related issues. In environmental pollution we include emissions in air, water and land, climate changes, landfilling, materials depletion, land use etc. and increasing energy demand is mainly caused by population growth, consumer life style, increasing life standard and increasing heated surfaces.

The issue of energy also includes high energy dependence of certain countries and European Union (EU) as a whole. The current energy demand in the EU is in 55% covered by imported energy sources and energy itself. Energy dependence causes the vulnerability of the EU, particularly in the potential loss of energy supply. While pollution represents mainly environmental risk, the energy dependence represents predominantly economic and socio-political risk and the challenge to restructure the EU energy sector.

Petroleum products which are a mixture of hydrocarbons cause several emissions in the process of combustion. The usage of petroleum products therefore degrade the natural environment and affect human health. Modern lifestyle is highly dependent on oil and, in the case of supply shortfalls, is also very vulnerable. Rarity of conventional energy sources (CES) in combination with increasing energy demand increases the price of energy from CES. Scarcity of resources, therefore, forces mankind to search and implement new, alternative energy sources and utilize untapped potential of renewable energy sources (RES). Since the EU has very limited oil reserves, it is especially important to focus to the development of RES.

Energy related external costs represent the negative environmental and socio-economic effects generated by energy production, expressed in the form of cash (Barle and Golc, 2004). Scientists, professionals and politics emphasize that market distortions will continue to feature the internal energy market until the "polluter pays principle" will not be implemented and used in practice. EU already directs Member States to internalize the external costs of energy, including all environmental costs. The internalization of external costs (IEC) will introduce a new evaluation of various energy sources since it indicates the direction of the evaluation of energy systems with the life cycle approach.

Promotion of IEC in the EU is already noTable in the field of industrial pollution, packaging waste and emissions. Although IEC would facilitate the development of renewable energy sources and would also enable faster transition to sustainable energy, IEC in the energy sector is not yet fully activated. It is estimated that the price of energy from CES would significantly increase; Barle and Golc (2004) argue that the price of electricity produced from CES would increase for at least 5-7% if external costs would be internalized in energy price. IEC in the energy sector is also prevented by powerful energy lobbies. However, we must be aware that the increase in energy prices are highly dependent on the methodology by which we define, identify, assess and evaluate external costs.

In this paper different renewable energy sources were studied to find out which renewable energy sources are competitive to conventional energy sources if external costs are internalized as well. The study was made on the basis of external costs data identified and published for European States.

Methodology

In the context of the topic, the most important field of external costs that should be internalized are emissions. Polluters should pay the contribution for the released emissions. In this way social preferences could be changed and the structure of energy supply could become more sustainable. Therefore IEC is identified as an appropriate criterion for the selection/recognition of sustainable energy sources or development more sustainable energy production technology.

For this paper we reviewed current scientific and professional literature on external costs. Based on literature review we collected the data on external costs in the energy sector, evaluated in different studies. Due to the large variations between the external costs in different countries, we decided to identify and examine the external costs of selected European countries. The differences between external costs of different countries can be significant;

therefore, to identify detailed external costs of one region, they must be studied specifically for certain geographic area.

Based on literature review we identified external costs of individual European countries (EU15 and Norway). Data were analysed with descriptive statistics, such as the average value of external costs for specific external costs of European Member states and Norway.

Additionally, we identified and cross compared electricity production costs by energy sources and examined how cost-competitive are individual energy sources when considering only production costs. After that we synthesised gathered data to find out whether RES are competitive to CES if external costs are not considered. These results were upgraded with external costs data. Production and external costs were merged to identify, whether RES are competitive with CES and if they are more competitive, when external costs are taken into account.

Results and discussion on evaluation of investments, production and external costs of different energy sources

Investment in energy infrastructure and production costs of energy represent an essential factor in investment planning for new power plants. Renewable and/or sustainable energy sources are very important part of sustainable energy industry. In Table 1 evaluated investment and production costs of different energy sources and energy technologies are presented.

Data in Table 1 are indicative investment values and indicative production costs.

As presented in Table 1, the investment in hydropower, wind power, geothermal energy plants or in some cases solar power is already competitive to investment in coal or lignite fired power plant which is still argued to be one of the cheapest electricity production technologies. The lowest investment is required for gas power plant and waste incineration. The highest investment is required for installation of biogas plants and small solar power plants. From the perspective of average production costs per kWh of energy, the best way to produce energy is in nuclear power plants, hydroelectric power plants and waste incinerators. REN Report (2010) stated that the investments in RES are getting more and more competitive since 2005. The same trend is expected also in the future.

Production prices may differ due to specific local conditions. We highlighted some essential factors that can affect the price of energy production, such as: the duration and intensity of solar radiation in solar power plants, the number of windy days and wind intensity within wind power, the amount of water in rivers for hydro-electric power plants, calorific value of

the waste in waste incineration plants and the efficiency of all types of energy industry facilities. All these factors have a significant impact on the production cost of energy in individual power plants.

When considering investments costs it is also necessary to include the interest rate and expected return of investment. The Oil Drum organization (2010) announced that in case of discount rate 5% (interest rate) production costs of electricity from nuclear power plant are up to 60% lower than when expected discount rate is 10%. Expected discount rate is a significant impact on the profitability of investments in energy installations. This is especially true for large power plants such as nuclear power plants that paid off on the very long run.

There are also some exceptional cases, where prices differ significantly, such as large-scale solar power plant Ivanpah Solar Electric in California. It uses solar energy to vaporize water and to produce electricity by steam turbine technology. The power plant is much cheaper than the reference price in Table 1. The investment in Ivanpah Solar Electric power plant (392 MW) amounted to EUR 120 million (California Energy Commission 2011), or approximately € 310,000 per MW of installed power.

The production cost of energy from RES is in some cases, as seen in Table 1, competitive with CES. The differences in investments in RES and CES are also getting smaller. It is expected that the investments in renewable energy sources are becoming economically competitive alternative; therefore new investments in RES will become very strong promoter of making sustainable energy a reality. Nevertheless, the share of renewables in primary energy consumption in the world does not significantly increase, but is remaining on the same level although we promote and implement numerous measures for increasing RES. Growth in the share of RES is however clearly visible in the EU, therefore we expect that this trend will also be visible in global primary energy consumption.

As it is presented in Table 1, the total investment in nuclear or thermal power plant is for example much higher than the investment in a diversified renewable energy sources. Because large investments are rare in the period of economic crisis, relatively smaller investments in RES are more realistic.

In contrast, renewable energy installations are more dispersed, dependent on natural resources, decentralized, and generally smaller than plants in CES. Therefore, phasal/progressive invests are possible in renewable energy sector, which is especially suiTable for smaller organizations and the economies which have their own sources of renewable energy and want to gradually reduce dependence on energy imports, but do not have large funds to invest in large central energy facilities on CES. Investments in renewable energy sources are also suiTable for large economies and organizations since

reducing the import dependence of fossil fuels reduces the risk of price volatility, very common for oil and have less impact on the environment.

Table 1. Investment and indicative production costs for energy produced from different energy sources (for year 2011)

Biodiesel	0.2-0.9	0.29-0.57 EUR/liter
Ethanol	0.6-2.2	0.21-0.57 EUR/liter

* average investment per MW in Lower Sava hydroelectric power plant chain

	Investment (million EUR/MW)	Production costs of kWh 2009 (EURO cent)
Hydro		
- large hydro >10 MW	2.6*	2.1-3.6****
- small hydro <10 MW	1.3-3.0	3.6-8.6
Photovoltaic		
- large PV > 200 kW	2.0-3.5	8.6-21.4
- small PV	2.5-5.0	14-35
Solar panels – heat	<0.7	0.7-5.7
Wind	1.0-1.4	3.6-14
Biogas – electricity/CHP	2.5-5.0**	3.6-12
Biogas – heat **	od 0.5	0.7-4.3
Geothermal – electricity	2.0-3.5	2.8-5
Geothermal - heat	0.8-2.0	0.4-1.4
Waste incineration – CHP	ca. 0.8	ca. 2
Thermal power plants	2.0***	4.5-5.5***
Gas powered power plant	0.7 - 0.8	14
Nuclear power plant	2.8	2.8-3.5

** average investment in biogas plants in Austrian Steyer
*** investment in Thermal power plant Šoštanj, block 6 and its expected production costs
****production price of electricity from large hydro can be lower

Sources: REN, 2010; REN, 2011; Obrecht in Denac, 2010*; LEV, 2003**; TEŠ, 2010***; Morgan, 2010; Risto in Aija, 2008; Nuclear enregy institute, 2010, Ragwitz et al., 2009.

In Slovenia, which is defined as a small economy, we therefore propose gradual investments in diversified local renewable energy sources, to reduce the pressure on public finances, have less impact on the environment (lower external costs) and mainly also positive social impact. Large and centralized power plants usually have negative affect to the equal regional energy supply within the country.

The competitiveness of renewables additionally increases if external costs are included. External costs significantly change the suitability of individual energy sources. Average external costs of electricity production from different energy sources are also graphically presented on Figure 1.

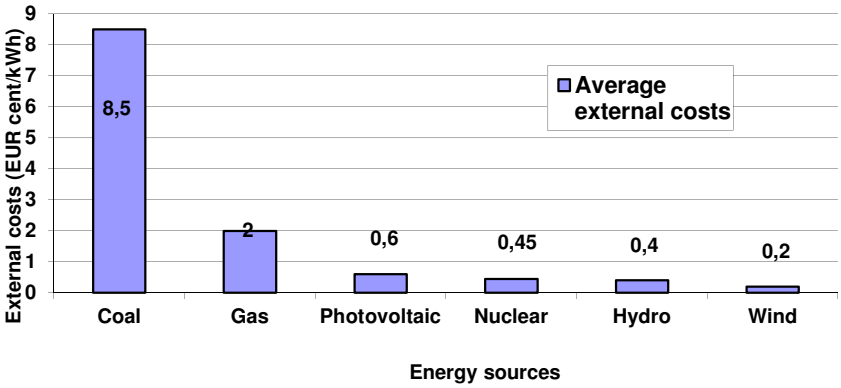


Figure 1. Average external costs of electricity production from different energy sources in EU Member states and Norway

Source: own calculations.

According to the differences in the energy mix, geographic location, use of local resources and the technology used, there are also differentiations in external costs of energy from the same energy source. In certain geographical areas can be better to produce energy with one energy source and again in other area another energy source can be the most appropriate. The distinction between external costs is noTable already on the level of European countries, presented in Table 2. Marriot and co-authors (2010) stated that environmental impacts of individual energy sources in one State can be up to 100% different from the impact on the environment in another state. Therefore external costs can also vary considerably.

As a measure to promote IEC we propose the establishment of tax incentives for leading organizations in the field of environmental protection, both for energy producers and energy consumers. This proposal is an economic incentive. Complete elimination of pollution and emissions only by economic incentives is however not the best long-term solution. Economic incentives should only represent the initial phase of the transition to a sustainable society. In the long term incentives should base on ethical and moral changes, changing lifestyles and different patterns of thinking.

The sum of the average production prices in kWh (data from Table 1) and the average external costs (data from Figure 1) indicates that when we include external costs, CES are in most cases not competitive with RES any more. The results of the calculation of average production prices, the average external costs and the total cost of production and external costs in kWh of electricity are shown in Table 2.

The values on Table 2 are presented in intervals (min. – max.) and calculated in averages and are not the exact calculations, therefore the values in the column "Total costs" can vary. This is due to geographical conditions

and natural resources (solar irradiation, number of sunny days, the average wind speed, the constancy of wind, water flow etc.). The results in Table 2 show that the average price of electricity from thermal power plant obtained with incineration of coal is much higher than, for example, the price of electricity from renewable energy sources (eg hydro, wind and biomass).

As presented on Table 2, RES will become much more competitive than CES if external costs are internalized. Because IEC could lead to the increase of the price of energy, the countries and organizations should start to reduce its energy use, increase energy efficiency, use environmentally preferable energy sources and alternative heating methods. This would indirectly change the lifestyle and increased energy efficiency. A similar strategy of increasing energy prices as an incentive for increasing energy efficiency is already in use in Denmark which effectively increases the share of RES, energy efficiency and efficiently prevents the growth of energy use.

In Table 2 is also indicated that the electricity from coal fired power plant can be even more expensive than electricity from photovoltaic system. The high cost of production is noted by gas. However, the price of gas is also very volatile and plays essential role in production price since the investment in gas-steam power plant is among the lowest.

Table 2. Comparison of average production costs, average external costs and total sum of production and external cost of electricity in EUR cent/kWh (for different energy sources)

Energy sources	Production price	External costs	**Total costs**	**Average total costs**
Hydroenergy	2.1-3.6	0.4	**2.5-4.1**	**3.2**
Wind	3.6-14.0	0.2	**3.8-14.2**	**9.0**
Biomass-biogas	3.6-12.0	1.4	**5.0-13.4**	**9.2**
Sun	8.6-21.4	0.6	**9.2-22.0**	**15.6**
Coal / lignite	5.5	5.5	**11.0**	**11.0**
Nuclear	2.8-3.5	0.4	**3.2-3.9**	**3.6**
Gas	14.0	1.8	**15.8**	**15.8**

Based on data from Table 1 and Figure 1

Good result was achieved also by nuclear energy. Because of the low assessed impact on the environment nuclear energy has low external costs, which are mainly the consequence of radioactive waste. Despite the low production cost the initial investment in nuclear power plant of peak power approximately 1000-1500 MW is capitally very intensive and must be very carefully designed and even more carefully positioned in the appropriate area. In addition, it is necessary to take into account the managing of nuclear power plant at the end of its life cycle.

Conclusions

Based on the results of the analysis and comparison of investment prices, we found out that investments in energy industry are generally higher when investing in RES. Higher investment is also needed for investment in nuclear power. Furthermore, we analysed and compared production costs and identified that production costs of RES are mainly that production costs of CES, especially in hydropower, solar power and wind power. Nuclear power plant is also identified as cheap source of energy. When internalizing external costs, RES were far more competitive than CES, since total costs were lower by RES. The exception is nuclear energy, where external costs compared to coal or gas are very low. However it should also be considered that the consequences of a nuclear accident are almost impossible to predict and assess.

Key findings based on a comparative analysis of production and external costs of energy produced from RES and CES are that environmentally preferable and more sustainable energy sources/energy production technologies are not necessarily more expensive. Furthermore RES are mainly seen as a cheaper energy source when external costs are taken into account.

Even when external costs are not included, some environmentally preferable solutions, such as hydro-electric power plants, in the energy sector are not necessarily economically less suiTable than CES.

Further assumption was made that RES (also sustainable energy sources) are particularly suiTable for smaller economies (smaller countries or regions, local communities). These economies have less available resources and are unable to implement large capitally intensive investments and are, due to the small energy sector easier to switch to RES. In this type of economy energy self-sufficiency is even more important since these economies are even more susceptible to change.

References

Morgan J., 2010, Comparing Energy Costs of Nuclear, Coal, Gas Wind and Solar, Nuclear Fissionary 2010.

Obrecht M., Denac M., 2010, Evaluation of potential and options of renewables for development of sustainable energy in Slovenia. V: Facing the Challenges of the Future: Excellence in Business and Commodity Science, 17th IGWT Symposium and 2010 International Conference on Commerce, pp. 1164-1171.

Ragwitz M., Schade W., Breitschopf B., Walz R., Helfrich N., Rathmann M., Resch G., Panzer C., Faber T., Haas R., Nathani C., Holzhey M., Konstantinaviciute I., Zagamé P., Fougeyrollas A., Le Hir B., 2009, EmployRES - The impact of

renewable energy policy on economic growth and employment in the European Union, Karlsruhe, Fraunhofer ISI.

Risto T., Aija K., 2008, Comparison of electricity generation costs. Research report, Lappeenranta, University of Technology.

International Energy Agency (IEA), 2010, World Energy Outlook 2010 Factsheet. IEA.

California Energy Commission, 2011, Ivanpah Solar Electric Generating System, [online], http://www.energy.ca.gov/sitingcases/ivanpah/index.html, accessed 14 March 2014.

LandesEnergieVerein (LEV), 2003, Biogas plants on Austrian Steyer and Slovenia, LEA.

Nuclear energy institute, 2010, U.S. Electricity Production Costs and Components (1995-2010), Nuclear energy institute.

REN 21, 2010, Renewables 2010 global status report, Paris, REN21 Secretariat.

REN 21, 2011, Renewables 2011 global status report, Paris, REN21 Secretariat.

European commission (EC), 2003, External Cost: Research results on socio-environmental damages due to electricity and transport, Brussels, European Commission, Directorate-General for research.

Global wind energy council (GWEC), 2005, Wind Force 12: A Blueprint to achive 12% of the World's electricity from wind power by 2020, EWEA & Greanpeace.

TEŠ, 2010, Data on emissions of specific blocks of thermal power plant Šoštanj, Internal material.

The Oil Drum, 2010, Renewable and fossil electricity generation costs compared, [online], http://www.theoildrum.com/pdf/theoildrum_7275.pdf, accessed 15 March 2014.

Marriot J., 2010, Impact of Power Generation Mix on Life Cycle Assessment and Carbon Footprint Greenhouse Gas Results, Journal of Industrial Ecology, vol. 12, no. 6, pp. 919-928.

Barle D., Golc M., 2004, External costs of electricity production, EGES 3/2004, pp. 2-4.

THE CONTRIBUTION OF MARITIME TRANSPORT TO SUSTAINABLE DEVELOPMENT

Marzenna Popek

Department of Chemistry and Industrial Commodity Science,
Gdynia Maritime University,
m.popek@wpit.am.gdynia.pl

Introduction

International maritime transport is the main carrier for the movement of more than 90% of the global trade. Without cost efficient maritime transport, the movement of raw materials and energy in bulk to wherever they are needed, the transport of manufactured goods and products between the continents would simple not be possible.

In independent and globalized world, efficient and cost-effective transportation system links global supply chains that are the driving force for economic development and prosperity.

The world economy slowed down in 2012 and 2013 with GDP increasing by 2.2% down from 2.8% in 2011. Due to the fact that reorientation in global production and trade proceeds, the developing countries contribute large shares to world output and trade.

Driven in particular by rise in China's domestic demand as well as increased Asian trade, international seaborne trade performed better than the world economy, with volumes increasing at an estimated 4.3% in 2012, nearly the same rate as in 2011. Nevertheless, the performance of international seaborne trade remains vulnerable to downside risks as well as the world economy and trade. Currently about 9.2 billion tons of goods are loaded in ports worldwide (Figure1) (UNCTAD, 2013).

Global concerns about climate change, energy use, environmental impacts, and limits to financial resources for shipping industry require new and different approaches to planning, designing, constructing, operating and maintaining transportation solutions.

Rapid and greatly aggravating the natural environment development of maritime transport, taking place in recent decades and occurring at the turn of the century, the imbalance in the field of human activity have become reasons

to relate the concept of sustainable development in relation to the carriage of goods by sea.

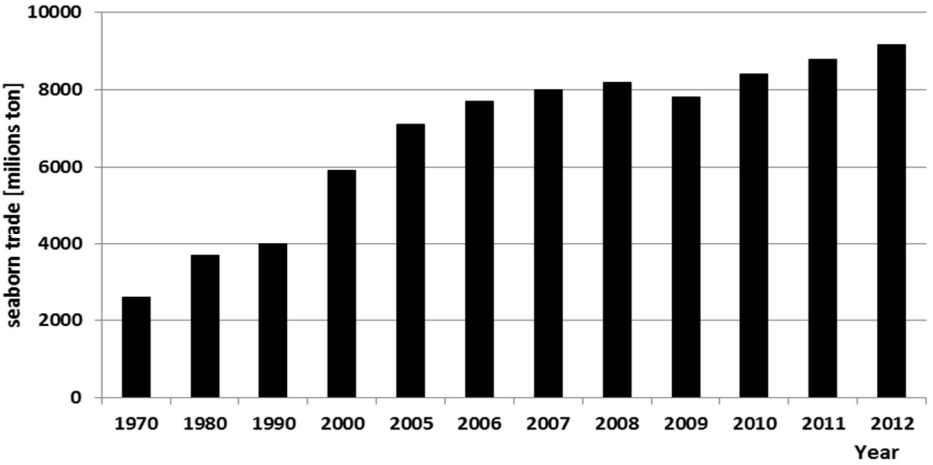


Figure 1. Development in international seaborne trade

Source: UNCTAD, 2013.

The continuous increase in the number of vessels and their exploitation result in reduced amount of natural resources, particularly oil and pollution from the combustion of fossil fuels which contribute to the destruction of the ecosystem and threaten human health on the global and local level.

Not less important issues related to maritime transport are accidents, i.e. harmful to human health noise and land use patterns that interfere with the patterns of settlement, migration and ecosystem integrity.

Maritime transport (shipping industry) contributes significantly to the three pillars of sustainable development social, environmental and economic. The ship operation, operation of the maritime management system, port and multi-modal connections are all components of maritime transportation system and have an important part to play in defining and achieving sustainable development .

Furthermore, maritime transport will be indispensable in a sustainable, future global economy as is the most environmentally friendly mode of mass transport, both in terms of energy efficiency and the prevention of pollution. These environmental, social and economic dimensions of maritime transport are equally important and should be fully recognized in any strategy, policy, legislation framework or action.

In the paper the main areas are identified that should be addressed if maritime sustainable development is to be achieved.

Maritime Sustainable Development

World Commission on Environment and Development in 1987 formulated the most widely used definition of Sustainable Development: *Development that meets the needs of the present without compromising the ability of the future generations to meet their own needs.* Sustainable development promotes the idea that social, environmental and economic progress are all attainable within the limits of our earth's natural resources (World Commission on…, 1987).

The University of Plymouth Centre provides a definition of sustainable transportation system that states

A sustainable transportation system is one that:

- *allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations;*
- *is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy;*
- *limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non –renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise* (AASHTO, 2009).

Shipping is an essential part of any program for sustainable development. The world economy is based on safe and efficient international shipping, for which IMO develops and provides a comprehensive framework for many years focused on environmentally friendly solutions and the concept of sustainable development.

The fundamental assumption of the marine sustainable development was formulated as follows:

International regulations concerning maritime transport, focus primarily on the application of the principle of freedom to provide services and to ensure the correct application of the competition rules, while ensuring a high level of safety, decent working conditions and high environmental standards.

Economic pillar

The maritime transport is global in nature, as it services world trade by connecting markets in different parts of the world, moving 90% of cargoes and commodities to all corners of the world at comparatively low cost when compared with the value of the goods being shipped. Global food security depends on a safe and secure delivery by sea.

The economic pillar of sustainable development is implemented by (IMO, 2012a):

- operation well-run merchant and fishing fleets,
- facilitation of the movement of around 90% of global trade,
- improved turnaround of ships/port throughput,
- increasing world commerce,
- improvement balance of payments,
- generation of wealth/prosperity of nations.

Environmental pillar

International shipping is facing new and complex problems of environmental protection that involves both challenges. Climate change in opp. ortunities particular continues to rank high on the international agenda, including the shipping and port business. Despite positive developments on a number of fronts, the world in not yet on track to limit the average global temperature rise by 2°C (above pre-industrial levels) (International Energy Agency, 2013).

It can be observed that in the last years public concern regarding environmental impacts of maritime transport has been increasing. Environmental impacts include both air and water pollution.

Maritime transportation is generally considered environmentally friendly compared with other transportation means, above all if energy efficiency is measured per tonne transported/per mile. Nevertheless, emissions from the growing maritime transport sector represent a significant and increasing air pollution source (ESPO, 2005). Ships emit ozone and aerosol precursors (NO_x, CO, SO_2) and greenhouse gases (CO_2) into the atmosphere.

Most of the maritime transportation activities impact water condition, as it can be expected due to their proximity and strict relation with the sea. In particular, the several chemical products involved in these activities as well as substances transported by ships can end up in the sea, causing water pollution. That discharge can originate from authorized activities, accidents, but also from illegal actions (Trozzi, 2003).

One aspect, which is considered during the analysis of accidental events, is that the continuous movement of ships in a confined and reduced area such as the port, inevitably gives rise to collisions between ships or between ships and the coast, and the consequent risk of release of hazardous materials, which may pollute the marine environment (Darbra, Royston, Royston, 2007).

By protection of the marine and atmospheric environments is understood:

- the reduction in discharges into sea and air emissions,
- cleaner waters, coasts and air,

- improvement of human health,
- protection of marine areas (routing measures, Special Areas, and Particularly Sensitive Areas),
- sustainable growth in tourism,
- integrated coastal zone management.

Social pillar

International maritime transport employs over 1.5 million seafarers and many more port and logistics personnel, who are responsible for the safe and reliable delivery of food, raw materials, energy and consumer goods.

The specific aim is to promote seafaring as an attractive option for young people, one that can provide them with rewarding, stimulating and long-term prospects, not only at sea but also in the broader maritime industry.

Shipping provides job opp. ortunities to people in developing countries.

Shipping has been historically a male-dominated industry and that tradition runs long and deep. IMO started to promote Programme on the Integration of Women in the Maritime Sector to woman engagement inspire and boost in the maritime sector. It has primary aim to encourage the Governments to open doors of the maritime institutes to enable women to train alongside men.

Furthermore some IMO's programs are addressed to the maritime needs of developing countries by focusing on three priorities that, together, can ensure sustainable maritime development, efficient and safe maritime services as well as effective environmental protection.

Shipping's contribution to the social pillar of sustainable development is realized by:

- employment of 1.5 million seafarers, the majority of whom are from developing countries,
- foreign exchange remittances,
- direct impact on local communities and economies including land-based workers,
- advancement of women in the maritime sector,
- promoting Corporate Social Responsibility (CSR).

The key issues of maritime sustainable development

IMO, civil society and shipping industry work together to ensure the contribution towards a growth within a sustainable development, which is achieved through:

- development and implementation of *Global standards* for green and sustainable shipping,
- technical and operational measures to increase *Energy Efficiency*, for efficient fuel consumption based on the basic recognition that fossil energy resources are not infinite and every effort must be made to save energy resources,
- promotion of *New Technology* for safety, environmental protection, security, clean energy and efficient operation of shipping,
- support for *Education and Training* to ensure the continuous supply of quality seafarers and maritime expert required for all aspects of the maritime industries
- improved *Maritime Security*, covering the application of international measures for maritime security, anti-piracy measures and law enforcement mechanisms for maritime zone security,
- enhancement of *Maritime Traffic Management* in straits and sea areas of significant importance for maritime navigation, covering co-operative mechanisms of littoral States, public-private partnership for future maritime traffic management system,
- improvement of *Maritime Infrastructure* including aids to navigation, search and rescue, port facilities and technical co-operation to ensure availability of proper infrastructure in all parts of the world (IMO, 2012a).

Global standards

Goods are first subjected to the maritime infrastructure, policies and economic, social and environmental conditions of their country of origin. Then they move through a port system into international carriage, where a different set of rules applies. Because of inherently international nature of shipping, the rules are based on internationally applicable commercial regulations and on global standards, rules and regulations developed by IMO.

IMO regulates all technical aspects of international shipping, introducing more than 50 conventions, supplemented by 800 codes, guidelines, circulars, recommendations. IMO's regulatory framework covers all kinds of technical matters pertaining to the safety of ships and of life in sea, efficiency of navigation, and prevention and control of marine and air pollution from ships.

The two most important pillars of the maritime legislation are the SOLAS Convention and MARPOL Convention (IMO, 2011; IMO, 2012).

The International Convention for the Safety of Life at Sea (SOLAS Convention) is the most important of all treaties dealing with maritime safety. This was achieved in 1960 and covers such matters as the facilitation of international maritime traffic, load lines and the carriage of dangerous goods.

In 1973, IMO adopted the International Convention for the Prevention of Pollution from Ships (MARPOL Convention), which has been amended by Protocols adopted in 1978 and 1979. The MARPOL Convention addresses pollution from ships by oil, noxious liquid substances carried in bulk, harmful substances carried by sea in packed form, sewage, garbage and prevention of air pollution from ships .

Convention has greatly contributed to the significant decrease in pollution from international shipping and applies to 99% of the world's merchant tonnage.

Maritime Labour Convention, which entered into force in 2013, consolidates and updates more than 68 international labour standards relating to seafarers, setting out their responsibilities and rights with regard to labour and social matters in the maritime sector. It is considered an important fourth pillar, complementing three major IMO conventions, namely the SOLAS Convention, 1974, the STCW Convention and the MARPOL Convention.

Furthermore, all regulation cannot be static. Periodic changes should be introduced to accommodate new technological advances and increased social expectations for improved safety, security and environmental protection.

Energy efficiency

Shipping is by far the most energy efficient means of mass cargo transport.

Higher oil prices impact trade and maritime transport trough both their damping effect on growth and the upward pressure on the costs of fuel used to propel ships. The oil process more than doubled between 2005 and 2012 and have increased by more than half since 2007 (UNCTAD, 2013).

Shipping is continuously finding ways of further reduction of fuel consumption with the view to improving ships' energy efficiency.

Since 2007, slow steaming as a fuel-saving measure is being implemented across shipping sectors and routes (Clarkson Research Services, 2013a). Some authors concluded that mandatory slow steaming is legally feasible either under a global agreement or unilaterally as a condition of entry to a port and that it entails both benefits and costs (Faber, Nellisen, Hon, Wang, Tsimplis, 2012).

Another concern relates to the technical requirements associated with the slow steaming and the need to retrofit engines on existing ships which generates additional costs (Miola, Paccagnan, Mannino, Massarutto, Perujo, Turvani, 2009).

In 2011, IMO adopted a new amendment to MARPOL (Annex VI) that includes a package of mandatory technical and operational measures to reduce

greenhouse gases emissions from international shipping, with the aim of improving the energy efficiency for new ships through improved design and propulsion technologies – Energy Efficiency Design Index (EEDI). The Ship Energy Efficiency Management Plan (SEEMP) is required for all ships in operation.

These measures could increase efficiency and reduce the emissions rate by 25% to 75% below the current levels.

As ships do not operate independently, efficiency must extend to the ports, which must deliver an efficient service and provide the essential maritime infrastructure as well as other entities in the logistics chain (cargo handling, vessel traffic management.

New technology

The maritime transport industry should take advantage of new technology in order to maximize its environmental performance as well as to enhance safety and be prepared for new cargo types and new trades. New ships should be sophisticated in all aspects of their design, construction and operation. For existing ships it is required to adopt their operational practices to comply with new regulatory requirements for retrofitting equipment. This entails partnership between governments, ship builders, classification societies, manufacturers and academic institutions.

High fuel costs and rising environmental regulations demands more fuel-efficient and eco-friendly maritime transport. In this context shipping industry introduced term "Eco-shipping". Eco-shipping can be described as a ship, which through the process of hull, engine design, and new technologies makes significant savings on costs, with the main saving being on the engine fuel consumption (Roussanoglou, 2013).

Many experimental designs and concepts for eco-friendly ships (for example wind and solar power) are being reported but their application in the near future remains doubtful (UNCTAD, 2013). Nevertheless Eco-ships are expected to be almost 30% more fuel efficient than current generation of ships.

Education and Training

Shipping introduces more sophisticated equipment for enhancing the safety of ships and cargo, route planning and navigation, cargo handling, energy efficiency monitoring, vessel-source pollution control and preventing. Retrofitted and new equipment, together with evolving shipboard procedures will lead to crews performing new function. Furthermore it will require training and education of maritime professionals including engineers, lawyers, port personnel, ship manager and policy administrators. The training and

education should be based on The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention) (IMO, 2012c). It should include refresher training and educational upgrades, as necessary. For global development of maritime transport, training and education of employers especially in developing countries are necessary.

For more than two decades, IMO has offered to developing and developed countries the possibility to enrol in a high-level maritime education through the establishment of training institutions. They have established an excellent reputation as the global centre for advanced education, training and research for specialist personnel from the international maritime community.

In view of the difficulties associated with the career at sea, the shipping industry will face greater pressure to provide a better and more attractive work environment for seafarers.

Maritime security

The damaging consequences of security-related incidents could affect not only the poorest people especially, in terms of food security, but also threaten the energy security of the world. As world trade expands, extending to new sea routes and new ports and leading to more congested shipping traffic in certain regions, new security challenges will emerge. IMO has extended its activities to the enhancement of maritime security for both ships and port facilities and to the promotion of measures to combat piracy and armed robbery against ships. The International Ship and Port Facility Security Code (ISPS) is required to be implemented and enforced not only on board all ships, but also in all ports engaged in international maritime transport (IMO, 2009).

Maritime traffic management

The use of the oceans is becoming more intensive as a result of the increase in maritime transport and other uses, such as offshore exploration and exploitation of traditional and renewable energy sources, fishing and tourism. In more crowded sea region with greater traffic density and larger ships, shipping routes will need to be supported by better and clearer information systems such as oceanographic and hydrographic services, aids to navigation, technology (Vessel Traffic services), Safety System (GMDSS) and satellite communication technology.

Rapid technological advances in navigation bring challenges for both safety and efficiency, as does the general lack of standardization in the shipping industry with respect to harmonization of equipment and systems.

The IMO recognizes that some areas need additional protection. MARPOL Convention defines certain sea areas as “Special Areas” in which

the adoption of enhanced special measures for prevention of pollution is required. Furthermore, IMO designed Particularly Sensitive Areas, which are deemed to require a higher degree of protection because of their particular significance for ecological, socioeconomic or scientific reasons. They may be vulnerable to damage due to international maritime activities. The criteria have been formulated to allow areas to be designated as Particularly Sensitive Areas, including: ecological criteria, such as unique or rare ecosystem, diversity of the ecosystem or vulnerability to degradation by natural events or human activities; social, cultural an economic criteria, such as significance of the area for recreation tourism; and scientific and educational criteria, such as research or historical value. When an area is described as Particularly Sensitive Area, specific measures should be used to control the maritime activities in that area, such as routing measures, strict application of discharge and equipment for ships and installation of Vessel Traffic Services.

Maritime infrastructure

Port development is seen as a catalyst to stimulate economic activity and create employment. Many ports are ill- equipped and unable to deal with increases in ships traffic. Shortcomings in port infrastructure can have significant effects on global commodities prices, particularly when the port in question is the source of a significant share of global supply.

There is a clear trend of increasing investment in port infrastructure in light of changes to the world trade. Virtually every government, national, regional or local authority as well as the ports themselves, have a port development plan with the aim of increasing the wealth of its citizens through the provision of some service.

The port is not an isolated entity and must be linked to its hinterland (Oxford Economics, 2013). The focus on upgrading port infrastructure needs to be balanced with the requirement to develop supporting rail and road links so that goods can be transported internally. This will lead to more investment into rail, roads and pipelines.

The infrastructure project may be more social than economic, for example, building roads or bridges to remote communities with small populations.

In Europe, port developments relate mainly to building new terminals within existing ports rather than developing new greenfield sites. As such, much of the reform process is more to do with the organization and operational aspects of ports (Dynamar, 2012).

Global port developments are continuing despite of the recent uncertainties in world trade. Efficient ports could help to lower transport costs

by enabling goods to get to and from markets in a more timely and cost-effective fashion.

Conclusions

World trade and maritime transport are fundamental to sustaining economic growth and spreading prosperity throughout the world, thereby fulfilling a critical social as well as economic function. The three dimensions of sustainable development, namely the economic, environmental and social dimensions, are equally important – in the context of maritime transport.

Maritime transport should be a safe, efficient and reliable transport which delivers the goods across the world, while minimizing pollution, maximizing energy efficiency and ensuring resources conservation. To achieve this it must be operated in responsible manner, adhering to best practices and applying them, from the ship's design stage, through all phases of operation, to its ultimate disposal for recycling at the end of its useful life.

The main role of IMO is to create a regulatory framework for shipping industry that is fair and effective, universally adopted and universally implemented. The IMO rules and regulations have been successful in reducing the loss of life in sea and the quantities of oil spilled by ships. However, a number of factors, such as the lack of required resources and skills in developing countries, can influence the level of global maritime safety and continue to threaten the safety of life in sea, the security of shipping and the marine environment. Therefore, permanent activities of IMO are important in helping developing countries implement instruments for safer and more secure shipping and enhanced environmental protection.

Providing effective education plays a key role in efforts to enhance the human element in striving for development that is sustainable.

References

AASHTO, 2009, Transportation and Sustainability Best Practices Background, Gallaudet University Kellogg Centre.

Clarkson Research Services, 2013a, Container Intelligence Monthly, 15(6).

Clarkson Research Services, 2013b, Shipping Review and Outlook.

Darbra R.M., Royston R., Royston K., 2007, Environmental initiatives in European Ports, Marine & Port Review.

Dynamar, B.V., 2012, DynaLiners Weekly, 21.

ESPO, 2005, Review of European Performance in Port Environmental Management.

Faber J., Nellisen D., Hon G., Wang H., Tsimplis M., 2012, Regulated slow steaming in maritime transport: An assessment of options, cost and benefits, CE Delft, Delft.

International Energy Agency, 2013, World Energy Outlook Special Report: Redrawing the Energy-Climate Map.

IMO, 2009, International Ship and Port Facility Security Code, (ISPS Code), London.

IMO, 2011, International Convention for the Safety of Life at Sea, (SOLAS Convention, London.

IMO, 2012a, A concept of a sustainable maritime transport, World Maritime Day, London.

IMO, 2012b, International Convention for the Prevention of Pollution from Ships, (MARPOL Convention), London.

IMO, 2012c, International Convention on standards of Training, Certification and Watchkeeping for Seafarers, (STCW Convention), London.

Miola A., Paccagnan V., Mannino I., MassaruttoA., Perujo A., Turvani M., 2009, External Costs of Transportation, Case study: Maritime transport.

Oxford Economics, 2013, The economic impact of the UK maritime services sector, Oxford Economics.

Roussanoglou N., 2013, Eco-ships growing in numbers, could undermine value of older ships, Hellenic Shipping News Worldwide.

Trozzi C., 2003, Environmental impact of port activities, 1th International Scientific Symposium Environment and Transport, France.

UNCTAD, 2013, Review of Maritime Transport.

Wiessman A., 2010, Slow steaming – a viable long-term option? Wartsila Technical Journal.

World Commission on Environment and Development, 1987, Our common future, Oxford University Press, Oxford, p. 43.

ON POSSIBILE APPLICATION OF THE PRODUCT LIFE CYCLE ANALYSIS (LCA) IN ENVIRONMENTAL LABELLING

Magdalena Wojnarowska

Department of Technology and Ecology of Products,
Faculty of Commodity Science, Cracow University of Economics,
wojnarom@uek.krakow.pl

Introduction

With increasing negative impacts of the mass consumption and production processes the development of knowledge about the quality of manufactured products oriented to resource use reduction in the whole product life cycle becomes more and more important. Environmental labelling is an important tool informing that a specified product is more environmentally friendly than other products within the same product group(that is it poses lesser environmental loading). It is important that environmental labelling could guarantee environmental safety in any product life cycle phase, beginning from raw material deriving and extracting through production, distribution till disposal of used products.

In practice ecolabelling systems take into account the following (Adamczyk, 2004):

- all product quality features, including ecological and the whole product life cycle,
- whole product life cycle or certain selected stages only,
- besides ecological features also other criteria, e.g. qualitative features,
- ecological features only,
- one criterion only.

An impact of a product can be assessed by considering one criterion only. This applies to the products fulfilling the condition of recyclability and developed usually in the design process referred to as *design for recycling*. More comprehensive approach is of multi-criteria nature and uses ecobalance and product life cycle analysis, while considering social and economic aspects. The scope of assessment is extended beyond the product itself into manufacturing processes (Adamczyk, 2004).

The aim of this paper is to present capabilities of product life cycle assessment in environmental labelling. LCA found its particular use ecolabelling of I and III types and therefore these two types are described in the product life cycle context. Also examples of ecolabels awarded on the LCA basis are presented in this paper. The subject matter has been undertaken due to an increasing amount of manufactured products and continuous development of manufacturing processes that induces the use of comprehensive environmental impact assessment methods based on a consistent methodology in the context of increasing environmental quality deterioration.

Environmental labelling in the ISO 14020 series of standards

According to the ISO 14020 standard environmental labelling is "a claim which indicates the environmental aspects of the product or service, that may take the form of a statement, symbol or graphic on a label, in product literature, in technical bulletins, in advertising or in publicity, among other things" (Etykiety i deklaracje środowiskowe…, 2003). Thus, the aim of ecolabelling is to mark off environmentally friendly products and to ensure that the "eco-friendly" claim declared by the manufacture is true. This standard presents also general principles of environmental labelling development and use.

It is important that ecological features of a product could be applied to each stage of its life cycle. Therefore, all life cycle stages for a product or service should be taken into account up to the post-consumption phase (while considering the widest spectrum of environmental issues at each of these stages) (Poskrobko, 2007). Ecologization of a product at particular stages of its life cycle is shown in Figure 1.

It is emphasized that the use of life cycle analysis in environmental labelling is one of more important applications of this concept in the public sphere. The objectives of eco-mark implementation include (Allen, Consoli et al., 1995):

- observed changes in customer's behaviour caused by increased ecological awareness that is transferred into their purchasing decisions,
- providing fair and reliable information about environmental impacts of products, thus enabling consumers to choose environmentally friendly products,
- developing customer's awareness of environmental aspects of products and an effect of their purchasing decisions on reducing environmental impacts, while considering the whole product life cycle.

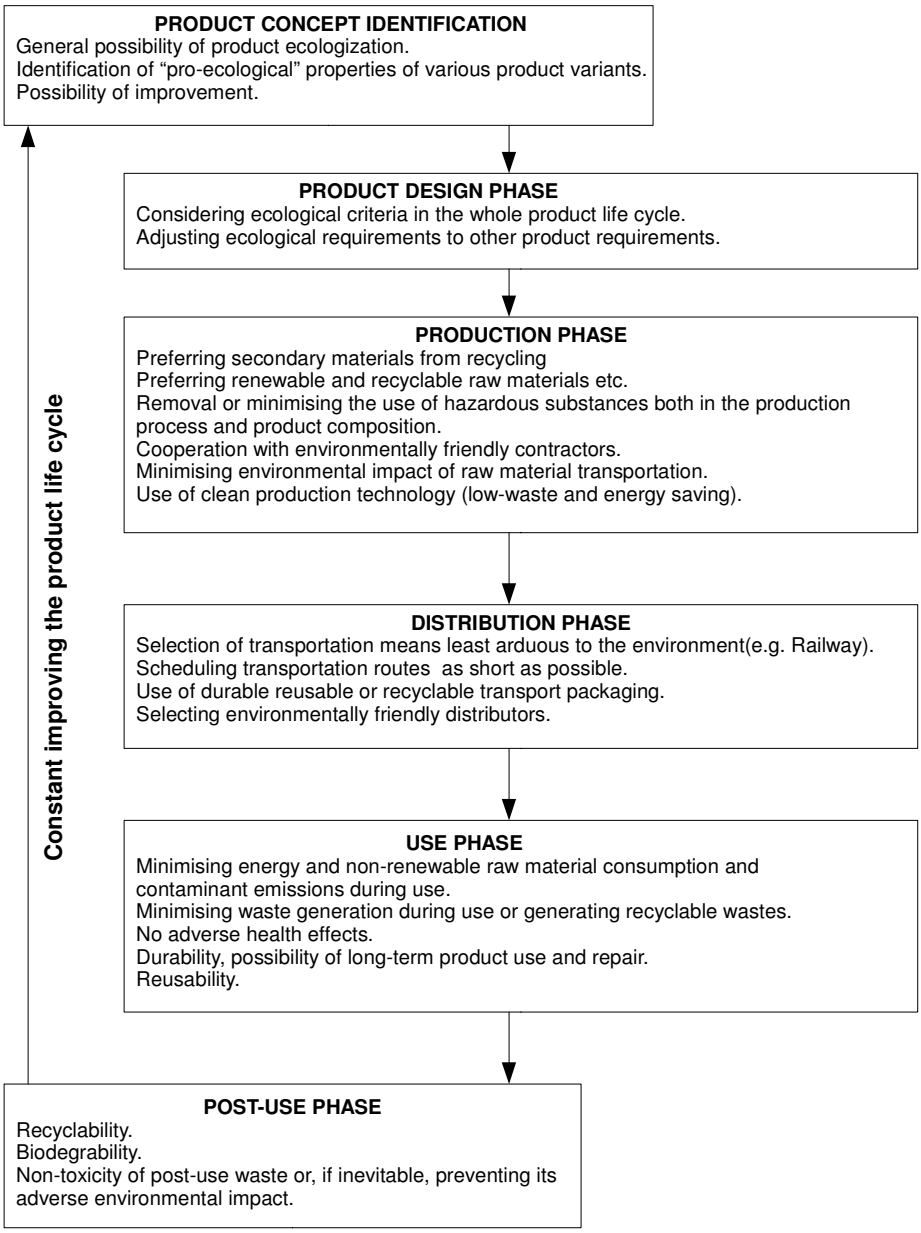


Figure1. Ecologization of a product at particular life cycle stages

Source: Poskrobko, 2007.

Based on Figure 1 one may conclude that the requirement that the product is properly shaped and environmentally friendly included the phases of design,

production, use and processing and disposal. Thus, the following is important for manufacturing environmentally friendly products: reducing the amounts of raw materials (and raw materials used should be less harmful to the environment), minimizing energy consumption in each life cycle phase as well as reducing to a minimum product packaging (or not using at all).

Although all important aspects of product life cycle are taken into account when developing environmental labels and declarations, it should be noted that life cycle assessment may not be made in any case. This depends on product category and type of environmental labels or declarations. The ISO 14020 series of standards identifies three types of environmental labelling and general principles of the use of environmental labels and declarations that are consistent in assumptions with the ICC and WTO recommendations are contained in the ISO 14020 standard (Adamczyk, 2004):

- **PN-EN ISO 14020:2003** *Environmental labels and declarations – General Principles*
- **PN-EN ISO 14024:2002** *Environmental labels and declarations. Type I environmental labelling – Principles and procedures*
- **PN-EN ISO 14021:2002** *Environmental labels and declarations – Self-declared environmental claims(Type II environmental labelling)*
- **PN ISO 14025:2010** *Environmental labels and declarations – Type III environmental declarations – Principles and procedures*

LCA in Type I ecolabelling

According to ISO 14024 the Type I environmental labelling is a multi-criteria, third party programme that awards a licence authorising the use of environmental labels on products indicating overall environmental prefer ability of a product within a particular product category based on life cycle considerations (Etykiety i deklaracje środowiskowe…, 2002).

The goal of Type I environmental labelling is to decrease environmental impacts based on the identification of products and services fulfilling the specified criteria of environmental preferences. Besides observing the rules contained in general principles the ISO standard recommends that applicants should comply with law and consider life cycle when setting the product environmental criteria. Life cycle analysis should include: extraction of raw materials, production, distribution, use and disposal combined with significant intermedia environmental indicators. The product environmental criteria should result from consultations between the interested parties (Adamczyk, 2004).

An example of selection matrix for product environmental criteria, combining the product life cycle stages with input-output environmental indicators.

Table 1. Selection matrix for product environmental criteria

Life cycle stage	Input-output set environmental indicators					
	Energy (renewable/ non-renewable)	Natural resources (renewable/ non-renewable)	Emission to			Other
			Water	Air	Soil	
Raw material deriving						
Production						
Distribution						
Use						
Disposal						

Source: Environmental labels and declarations. Type I environmental labelling – Principles and procedures, PN-EN ISO 14024:2002.

Type III ecolabelling in the LCA context

Along with Type I environmental labels the customers can use another tool, i.e. environmental declarations that are of utmost importance in the LCA context when choosing environmentally friendly products. There are sets of information about environmental impacts of a given product during its whole life cycle. Such data are based on life cycle assessment according to the ISO 14040 and 14044 standards. In addition the data can be supplemented with important information. In this case it is important to disseminate information to the public and its reliability. One of objectives of product declaration preparation is to encourage the demand for and supply of, products which cause less stress on the environment. Product declarations are subject to the following rules (Kulczycka, Góralczyk, 2009):

- objectiveness – product assessment based on the recognised LCA methodology,
- credibility – independent declaration verification and approval,
- neutrality – declaration itself does not indicate automatically any reduced environmental impact but only reflects the actual state of this impact,
- comparability – through principles established for a product category and harmonisation with the LCA rules.

It is possible to achieve this goal by supplying quantitative environmental data, thus enabling products to be compared within a given category. In this case environmental information about a product is based on product LCA procedures all of them based on LCI (Adamczyk, 2004):

- Life Cycle Inventory (LCI) analysis,
- LCI, and then Life Cycle Inventory Assessment (LCIA),
- LCI with additional data analysis.

Type III environmental declaration can be supplemented by results of other environmental analyses (on a voluntary basis). Regardless of adopted procedure option and LCA techniques resulting from the ISO standards, Type III environmental declaration is based on general principles contained in the ISO 14020 standard, and designed for providing numerical numbers which could be used for comparative evaluation of goods in compliance with ISO 14040 (Adamczyk, 2004).

Type III environmental declaration is verified by a qualified third party, thus guaranteeing its reliability. Due to particularity and more technical way of data presentation, such labels are designed primarily for enhancing communication between entrepreneurs at various levels of the production chain, i.e. so called B2B (business-to-business) relationships (although the data contained in them can be useful for final customers, too). Their role is particularly important when selecting semi-finished products or components to manufacture more complex products to be environmentally friendly. This is influenced by modular structure od Type III environmental declarations, thus indicating that overall environmental impact of all semi-finished products is taken into account when determining the impact of final product (Adamus 2008).

Figure 2 indicates the rules for preparing Environmental Declaration according to ISO TR 14025.

Type III environmental declaration reliance on LCA is connected with the necessity to make a complicated analysis, where it is easy to make errors and malfeasances. Therefore they are subject to verification by qualified organisations. In practice the following format of Type III environmental declarations has been established (Nierzwicki, 2006):

- Description of product and company where the product is manufactures (along with functional unit to which the LCA result applies),
- Environmental effects (the most important part of declaration, obviously based on LCA),
- Information about contact person, certifying body and accreditation, if any, and certificate validity period.

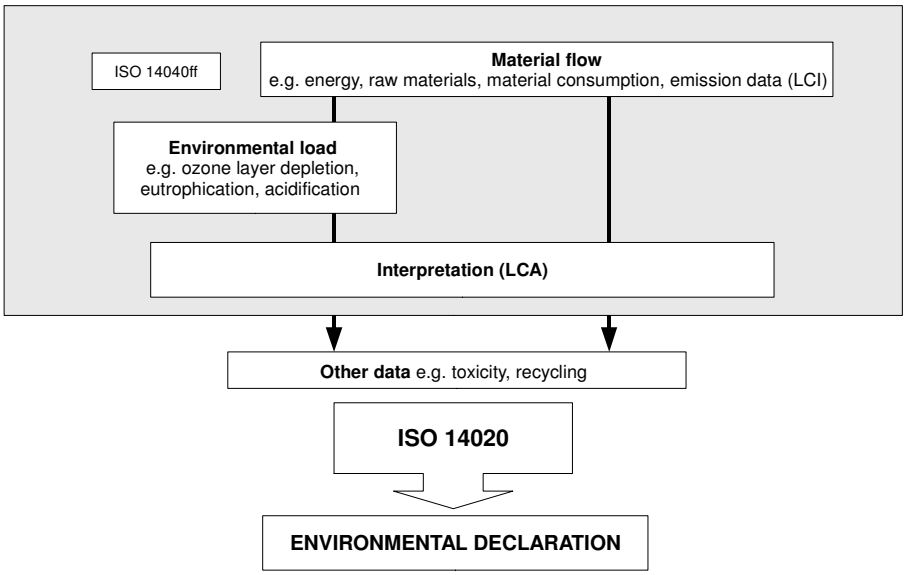


Figure 2. Rules for preparing Environmental Declaration in compliance with ISO TR 14025

Source: Piasecki, 2009.

Examples of application of LCA in environmental labelling

An example of Type I environmental labelling is Ecolabel, ecological mark established by the European Commission in 1992 to identify environmentally friendly products. The Ecolabel mark on products informs that goods are less harmful to the environment than similar products throughout their whole life cycle, because fulfil the published environmental criteria agreed between the EU Member States under agreement with interested parties. The methodology used is product life cycle analysis. The marks are awarded based on ***Regulation (EC) No. 66/2010 of the European Parliament and of the Council of 25 November 2009 on EU Ecolabel.*** This regulation contains new rules for awarding the new EU labelling. The regulation became effective on 20 February 2010 replacing Regulation (EC) No. 1980/2000. One of objectives of this new regulation is to limit bureaucracy and speeding up the ecological criteria developing and updating procedures. It is also important to increase the number of product groups to 40-50 by the year 2015, while considering goods having the greatest environmental impact. Currently the EU ecological marking scheme includes 26 product groups such as, for example, cleaning up products, electronic equipment, textile products and tourist accommodation services. An important change regarding previous regulation is the simplification of criteria, lowered license fees and joining criteria with public procurements. Due to increasing

customer's interest in extending the EU Ecolabel marking scheme onto food and beverages and relevant analyses will be made in the future in the aspect of developing criteria for these products (Tkaczyk, 2010).

The EU environmental labelling can be used with regard to products that passed an appropriate compliance verification procedure. According to Regulation No. 66/2010 the Member States are obliged to establish within the ministry or outside it a competent organisation to perform tasks under regulation. To complete product compliance procedures the competent organisation should have (Tkaczyk, 2010):

- relevant technical knowledge and experience sufficient and appropriate for performing tasks related to compliance assessment;
- appropriate policy and compliance assessment ensuring transparency and repeatability of assessment enabling the tasks performed by the competent organisation to be distinguished from any other activity;
- procedures serving for running an activity, while considering the size of an enterprise, sector where it operates, its structure, degree of complexity of manufacturing technology for a given product and mass or serial nature of the production process.

The necessary condition for marking a product with the Ecolabel is fulfilling the EU environmental labelling criteria that strictly define environmental requirements. These criteria are based on the environmental performance of products while laying emphasis on its whole life cycle. They take also into account the most recent EC strategic environmental targets and scientific achievements in this area. When establishing EU environmental labelling criteria the following factors should be taken into account (Regulation of the European Parliament…, 2009):

- most significant types of environmental impacts, in particular an effect on climate changes and biological biodiversity, energy and resource consumption, waste generation, emissions to all environmental elements, contamination by physical effects and the use and release of hazardous substances;
- replacing hazardous substance with safe ones as such or the use of other materials or design modifications whenever it is technically feasible;
- potential of environmental impact reduction due to product durability and possible re-use;
- net balance of environmental benefits and burdens, including health and safety issues at particular life cycle stages of specified products;
- in relevant cases social and ethical aspects, e.g. by referencing to appropriate conventions and international agreements such as applicable the ILO standards and codes of procedure;

- criteria established for other environmental packaging, especially EN ISO 14 024 Type I environmental labels officially recognised at the national or regional level, when such criteria exist for a given product group to enhance the synergic effect.;
- reducing animal testing principle, if possible.

It follows from the data taken from the European Commission website that in 2011 the total number of Ecolabel marking licences was 1357. A systematic increase in awarded licenses for use of this mark is clearly visible.

The EU Ecolabel marking scheme is an integral part of both sustainable consumption and sustainable production being realized in the European Community and targeted at reducing negative impact of consumption and production on health, climate and natural resources. One of objective of this marking is to promote the products that achieved a high environmental quality and health level. Therefore, the criteria on which the Ecolabel certification is based must rely on the recent scientific achievements, while being simple and user friendly. Thus, they should focus on the most important environmental impacts during the whole life cycle (Tkaczyk, 2010). The application procedure for the Ecolabel mark is presented in Figure 3.

Another example of Type I environmental labelling is ***EKO*** – znak, ecological mark one of three marks registered on behalf of PCBC S.A. that can be awarded through voluntary certification to domestic and foreign services and products, that cause no negative environmental impacts (compared to pre-set accepTable level) and meet the established criteria related to health care, environmental protection and economical use of natural resources during the whole product life cycle. According to the decision of the Committee for *Eko-znak* and *Ecolabel*, made at chamber held on 20 June 2005, the EKO award system in Poland is based on the same criteria for products and services as those contained in the Commission decision establishing environmental criteria within the scope of the EU *Ecolabel* award scheme that should promote the products causing a limited environmental impact during the whole life cycle. Thanks to such decision the applicants can be awarded both labels simultaneously under favourable financial conditions. The ecological certificate confirms the product meets the requirements of criteria on which the certificate is based and causes no adverse impacts to the environment and health during the whole product life cycle. In addition the certificate licences the manufacturer to use the EKO-ecological mark registered by PCBC S.A., on the certified product. At present the EKO marking is awarded to the following product groups: writing utensils; hand dishwashing detergents; detergents for dishwashers; laundry detergents; paints and varnishes for indoor use; personal computers; notebook computers; cosmetics; wooden furniture; soaps and shampoos; footwear; TV sets; copying and graphic paper; tissue paper; packaging paper; heat pumps;

lubricants; interior decoration woven fabrics; hard floor coverings; all-purpose cleaners and sanitary cleaners; hotel services; campsite services; textile products; toys; printed paper products; light bulbs. The criteria for next product groups, e.g. window joinery are developed now (Oznakowanie ekologiczne EKO…, 2010).

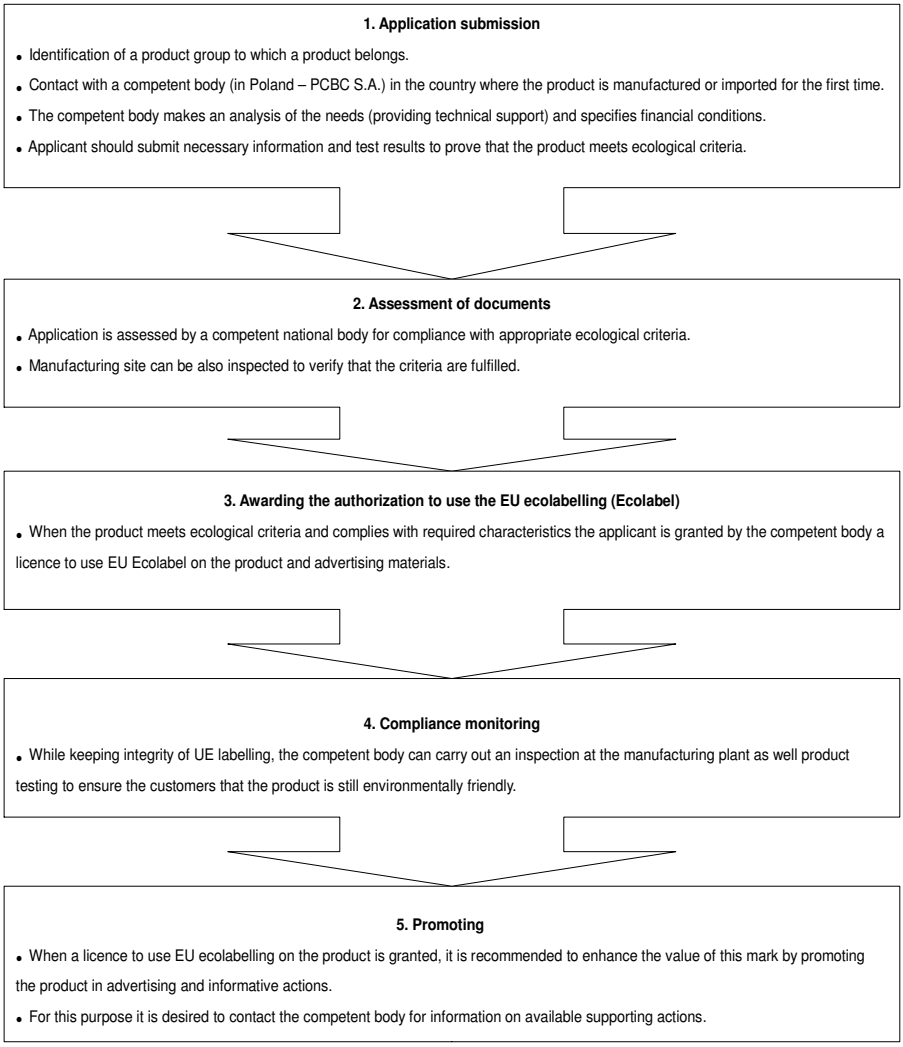


Figure 3. App. lication procedure for the *Ecolabel* mark

Source: own research based on 5 kroków prowadzących do…, 2011.

Conclusions

The factor highly influencing the decision on undertaking pro-environmental activities by enterprises is the customers pressure. Therefore it is important that consumers decisions are made based on ecological data, i.e. environmental labels placed on products. The key role will be played by the customer's and manufacturer's ecological awareness that can be formed based on the ecological awareness building scenario on appropriate ecological offer and marketing. The use of LCA-based environmental labelling LCA is a chance. Such tool guarantees environmental safety of manufactured products throughout its whole life cycle.

In addition, placing environmental labels on products contributes in building image of an environmentally friendly enterprise. This gives the customer an opp. ortunity to choose consciously products manufactured in a way minimising environmental impacts. However, the basic condition for ensuring the customers to make conscious choice is the degree of understanding information about ecological aspects. Otherwise an information noise may arise and this could be used by unfair manufacturers wanted to increase sales of their products only by marking their products illegally with symbols suggesting its ecological characteristic.

This is why the key question is that information on which the environmental labelling award is based was developed by using renown and crediTable methods such as LCA. The use of LCA technique for this purpose causes that the environmental label provides all interested customers with easy access to reliable information about environmental aspects during the whole product life cycle.

References

5 kroków prowadzących do oznakowania Ecolabel, 2011, Polskie Centrum Badań i Certyfikacji S.A., http://www.pcbc.gov.pl/ecolabel/index.php?option=com_content&view=article&id=2&Itemid=2, accessed 11.04.2014.

Adamczyk W., 2004, Ekologia wyrobów, PWE, Warsaw, (in Polish).

Adamus Ł., 2008, Etykiety i deklaracje środowiskowe według norm ISO, Zrównoważone Budownictwo, nr XX, Instytut Techniki Budowlanej, http://www.zb.itb.pl/informator/etykiety-i-deklaracje-rodowiskowe-wed-ug-norm-iso, accessed 11.04.2014.

Allen D., Consoli F., Davis G., Fava J., Warren J., 1995, Public Policy App. lications of Life-Cycle Assessment: Proceedings from the Pellson Workshop on App. lication of Life-Cycle Assessment to Public Policy, SETAC, USA.

Ecolabel - Oznakowanie Ekologiczne UE, 2013,Polskie Centrum Badań i Certyfikacji S.A.,http://www.pcbc.gov.pl/ecolabel, accessed 11.04.2014.

Etykiety i deklaracje środowiskowe, Etykietowanie środowiskowe I typu, Zasady i procedury, 2002, PN-EN ISO 14024:2002, PKN, Warsaw, (in Polish).

Etykiety i deklaracje środowiskowe. Zasady ogólne, 2003, PN-EN ISO14020:2003, PKN, Warsaw, (in Polish).

Kulczycka J., Góralczyk M., 2009,Znaczenia i możliwości stosowania oceny cyklu życia (LCA) i kosztów cyklu życia (LCC) w ekologicznych zamówieniach publicznych, [in:] Zielone Zamówienia publiczne, Urząd Zamówień Publicznych, Warsaw, (in Polish).

Nierzwicki W., 2006, Zarządzanie środowiskowe, PWE, Warsaw, (in Polish).

Oznakowanie ekologiczne EKO – informacje ogólne, 2010, Polskie Centrum Badań i Certyfikacji S.A., http://www.pcbc.gov.pl/index.php?option=com_content& view=article&id=321&Itemid=639, accessed 11.04.2014.

Piasecki M., 2009, Czyste środowisko - oceny ekologiczne, Instytut Techniki Budowlanej, seminarium BUDMA 2009, Poznań, (in Polish).

Poskrobko T., 2007, Zarządzanie środowiskiem w przedsiębiorstwie, [in:] Zarządzanie środowiskiem, red. naukowa B. Poskrobko, PWE, Warszawa.

Regulation (EC) No. 66/2010 of the European Parliament and of the Council of 25 November 2009 on EU Ecolabel.

Tkaczyk J., 2010, Nowe uregulowania prawne oznakowania ekologicznego UE - Ecolabel, Problemy Jakości nr 6, Warszawa, 16-18.

Total Number of Licences Issued from 1992 to 2011, http://ec.europa.eu/environment/ecolabel/facts-and-Figures.html, accessed 11.04.2014.

THE MODEL OF ORGANIZATION FOR SUSTAINABILITY IN THE SOCIAL REPORT OF UNIVERSITIES

Antonella Valvassori[*], Cristina Cordoni[**], Vittorio Vaccari[***], Immacolata Manco[****]

[*] *Dipartimento di Discipline Odontostomatologiche, Università degli Studi di Pavia, antonella.valvassori@unipv.it*
[**] *Dipartimento di Scienze del Sistema Nervoso e del Comportamento, Università degli Studi di Pavia, cristina.cordoni@unipv.it*
[***] *Salute e Sicurezza nei Luoghi di Lavoro, Centro di Ricerca Interdipartimentale, Università degli Studi di Pavia, vittorio.vaccari@unipv.it*
[****] *Dipartimento di Sanità Pubblica, Medicina Sperimentale e Forense, Università degli Studi di Pavia, immacolata.manco@unipv.it*

Introduction

The most recent ISO standards, ISO 26000 published in November 2010, on the Social Responsibility of Organisations – defined standard but not standard, since it expresses Guidelines for understanding and applying the Social Responsibility for organizations and not a certifiable standard by a third party spreading the culture of CSR – includes between 7 core subjects, appears the theme of environment protection, in the interpretation of biodiversity and habitats to be protected, pollution prevention measures, the use of renewable energy. The standard stems from the CSR (Corporate Social Responsibility), a perspective of business management that not only achieves the economic objectives, but also social and environmental. For ISO 26000: "An organization should be responsible to account for their impacts on society, economy and environment" (ISO 26000, 2010).

In this context of reporting the Social or Sustainability Report is the reporting tool that companies or enterprises use to communicate externally the activities that the organization performs, informing relevant third parties. The information on the characteristics of the production chain and the specifications of products and/or services provided, give an account of the

behaviors that exist between the institution and its stakeholders, be they staff or external community, customers and suppliers, public institutions.

The document has now become the sound box for full information of all stakeholders and the present paper analyzes how this instrument is used by Italian Universities, which are able to communicate with the reports to interested third parties the virtuous behavior they have with the territory, for what concerns the Quality of services provided and the attention to the environment seen as an Ecosystem, particularly on the issues of energy saving and waste management.

This paper is intended to be a document of analysis to highlight the propositional and proactive characters of Report and communicate a collaborative spirit with stakeholders in a view of sustainability, conjugated according to Quality and Environment as an Eco-system, in order to improve an already prestigious written.

We have examined the Annual Reports of the Italian University in accordance with Quality and Environment, under the Law in force in Italy, but also according to the application of ISO dedicated and the self-evaluation of the public service provided by the Universities, which must be done through the CAF (Common Assessment Framework) a specific tool for Universities, by means of indicators and scores.

Other relevant documents to the writing of the paper were the Guidelines of the Third and Fourth edition of the Global Report Initiative (GRI 3, 2000-2006; GRI G4, 2013), as well as the Principles for the drafting of the Report prepared by the Gruppo Bilancio Sociale, that is a working group to study the Social Report (GBS, 2008). The reality of U.S. colleges was also analyzed, where the documents dedicated to the environment constitute the basis of scores for the sustainability of the same universities.

Material and methods

In the Introduction of the Social Report of the University of Pavia, introduced November 6, 2010 in relation to the 2007-2009 period, it gives motivation to the drafting of lengthy document in order to “allow all civil society to understand clearly what is the 'social, economic, scientific and cultural effect of our University. ” (University of Pavia, 2010). In these words the whole philosophy that lies at the basis of the information included in the elaborate written by a strategic group possessing different and transversal skills, well built and helpful in analyzing in detail the proposed themes. This is just an example that includes the Guidelines underlying the reporting document, which aims to disclose to third parties the virtuous behavior of an academic organization that, without the drafting of the paper, would remain hidden from the public.

The Observatory Socialis, which is the promoter namesake award for degrees dedicated to social responsibility and sustainable development, now the eleventh edition of the December 2013, in the document proposed at that occasion - "Decalogue for making CSR" - in point 3 refers to the theme "LISTEN TO THE LAND AND THE MARKET : To produce and sell at to listen and reply. "We must interact positively with territory and market to look for synergies, connections (or potential conflicts to be resolved), between the pursuit of corporate interest and collective interest and local levels".

Another point of the Decalogue deals with *REALIZE AND MEASURE: It means preparing operating systems of implementation, measurement and verification of plans for CSR. It should also assess periodically the consonance between instruments, objectives and results of responsible behavior.*

The Award Socialis was created with the aim of helping to identify the best academic studies on the evolution of the phenomenon of social commitment to make a concrete contribution to the integration of social responsibility practices in the activities of the companies, of organizations and Public Administration (www.premiosocialis.it), also in accordance with the Legislative Decree n. 150 of 27 October 2009, in implementation of the Law of 4 March 2009 n. 15, *on the optimization of the productivity of public work and the efficiency and transparency of public administrations.* Today, 48 on 78 Italian Universities have training in the Educational Offer 90 teachings regarding sustainability, in most cases related to the faculty of Business Economics (66%), but also on other departments such as Political Science, Humanities, Engineering, Architecture, Natural Sciences, because the theme is conjugated in its application forms such as CSR, business ethics, communication through devoted reports, design, with an increasing trend compared to previous years (www.osservatoriosocialis.it).

This attention constantly rising from the side of the users, may only encourage a greater commitment on the part of the Universities in detailing not only the educational Offer, but also relative to its behavior towards the community. It is important to point out that the financial statements of Italian Universities prefer the social relations between users and organization, devoting ample space about the types of services offered and the satisfaction that follows, through questionnaires and interviews.

The GBS model, which is a reference text for the Report-writing of organizations in the Research Paper No. 7, dedicated specifically to the Social Accountability in the University, hopes to "provide a model useful to compare the different realities that they adopt". Following, should be indicated "the resources used and those invested with specific indication of the individual areas of activity" communicating the benefits derived from the results to the stakeholders involved (GBS, 2008).

It should be remembered that the value of the activities carried by a University certainly did not materialize in the amount of registration fees, but rather in intangible assets such as the Research and Education, as well as reputational and relational capital, which express, respectively, the consideration of which the organization enjoys and the "wealth of internal and external relationships that can generate a virtuous cycle of exchange and create benefits" (University of Pavia, 2010).

To better investigate issues related to Quality and Environment some Italian Universities are certified to ISO 9001 and ISO 14001 only the University of Ferrara. The sensitivity towards regulatory models that investigate the Quality through the application of ISO 9001 is now sought after by many universities, although the evolution of this benchmark leads to Total Quality, implemented through the techniques of continuous improvement.

Take into account that in Italy, in compliance with EU legislation was introduced the Green Public Procurement with the Interministerial Decree n°135 of April 11, 2008, entitled "Action Plan for the environmental sustainability of consumption in the field of Public Administration" which, although not a requirement, it promotes in the procurement of supplies short or long use - stationery, supplies, services, energy, transport and cleaning, construction, furniture - that firms possess characteristics of respect for the environment.

University and quality

If we interpret sustainability with the word Quality of the University and their implementation as ISO 9001, only ten universities are certified as an organization, even if the number increases reaching 23, if we consider the parameterization of the Quality not for the entire academic system but for some operational areas of the University, such as voice Secretary, Library, the individual Departments.

Other 9 Universities, although not possessing ISO 9001 certification, have the Presidium for Quality or Quality Center, a dedicated internal system which involves the entire university system, in its sectoral components for the structure: Research, Teaching, Teaching, activities of technical and administrative services. The "Center for Quality of University" is, for the University of Naples Parthenope, "an organizational structure established to develop a culture of Quality within the facilities of the University, through appropriate coordination, management and promotion of scientific and educational activities concerning, in particular, the Quality assurance of Research activities, also multidisciplinary and of Service". (www.uniparthenope.it).

Specifically, the Center of the University of Naples operates in relation to European standards regarding the rules about Quality and ISO 9001:2000 series, which were added the standard UNI CEI EN ISO / IEC 17025.2000, specifically for testing and calibration laboratories and then ISO 13485 for Quality Management System in the Medical field. Some universities favor a focused approach to the sustainability of the university campus. This is the case for the University of Milan and the Polytechnic of Milan, which together in the website www.campus-sostenibile.polimi.it, deal five identifying areas:

- People – in this area is stimulated the participation of all users of the campus such as students, employees, residents;
- Energy – is the classic themes of energy, such as saving, managing, monitoring, also by means of new systems and the use of renewable energy;
- Environment – examines the virtuous lifestyles, is responsible for management of water, soil, waste, green areas, minimizing the negative environmental impact;
- Accessibility – sustainable mobility, walking and cycling routes, even with the car service pooling, mapping and indications;
- City – has a plan to integrate the campus with the district and the city, through shared projects, opening the doors of the campus to the community.

The University of Siena offers, from its website, a dedicated portal to sustainability, called Ne.S.SO. Siena Sustainability Network (www3.unisi.it/v0/portale), where it presents a paper on sustainability, devoted to the following activities: the use of materials and products with low environmental impact, effective waste management and their reduction, efficient use of resources and eventual recovery, energy conservation and reduction of greenhouse gas emissions, innovations in sustainable technologies, diffusion of a culture that preserves the environment near and far.

In the website of the University of Venice, *"Ca' Foscari sustenibile*" since 2010 there is the Charter for Sustainability commitments that *defines the objectives aimed at minimizing the impact of the university on the environment and natural resources, to increase social cohesion and reduce inequalities within, to promote cultural growth and economic sustainable territorial progress* (www.unive.it). The strategic objective of the University, which concerns the sustainability of the organization like a trasversal orientation, about the point on the reinforcement of devoted behavior, it is said for a pilot project on carbon footprint reduction of carbon emissions, called "Carbon Program, " whose methodology can create Guidelines for implementation in the Italian Universities, as urged by the Ministry for the Environment.

CAF – Common Assessment Framework

This model is based on Total Quality and upon the axioms provided by EFQM European Foundation for Quality Management and it evaluate the organization according to 9 weighted criteria that outline a vote. This evaluation project takes place in the prospect of moving from the sequence Plan–Do, widely used by the Public Administration with a purely bureaucratic approach,to the most comprehensive integrated cycle of Plan–Do–Check–Act, implemented in most enterprises, since the dynamical system and adapTable to various circumstances, developed in its four phases. PLAN – schematization of the processes, setting goals and the trategies to achieve them, which is followed by evaluation of the results of the various alternatives; DO – implement the processes chosen; CHECK – examine and evaluate the results of the implemented processes, analyzing the differences between the data and the data obtained estimates; ACT – according to the deviations detected in the previous step, to take actions that improve the performance of the process, repeating the previous steps (W.E. Deming, 1990).

The University CAF model has been developed with the collaboration of 38 Italian Universities and with the patronage of ANVUR (National Agency of Evaluation of the University System and Research was established in 2006), with the incipit: "the Quality of the results is the result of Quality the organization " (CAF University, 2012). It is a model that, with the updated version of 2012, with examples of best practices, facilitates the analysis to check the weaknesses on which action is taken with improvement techniques, which, being in the presence of a holistic model, will produce improvements to the entire system. The CAF model UNIV consists of 9 points, of which the first 5 deal with the Enablers – criteria that express the activities that the organization performs and operational strategies for the activities to reach the desired results – and the other 4 outcome measures obtained in relation to stakeholders and key performance.

Social reports by the universities

After years of use in the nonprofit sector, the Report of social reporting, Social Report, for mission, of sustainability, environmental, was also borrowed from the field of PA that must operate in transparency, informing the relevant third parties. In Italy the public and private Universities are 78 and those who have compiled this document are 24, then less than a third of the entire Italian University system.

The document is not always easily found on the home pages of the websites of the Universities, while it would be desirable to invitation to the consultation by the users, with a direct link and readily available; other times

the Environment appears treated in a little deeper and without their demonstration data. Let's examine the salient points relating to Sustainability Reports submitted by the universities in no particular order.

The University of Sannio in its Fourth Social Report 2012 hopes to move the disclosure line of the document *thanks to the gradual overcoming of the traditional double bottom line reporting, to give greater importance to the triple bottom line that highlights not only the impacts and effects in terms of social and economic, but also environmental.*

Sustainability policies of the University are outlined: it refers to an Interregional Operational Programme "Renewable Energy and Energy Conservation 2007-2013", in relation to which the University has proposed a draft about "solar heating and cooling, " funded by the Economic Development Ministry. This idea relates to the implantation of solar collectors, thermal storage tanks for the winter and a pump absorption heat for the summer. It is a system that does not impact on the environment, reduces energy consumption and emissions.

The University of Bologna has an Internal Quality Assurance System which applies self-assessment, in order to improve the quality of the courses. The topic "Impacts on Sustainability" declines this subject on the classic themes of environmental sustainability: energy saving, sustainable mobility, environmentally friendly buildings, renewable energy, accompanied by the facility management focused on building management. There is a three-year plan called MOSES 2009 (Mobility Sustainability Energy Solutions) and Movements of the House Plan - Work / Study of the University (PSCLS), for energy-saving and efficiency benefits.

The University of Ferrara headlines the Chapter number 8 of the 2011 Social Report, 2012 edition, "The University of Ferrara and sustainability, " and it is called the lesser negative impact with its territory and working with the community for its protection, through synergies and concrete measures. Reference is made to the courses of study, master, doctoral and specialization courses having as their object the environment. Essential, however, is the dialogue with third parties and in particular with institutional stakeholders such as the Municipality and the Province of Ferrara and the local authorities.

Energy efficiency will be achieved with control systems of the plants in remote management; centralization of air conditioning systems; installation of windows and glazing with thermal insulation; automated management of the facilities. For the adoption of water-saving taps with mixer units to flow reduction and use of a cassette toilet with dual exhaust button.

The Green Purchases are a typical aspect of the sustainability of this institution, with the inclusion of environmentally aware criteria in competition notice for the supplies of Ateneo, in particular for furniture, computers, catering.

Being present in this University the Office of Safety Health Environment, the waste are managed in a centralized way: storage, collection, transport and disposal of special waste (chemical, biological, pharmaceutical, radioactive, similar to urban waste, bulky equipment out of use) arising from the activities of the University. Were required ISO 14001 or EMAS, for plants of destination of the waste.

The University of Trieste, in its 2012 Social Report talks about Land Economics with reference to the environment and landscape issues, dealing Environment for energy saving, rationalization of mobility, waste management. Energy management is in the hands of the Energy Manager, a Figure that is responsible for the preparation of energy balances for the needs of the institution. Electricity consumption is higher than the thermal energy. Studies are in progress for projects of solar cells not derived from silicon technology, rather oriented thin film solar cells on cadmium telluride. The University classifies as special all the waste it produces in its sphere, from whatever sector they come from, even if it's different sectors, some similar to municipal waste, other than those toxic, or chemical or radioactive.

The Fondazione Politecnico of Milan, is developing some important projects in the field of energy saving. About the safe, clean and efficient energy, the document refers to the Joint Research Center (JRC), in collaboration with Ansaldo Energia, ENEL, ENI, Siemens, regarding renewables, energy efficiency, clean coal technologies, carbon capture and storage of carbon dioxide. There is a permanent Technological Observatory to monitor the issues of energy and environment. Other innovations are the projects for photovoltaic glass for buildings, building envelopes, photovoltaic glass tiles for architecture, smart grid.

The University of Insubria, in Social Report 2007 focused attention on the indicators used in Italy and abroad and compared them in a grid, where they appear as GBS, GBS University, Ministry of Welfare, Guidelines Public Administration, GRI 3 and by this latter divided into core and additional. The University is documented in 114 of 314 indicators its full answer. Unfortunately, indicators of environmental performance have not been met, but in chapter 5 - *Improvement Objectives* - talking about the future editions of the document, with the completion of these areas not yet monitored.

The University of Molise, in section 3.3 of the Social Report 2011, titled *Universities and Environment*, shows the commitment to sustainability and demonstrates the consideration that the University devotes through the Energy saving with a photovoltaic system with 162 panels for 158 square meter with a power of 20 kWp, with real-time monitor that shows the power produced.

The University of Bari, in December 2006 Social Report in Chapter 7, “First elements for an environmental report” presents a paper of intent for a future study of the subject, while the analysis carried out until then speaks

about negative effects of the institution in relation to disposal of waste and emissions, but also about the remediation of asbestos structures estate of the old building.

The University of Foggia presents an Environmental Report called "Towards a sustainable university. " Unique in its kind, perhaps similar to Ca' Foscari of Venice, is a document that expresses sensitivity of the institution to the sustainability, not only with devoted degree courses, but with projects for technological innovations applied to the environment and even with the establishment of a Doctoral School on "Culture environment, land and landscapes. " Through detailed Tables are presented the electricity consumption in the period 2006-2008, with the knowledge of having wasted energy, due especially to an old concept in the structures of the buildings.

Identified deficiencies, the University has the appropriate solutions, regarding the possibility of having a greater production of energy with photovoltaic, present in a seat for 20,000 kWh, the verification and adjustment of lighting, even with renewal with new-generation lamps (fluorescent and LEDs) and intelligent systems with crepuscular (photosensitive, that with sufficient light turn off); stand-by mode on electrical equipment. Then goes into the detail with Tables dedicated to photovoltaic system and water consumption, with savings achieved through measures such as accelerators of the water flow and flow nets breaker.

The University of Cagliari in the Social Report 2008 is aimed towards the Quality of Studies, with the Project Quality Campus, in order to establish a system of Quality dedicated to teaching.

The University of Rome La Sapienza in its Social Report 2011 illustrates the techniques of building renovation that follow the criteria of environmental sustainability, designing transparent surfaces that capture solar radiation in the south and the use of empty space requirements at different heights for greater ventilation in summer, in addition to the use of photovoltaic panels and solar.

The Social Report 2009-2012 of the University of Pisa speaks of "Project Phases H2 Hydrogen" (January 2008, December 2011), which has developed research on technologies for the propulsion of Hydrogen for the combustion of internal engines or on fuel cells. Also in Pisa, as in Trent, we find the Figure of Energy Management. Are in progress innovative photovoltaic installations, such as monocrystalline polycrystalline, amorphous, fixed or tracking.

The focus of the University of Florence in the Social Report 2006 for the certification of quality is highlighted by the numbers: 78 courses and 7 guidance Faculty centers are accredited and this is the highest number of ISO certifications in Italy for universities. There is also a section dedicated to environmental sustainability, protection of environment and renewable energies, with the creation of Agreement Protocols for alternative energy

sources and energy consumption. It is a photovoltaic system was implemented in the coverage of the backyards of some locations.

The Social Report 2004-2006 of the Scuola Normale Superiore in Pisa shows that in 2005 some areas of the University have achieved the integrated certification on Quality and the ethical-social sector, in accordance with the ISO 9001:2000 and SA 8000:2001 (international standard created by Social Accountability International, which is based on ethical Principles resulting from the UN Conventions and the Declaration of Human Rights).

In the Libera Università of Bolzano, the Social Report 2010 describes the teaching of the Faculty of Science and Technology applied to research, with great attention to renewable energy and in particular woody biomass, forestry or agricultural residues and waste from manufacturing and industrial, with thermochemical processes and biochemical studies.

In the Social Report 2010 of the University of Pavia, the Ecosystem is the topic of Chapter 5 of the document, which illustrates the reality and the intentions that the University addresses to the environment, by monitoring the consumption of energy and water , emissions, waste management, mobility. It is said that the University just puts in the document a plan of intent for a future deepening of environmental impacts. In detail, were replaced by the 2000 oil-fire heating systems with systems running on natural gas and in the campus of Cravino a photovoltaic plant will be built by a Project Financing.

The Foundation University d'Annunzio of Chieti, with the Social Report 2007 places focus on recovery, recycling and waste reduction, differentiated in general, special, radioactive, for the latter entering into contracts with companies certified and specialized drafting “safety cards” , to have a clear specification of the physical and chemical characteristics.

The foreign universities

“The *College Sustainability Report Card* is the only comparative evaluation of campus sustainability and endowment activities at colleges and universities in the United States and Canada. In contrast to an academic focus of sustainability in research and teaching, the Report Card examines colleges and universities as institutions through the lens of sustainability. The Report Card is designed to identify colleges and universities that are leaders in sustainability, and to provide accessible information so that schools can learn from each others experiences and establish more effective sustainability practices” (Boston University).

Sustainability Indicators provided by GreenReportCard are aimed at:

- Administration – sustainability policies and staff, green purchasing policy;

- Climate change and energy – carbon emissions, energy efficiency, energy conservation, use of renewable resources;
- Food – cooking with local produce, organic food;
- Green Building – Green building policy to build and restore;
- Involvement of students – awareness campaigns;
- Transport – to encourage the use of public transport and bicycles;
- Investments – renewable energy installations.

As you can see, it is a report addressed to the conduct green/virtuous in all its conjugations, and for years was the Green Report Card for the University of North America as a reference for the sustainable behavior of American Universities. This document was produced from 2007 until March 2012 and its implementation during this time has provided a data base with more than 20,000 pages of data collected over the past five years.

During the five years of implementation of the Sustainability Report, the data had interesting increments, with the percentage of responses received up to 90% in the last year of the survey of Universities and with a progression of the commitments that you can see from the data reported below, which show the percentages of the University in 2006 and 2012 includes the following programs: Commitment to carbon emissions reduction (da 23% in 2006 a 64% in 2012), Campus farm or garden (da 9% in 2006 a 70% in 2012), Trayless dining (0% in 2006 a 75% in 2012), Green building policy (da 22% in 2006 a 79% in 2012), Sustainability committee (da 40% in 2006 a 95% in 2012).

The items collected illustrate the achieved energy savings but now the legacy of the Green Report is passed to the Project Billion Dollar Green Challenge. This transition comes from the fact that colleges have not had economic advantages from the energy savings achieved. It was therefore decided to make the cost of energy efficiency, an investment for the Universities, through dedicated funding and self-managed. The challenge is to invest one billion dollars in total self-managed revolving funds, to finance energy efficiency improvements.

This is a project that takes place with proactive approach, thus adapting to changing circumstances and new ideas from which to take forever in continuum, which involves as foundations and private donors. The Billion Dollar Green Challenge not only supports the University, but also other non-profit institutions – newly municipalities and health care institutions in the future even individuals – to invest a billion dollars in self-managed funds in rotation, thus funding for internal improvement in energy savings and the reduction of greenhouse gases, but also for all the sustainability practices that lead economy in the use of resources. These funds "green" saved replenish the fund for later re-invested in other projects by the institution of saving green.

With this procedure, 900 projects have been funded in the American College green with the use of $ 111 million.

The procedure is illustrated in a Guide for the Organizations, which are expressed the procedures for the implementation of a green fund; this guide is a co -publication of the Sustainable Endowments Institute (SEI) and the Association for the Advancement of Sustainability in Higher Education (AASHE), prepared with the assistance of the consulting firm ICF International. It is an expansion of green culture, which once applied feeds on itself and creates new awareness of green behaviors. Partners of the project are, among others : American College and University Presidents' Climate Commitment (ACUPCC) , American Association for the Advancement of Sustainability in Higher Education (AASHE) , Green Building Initiative, National Wildlife Federation Campus Ecology Program, Rockefeller Philanthropy Advisors, Rocky Mountain Institute.

The Lenders are: David Rockefeller Fund, John Merck Fund, Kresge Foundation, Merck Family Fund , Rockefeller Brothers Fund , Roy A. Hunt Foundation.

The turn towards the green funds was decided also because in the past were held Pilot projects carried out in this way and have been a success. One example: the University of Harvard in the '90s began a Pilot project with the use of funds dedicated toll with $ 1.5 million funded by the Bureau and has now reached the sum of 12 million to re-used for other funding sustainable projects into the campus, with a return of 30% and an even lower environmental impact.

Conclusions

This paper shows that, similarly to the challenge launched by the North American University to turn the monetary resources dedicated to sustainability by cost to investment, Italian Universities are carrying out a long time a way toward transparency of virtuous behavior for the community. It is a course that requires a multidisciplinary approach: by the impact that the organization has on the territory conjugate with the environmental view, reaching the energy saving, by the containment of the use of resources to the use of renewable energy. It is a path similar to that initiated by private firms for a long time.

The framework represented by the research identifies a situation inhomogeneous, almost leopard spots, with aspects to deepen and items to rethink, in order to reach the drafting of a common format. Our discussion can begin a way to define shared models for behaviors and operating modes, also to be able to make a comparison between different realities and thus achieve

the desired transparency in communication organizations as required by the community.

References

Book:

CAF Migliorare un'organizzazione attraverso l'autovalutazione, 2006, Fondazione CRUI, Italia.

CAF Università, 2012, Il modello europeo di autovalutazione delle performance per le università, Fondazione CRUI, Italia.

Fondazione Università d'Annunzio, 2014, Bilancio sociale 2007, Ed. Fondazione Università D'Annunzio, Chietei e Pescara, Italia.

Global Report Initiative, 2006, GRI 3.

Global Report Initiative, 2013, GRI 4.

Gruppo di Studio per il Bilancio Sociale Il Bilancio Sociale - Documenti di ricerca n° 7 – La rendicontazione sociale nelle Università, Ed. Giuffrè 2008.

Università degli Studi di Bari, 2006, Bilancio sociale 2006, Ed. Università degli Studi di Bari, Italia.

Università degli Studi di Cagliari, 2008, Bilancio sociale 2008, Ed. Università degli Studi di Cagliari, Italia.

Università degli Studi di Venezia Ca' Foscari, 2013, Report di sostenibilità aa 2012/13, as 2012, Ed. Grafiche veneziane, Venezia, Italia.

W.Edwards Deming, 1990, Sample Design in Business ResearchEd. Wiley-Interscience, Hoboken, USA.

Sitografia

www.premiosocialis.it/rassegna-stampa.htm accessed 09 January 2014.

www.osservatoriosocialis.it/universita accessed 14 January 2014.

www.bu.edu accessed 14 January 2014.

www.eipa.eu/files/File/CAF/Brochure2006/Italian_2006.pdf accessed 08 February 2014.

www.cqa.unisa.it/ accessed 12 February 2014.

www.poliba.it/index.php/it/ateneo/presidio-di-qualita.html accessed 08 February 2014.

www.unive.it accessed 15 February 2014.

http://www.greenreportcard.org/ accessed 22 February 2014.

www.uniparthenope.it. accessed 26 February 2014.

www3.unisi.it/v0/portale accessed 06 March 2014.

http://www.unife.it/ateneo/bilanciosociale/bilancio-sociale-2011.

http://www.fondazionepolitecnico.it/contenuti/file/Bilancio_Sociale_2012-2013_Fondazione_Politecnico_di_Milano.pdf

http://www.unibz.it/it/public/press/Documents/2011-bilancio-finale_it.pdf

http://download.sns.it/placement/bilancio_caps_0406.pdf

http://www.unisannio.it/amministrazione/pdf/ragioneria/Bilancio_Sociale_2012.pdf

http://www.erdisu.trieste.it/BilancioSociale/BilancioSociale2009.pdf

http://www.unipi.it/presentazione/bilanciosociale.pdf

http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CEAQFjAB&url=http%3A%2F%2Fwww.unipv.eu%2Fsite%2Fhome%2Fateneo%2Fdocumento8130.html&ei=TwRMU_GMGoLNygOw9oHYAQ&usg=AFQjCNFiF7AZssS0W51DGkosZQR5wKqRBA&sig2=REXrMuQ-f37fap4QvKXxcA&bvm=bv.64542518,d.bGQ

http://www.uniroma1.it/sites/default/files/estratti/estrattodelibera176_16_07_2013.pdf

http://www.unimol.it/unimolise/allegati/54427/Bilancio%20sociale%202011.pdf

https://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&cad=rja&uact=8&ved=0CE8QFjAG&url=https%3A%2F%2Fwww4.uninsubria.it%2Fonline%2Fdownload.jsp%3FidDocument%3D303214%26instance%3D3&ei=jgVMU9XSCKWCzAPqqoLYBA&usg=AFQjCNE4J9MsYdjVB6aZZYtwhOTKr27sIA&sig2=OBuADDBYgXJkf5U57KYIZA&bvm=bv.64542518,d.bGQ

http://www.unifi.it/upload/sub/bilancio/bilancio_sociale_fup_2006.pdf

http://www.rettore.unifg.it/dwn/BILANCIO%20AMBIENTALE.pdf

http://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CDAQFjAA&url=http%3A%2F%2Fwww.unibo.it%2Fit%2Fallegati%2Fbilancio-sociale-universita-di-bologna-2012%2F%40%40download%2Ffile%2FBilancioSocialeUnibo2012.pdf&ei=cQZMU_ejFaH8ygPatIGgDQ&usg=AFQjCNEQjwazQ9RxGR9wGFsnevvVlWnZNw&sig2=EIh1VsM2_tGQV5tPOH3tHA&bvm=bv.64542518,d.bGQ

ENVIRONMENTAL ATTITUDES AND ACTUAL BEHAVIOR OF BULGARIAN CITIZENS

Elka Vasileva, Daniela Ivanova, Nina Tipova, Stiliyan Stefanov

Department of Natural Resources Economics,
University of National and World Economy,
elkav@unwe.bg

Introduction

In recent years, numerous studies have been conducted to establish the relationships between consumer attitudes and behaviour towards the environment. Initial studies in this area had sought to determine how various demographic and economic factors such as age, gender, place of residence, income and education influenced the environmental attitudes and behaviour.

The predominant approach in research today is based on the assumption that the increase in users' information about the problems leads to awareness and the adoption of "friendly" attitude to the environment (Torjusen et al., 2004; Thogersen, 1998). Different approaches to the study of the mechanisms leading to the perception of the problem or the attitude towards such behaviour can be distinguished. They cover a wide range - from purely educational approaches aimed at the role of training for gaining information and knowledge to achievement of personal involvement with environmental issues. Some approaches emphasize the role of value orientation (personal characteristics) of the consumer while others focus more on the role of his/her beliefs or attitudes toward problems (Finger, 1994). There are such socio-psychological approaches that examine the intentions as factors that best predict consumer behaviour (Fischbein & Ajzen, 1975; Ajzen & Fishbein, 1980).

One of the more vexing problems associated with environmental attitude research, however, continues to be the relationship between environmental attitude and actual behaviour (Ewert & Galloway, 2004). In this case, much less consistency has been found between environmental concern and environmental behaviour (Kraus, 1995). That is, individuals expressing high levels of environmental concern and pro-environment attitudes often display behaviours and actions that have low levels of congruency with their

expressed views. Moreover, many of the variables that show some consistency with respect to environmental attitudes, display weak or inconsistent relationships to environmental behaviours (Olli, Grendstad & Wollebaek, 2001; Diekmann & Preisendorfer, 1998).

The aim of this work was to investigate the environmental attitudes of Bulgarian citizens and their intentions for ecological behaviour and actual personal behaviour. We start from the premise that research efforts should be primarily interested not in attitudinal factors such as environmental awareness or environmental concern, but in actual behaviour of people in the context of their daily life. In line with numerous previous studies we will show that environmental attitude and behaviour are indeed inconsistent in many respects.

In connection with the accomplishment of these aims the following tasks have been defined:

- To collect information on the attitudes of citizens towards environment protection.
- To establish the primary intentions for ecological behaviour and the actual personal behaviour.

Material and methods

Empirical study was conducted with 1011 adult citizens of the Republic of Bulgaria. The sample was formed from the official population database (electoral rolls) on the basis of two-stage random cluster sample (100 clusters).

The survey was conducted in April - May 2013. Information was collected through direct personal face-to-face interviews with the persons included in the surveyed group. The socio-demographic characteristics of the participants are summarized in Table 1. Characteristics of surveyed group.

Questionnaire

The survey was conducted by using questionnaire. In structural terms, the questionnaire consists of four parts. In the Introductory part the aims of the research and examples of how to fill in the questionnaires were presented briefly. The questions in the First part examined the attitudes of citizens towards environment protection. The Second part examined the fundamental attitudes towards environmental behaviour, intentions for environmental behaviour and actual personal behaviour. The Third (identification part) contained questions about the demographic and social characteristics of the respondents.

Table 1. Characteristics of surveyed group

	Surveyed Group,%	For the country, Statistical Data[1],%
Gender		
Men	44.1	48.7
Women	55.9	51.3
Total	**100.0**	**100.0**
Age		
18 – 29	11.3	16.3
30 – 39	18.5	18.0
40 – 49	15.2	16.8
50 – 59	18.1	17.3
60 – 69	19.3	15.9
70+	17.5	15.8
Total	**100.0**	**100.0**
Education[2]		
University	23.4	19.6
Secondary	55.3	43.5
Primary or lower	21.3	36.9
Total	**100.0**	**100.0**
Social Group		
Students	2.8	**-**
Employed	48.8	**-**
Unemployed	11.6	**-**
Pensioners	34.5	**-**
Other	2.4	**-**
Total	**100.0**	
Place of residence		
Sofia	16.8	16.5
District Town	32.7	33.2
Smaller town	22.7	22.7
Village	27.8	27.5
Total	**100.0**	**100.0**
Ethnic group		
Bulgarians	87.7	85.5
Turks	5.1	8.9
Roma	6.3	4.9
Others	1.0	0.7
Total	**100.0**	**100.0**
Personal monthly income (levs)		
No income	7.3	**-**
Up to 200	18.2	**-**
201-500	51.6	**-**
501-1000	20.7	**-**
Over 1000	2.2	**-**
Total	**100.0**	

[1] National Statistics Institute, 2012
[2] The data for the country are for the population aged 7 years and over

Results and discussion

Attitudes towards environment protection

The study shows a high level of support for measures and actions aimed at protecting the environment. About 98% of the respondents agree that special care should be taken of the environment as people are dependent on it. The effectiveness of these actions requires cooperation between citizens and institutions for 97% of the respondents. Environmental behaviour of citizens should be purposefully supported and encouraged by politicians and government institutions through the creation and implementation of appropriate legislation. Moreover, the proportion of people who speak strongly about these ideas is extremely high - between 75-80% (Figure 1. Attitudes towards action on environment protection).

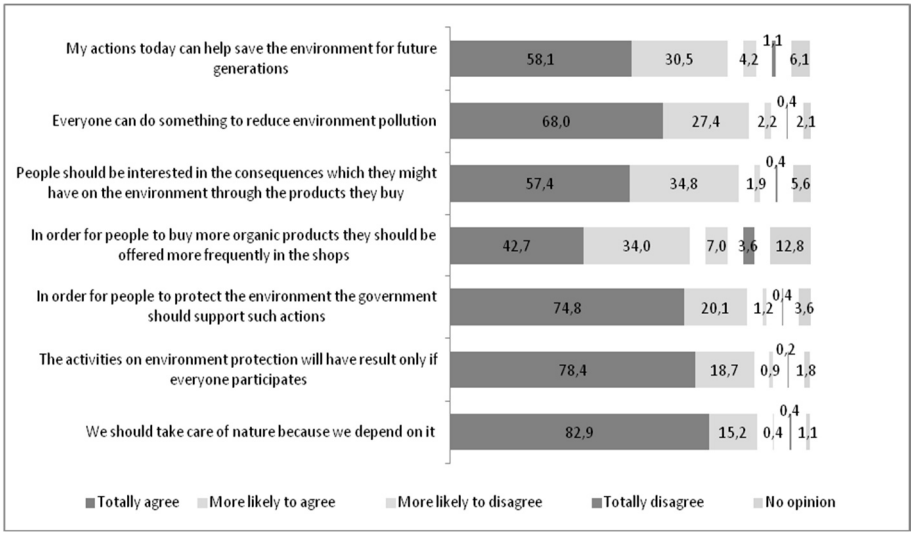


Figure 1. Attitudes towards action on environment protection (% Responded)

Source: own research.

The same strong approval we found when considering these broad principles at individual level. About 90-95% of respondents support the view that individual behaviour is important for environment protection, including through selection of purchased goods. Here, however, the support is clearly less and is moving from 60% to 70%.

Eurobarometer surveys conducted in 2007 (European Commission, 2008) and 2011 (European Commission, 2012) in the 27 member states of the

European Union gathered information about the attitudes of European citizens towards the environment. This enables us to compare data Eurobarometer and our research. According to the Eurobarometer almost all European citizens recognize the importance of environmental protection. On the whole, 95% of EU citizens (-1 point since 2007) feel that protecting the environment is important to them personally. Bulgaria, Greece, Slovenia and Sweden return "important" scores of 98% (European Commission, 2012).

The respondents in our study were proposed to assess the ecological importance and the effect of different individual activities (Figure 2. Assessment of the environmental importance of individual activities). Among them the purchase and use of energy-efficient appliances was mentioned most often as an action which facilitates the protection of the environment. According to about 87% of the respondents this has a great or very great ecological importance.

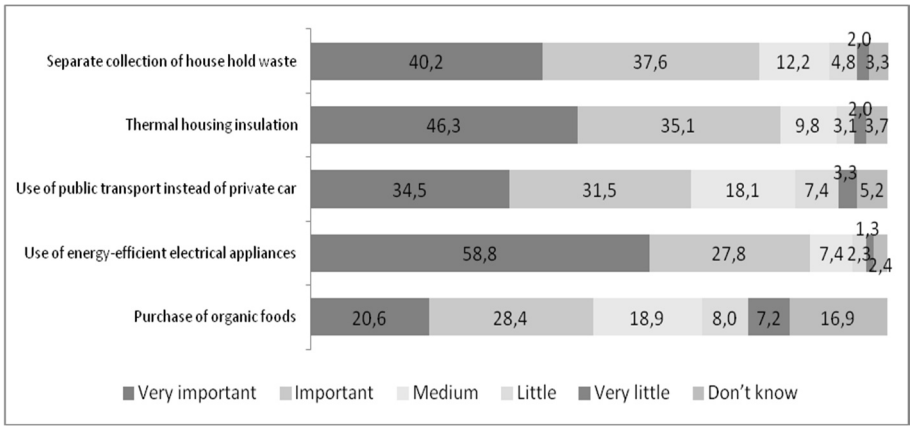


Figure 2. Assessment of the environmental importance of individual activities (% Respondents)

Source: own research.

Next in place came another way of reducing individual energy costs – thermal housing insulation and separate collection of household waste. About 80% of the respondents agree that these are ways to provide a great or very great help to the environment.

The most common are the reservations regarding the environmental importance of the exchange of the private car use for the public transport and the purchase and consumption of organic foods. About 66% and about 49% of the respondents advocate the view that such behaviour has significant environmental results. Most fluctuations and weak support are demonstrated in regard to the reduction of the negative impact on the environment through the purchase of organic foods. Only about 20% of the respondents are of the

opinion that the choice of such foods is of great importance for nature conservation.

According to the Eurobarometer about 55% of Bulgarians believe that recycling of waste and energy conservation should be activities with the highest priority for environment protection (European Commission, 2012). It is important to note that the motivations behind the reduction of energy consumption could be based on financial reasons due to rising energy costs instead of real pro-environmental issues. The lowest level of positive responses was given to the purchase of goods labelled as environmentally-friendly. This was followed by reducing car use (European Commission, 2012).

Intentions for ecological behaviour and actual personal behaviour

By examining previous literature on this subject, we can see that there is not necessarily a connection between individual opinions and actual pro-environmental actions (Pirani & Secondi, 2010).

The survey results show a big difference between strong support for environmentally oriented models of individual behaviour and significantly less likely following of these patterns in everyday life.

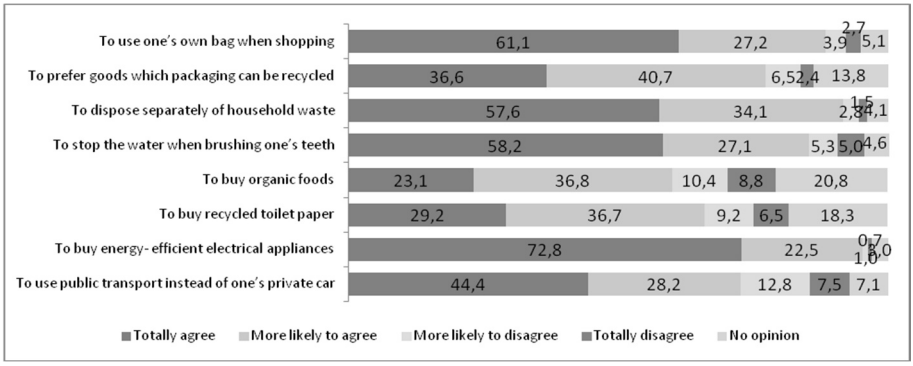


Figure 3. Attitudes toward models of individual behaviour for environment protection (% Respondents)

Source: own research.

App. roval for environmentally oriented patterns of behaviour range from about 95% for the purchase of energy-efficient appliances to 60% for the targeted search, purchase and consumption of organic food (Figure 3. Attitudes toward models of individual behaviour for environment protection). However, when it comes to conscious and consistent daily action the share of environmentally oriented respondents falls from 2 to 5 times (Figure 4. Personal behaviour towards environment protection). As an example, while

about 74% of the respondents strongly approved the purchase of appliances of high energy efficiency class only about 46% make that choice when buying an appliance themselves.

About 58% of the respondents categorically approve of separate disposal of household waste but only 13% state that they separate paper, plastic and glass waste in their own households.

These data were confirmed by Eurobarometer survey in 2011 - about 55% of the respondents approve of separate waste collection but only 19% state that they had done that a month before the survey (European Commission, 2012).

In the present study, about 23% state categorical approval of buying and eating organic foods, but only 4% define themselves as regular users of such foods. In the whole series of questions, the study showed a discrepancy between approval of environmental models and personal, everyday behaviour of respondents.

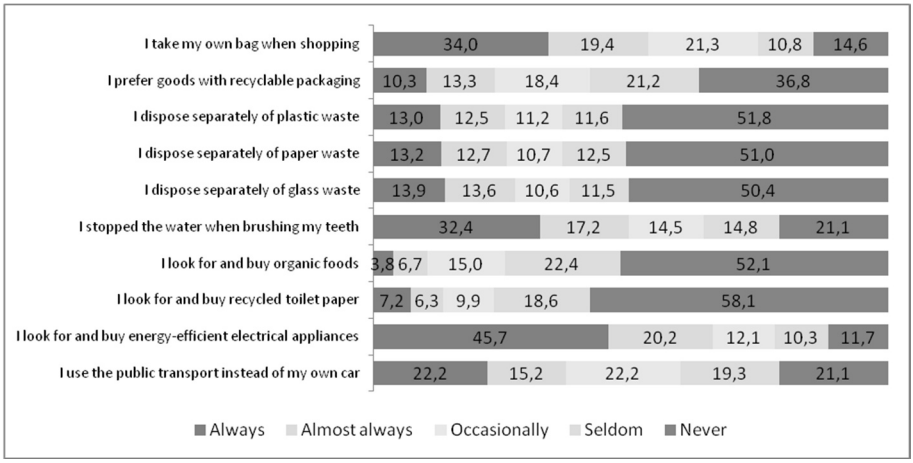


Figure 4. Personal behaviour towards environment protection (% Respondents)

Source: own research.

In some of the cases external factors which constrain the orientation of individual behaviour towards approved ecological models can be sought: the price of electrical appliances, the lack of waste bins for separate disposal of household waste or the larger financial cost that accompanies the incorporation of organic products in the food diet. However, the same picture is observed in cases where actions depend solely on personal choice - for example, the use of own reusable bag when shopp. ing or stopp. ing the water while brushing the teeth where the difference between approval and actual action is nearly twice.

Conclusions

The study shows a high level of public support for the measures and actions aimed at environment protection in Bulgaria. This support is manifested more strongly in more abstract general principles and less so when it comes to individual actions.

Almost all respondents agree that the environment should be taken special care of both by the citizens and government institutions. Participants in the survey support the view that individual behaviour is important for environment protection, including through the selection of purchased goods where approval is weaker.

Consumers appreciate the environmental significance and effect of the various individual activities such as:

- the use of energy-efficient appliances;
- thermal housing insulation;
- separate collection of household waste.

The most common are the reservations regarding the environmental importance of the exchange of the private car use for the public transport and the purchase and consumption of organic foods.

The survey results warrant the conclusion that strongly approved environmental models of individual behaviour rarely motivate and direct the daily activities of consumers.

These results confirm the general profile of EU citizens, who in general are highly worried about global environmental problems, but only mildly worried about issues that are directly linked to their own behaviour (Pirani & Secondi, 2010).

Acknowledgments

The financial support provided by the National Science Fund and the Ministry of Education and Science (Project "Sustainable consumption in Bulgaria – changing patterns") is gratefully acknowledged.

References

Ajzen I., Fishbein M., 1980, Understanding attitudes and predicting social behaviour, Englewood Cliffs, New Yersey, Prentice-Hall.

Diekmann A., Preisendorfer P., 1998, Environmental Behavior: Discrepancies between Aspirations and Reality, Rationality and Society, 10 (1), 79-102.

European Commission, 2008, Attitudes of European citizens towards the environment, Report on Eurobarometer Survey 68.2-2007.

European Commission, 2012, Attitudes of European citizens towards the environment, Report on Eurobarometer Survey 75.2-2011.

Ewert A., Galloway G., 2004, Expressed Environmental attitudes and actual behaviour: exploring the concept of environmentally desirable response, [in:] Connections and Disconnections: Examining the reality and rhetoric. International perspectives on outdoor education theory and practice, 6-9 July 2004, La Trobe University, Bendigo, Victoria, Australia.

Finger M., 1994, From Knowledge to Action? Exploring the Relationships Between Environmental Experiences, Learning and Behaviour, Journal of Social Issues, 50 (3), 141-160.

Fischbein M., Ajzen I., 1975, Belief, Attitude, Intention and Behaviour. An Introduction to Theory and Research, Reading, Massachusetts, Addison-Wesley.

Kraus S. J., 1995, Attitudes and the prediction of behavior: A meta-analysis of the empirical literature, Personality and Social Psychology Bulletin, 21(1), 58-75.

Olli E., Grendstad G., Wollebaek D., 2001, Correlates of environmental behaviors: Bringing back social context, Environment and Behavior, 33(2), 181-208.

Pirani E., Secondi L., 2010, Eco-Friendly Attitudes: What European Citizens Say and What They Do, International Journal of Environmental Research, 5(1), 67-84.

Thogersen J., 1998, Understanding Behaviours With Mixed Motives. An App. lication of a Modified Theory of Reasoned Action on Consumer Purchase of Organic Food Products, [in:] E - European Advances in Consumer Research Volume 3, eds. Basil G. Englis and Anna Olofsson, Provo, UT, Association for Consumer Research, pp. 286-287.

Torjusen H., Sangstad L., O'Doherty Jensen K., Kjærnes U., 2004, European Consumers' Conceptions of Organic Food: A Review of Available Research, National institute for consumer research, Oslo, Norway.

WATER AS A VALUABLE ASSET

Jerzy Żuchowski

Department of Commodity Science, Faculty of Economics,
Kazimierz Pulaski University of Technology and Humanities in Radom,
j.zuchowski@uthrad.pl

Introduction

Experts in Commodity Science until now in small way analyzed the meaning of this unusual substance for achieving high quality processes and productivity. Also in a product's cycle of life amongst its many determining factors meaning of water is not exposed enough. In this cycle more important role is given to energy and power consumption, waste management and recycling than to water economy and rational water and sewage management.

Promoting energy saving is more visible than promoting water saving. In Poland where for one inhabitant are accrued same amounts of water as in Egypt – we have not learned to respect this amazing substance properly.

Physiochemical parameters of water (reaction, density) make it very important quality reference in analytical research.

Mentioned information, have been an inspiration for the Author in presenting meaning of water from the Commodity Science point of view. The goal of these analyses will be the evaluation of this substance in approach to products cycle of life in sustainable development.

In this article there will be presented availability of freshwater, properties of water, reasons of its pollution, partial water stock management as well as ways of saving and regenerating water stocks. There will be also presented its role as a medium in creating, evaluation and protection of the product.

Attempt of defining

Any attempts of defining water which in itself constitutes a valuable asset, shall be a priori deemed as imperfect. An adequate definition by a splendid Antoine de Saint-Exupéry "water you are life", makes us aware of a challenge that stands before us. Thus, instead of basing on a general definition, we should base on its certain partial features, which may define the essence of water more precisely when treated comprehensively.

This incredible substance may be defined from the following points of view: physical features, chemical features, commodity features, biological features, adiabatic and biotic features, hydro-morphologic and physicochemical elements. We may define its cleanness by means of the characteristic of biocenoses, bloom dynamics, chemistry of waters, deviation from the natural condition or fitness for direct use. The process of defining this substance cannot include merely the measurable elements (laboratory elements), as the quality characteristics identified with the commodity science play an extremely important role (taste, fragrance, appearance).

The philosophy of new attitude towards the management of water resources included in the EU Water Framework Directive makes an attempt to define water as well. The directive defines water not from the point of view of a commercial product but as a heritage, environmental element or a unique phenomenon. The attempt of defining water in this study was based on a quality approach determined by physical, chemical, biological and commodity features.

Characteristic physicochemical features of water include:

- Density – water obtains the maximum value of 1 g/cm^3 in the temperature of 277.14 K (4ºC). Above and below this temperature water density is lower than one. Thanks to this water in rivers and lakes freezes only on the surface what enables the existence of the biological life in its depth.
- Volume which decreases in the course of cooling down water below the temperature of 277.14 K (4ºC) and increases by more than 9.3% solidifying into ice. It has far-reaching consequences for technological processes due to the fact that this phenomenon may contribute to the breaking of containers, pipes or radiators.
- Pressure the increasing of which causes an increase in the temperature of boiling water. This dependency is applied in steam rises and autoclaves. Under decreased pressure the boiling temperature of water decreases (rotary evaporators, vacuum apparatus).
- App. ropriate warmth – water has one of the highest values of this warmth [1.00 cal/(g×ºC) w 15ºC].
- Surface tension – the highest from among all liquids.
- Solubility – water is the best solvent from all liquids. It causes hydrolysis and hydration of dissolved substances. In reactions with metal oxides water creates alkalis, with non-metal oxides – acids.
- pH – clean water has a neutral reaction (pH = 7), to a minimum degree it is subject to ionic dissociation into cations H^+ and anions OH^-.
- Salinity – water is sweet depending on dissolved salts (0.05 ‰ of dissolved salts) and it is salted in different degree (oceans from 32 to 38 ‰,

Black Sea 15 ‰, Baltic Sea 9 ‰, Red Sea 43 ‰, Dead Sea 260 ‰). 97.4% of water on Earth is "salty".

- Hardness – water hardness is mainly determined by the content of salt of calcium, magnesium, manganese and iron. The excessive hardness of water is undesired and very often it is harmful to technological processes (production of scale deposit and consequently the excessive losses of fuel and wear and tear of boilers). Total hardness of water is the sum of the carbonate hardness – [$Ca(HCO_3)_2$ and $Mg(HCO_3)_2$] – the so-called temporary hardness which may be removed in the process of heating and non-carbonate permanent hardness caused by sulphates, chlorides, calcium nitrate and magnesium nitrate. Water hardness is measured in German degrees or mval/dm^3 (1 mval/dm^3) = 2.8ºn.

Basic features of water are presented in Table 1.

Table 1. Basic physicochemical features of H_2O

Features	Value	Titre
Molecular mass	18.015	u (unit)
Density in the temperature of 4ºC	1.0	g/cm^3
Boiling temperature under pressure of 1 atm.	373.12	K
Melting temperature under pressure of 1 atm.	273.15	K
Triple point	273.16	K
App. ropriate warmth in the temperature of 15ºC	4.19 1.0	J/(g×K) cal/(g×ºC)
Dynamic viscosity in the temperature of 15ºC	1.79	mPa×S
Critical temperature	647.15	K

Source: Żuchowski, 2001.

Biological features are also significant in the course of defining water and specifying its nature.

Water participates in the course of the majority of metabolic processes. It is a great solvent, temperature regulator and it constitutes an intraorganic means of transport (for chemical substances, hormones and enzymes). The body of an adult contains 70% of water. Blood plasma is made of 95% of water, bones of 20%, even dental enamel includes 10% of this substance. Fruit hold even 90% of water.

Microbiological parameters play an important role in specifying water's usefulness for consumption by people. Water of such purpose should be practically free from any pathogenic bacteria. In Poland, health safety of water is regulated by the Regulation of the Minister of Health of 20th April 2010 (Rozporządzenie Ministra Zdrowia z dnia 20 kwietnia 2010 r.) concerning the

quality of water destined for consumption based on the EU Directive (Dyrektywa Rady Unii Europejskiej 98/83/WE).

Microbiological parameters specified in the above mentioned Regulation are based on indicatory organisms such as: coli group bacteria, streptococci, or clostridium perfringens. Presence of Escherichia coli or any coli group bacteria in water indicates that its treatment and disinfection are improper. Decomposing floral material and sewage are the main sources of pollution of water distribution systems with these microorganisms.

The content of coli group bacteria and streptococci constitutes a quality index of water system treatment. The presence of indicatory organisms from clostridium perfringens group at particular stages of its coagulation, sedimentation or filtration indicates that the treatment process is carried out properly. Constant monitoring of drinking water is conducted on the basis of the study of the general number of microorganisms in the temperature of 22ºC after 72 hours. Deviations from typical values signalize changes in the microbiological quality of water.

Biochemical and chemical indexes specifying the need for oxygen are BZT and ChZT parameters. BZT5 and BZT10 parameters specify the consumption of oxygen necessary for the oxidation of organic compounds in sewage and water. ChZT parameter specifies chemical need for oxygen necessary for the oxidation of organic and non-organic compounds. BZT parameter is the part of ChZT parameter and their proportion constitutes an important hint concerning sewage biodegradation. An ideal biodegradation is noticeable at BZT/ChZT = 1.

For better presentation of the usefulness of BZT index, we may list the following data:

- Crystal clean water has the value of: BZT5 = 1,
- Slightly polluted water: BZT5 = 6–8,
- Well purified municipal waste water: BZT5 = 10
- Non-purified municipal waste water: BZT5 = 400–600,
- Leachates from landfills: BZT5 = 2000–16000.

However it should be noticed that the study of BZTS requires five days for its marking, whereas the level of ChZT can be determined after few hours.

From the commodity science point of view, organoleptic characteristics evaluated by means of taste, sight, smell or touch, seem to be extremely important when defining water. Thanks to this analysis, we evaluate the aftertaste, colour, transparency or opacity and sometimes the warmth of water. Organoleptic characteristics depend mainly on the chemistry of water.

- Colour – is caused by the presence of organic substances, iron and other metals being the natural water components, however they also originate from corroded pipes or reservoirs.
- Opacity – is connected with improper treatment of water and content of iron and manganese. Water opacity may be caused by precipitating compounds of the above mentioned iron, manganese and aluminium. It is caused by hummus acids, plankton, parts of rocks and soil as well as waste discharged to water.
- Taste and smell are determined by the presence of compounds of organic origin and gases (hydrogen sulphide, chlorine, ammonia). Compounds of phenol and its derivatives may influence the fragrance. Plants as a result of their biologic decomposition contribute to the existence of putrefactive smell.

Generally we may state that the above described indexes are mainly influenced by the content of: iron, manganese, ammonium, nitrates and nitrites, chlorides and fluorides. The most dangerous living organisms and environment include the compounds of mercury, chromium, cadmium and lead (death metals). Trihalomethans (by-products of the processes of water disinfection), derivatives of chlorine, chlorine amines, showing carcinogenic and mutagenic features as well as polycyclic aromatic hydrocarbons and pesticides and artificial fertilizers, are extremely dangerous substances.

Healing water containing mineral elements and radioactive radon (not less than 75 Bq/dm^3), is highly advantageous for the society. From the point of view of commodity, water should serve well its consumers and at the same time remain in accordance with legal regulations in respect of its chemical, physical, biological and other characteristics.

The quality of water is determined by various natural and anthropological interactions. The latter ones depend on our attitude towards this substance. In the policy of sustained water economy, economic and environment interests should be rationally balanced.

Commodity science aspects

Taking into consideration the above mentioned attempts of defining water, we should pose a question whether this valuable substance can be treated in the same way as other products or goods?

From the point of view of commodity approach, products are formed in an appropriate manner, evaluated and protected. All these elements are also applied in respect of this specific product, i.e. water, but only in certain situations (water treatment, filtration, purification and recycling). However,

this kind of approach is connected with the defining of water in terms of the commercial product.

However, in the comprehensive approach towards this particular asset, we may not apply merely the elements of the commodity usability. Recommendations included in the EU Water Framework Directive (Ramowa Dyrektywa Wodna, 2000) should be observed. The said Directive states in its preamble that water is not a commercial product similar to any other product, but it is an inherited asset, which should be protected and treated in a proper manner.

The general purpose of the directive is to achieve an adequate water level. The adopted policy of accomplishing this purpose, based on the principles of sustained development, concerns the following aspects:

- Satisfaction of the need for water demonstrated by people, farmers and industry.
- Promotion of sustained use of water.
- Protection of water and eco-systems being in a good condition.
- Improvement of the quality of water and the condition of eco-systems degraded by the human activity.
- Reduction of the pollution of surface water.
- Mitigation of the consequences of floods and draughts.

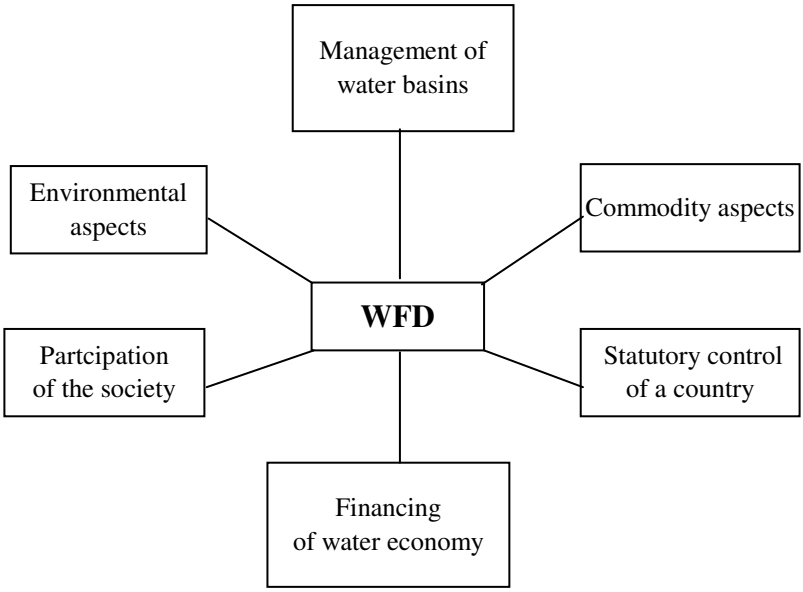


Figure 1. Management of water resources in accordance with the Water Framework Directive

Source: own study.

Rational management in water economy, according to the EU WFD, is presented in Figure 1.

In the Water Framework Directive, economic and commodity aspects connected with the analysis of the costs of water services provided for particular sectors of the national economy (industry, agriculture or households), cannot be omitted. Paying the fees for water intake and sewerage results from the Water Law (Ustawa z dnia 18 lipca 2001 r. Prawo wodne). Therefore, such commodity elements as specification of the need for water in the course of manufacturing goods and providing services in the context of water resources and intake payments, are of primary importance.

Water resources

Water resources on Earth are difficult to be presented and much more difficult to be imagined. It is estimated that there is approx. 1 billion and 400 million km^3 of water on Earth. The prevailing mass of this sweet substance is contained in glaciers and underground waters. Surface waters constitute merely 1% of sweet waters, i.e. approx. 0.025% of all water on Earth (Gleick, 1966). Although global resources of water on Earth are massive, it should be used economically and very carefully, due to the fact that its sweet resources are used more intensively. This particularly concerns the areas poor in water. This situation concerns Poland and what is worse people are unaware of this matter.

Annually, approximately 1,700 m^3 of water is consumed by one Pole on average. The average in Europe is 5,100 m^3 of water per one inhabitant (Heinrich, Jędrzejkiewicz, 2007). However, the worst situation is in Africa. In the entire world, over one billion and 200 million people have hampered access to water and suffer from thirst.

When evaluating the condition of water resources in Poland, it is worth establishing that:

- The entire resources of flowing waters in Poland amount to 62bn m^3 per year on average.
- Within the territory of Poland there are approx. 2,900 lakes of the surface amounting to 10 ha each, whose total capacity amounts to approx. 18bn m^3 and 100 storage reservoirs of the total surface equal to approx. 3.5 m^3.
- The volume of sweet underground waters kept in store is estimated to approx. 6,000 bn m^3.
- Area with the least water resources is the area of the middle Poland belt covering the territory between Poznań and Warsaw.
- Disposable resources of flowing waters is estimated at approx. 10bn m^3 per year i.e. 260 m^3 per each inhabitant.

- Resources of underground water available to be managed amount to approx. 14bn m^3 per year, what equals 360 m^3 per one inhabitant per year.
- Water quality level in rivers and lakes is unsatisfactory (43% of IV class water and 19% of V class water) (Ochrona Środowiska, 2006).

Satisfaction of the need of the society and national economy for water is carried out with the use of surface water resources (85%) and underground water resources (15%). App. roximately 85% of used water comes back to the surface waters, but unfortunately in the form of polluted sewage.

Water absorption

Water absorption is one of the most important elements of Sustained Development. Country's sustained development, recognized as the Constitutional Rule of the Republic of Poland, was defined in the Act *Environment Protection Law* as such social-economic development which covers the integration process of political, economic and social activities with nature balance and durability of basic nature processes in order to guarantee the possibility of satisfying the fundamental needs of particular societies or citizens, both the contemporary generation and generations to come (Żuchowski, 2012).

In Poland, a separate strategy of sustained development is lacking, however social and economic purposes in a long-term perspective were clearly specified in many strategic documents. The said purposes became the basis for the selection and analysis of indexes used to monitor their achievement. Such indexes were presented by the Central Statistical Office in Poland (indexes of sustained development) (Wskaźniki zrównoważonego rozwoju Polski, 2011). Issues connected with water absorption converted into The Gross Domestic Product according to Eurostat 2007 are presented in this study as well.

Water absorption means the quantity of water used for the need of industry, agriculture, forestry and the exploitation of the water supply network falling on the GDP per capita. Water absorption of the Polish national economy against the European Union countries is presented in the Figure 2.

The analysis of the index of water used for the production of 1000 euro of the Gross Domestic Product (GDP) indicates high water absorption of the Polish economy. Such countries as Bulgaria, Hungary, Estonia, Latvia and Romania have higher water absorption than Poland. Spain demonstrates similar water consumption. Whereas all other EU countries have much lower water absorption. It should be noticed that Poland among all these countries has one of the lowest water resources (three times lower than the European average).

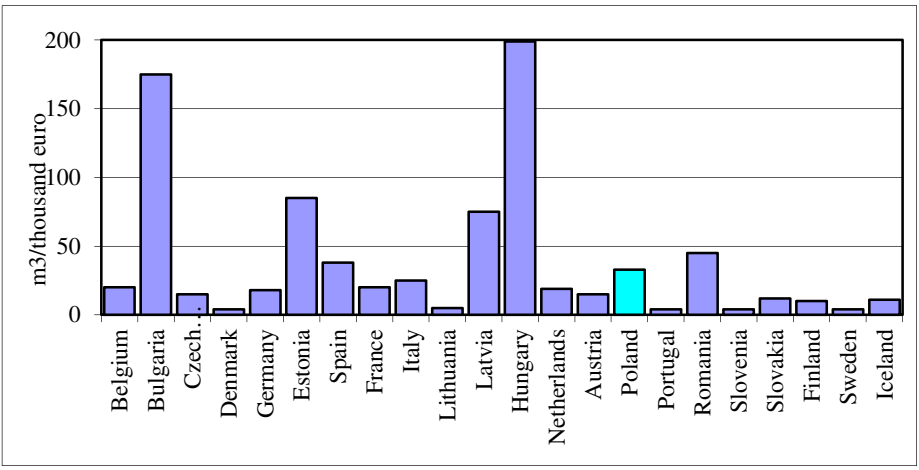


Figure 2. Water absorption of the national economy in selected European countries (Eurostat 2007)

Source: own study.

However, it should be emphasized that in the recent years a tendency of reducing the overall water consumption has appeared, especially for production purposes and within the existing collective supply of inhabitants.

It is estimated that the water intake for the needs of domestic economy reaches the level of 12bn m^3 per year. Distribution of consumption for particular sectors is at the following levels: 70% industry, 20% municipal economy, 10% agriculture. Percentage water consumption in the basic branches of industry is presented as follows: fuel and energetic – 78.5%, chemical – 8.5%, metallurgical – 2.5%, electromechanical – 1.5%, mineral – 1%, light – 1%. These fundamental branches consume 98.8% of water in the entire Polish industry.

When fulfilling the purposes of sustained development, it is worth to emphasise the significance of water conservation next to the energy conservation in the Polish economy.

Water conservation (water footprint)

Energy conservation expressed by the so-called "carbon footprint", has a permanent place in the sustained development. Such a place should also be created for the water conservation with its "water footprint".

Carbon footprint is the methodology of estimating the total emission of greenhouse gases, in the carbon equivalents produced during the entire life cycle of a manufactured product – beginning with its design, production, trade turnover and ending with the moment of exploitation or potential recycling.

The concept of water footprint was established by John Allan. The water footprint of a person, company, city or country is the sum of the quantity of water used for the production of goods and provision of services or directly for the social needs. Direct needs are connected with an indispensable consumption of water by people for such purposes as: laundry, dish washing, watering, cooking or taking care of hygiene. "Water footprint" referring to the production of goods and provision of services and its monitoring in the entire life cycle of a product is particularly significant for the commodity science.

In the enterprises a new ISO standard – ISO 14046 was established for the purposes of comprehensive analysis of the regional water economy. No international norms covering water consumption existed before this particular ISO standard. The standard ISO/DIS 14046.2. Environmental management – water and footprint – principles, requirements and guidelines covers coherent tools used to measure water consumption and management systems and branch practices as well as it provides hints regarding rational water economy and monitoring.

The intake of water for the needs of direct consumption by people may be estimated in a relatively easy way. It is much more difficult to make such estimates in respect of produced goods and provided services. In the course of these estimates the entire so-called "water footprint", i.e. need for water at all levels of production process of a particular good (commodity), is taken into consideration. Beginning with the spheres that are very distant from the product. For example the "water footprint" in the course of manufacturing of 0.35 l of coke can reaches the growing of carbohydrate raw materials necessary for its production, production of sugar and in the end a drink itself.

The "water footprint" included in the production of an exemplary can of coke cannot be mistaken with the need for water in the company manufacturing the product. This stage is merely one of the fragments of the "water footprint". Thus, bearing the above explanation in mind and taking into consideration the entire "water cycle", the information that 200 l of water is needed to produce 0.35 l of a can of coke, should not be surprising at all (www.waterfoot.print.org.pl).

Total consumption of water for chosen food products (water footprint estimate) is presented below:

- an egg (1) – 200 l of water,
- rice (1 kg) – 4,000 l of water,
- wheat (1 kg) – 1,500 l of water ,
- chocolate (1 kg) – 2,400 l of water,
- loaf of bread – 450 l of water,
- potatoes (1 kg) – 125 l of water,

- milk (1 l) – 1,000 l of water,
- bear (1 l) – 150 l of water (www.waterfoot.print.org.pl).

The consumption of water needed for the production of a car was given as an example of water consumption as regards industrial goods; it requires approximately 400-500 thousand l of water (www.cro.org.pl).

To summarize, it should be stated that from the commodity point of view, the "water footprint" may be incredibly useful in handling the rational water economy and the achievement of the purposes of sustained development.

Summary

Water should not be perceived as a commercial product, but in a much broader way – as a special good. Water in the commodity science, science of the quality of processes and products, plays a very important role. It determines the course of processes and at the same time it forms the quality of products.

Without water no product could exist. On the basis of conducted analyses and reflections included in this study, the following conclusions could be drawn:

- quality definition of water requires various points of reference by means of analysing its physical, chemical, commodity, biological features as well as abiotic, hydro-morphological and physicochemical parameters,
- water has numerous physicochemical features which may be defined as indicatory ones (pH, density, triple points of water),
- management of water resources contained in the "Water Framework Directive" defines the policy of achieving an appropriate level of waters and it is based on the principles of sustained development,
- water resources in Poland are the poorest ones in Europe. Annually 1,700 m^3 of water falls on one Pole on average, while the European average is 5,100 m^3 per one inhabitant,
- indexes of water consumption needed for the production of 1,000 Euro of the Gross Domestic Product (GDP) indicate a high water absorption of the Polish economy, what by low water resources (three times lower than the European average) is an unfavourable situation for the development of economy,
- the highest percentage water intake is demonstrated by the industry (70%) which covers the fuel and energy branch (78.5%),
- in the rational water economy, the term of the so-called "water footprint" is of considerable significance and it could play the similar role as the one played by the "carbon footprint" in energetics,

- the ISO standard – ISO 14046 may be particularly important in the comprehensive analysis of the rational water economy in enterprises.

References

Dyrektywa Rady Unii Europejskiej 98/83/WE.

Gleick P.H., 1966, Water resources, [in:] Encyclopedia of Climate and Weather, S.H. Schneider (ed.), Oxford University Press, New York, vol. 2.

Heinrich Z., Jędrzejkiewicz J., 2007, Analiza zużycia wody w miastach polskich 1995–2005, Ochrona Środowiska, 4, 29-34.

Ochrona Środowiska 2006, 2006, GUS, Warszawa.

Ramowa Dyrektywa Wodna. Parlament Europejski 2000/60/WE.

Rozporządzenie Ministra Zdrowia z dnia 20 kwietnia 2010 r. zmieniające rozporządzenie w sprawie jakości wody przeznaczonej do spożycia przez ludzi (Dz. U. Nr 72, poz. 466).

Ustawa z dnia 18 lipca 2001 r. Prawo wodne (Dz. U. z 2005 r. Nr 239, poz. 2019).

Wskaźniki zrównoważonego rozwoju Polski, 2011, Urząd Statystyczny, Katowice.

www.cro.org.pl.

www.waterfoot.print.org.pl.

Żuchowski J., 2012, Energy Consumption and its Effects on the Economy and the Environment, 18th IGWT Symposium, Rome.

Żuchowski J., 2001, Zarządzanie jakością procesów, produktów i środowiska, PWN, Warszawa.

COMMODITY SCIENCE
IN RESEARCH AND PRACTICE

series consists of eight monographs:

ACHIEVEMENTS AND CHALLENGES
OF COMMODITY SCIENCE IN THE AGE OF GLOBALIZATION
Edited by Andrzej Chochół & Jerzy Szakiel

CONSUMER PROTECTION AND SATISFACTION
Edited by Andrzej Chochół

FOOD PRODUCTS' QUALITY
Edited by Małgorzata Miśniakiewicz & Stanisław Popek

FUTURE TRENDS AND CHALLENGES IN THE FOOD SECTOR
Edited by Małgorzata Miśniakiewicz & Stanisław Popek

INNOVATIONS IN PRODUCT DEVELOPMENT AND PACKAGING
Edited by Agnieszka Cholewa-Wójcik & Agnieszka Kawecka

NON-FOOD PRODUCTS' QUALITY & INNOVATIONS
Edited by Renata Salerno-Kochan

TOWARDS QUALITY - MANAGEMENT SYSTEMS
AND SOLUTIONS
Edited by Tadeusz Sikora & Joanna Dziadkowiec

TOWARDS SUSTAINABLE DEVELOPMENT
Edited by Wacław Adamczyk

ISBN 978-83-62511-38-9 *(printed version)*
ISBN 978-83-62511-04-4 *(html)*