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REVIEW

Sustainable consumption and production as a system: experience in Lithuania

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Abstract Activities in the area of sustainable consumption and production in Lithuania started in 1993 when the first cleaner production projects were implemented. The capacity in the area of cleaner production enabled further development and implementation of preventive environmental initiatives. Cleaner production activities have been followed by establishment of a system for development, financing and implementation of preventive innovations, implementation of environmental management systems (including development of new approaches for implementation, particularly in small and medium-sized enterprises), product-oriented measures such as life cycle assessment, eco-design, and sustainability reporting. A very important role in building the basic capacity level and implementing the sustainable consumption and production initiatives in Lithuania has been played by the Institute of Environmental Engineering (APINI) at Kaunas University of Technology. This article presents an overview of activities in the area of sustainable consumption and production in Lithuania since 1992 as well as results/lessons learnt from these activities. To overcome barriers and to ensure progress in the area of sustainable consumption and production, a model of a system of sustainable consumption and production has been developed. The objective of the system is to minimise energy and material use as well as waste output, and to eliminate the "rebound" effect.

Keywords Sustainable consumption and production · Preventive innovations · Integrated management systems · Eco-design · Life cycle assessment

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Introduction

Sustainable development at an organizational level is usually described to use a triple bottom line that divides performance into economic, environmental and social dimensions. Hence, sustainable industrial development may be defined as a strategy for adopting activities to meet the needs of enterprises and other stakeholders today, while protecting, sustaining and enhancing the human and natural resources that will be needed in the future.

The concept of sustainable development is more often considered by industrial enterprises as vague and hardly operational. Moreover, the word "sustainability" in relation to industrial activities has been so heavily overused, with so many different meanings applied to it, that it has become quite meaningless (Aras and Crowther 2009).

To ensure contribution of industry to the process of sustainable development, a need arises to explain in operational terms what the concept of sustainable development means to industry and, more specifically, to an industrial enterprise. To make it operational, sustainable industrial development may be considered as a process of continuous improvement of environmental, economic and social performance in industry. Such a process approach allows specialists to identify particular process performance parameters that could be controlled and managed. In this context, sustainability performance can be interpreted as a result of management of sustainability aspects in enterprises (Staniskis and Arbaciauskas 2004).

Progress in the process of sustainable industrial development depends on the enterprises which systematically apply sustainable industrial development tools enabling them continuous performance improvement aimed at (i) production processes, (ii) management practices, (iii)

products, and (iv) communication with internal and external stakeholders. Therefore, to achieve a wide participation of industrial enterprises in the process of sustainable development and to facilitate effective decision making in the sustainability management process at an enterprise level, key tools of sustainable industrial development focused on these areas have to be identified. There are a number of tools aimed at reducing environmental impacts and improving sustainability performance. It is evident that industry cannot fully rely on the pollution control technologies because of their limitations and excessive cost, moreover, application of preventive environmental approaches is becoming an important factor of business competitiveness. Research and practical experience shows that to ensure sustainable industrial development, the following tools should be systematically applied (Staniskis and Arbaciauskas 2004):

- Cleaner production to improve production processes.
- Eco-design to improve product characteristics.
- Integrated (environmental, quality and occupational health and safety) management systems to improve management practices. Nowadays, most of the companies integrate their management systems, e.g. one study shows that 86 % of companies from a 435 companies sample have integrated or almost integrated management systems (Bernardo et al. 2009).
- Sustainability reporting based on sustainability performance evaluation to improve communication with internal and external stakeholders.

Application of various measures related to sustainable consumption and production in Lithuania has undoubtedly contributed to the positive developments in Lithuanian economy and relative reduction in resource consumption and pollution generation.

In principle, work in the area of sustainable consumption and production in Lithuania started in 1993 when the first cleaner production projects were implemented. Initially, all activities focused on preventive measures aimed at reduction of environmental impact from production processes. This was a logical start because of significant inefficiency of very high energy and material use intensity in Lithuanian industry. Gradually, attention shifted towards products, but improvement of process efficiency in processes remained an important element of the overall process towards more sustainable consumption and production.

Initially, most of the activities related to sustainable consumption and production in Lithuania as in other Central and Eastern European countries have been supported by foreign and international donors. This enabled local stakeholders to build necessary capacity and to spark an interest among enterprises to pay more attention to challenges of sustainable development and associated opportunities.

While initial support and interest from governmental institutions in Lithuania was limited, revision of environmental legal basis, integration of preventive approach in strategic documents (e.g. national strategy for sustainable development) have created preconditions for progress in the area of sustainable consumption and production in the country.

Capacity building activities in Lithuania

Capacity building activities in the area of cleaner production (CP) in 1993 could be considered as a beginning of sustainable production development in Lithuania. These activities appeared to be in line with the concept of basic capacity level (BCL) for CP defined by Organisation of Economic Co-operation and Development (OECD) in 1996, when the Task Force for the Implementation of the Environmental Action Programme (EAP) in Central and Eastern Europe (CEE) endorsed the Work Programme on Environmental Management in Enterprises. The BCL was defined as the level which is needed for further dissemination of the CP concept and principles throughout industry and society by the host country. Specifically, it involves creating: (i) an active core of CP advisors and trainers; (ii) a set of CP case studies, demonstration projects and model business plans; (iii) a functioning CP Centre or Centres; (iv) training materials in the local language; (v) cleaner production principles, included in the university course curriculum, and (vi) a monitoring framework and quality assurance (OECD and EAP Task Force 1998a).

OECD assessment carried out in OECD and EAP task force (1998b) concluded that Lithuania was among a few CEE countries that had achieved the BCL (OECD and EAP Task Force 1998a). The capacity in the area of CP enabled further development and implementation of preventive environmental initiatives. CP activities have been followed by implementation of environmental management systems (including development of new approaches for implementing them, particularly in small and medium-sized enterprises) and product oriented measures. A very important role in building BCL and implementing sustainable production and consumption initiatives in Lithuania was played by the Institute of Environmental Engineering (APINI) at Kaunas University of Technology.

A role of cleaner production centre in Lithuania has been played by the Institute of Environmental Engineering (APINI), Kaunas University of Technology. APINI coordinated most of the programmes/projects supported by foreign donors related to sustainable consumption and production in Lithuania. When foreign donor support diminished, APINI continued to play an active role in

further development of preventive approaches and assisted Lithuanian industry to improve environmental and economic performance.

The key objective of demonstration projects was to show the potential of CP concept in pilot enterprises and subsequently to introduce the concept to a broader number of enterprises. In general, the projects show economic and environmental benefits of CP measures. Virtually all CP demonstration projects in Lithuania have been implemented in the framework of two programmes: (i) World Environment Centre (WEC) Pollution Prevention Programme and (ii) Norwegian Cleaner Production programme.

A number of technical improvements that resulted in environmental and economic benefits have been implemented, but the lack of follow-up and lack of involvement of local experts (particularly in case of the WEC programme) in implementation of these measures did not spark the expected multiplier effect (Staniskis and Arbaciauskas 2004). Lithuanian experience showed that achieving desired objectives required more than providing cleaner technology hardware. However, the case studies developed in demonstration projects have been a valuable source of reference for further CP activities.

Training programmes have been a core of most of CP and other projects related to sustainable consumption and production in Lithuania. In principle, two types of training programmes have been used: (i) long-term training programmes and (ii) short-term training programmes.

For example, within the Norwegian CP programme, prior to receiving their certification, trained experts had to prepare reports which included three types of projects: (i) zero investment; (ii) payback on investment of less than 1 year; and (iii) long-term measures with larger investments which could be considered after options (i) and (ii) had been exhausted. Systematic environmental, economic and technical feasibility analysis of identified CP options proved to be extremely important in ensuring that the priority options were selected and implemented. Short-term training programmes have been mainly used for senior managers of enterprises and representatives of governmental institutions.

An important activity to promote application of preventive environmental measures was information dissemination targeted at specific audiences, mainly industry as well as national and local governmental institutions. A number of seminars, workshops and conferences focusing on information dissemination and exchange have been organised. A number of training materials in Lithuanian language have been translated/developed and published by APINI.

Today, we can foresee an increasing demand for engineers with high competence in technologies for CP and integrated environmental management, because the number of companies applying different preventive environmental measures is increasing (Staniskis and Arbaciauskas 2003). Therefore, nine technical universities in the Baltic Sea region in the framework of the BALTECH consortium decided to develop and implement a new M.Sc. Programme in Environmental Management and Cleaner Production, based on an integrated approach of industrial ecology. This is a two-year (120 ETCS Credits) Programme suitable for graduates with qualifications in many engineering fields such as chemical engineering, mechanical engineering, civil engineering, environmental engineering and others. The Programme started at Kaunas University of Technology in September 2002. In 2005, after evaluation of M.Sc. programmes in Lithuania, the National Centre for Quality Evaluation of Studies has concluded that M.Sc. programme in Environmental Management and Cleaner Production at Kaunas University of Technology was the best M.Sc. programme in the environmental area. The Programme aims to provide M.Sc. education to engineering students at B.Sc. level or the equivalent with a specialisation in Environmental Management and Cleaner Production with a strong technology component at advanced level consolidating the engineering area of the candidate's Bachelor's Programme. The Programme offers an integrated approach towards current and long-term/strategic environmental issues, focusing on technologies and concepts in environmental planning and management for a sustainable industrial development (Staniskis and Arbaciauskas 2003).

The educational programme is structured according to the following main guiding principles:

- *Multidisciplinary approach:* The environmental field is in its nature multidisciplinary, which is mirrored in the course structure of the Master's course. The compulsory part of the course includes areas such as Technology, Management, Policy, Law and Economics and environmental strategies such as Cleaner production and Eco-design. The optional course programme widens the multi-disciplinarity of the programme with areas as Sustainable Development, Systems Analysis, Monitoring and Modelling as well as advanced courses in technical areas. To summarise, the programme has a strong emphasis on engineering, management and policy to make sure that graduates have broad understanding and capability to work with complex issues of sustainable industrial development.
- *Strongly research-connected*: Most of the optional courses are treating advanced topics with close research connections. The subject matter as well as the topics of course assignments and projects are closely linked to the research of the department giving the course or to its R&D co-operation with Industry, with projects

defined by the need for solutions to current environmental or environmental management problems in the industrial company. The connection with the research will in particular be ensured in the thesis projects for which preferentially active researchers will be engaged as supervisors.

- *Practical education*: Kaunas University of Technology has very strong links to industry and governmental institutions. The Institute of Environmental Engineering at Kaunas University of Technology implemented a number of training programmes for industrial enterprises and assisted more than 150 companies to develop and implement CP projects. M.Sc. students of the Programme in Environmental Management and Cleaner Production have an opportunity to participate in the projects aimed at improvement of environmental performance in industry and to acquire valuable practical experience.
- *Integrated programme*: The aim is to provide M.Sc. students with a solid theoretical knowledge and hands-on experience in the real world. This is achieved by a balanced and integrated theoretical and practical education. M.Sc. students use theoretical knowledge in their practical assignments accomplished in industrial companies that result in practically applicable sustainability performance improvement projects.

Development, financing and implementation of preventive innovations in Lithuania

The Policy Statement on Environmental Management in Enterprises in Central and Eastern Europe indicates that "success in financing mechanisms provides a powerful impetus for strengthening environmental management in enterprises and the promotion of environmentally sound economic development" (OECD and EAP Task Force 1998a). To promote CP and facilitate implementation of CP options that require investments, a special revolving facility to finance CP investments in Lithuania, Latvia, Estonia and Russian Federation was established by Nordic Environment Finance Corporation (NEFCO) in 1998.

The main objective of the revolving facility is to provide soft loans for the implementation of high-priority CP investments with rapid payback that yield environmental and economical benefits ("win–win projects"). The facility provides financing directly for a project and the loan is repaid by the company in accordance to the payback period (NEFCO 1997).

To date the revolving facility has most successfully operated in Lithuania. The key partner of NEFCO in Lithuania is the Institute of Environmental Engineering (APINI), which plays a crucial role in CP projects identification, evaluation, implementation and reporting. Since 1998, NEFCO approved the loans for more than 140 projects in more than 60 Lithuanian companies. The success of the NEFCO initiative in Lithuania is to a considerable degree the result of local capacity in cleaner production and availability of a local institution that can support the identification of CP opportunities and the elaboration of loan applications. Another success factor is that the process of innovation generation and development is carried out jointly by researchers and industry from the very beginning. Experience of the APINI in pollution prevention investment financing has been extensively used in international projects aimed at facilitation of financing CP investments in several developing countries.

Over the past years, along with the change in economic situation in the country, industrial enterprises increasingly use their own resources for investments in the innovations aimed at improvement of resource efficiency, energy efficiency, pollution and waste prevention and overall reduction of environmental impact using economically viable technical and managerial options. This shift is in line with the conceptual changes in the CP approach that can be observed globally. For instance, the CP concept has been transformed by UNEP into resource efficient and cleaner production.

Sustainable production through innovation in small and medium-sized enterprises

Small and medium size enterprises (SMEs) play a major role in economic growth and provide most new jobs. In Lithuania, SMEs represent 99 % of the total number of enterprises and account for 74 % of employment. In the past decade, the number of SMEs in Lithuania was rapidly growing. Contribution of SMEs to the Lithuanian economy is determined by a high share of these companies in the overall number of enterprises. At the same time, SMEs pose serious environmental problems due to their high numbers and their cumulative effect. For example, a report on SMEs and the environment produced for the European Commission by ECOTEC Research and Consulting mentions that SMEs are estimated to generate as much as 60 % of commercial waste and 80 % of pollution incidents (Commission of the European Communities, Directorate General Enterprises and Industry 2006). A study conducted by the Institute of Environmental Engineering, Kaunas University of Technology for the Ministry of Economy in 2007 revealed that the total volume of hazardous waste generated in SMEs amounted to 35,000 t/year and 300 000 tons of non-hazardous waste per year (Staniskis et al. 2008).

One of the main features of SMEs sector is continuous change. To survive in the rapidly changing business environment, SMEs have to be flexible, dynamic and open. In this context, innovations have a particularly important role.

To ensure an increase in exploitation of the innovation potential from SMEs throughout the Baltic Sea region (BSR) to enhance sustainable production processes in SMEs leading to the creation of public benefits and private profits whilst reducing economic and environmental costs, the international project Sustainable Production through Innovation in SMEs (SPIN) has been developed and is under implementation with financial support from the EU INTERREG Programme. SPIN is a Baltic 21 lighthouse project, which implies that it has already applied an integrated territorial approach to the BSR. Disparities in the territorial distribution of the technological and managerial innovation performance prevail in the BSR predominately among urban and rural areas. SPIN is addressing the specific needs of SMEs in BSR in two ways: It supports SMEs to diffuse their innovations and it supports SMEs that struggle to respond to legal requirements set to secure responsible use of natural resources in the EU.

Company performance—be it in the production or service sector—can substantially be turned more sustainable in terms of environmental, economical and social performance through technical and organizational innovations. Within this context SPIN aims more specifically at

- Identifying eco-innovation highlights developed throughout the BSR and supporting their dissemination and deployment;
- Addressing the needs of SMEs by matching supply and demand for technical and organizational solutions;
- Development and testing of tools/instruments/schemes facilitating the application of eco-innovations in SMEs;
- Identifying and testing of appropriate incentives for SMEs to apply eco-innovations;
- Creating a consistent transnational framework.

In order to achieve its objectives SPIN is connecting the potential from the involved 8 partner countries (Germany, Denmark, Estonia, Finland, Lithuania, Poland and Sweden) via a strong transnational network to maximise the resources available and the outreach possible. By doing so, it increases the competitiveness of SMEs in the BSR that supply technological and managerial eco-innovations by increasing their market.

SPIN is identifying existing/evolving eco-innovation clusters in the BSR (also across the borders) and analyses successful patterns for their build-up. In an extension phase, the whole BSR shall be promoted as one of the leading eco-innovation clusters of the world. SPIN has a direct positive impact on the environment and contributes to the achievement of the Gothenburg goals that are referring to the environmentally friendly use of natural resources.

SPIN is supporting sustainable production and consumption. In contrary to expensive end-of-pipe solutions, SPIN helps to improve the resource productivity by getting more output from each unit of energy/material used, and reducing the environmental damage caused by each unit and avoiding overexploitation of renewable natural resources. By pushing eco-innovations that help to enforce critical EC environmental directives, SPIN contributes significantly to the reduction of risks and impacts of man-made hazards.

In the framework of the project, several experience exchange conferences and seminars have been organised and a training programme on practical development of sustainable innovations has been implemented for Lithuanian SMEs. Moreover, a study to identify barriers and incentives for development and implementation of sustainable innovations in SMEs has been conducted and policy recommendations for improvement of framework conditions have been developed based on the results of this study.

Role of environmental management systems in promoting sustainable production

While the number of enterprises implementing environmental management systems (EMS) in enterprises is constantly increasing, SMEs pose still a problematic issue due to the limited resources available and the fact that the international standard ISO 14001 and the EU EMAS are not sufficiently tailored to the needs of SMEs.

The application of a new innovative methodology to EMS implementation developed in co-operation of the International Network of Environmental Management (INEM) and implemented in co-operation with the local partners from Estonia, Latvia, Lithuania, Hungary and Poland enables reduction of EMS documentation in companies and makes EMS more attractive and more applicable for SMEs. “EMAS easy” is an environmental management system which is proportional to the size, financial capacity and organisational culture of small business. It assists with a number of new features to be in compliance with ISO 14001 and EMAS but still focusing on what matters i.e. environmental protection on the shop floor. The shared documentation and procedures allow cluster approaches in a very cost effective way. The environmental declaration is compact and delivers the basic and really needed information. The work process from start to end takes 30 straightforward steps using standard forms, designed to meet the needs of SMEs and to minimise the volume of documentation. (INEM 2007).

In the process of EMS implementation, SMEs participating in the initiative have identified and implemented a number of cost saving measures. Most of these measures fall in the following categories: (i) simple good housekeeping measures for energy/water/other resource saving; and (ii) equipment modification/replacement. This methodology for simplified implementation of EMS in SMEs has been evaluated by the European Commission as a best practise for compliance promotion in SMEs (Commission of the European Communities, Directorate General Enterprises and Industry 2006).

To date Lithuanian companies have been actively implementing EMS in accordance with ISO 14001, and only recently the first companies have been registered in accordance to EMAS. Unfortunately, contribution of environmental management systems in enterprises towards more sustainable production has not been thoroughly evaluated. Considering that "certificate driven" approach prevails in many companies, it could be assumed that potential of EMS in improving sustainability performance in enterprises has not been utilised. Regional projects focused on selection of performance indicators and development of environmental/sustainability reports have been implemented in Lithuania. One of the key projects related to sustainability reporting was international Norwegian—Lithuanian project "Environmental Management and Reporting in Lithuania". The project was financed by the Norwegian Ministry of Foreign Affairs and implemented by Norwegian Institute of Technology, Norwegian company Global & Local and the Institute of Environmental Engineering, Kaunas University of Technology. Taking into account that this project was a first step in promoting and implementing sustainability reporting in the country, for practical reasons, the main focus was on environmental aspects with intention to extend the reporting framework by incorporating social and economic indicators at a later stage. In the development of the regional reporting framework, 10 selected companies and Klaipeda municipality have been involved (Magerholm et al. 2009).

Life cycle assessment

Over the past years, a number of companies in Lithuania have become aware of the fact that proactive policies and preventive measures are far more attractive both economically and environmentally than the end-of-pipe technologies as they encourage greater efficiency, reduction in material use and reduction or elimination of toxic substances (Staniskis et al. 2005).

The research into the area of cleaner product development based on a life cycle approach in Lithuanian industry has been initiated by APINI in the framework of the project "Implementation of Green Product Development in the Baltic Sea Region and Establishment of Green Company Clusters in Latvia, Lithuania and Russia with Strong Links to Sweden". The pilot LCA was carried out for five selected products: a firewood stove made by JSC "Vienybė", a solar sensor SMD for passenger cars (used to control the interior climate in medium size passenger cars) and a buckle switch for passenger cars (both made in "ACCELL Elektronika"), a domestic refrigerator made by the company "Snaigė" and a corner sofa by "Kauno Baldai". The goals of this study have been to assess the environmental impact of the selected products and to promote the life cycle thinking as a viable tool that decision makers could use when handling all environmental issues. The objectives have been to find the most significant environmental aspects in product life cycle and to acquire a basic knowledge for cleaner product development (Staniskis and Varzinskas 2005).

The first pilot LCA research has given a clear view how the introduction of an LCA tool in business modifies the classical product development process by introducing new concepts and measures (product requirements readjustment, environmental product evaluation and Eco-design application). It should be kept in mind that introduction of environmental quality into product development processes is highly influenced by a company's environmental attitude, strategy or policy, in other words, the mixture of what a company can, wants and must do in the environmental area. This process is influenced by environmental, competitive, financial and social considerations. After completing LCA in selected companies, the process of an environmentally improved product development started. In the case of corner sofa, buckle switch, solar sensor and firewood stove "hot-spot" identification in the product system was done and eco-design tools were applied. In the case of refrigerator, the Environmental Performance Declaration was developed, and LCA results were used for strategic business development, policy development and also for education of employees (Staniskis and Varzinskas 2010).

Research into the area of packaging was carried out in 2007–2008 in the framework of a joint Lithuanian- Ukrainian research and experimental development project "Study of special printing and packaging production technologies, considering their ecological and operational qualities".One of the basic requirements is to produce packaging in such a way that its volume and weight are restricted to the minimum dimensions needed to meet the safety, hygiene and packaging demands acceptable for the consumer. Quantitative analysis method "Eco-indicator'99" based on the product life cycle was applied to both evaluating the package impact on the environment and determining priorities (Varžinskas et al. 2009a).

It may be stated that the ecological issues in designing and producing packaging products, and not only them, can

be most efficiently solved by applying joint comprehensive means, embracing assessment of CP benefits, quality and environmental management systems, life cycle and costs, ecological design principles and measures. Since packaging production is extremely varied, the variety of concrete solutions in terms of technological processes and equipment is also great (Varžinskas et al. 2009b).

Eco-design

Products and materials should, if economically feasible, be used as long as possible before their material content is reused and reprocessed any further. Eco-design refers to a systematic incorporation of environmental aspects into product design and development aiming at minimisation of environmental impacts along the entire life cycle of a product. A survey in Lithuania revealed that the main drivers for eco-design practices are market demands (33 % of all responses), cost reduction (29 %) and legal requirements (26 %). Other drivers mentioned in the survey were the interest of owners and/or top management (12 %) and company's environmental policy (Gurauskiene and Varzinskas 2010). The results of surveys imply that legislation is not the main driver for eco-design presently; however, the role of legislation as a driving force is often hidden under "market demands".

The investigation of applying eco-design in Lithuanian industry has been carried out by APINI in the framework of the project "Transfer of Knowledge in the Field of Eco-design". The main objectives of the study were to make analysis of eco-design situation in Lithuania and to create dynamic model for systematic use of different tools for the environmental product development and to apply this model to the process of creation of new products in industry (Staniskis et al. 2008). Developed eco-design methodology was implemented in the product development processes by a number of Lithuanian companies (Varzinskas et al. 2007; Gurauskiene and Varzinskas 2006).

Environmental considerations in production and product development are becoming increasingly important in the consumer electronics industry due to legislative pressure, cost savings and emerging green markets. One of the key areas of research was electronic and electrical equipment (EEE) that encompasses a vast range of goods, from computers to refrigerators. As a rule, the most significant environmental impact of these products from a lifecycle perspective is energy consumption during their use. Other environmental issues for EEE include the impact of materials used in manufacturing and product waste at the end of the item's useful life. Manufacturers of EEE are also under increasing pressure from regulatory bodies through the world to take responsibility for these products when they become waste. Strategies to reduce waste include increasing the product's durability and designing for disassembly and recycling (Varzinskas et al. 2007). In July 2005, the EuP Directive or Ecodesign Directive was adopted. A major goal of the Directive is to improve energy efficiency of energy using products (EuPs) and thereby contribute to the efforts to reach the European targets for climate protection. Taking into consideration that the design of a product has a fundamental impact on the environmental performance of a complex product, the requirements established under the EuP Directive are based upon an analysis of the environmental impact along the entire life cycle of the product.

To analyse the preparedness of Lithuanian industry for the new EuP requirements, research in Lithuanian enterprises producing EuPs (tertiary sector lighting products, personal computers, TV sets, boilers, standby-mode products, simple set-top boxes, external power supplies) was carried out. The basic goal of the research was to evaluate the potential and experience of product development, innovation implementation and eco-design application. The main research field was environmental performance data and general market information; level of companies innovativeness, product development experience, current fulfilling of the Directive 2005/32/EC legal requirements (for a particular product group). Qualitative and quantitative research methods were applied in the study. To identify the product development, innovativeness and application of an eco-design potential of defined sectors, a standardised type of the anonymous questionnaire survey method was applied. Questionnaires were distributed among managers and constructors of EuPs. In the analysis process of quantitative data, descriptive statistics was used (Fig. 1) (Gurauskiene and Varzinskas 2010).

Evaluation of the obtained data gives a possibility to summarise that the majority of Lithuanian EuP producers have a direct impact on the product development process. The primary aspect in product development is customer requirements. Slightly more than a half of respondents (52 %) have stated that their products need

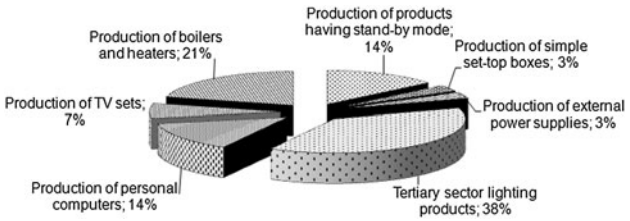

Fig. 1 Amount of manufactured or imported EuP in Lithuanian industry

some modification to increase product environmental performance, but 45 % of Lithuanian EuP producers do not see any need in making changes in product development. The majority (62 %) of respondents have stated that customers are slightly interested in environmental performance of products. As to the plans to implement eco-design in company product development processes in the future, 59 % of respondents have given negative answer, but it has been mentioned that legal requirements (such as Directive 2005/32/EC) will drive companies to search for proper tools for environmental product development. Innovative companies are supposed to have fewer problems with compliance and have the possibility to gain some benefit in the competition among rivals. SMEs have also all the opportunities to reach the sufficient level of competitiveness, if the action plan for implementation of eco-design tools is chosen properly (Gurauskiene and Varzinskas 2010).

Discussion

Since 1993, significant progress has been made towards more sustainable consumption and production practices, particularly in terms of increased production process efficiency, reduction in resource consumption and waste/pollution generation (Tables 1, 2). However, cleaner production and product oriented tools such as eco-design are (in general) diffusing comparatively slowly despite good results achieved, and it is argued that management systems are needed to make application of these tools continuous and systematic (Bonilla et al. 2010). On the other hand, management systems are often implemented with a "certificate-oriented" approach effectiveness of which in terms of sustainability performance improvement is low (Iraldo et al. 2009). Even if management systems are implemented with a "performance-oriented" approach, enterprises might not be able to realise their full potential for performance

Table 1 Economic benefits of sustainable production innovations implemented in Lithuania

No.	Sector	Number of companies	Number of implemented cleaner production innovations	Investments, thousands LTL	Economic benefits, thousands LTL/year
1	Production of textile products	15	41	10,640	8,927
2	Production of food and beverages	14	28	9,772	6,535
3	Supply of electricity and heat energy	8	19	18,958	8,699
4	Production of chemicals	6	13	1,500	1,700
5	Production of machinery and equipment	6	6	3,980	1,842
6	Furniture production	6	11	4,914	1,796
7	Production of other non-metal and mineral products	4	7	2,563	1,489
8	Production of wood products	4	7	5,415	4,075
9	Transport and communication	4	7	1,073	944
10	Production of metal products, except of machinery and equipment	3	9	1,422	1,251
11	Oil product terminal	3	3	1,771	585
12	Production of leather and leather products	2	3	629	779
13	Production of radio, television and communication equipment	2	6	5,264	2,115
14	Production of medical, precise and optical equipment	2	6	1,246	525
15	Production of refined oil products	1	3	4,484	1,331
16	Production of glass and glass products	1	1	742	345
17	Agriculture and forestry	1	1	2,295	707
18	Communal services	1	4	416	171
19	Supply of gas and water	1	1	395	160
20	Washing of textile and fur products and dry cleaning	1	1	1,415	377
	Total	85	177	78,895	44,354

Table 2 Environmental benefits of sustainable production innovations implemented in Lithuania

Environmental areas	Environmental benefits	Units/year
Reduction of resource consumption/losses		
Electricity	29,940	MWh
Heat energy	237,205	MWh
Chemicals and additives	2,289	t
Water	811	thousands m^3
Oil	90	t
Fuel	448	t
Fuel consumption, etc. from heat energy saving or from reduction of heat energy losses in production and supply	22,071	tne
Reduced impact to the environment		
Emissions to the atmosphere from stationary pollution sources	3,094	t
Emissions of greenhouse gasses (CO_2)	79,759	t
Emissions to the atmosphere from mobile pollution sources	184	t
Wastewater volume	774	thousands m^3
Wastewater pollution	521	t
Hazardous waste	621	t

improvement. One of the reasons is lack of motivation to maintain the system after certification. Our experience says that one of the ways to increase motivation of maintaining management system and ensuring its effectiveness is systematic use not only of CP but also the use of all other sustainable industrial development tools.

Integration of sustainability performance management into the overall business planning is another important aspect to be tackled because ineffectiveness of management systems may be due to the lack of links between the integrated management systems and strategic/financial decision making. Therefore, the process of sustainability performance management should be adequately controlled. Enterprises often lack explicit information about their activities, particularly quantitative information on technological processes and various sustainability aspects. Moreover, the existing data information is seldom systemized and made available to decision makers in a form suitable for effective decision making. Sustainability performance evaluation based on performance indicators is more likely to be the most appropriate tool to solve this problem.

Experience from implemented projects in Lithuania and abroad that focused on practical application of cleaner production, eco-design, sustainability management and

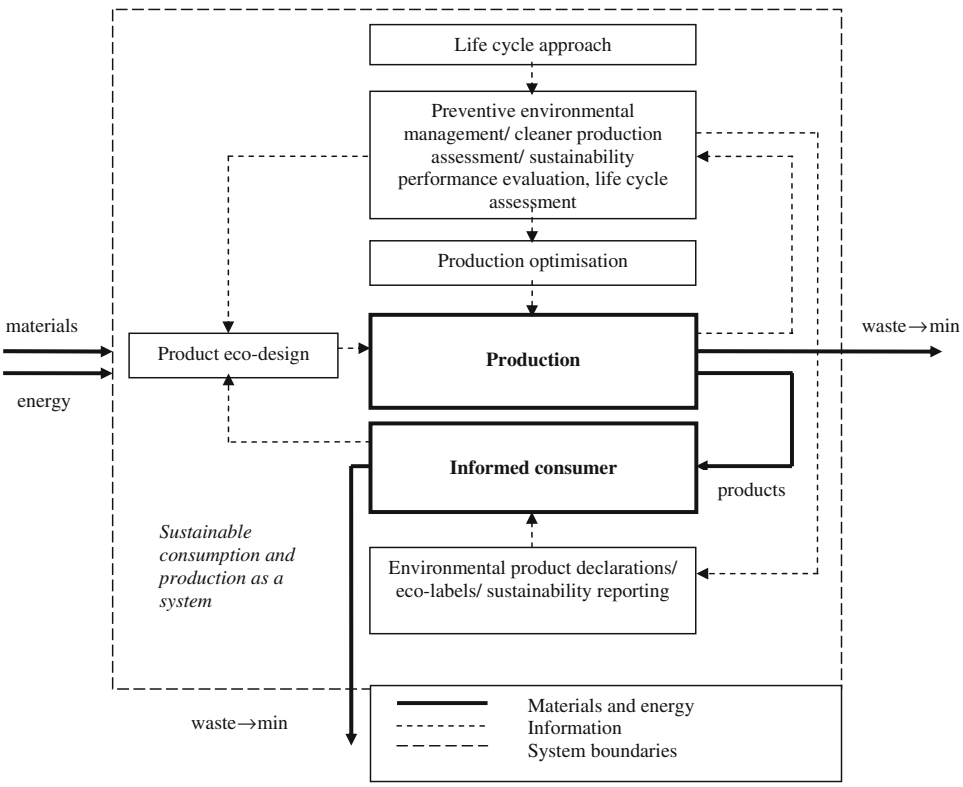

Fig. 2 Sustainable consumption and production as a system

reporting, sustainable innovations clearly demonstrated that improvement of production efficiency and products is accompanied by "rebound" effect, when increased production efficiency and reduced product prices lead to increased consumption and no total gains in terms of reduced impact to the environment are achieved. Companies will strive to increase production level as long as there is a market for their products. This leads to conclusion that sustainable industrial development without incorporation of consumption aspects (consumers and consumption habits) is not possible. Consumers will not change their consumption habits as long as sustainability awareness is low, and there is no sufficient information concerning production and product environmental performance. Awareness and capacity building activities (information campaigns and training programmes) are needed for both producers and consumers.

To overcome barriers and to ensure progress in the area of sustainable consumption and production, a model of a system of sustainable consumption and production has been developed (Fig. 2). The model corresponds to the type II model in accordance with industrial ecology concept (minimal material exchange between human activities and environment). The objective of the sustainable consumption and production system model is to minimise energy and material use as well as waste output, and to eliminate the "rebound" effect.

The model presents the key elements of the system. If any of these elements or the flows of the system fail, sustainable consumption and production will not be possible. The Interface between consumer and producer as well as a change of consumption habits are critical in the system. The system is governed by life cycle approach, and its functionality is ensured by application of practically tested preventive tools that enable sustainability performance improvement of production processes, products and sufficient information flow to consumers. Sustainable consumption is only possible when consumers are provided with sufficient information about sustainability performance of production and products. For this purpose, sustainability reporting, environmental product declarations and eco-labels could be used. This would ensure continuous reduction of the impact on the environment in the entire product life cycle.

To ensure efficient sustainability performance management, performance should be measured using sustainability performance indicators. Indicators may be quantifiable (quantitative) and non-quantifiable (qualitative). The best approach is the combination of both methods (Diakaki et al. 2006). Performance indicators have to address the sustainability aspects related to production processes, management practices, products and communication with stakeholders.

To ensure efficient communication between consumers and producers and to create incentives for application of the key sustainable industrial development tools, intervention of governmental institutions is needed in establishing policy framework conditions that promote sustainable consumption and production. Different policy instruments could be used for this purpose including command and control, economic and information-based instruments.

Conclusions

Analysis of experience in applying different sustainable consumption and production tools suggests that:

1. Despite positive results, cleaner production, eco-design and other preventive practices are still not considered by industry and other stakeholders as a primary option. End-of-pipe solutions are commonly applied without prior analysis of possible preventive alternatives.
2. It has been practically proved that investments in preventive innovations increase profitability for industry by increasing efficiency, productivity and product quality, cutting the costs for resources, reducing the need for large investments in pollution abatement equipment. Nevertheless, this area still lacks sufficient attention from industry, financial sector and governmental institutions.
3. While implementation of environmental management systems has rapidly increased during the last years, this tool is often applied just for the sake of market needs. Use of preventive practices in the EMS work is generally not sufficient. With increasingly stringent environmental protection policies, the costs to enterprises of waste and environmental damage are increasing steadily, but conventional managerial accounting systems used by majority of enterprises do not adequately identify these costs. In general, benefits provided by environmental performance evaluation, use of sustainability indicators, proper environmental cost accounting and environmental/sustainability reporting are generally not utilised by Lithuanian enterprises.
4. In terms of product oriented approaches, situation varies. Situation with public procurement is optimistic as all legal preconditions are in place. There is a basic need to introduce eco-design in industry gradually. The introduction of eco-design should generate possibilities to participate in pilot projects, experience exchange with similar companies. The document from the European Council "Sustainable Consumption and Production and Sustainable Industry Policy Action Plan" is particularly important in this regard as it is

based on eco-design concept and this way ensures more efficient use of resources and reduced impact on the environment.

5. Proposed model of sustainable production and development as a system incorporates production and consumption stages and demonstrates critical material and information flows that could ensure minimal material exchange between human activities and the environment that would lead to the ultimate reduction of an impact on the environment from both production and consumption and elimination of the "rebound" effect.
6. Sustainable industrial development without incorporation of consumption aspects, particularly, change in consumption habits is not possible. Awareness and capacity building activities (information campaigns and training programmes) are needed for both producers and consumers. In addition, intervention of governmental institutions is needed in establishing policy framework conditions that promote sustainable consumption and production. Different policy instruments could be used for this purpose including command and control, economic and information-based instruments.

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