Aplinkos tyrimai, inžinerija ir vadyba, 2009. Nr. 2(48), P. 51-62 *ISSN 1392-1649*
Environmental Research, Engineering and Management, 2009. No. 2(48), P. 51-62

Sustainability Assessment Methods and Their Application to Harmonization of Policies and Sustainability Monitoring

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(received in January, 2009; accepted in June, 2009)

Sustainability assessment methods and techniques are analyzed in this paper. Criteria for sustainability assessment of state policies are defined as based on priorities of the National Sustainable Development Strategy. Technique for sustainability assessment of state policies is developed. An integrated indicators approach is constructed for monitoring implementation of a sustainable development strategy in Lithuania.

This work aims at developing the technique for sustainability assessment of state policies and measures based on various sustainability assessment tools, methods and techniques developed by other scientists.

The most important methods and techniques for sustainability assessment are analyzed and systematized. Based on the analysis of priorities of Lithuanian government policies the principal economic, environmental and social criteria for sustainability assessment of policies and measures are established for Lithuania. The proposed multi-criteria decision analysis technique is based on the integrated sustainability indices developed for the state, region, enterprise level and it includes a set of social, economic and environmental indicators of different levels. Monitoring technique for the progress achieved towards sustainability is applied to monitoring implementation of the Lithuanian sustainable development strategy.

Key words: *Sustainability assessment, sustainability monitoring.*

Reference to this paper should be made as follows: Štreimikienė, D., Girdzijauskas, S. and Stoškus, L. Sustainability Assessment Methods and Their Application to Harmonization of Policies and Sustainability Monitoring. Environmental Research, Engineering and Management = Aplinkos tyrimai, inžinerija ir vadyba. 2009. Vol. 48, No. 2. pp. 51-62. Kaunas, Technologija. ISSN 1392-1679.

1. Introduction

Policies and measures targeting specific aims frequently contradict each other and have negative impacts on the other strategic priorities of the country. Nevertheless, harmonization of state policies according sustainable development targets can help increase efficiency of the state governance which is quite problematic in Lithuania and requires huge resources. Therefore, a very important issue is to assess the state policy impact on sustainable development or to carry out sustainability assessment of state policies. This sustainability assessment allows to compare and to rank policies and measures according their social, economic and environmental impact. Sustainability assessment can be performed by applying different approaches and tools ranging from indicators to sophisticated economic models. A significant issue in this context is multi criteria decision analysis which allows to trade-off between various criteria and to rank policies in sustainability assessment. Sustainability assessment can be performed for policies, technologies, projects, products, etc. covering different levels. There is the other possible application of sustainability assessment – monitoring towards the progress of sustainable development. For this type of sustainability assessment the same tools can be applied, however, the approach which should be followed is slightly different. For example, development of integrated sustainability indicators can allow monitoring progress towards implementation of the sustainable development strategy encompassing various social, economic and environmental goals expressed by specific targeting indicators. Multi-criteria decision aiding tools such as DAM, Multi Cases tool can be also used to assess the progress achieved towards implementing a set of targets. Therefore, sustainability assessment is currently gaining more and more attention in scientific research and in practical application to policy making.

The aim of the paper is to analyze various sustainability assessment approaches and tools and to develop sustainability assessment technique for both sustainability assessment of policies and measures and monitoring the progress towards sustainability.

Specific objectives of the paper seeking to attain its aim are the following:

– To analyze and systematize sustainability assessment approaches and tools based on the scientific literature review;
– To set criteria and indicators for sustainability assessment of policies and measures;
– To develop sustainability assessment technique for ranking and harmonizing the policies based on an integrated indicators approach covering different levels ranging from the country to enterprise levels;
– -To develop sustainability monitoring technique for assessment of the progress towards sustainable development targets based on an integrated indicators approach;
– To present an example of application of sustainability monitoring technique to monitoring the implementation of the National Sustainable Development strategy.

Further analysis of sustainability assessment techniques is based on the works of several foreign scientists (P. Francis, J. Rotmans, J. Rorarius, B. Ness, E. Urbel-Piirsalu, J. Pope et al.) and various studies.

2. Sustainability assessment tools

Sustainability assessment tools can be divided into three categories (see Table 1): **product-related assessment, project-related assessment** and **sector and country-related assessment.** Additionally, **indicators/indices** are classified. The purpose of such categorizing is to define which of the three aspects of SD (economic, environment and social) are fulfilled by different assessment tools, and –at which level sustainability assessment practices are to be implemented. (RORARIUS, J. Existing assessment tools and indicators: building up sustainability assessment. Some perspectives and future applications for Finland. Finland's Ministry of Environment, Report, 2007.).

2.1. Indicators

The first umbrella of sustainability assessment tools consists of indicators and indices. Indicators are simple measures, most often quantitative, representing a state of economic, social and/or environmental development in a defined region—often at the national level. When indicators are aggregated, the resulting measure is an index. HARGER, J. R. E., MEYER, F. M. Definition of indicators for environmentally sustainable development. Chemosphere 33, 1996, p.p. 1749-1775.) suggest that indicators should contain the following characteristics: simplicity, (a wide) scope, are quantifiable, allow trends to be determined, tools that are sensitive to change, and allow timely identification of trends. Indicators and indices, which are continuously measured and calculated, allow for the tracking of longer-term sustainability trends from a retrospective point of view. Realization of these trends allows making short-term projections and relevant decisions for the future. The tools in the category of indicators and indices are either *non-integrated*, meaning they do not integrate nature–society parameters, or *integrated*, meaning the tools aggregate different dimensions. There is also a subcategory of non-integrated tools that focuses specifically on regional flow indicators (HUETING, R., BOSCH, P., de BOER, B. Methodology for the calculation of sustainable national income. Environmental accounting. A review of the current debate. A. Markandya and R. Costanza, United Nations Environment Programme, 1993., HAMILTON, K., ATKINSON, G., PEARCE, D. Genuine Savings as an Indicator of Sustainability. GSERGE Working paper GEC, 1997, p. 97-103.).

An example of non-integrated indicators is the Environmental Pressure Indicators (EPIs) developed by the Statistical Office of the European Communities (Eurostat). The EPI set consists of 60 indicators, six in each of the ten policy fields under the Fifth Environmental Action Programme. It is also possible to aggregate the six indicators in each policy field into an index, which in total makes up ten environmental pressure indices. These indicators, which consist of, for example, forest damage, fishing pressure, tourism intensity, waste landfilled are intended to provide a common and comprehensive set of indicators for the EU member states to evaluate and measure environmental sustainability. These indicators permit a comparison of the environmental situation in different EU member countries, and an evaluation of the trends in the member states and in the EU as a whole.

Even though the EPI is striving to solve the problem of the data by cooperating closely with the statistical offices in the member and accession countries, it has three main weak points. First, it includes only environmental pressure indices, but sustainability goal includes also social and economic aspects. Second, it is very EU centred and even though the EPI group suggests that a similar index should be worked out for the rest of the world with the same goal to overcome the problem with insufficient data, it remains a problem until the results of such a work are visible. Third, it considers only the current state in the countries without a long-term perspective.

Another example is a set of 58 national indicators used by the United Nations Commission on Sustainable Development (UNCSD). The UNCSD was created to carry out the priorities of the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil in 1992. In order to arrive at "a broader, more complete picture of societal development" these indicators extend further than just the common economic indicators, to include social, environmental and institutional monitoring mechanisms. The indicators are not integrated or aggregated. Examples of the UNCSD indicators include water quality levels for an environmental category, national education levels, and population growth rates as social determinants, GNP per capita for the economic sphere, and the number of ratified global agreements in the category of institutional sustainability (NESS, B., URBEL-PIIRSALU, E., ANDERBERG, S., OLSSON, L. Categorising tools for sustainability assessment. Ecological Economics. Issue 3, 2007, p.p. 498-508.).

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Table 1. Sustainability assessment tools

	Indicators/ Indices	***Product-Related Assessment***	***Project-Related Assessment***	***Sector and Country-Related Assessment***
Environmental	- Environmental Pressure Indicators (EPIs) - Ecological Footprint (EF)	- Life Cycle Assessment (LCA) - Material Input per Service (MIPS) Unit - Substance Flow Analysis (SFA) - Processes energy analysis - Exergy analysis - Emergy analysis	- Environmental impact assessment (EIA) - Environmental Risk Analysis (ERA)	- Environmental Extended Input-Output (EEIO) Analysis - Input-Output Energy Analysis - Strategic Environmental Assessment (SEA) - Regional emergy analysis - Regional exergy analysis
Economic	- Gross National Production (GNP)	- Life Cycle Costing (LCC)	- Full Life Cycle Cost Accounting (FCA)	- Economy-Wide Material Flow Analysis (EW-MFA) - Economy wide substance flow analysis - Economic Input-Output (EIO) analysis
Social	- Social Indicators		- Social Impact Assessment (sIA)	- Social Input-Output (SIO) analysis
Integrated	- Human Development Index (HDI) - Environmental Sustainability Index (ESI) - Wellbeing Index (WI) - Sustainable National Income (SNI) - Genuine progress indicator (GPI), ISEW, Genuine Savings		- Cost-Benefit Analysis (CBA) - Risk Analysis (RA)	- Multi-Criteria Analysis (MCA) - Uncertainty analysis - Vulnerability analysis
ustainable Development	- Sustainable Development Indicators (SDI) - Sustainable energy development indicators (SEDI)			- Conceptual modelling - System dynamics - Sustainability Impact Assessment (SIA) - Integrated Sustainability

Analysis of material and energy flows allows an overview of the structure of resource flows and identification of inefficiencies within a system. Such studies may be used both for reconstructing historical flows and emissions and for forecasting and decision support. The Material Flow Analysis (MFA) analyzes the physical metabolism of society in order to support dematerialisation and reduction in losses to the environment connected to the extensive societal resources (FISCHER-KOWALSKI, M., HUTTLER,

W. Society metabolism. The intellectual history of material flow analysis, part II, 1970-1988. Journal of Industrial Ecology. Vol. 2, 1998, issue 4, p.p. 107-136.)

MFA studies have been performed in many countries and the numbers of regional MFA studies have increased during the last decades. Regional flow indicators are also non-integrated as they focus only on physical flows, thus on environmental aspects. Economy-wide MFA developed by Eurostat is a most standardized tool for MFA for regions. It is mainly used at the national level with the possibility of being applied to the other spatial levels (NESS, B., URBEL-PIIRSALU, E., ANDERBERG, S., OLSSON, L. Categorising tools for sustainability assessment. Ecological Economics. Issue 3, 2007, p.p. 498-508.).

2.2. Product-related assessment

The second umbrella consists of product-related tools focusing on the flows in connection with production and consumption of goods and services. Built on a similar flow perspective, they are closely related to the regional flow indicators of the previous category. But the tools in this category focus on evaluating different flows in relation to various products or services instead of regions. They evaluate resource use and environmental impacts along the production chain or through the life cycle of a product (from cradle to grave). The aims of identifying particular risks and inefficiencies to support decision-making are similar to the regional flow indicators, but in this case in connection with design of products and production systems. These tools do not integrate nature–society systems as they are mainly focusing on environmental aspects. However, life cycle costing tools may integrate environmental and economic dimensions. Product-related tools allow both retrospective and prospective assessments that support decision-making.

The most established and well-developed tool in this category is the Life Cycle Assessment (LCA). LCA has been used in varying forms over the past 35 years to evaluate the environmental impacts of a product or a service throughout its life cycle. It is an approach that analyzes real and potential pressure that a product has on the environment during raw material acquisition, production process, use and disposal of the product. LCA results provide information for decisions regarding product development and eco design, production system improvements, and product choice at the consumer level (EKWALL, T. Key methodological issues for life cycle inventory analysis of paper recycling. International Journal of Cleaner Production 7, 1999, p.p. 281-294.), the waste and energy field, as well as a multitude of other product and service areas.

Life cycle costing (LCC) is an economic approach that sums up “total costs of a product, process or activity discounted over its lifetime” (GLUCH, P, BAUMANN, H. The life cycle costing approach: a conceptual discussion of uefulness for environmental decision-making. Building and Environment 39, 2004, p.p.571-580.). In principle, LCC is not associated with environmental costs, but costs in general. A traditional LCC is an investment calculation that is used to rank different investment alternatives to help decide on the best alternative. There are many different tools for life cycle costing analysis, but only two of them include environmental costs — Life Cycle Cost Assessment and Full Cost Environmental Accounting.

Monetary valuation is also often referred to as shadow pricing or non-market valuation. This group consists of tools that are not sustainability assessment techniques themselves, but rather an important set of tools that can be used to assist other tools when monetary values are needed for goods and services not found in the marketplace. The tools, for example, Cost–Benefit Analysis, Genuine Savings, and Life Cycle Cost Assessment require such values to be used. With monetary valuation there are different ways to assign values. There is, for example, the Contingent Valuation method (previously called the Survey Method), which uses surveys to estimate people's willingness-to-pay for certain nature's goods and services. The Travel Cost method uses the price paid for travelling as a basis of its monetary value (JOHANSSON P. O. Cost-benefit analysis of environmental change. Cambridge: Cambridge University Press, 1996.), and the Hedonic Pricing method that focuses mainly on property markets through analysing prices influenced by its surrounding, which can be either positive (near beach or park) or negative (close to highway, airport or industrial area). There are also additional techniques for monetary valuation including Factor Income, Avoided Cost and Replacement Cost that can be used.

Analysis of material and substance flows is also used for product systems. The Wuppertal Institute for Climate, Environment and Energy has developed the Product Material Intensity Analysis based on the Material Input per Unit of Service (MIPS) index (expressed in weight). This analysis considers all the material flows connected to a particular product or a service including the so called *ecological rucksack*. Product energy analysis measures the energy that is required to manufacture a product or a service. It includes both direct and indirect energy flows.

2.3. Assessment at the project and country level

Tools under the third umbrella are integrated assessment tools; they are used for supporting decisions related to a policy or a project in a specific region. Project related tools are used for local scale assessments, whereas the policy related ones focus on local to global scale assessments. In the context of sustainability assessment, integrated assessment tools have an ex-ante focus and often are carried out in the form of scenarios. Many of these integrated assessment tools are based on systems analysis approaches and integrate nature and society aspects. Integrated assessment consists of the wide-array of tools for managing complex issues (FRANCIS, P. Integrated impact assessment for sustainable developmnet: a case study aopproach. World Development. Vol. 29, issue 6, 2001, p.p. 1011-1024.; PETTS, J. Handbook of Environmental impact assessment. Oxford: Blackwell Science, 1999.). There are many examples of integrated assessments of major environmental problems, but also the established tools such as Multi-Criteria Analysis, Risk Analysis, Vulnerability Analysis and Cost Benefit Analysis that do not necessarily pertain directly to only sustainability issues, but can be extended to a variety of other problem areas across disciplinary thresholds (NESS, B., URBEL-PIIRSALU, E., ANDERBERG, S., OLSSON, L. Categorising tools for sustainability assessment. Ecological Economics. Issue 3, 2007, p.p. 498-508.).

Conceptual Modelling analyzes qualitative (causal) relationships and often makes use of stock and flow diagrams, flow charts, or causal loop diagrams. Conceptual Modelling can be used for visualizing and detecting where changes in a given system can be made for increasing sustainability or as the initial conceptualisation mechanism in a larger computer modelling approach. Systems Dynamics refers to "the building of computer models of complex problem situations and then experimenting with and studying the behaviour of these models over time". Examples of models related to sustainability assessment include IIASA's air pollution model (RAINS, MESSAGE), the IMAGE model created to analyze social, biosphere, and climate system dynamics, and the Wonderland model designed to illustrate economic–environmental interactions.

Multi-Criteria Analysis (MCA) is used for assessments in situations when there are competing evaluation criteria. In general, MCA identifies goals or objectives and then seeks to spot the trade-offs between them; the ultimate goal being identification of the optimal policy. This approach has the advantage of incorporating both qualitative and quantitative data into the process. The alternative to MCA is Cost Benefit Analysis (CBA). CBA is an applied welfare economics tool with its roots reaching back to the early 20th century (JOHANSSON P. O. Cost-benefit analysis of environmental change. Cambridge: Cambridge University Press, 1996.). It is used for evaluating public or private investment proposals by weighing the costs of the project against the expected benefits. In the realm of sustainability assessment, CBA can be an effective tool for weighing the social costs and benefits of different alternatives in connection with, for example, energy and transports.

Risk is defined as "the possibility that certain losses or damages occur as the result of a particular event or series of events" (ROTMANS, J. Methods for impact assessment: the challenges and opportunities ahead. Environmental modelling assessment, No 3, 1998, p.p. 155-179.; ROTMANS, J. Tools for Integrated sustainability assessment: a tow track approach. The Integrated Assessment Journal Bridging Sciences & Policy. Vol. 6, 2006, issue 4, p.p. 35-57.). Risk Analysis is the assessment of these potential damages. The process begins with identification of the risk, and moves on to a qualitative and/or quantitative assessment of the risk—leading to certain management decisions regarding the minimization of that risk. The final stage of the Risk Analysis includes communication with stakeholders concerning the assessment and the corresponding decisions involved with minimizing the risk. Since risk is closely related to uncertainty, risk analysis cannot be separated from uncertainty analysis (ROTMANS, J. Methods for impact assessment: the challenges and opportunities ahead. Environmental modelling assessment, No 3, 1998, p.p. 155-179.). There are two types of uncertainties: stochastic uncertainty refers to natural variability of the system, fundamental uncertainty is the inability to predict due to lack of knowledge about the system (POPE, J. Conceptualizing sustainability assessment. Environmental impact assessment. No 24, 2004, p.p. 595-616.). Uncertainty and Risk Analysis involve both types of uncertainty. They estimate the probability of events predicting the events using the knowledge that is available. These aspects of natural variability and lack of knowledge are also the reason why societal and environmental risk analyses are forms of sustainability assessments (NESS, B., URBEL-PIIRSALU, E., ANDERBERG, S., OLSSON, L. Categorising tools for sustainability assessment. Ecological Economics. Issue 3, 2007, p.p. 498-508.).

Some tools may be integrated within their specific assessment dimensions. Efforts have been made through combining two or more different tools to extend the focus of analysis (WALKER J., JOHNSTON J. Guidelines for the assessment of indirect and cumulative impacts as well as interactions. Luxemburg: Office for Official publications of the European Communities, 1999.). Examples of this tendency are the simultaneous analysis of a product or service function using Life Cycle Assessment (environmental impact tool), Life Cycle Costing (economic tool) and/or Social Life Cycle Assessment. A shortcoming of such an approach is that the overall results of the study are not presently integrated.

To perform sustainability assessment of energy technologies the integrated tools need to be applied. The combination of indicators framework, LCA, LCC, MCA and an integrated indicators approach might be useful for sustainability assessment of policies and measures. The recent EU impact assessment procedures (European Comission. Communication from the Commisssion on impact assessment, 2002. Brussels.) are extended to a sustainability assessment approach (WILKINSON, D., FERGUSSON, M., BOWYER, C., BROWN, J., LADEFOGED, A., MAONKHOUSE, C., ZDANOWICZ, A. Sustainable Development in the

European Commission's integrated Impact Assessments for 2003. London: Institute for Environmental Policy, 2004.).

3. Criteria and indicators for sustainability assessment

Sustainable development is development of society providing opportunities to reach the welfare for present and future generations by harmonizing its environmental, economic and social objectives without exceeding allowable limits of an environmental impact. Main provisions of sustainable development were finally agreed upon at the World Summit – the United Nations Conference on Environment and Development in Rio de Janeiro in 1992, where sustainable development as the main long-term civil society's development ideology was legitimated. Lithuanian Sustainable Development Strategy was adopted on 11 September 2003 by the Decision of the Government of the Republic of Lithuania. Based on the National Sustainable Development strategy the following priorities of Lithuanian sustainable development can be selected: (Lietuvos Respublikos aplinkos ministerija. Nacionalinė darnaus vystymosi strategija, Vilnius, 2003.):

1. Moderate and sustainable development of economic branches and regional economies;
2. Decrease in social and economic disparities between regions and inside regions by maintaining their peculiarities;
3. Reduction in environmental impact in branches of economy (transport, industry, energy, agriculture housing sector, tourism);
4. More effective use of natural resources and waste disposal;
5. Reduction in health impacts;
6. Climate change and its impact mitigation;
7. Protection of biodiversity;
8. Protection of landscape;
9. Increase in employment, decrease in poverty and social vulnerability;
10. Increase in the role of science and education;
11. Protection of Lithuanian cultural peculiarity.

Main long-term, mid-term and short-term objectives and tasks were formulated, and the most important implementation measures in various sectors and their branches were envisaged in the Strategy. In addition, the creation of an effective monitoring system of Strategy's implementation, providing an opportunity to regularly assess the achieved progress and to identify obstacles and problems is foreseen. In order to monitor implementation of the Strategy, a list of sustainable development indicators has been defined. These indicators directly link the objectives and tasks outlined in the Strategy. These indicators have been published in the Statistical Yearbook of Lithuania since 2004.

Therefore, prior the choice of a policy measure it is necessary to assess the economic, environmental and social impact of this measure based on strategic priorities of the country or the sustainable development targets described above. The ex-ante evaluation of the policy measure impact on sustainable development targets can be assessed by modelling the impact of policy measures using Global equilibrium or Partial equilibrium models. The ex-post evaluation of the policy measure impact on sustainable development targets can be assessed by evaluating the changes of targeting indicators after implementation of policies.

The evaluation of social, economic and environmental impacts of policies can be performed by applying Multi-criteria analysis which allows assessment of policies based on sometimes contradicting criteria. For example, the most expensive policies placing a heavy burden on economy usually allow the biggest emission reduction. Therefore, seeking to compare policies according the contradicting criteria it is necessary to sum up various impacts and to allocate different weights for specific criteria taking into account the significance of the criteria in decision making. Several multi-criteria decision aiding tools are created which simply allow to conduct multi-criteria analysis and to assess policies based on social, economic and environmental criteria (ŠTREIMIKIENĖ, D., ČIEGIS, R., JANKAUSKAS, V. Darnus energetikos vystymasis. Vilnius: Vilniaus universiteto leidykla, 2007.).

Table 2 presents an example of the sustainable development indicators system for Lithuania based on the National sustainable development targets. These indicators can be applied to monitoring the impact of policy measures on sustainable development targets. As one can see from Table 2 these indicators can be applied at the country, region and enterprise levels.

Main strategic priorities of Lithuania are development of innovations and new technologies, increase in labour productivity and economic growth and competitiveness increase, decrease in regional disparities, increase in employment, reduction in unemployment, poverty and social development, effective use of natural resources and waste disposal. Therefore, it is possible to develop a system of indicators representing these main strategic priorities and to assess all policy measures according their impact on these targets. The application of multi-criteria analysis would allow ranking poly measures targeting the same policy aims according their efficiency of bringing country to the sustainable development path. This allows not just ranking policy measures but provides for harmonization of different policies targeting on different sectors and aims.

Sustainability assessment of policies should be performed at micro and macro levels. The indicators presented in **Table** 2 can be applied to this purpose. Development of integrated indicators constructed from a set of indicators presented in the Table above can be applied to sustainability assessment of policies and to monitoring the progress achieved towards sustainable development. In the following chapters the principles of integrated indicators development will be presented following the example of application of integrated indicators to monitoring the National sustainable development strategy.

Table 2. Examples of sustainable development indicators

	Indicators	Country level	Region level	Enterprise level	Units
Economic indicators					
Competitiveness	Created gross value added (GVA)	GDP	GDP	Value added	Lt
	Labour productivity	Labour productivity	Labour productivity	Labour productivity	Gross value added created per working hour, Lt
	Export expansion	Export	Export	Share of exported production in total production	Mill. Lt
	Investments	Direct foreign investments	Material investments	Return on investments	Mill. Lt
	Development of high technologies and innovations	Share of GVA produced by high and medium-high technology sector in the GVA of the manufacturing	Share of GVA produced by high and medium-high technology sector in the GVA of the manufacturing	Share of investments into new technologies in total investments	%
	Development of informatics society	Share of enterprises and households having internet access and using computers	Share of enterprises and households having internet access and using computers	Share of workers using computers	%
	Real wages	Average real wage	Average real wage	Average real wage	Lt/capita
Environmental indicators					
Environmental impact	Atmospheric pollution	Emissions of GHG and other classical pollutants	Emissions of GHG and other classical pollutants	Emissions of GHG and other classical pollutants	Thou t
Efficient use of natural resources	Recycling of industry waste	Recycling of industry waste	Recycling of industry waste	Recycling of industry waste	% of generated (collected) quantity
	Use of renewable energy sources	Share of renewable resources in the final energy consumption	Share of renewable resources in the final energy consumption	Share of renewable resources in the final energy consumption	%
	Energy intensity	Energy intensity of GDP	Energy intensity of GDP	Energy consumption per production unit	Ton of oil equivalent (toe)/ mill. Lt
Social indicators					
Activity indicators	Employment	Employment	Employment	Share of new working places created in total working places	%
	Unemployment				% from labour force
	Emigration	Emigration	Emigration	Share of gone workers	% from labour force

Social vulnerability indicators	Poverty level	At risk of poverty rate	At risk of poverty rate	Share of workers in enterprise having lower income than average	%
	Income inequality	Gini index	Gini index		Share of income between fifth and first quintile
	Human development index	Human development index	Human development index		Index

4. Integrated indicators for monitoring Sustainable Development Strategy and sustainability assessment of policies

Integrated sustainability assessment indicators are being developed for monitoring success of implementing the Sustainable Development Strategy and sustainability assessment of policies and measures seeking to reflect the main issues of sustainable development set in the National Sustainable Development Strategy. Such indicators constructed from a wide range of specific structural social, economic and environmental indicators aim to evaluate important features of the investigated social, economic and environmental issues addressed in the National Sustainable Development Strategy and at the same time they indicate how the changes of structural indicators influence dynamics of an integrated indicator. Therefore, integrated indicators represent:

- Static characteristics of structural indicators forming integrated indicators and their dynamics;
- Weights of structural indicators and their importance in tracking dynamics of integrated indicator;
- Forecast of structural indicators changes;
- Correlation of structural indicators;
- Static characteristics of an integrated indicator, its dynamics and forecast.

Static characteristics of structural indicators are based on the latest available statistical data. Dynamics of structural indicators is represented by time series of statistical data on a specific indicator. The forecast of structural indicators is being obtained by applying linear regressions based on the time series of statistical data. Similar approaches are applicable to integrated indicators for sustainability assessment.

Integrated sustainability assessment indicators can be calculated by summing the weighted indices of all indicators:

$$Q_n = \sum w_i * Q_{in}, \text{ where } \sum w_i = 1 \quad (2)$$

Here:

Q_n - integrated indicator for sustainability assessment at time moment n;
Q_{in}– index of indicator i at time moment n;
w_i – weight of indicator i in the integrated indicator.

Indices of indicators are derived by the following formula:

$$Q_{in} = q_{in} / q_{io} \quad (3)$$

Here:

Q_i – index of indicator i at time moment n;
q_{in} – value of indicator i at time moment n;
qi_{io}– value of indicator i for base year (the first year of monitoring).

If indictor decrease (e.g. external costs or private costs) is positive in terms of sustainability assessment, the indices of such indicators are integrated as inverted indices:

$$Q_{in} = 1/Q_{in} \quad (4)$$

The weights for specific criteria will be selected based on various performed studies, and various weighting schemes will be assigned to accommodate the range of possible stakeholders' considerations.

In this way, indicators acquire the form of scores making it possible to analyze the trends of an integrated indicator and assessing success of the sustainable development path in the country.

The ex-post evaluation of an impact of policies on sustainable development targets at a micro level can be performed by performing the surveys of enterprises and defining the changes of specific indicators at an enterprise level after implementation of policy measures. The ex-post policy impact assessment can be performed at a macro level by applying the statistical analysis methods defining correlations between indicators representing a policy measure and policy measures impact.

Therefore, sustainability assessment of policies or their ranking according an impact on sustainable development targets at the micro level can be performed by forming the integrated sustainability indicators consisting of various structural micro level indicators reflecting specific sustainability assessment dimensions at an enterprise level.

The integrated sustainability assessment indicators for policy measures assessment are obtained by summing the weighted indices of all indicators per policy measures:

$$Q_j = \sum w_i * Q_{ij}, \text{ where } \sum w_i = 1 \quad (5)$$

Here:

Q_j - integrated indicator for sustainability assessment of specific policy measure j;
Q_{ij} – index of indicator i for specific policy measure j;
w_i – weight of i indicator in an integrated indicator.

Indices for an integrated indicator are derived by the following formula:

$$Q_{ij} = q_{ij} / qi_{vid} \quad (6)$$

Here:

Q_{ij} – index of indicator i for specific policy measures j;
q_{ij} – value of indicator i for specific technology j;
qi_{vid} – average value of indicator i for all policy measures.

If indictor decrease is positive in terms of sustainability assessment, the indices of such indicators are integrated as inverted indices:

$$Q_{ij} = 1/Q_{ij} \quad (7)$$

Further on the integrated sustainability assessment indicators approach is applied to monitoring the Lithuanian sustainable energy strategy.

5. Example of application of integrated sustainability assessment indicators to monitoring Lithuanian Sustainable Development Strategy

Seeking to assess progress towards sustainable development in Lithuania the following 8 social, economic and environmental indicators have been selected: employment, the share of enterprises using computers, labour productivity, the share of high technology sector value added in total value added, average real wage, emigration, GHG emissions, human development index.

In dynamics of structural indicators for development of an integrated sustainability assessment indicator is presented. In our example just 8 structural indicators have been selected, whereas the quantity of indicators is not limited.

Table 3. Dynamics of structural indicators of integrated sustainability indicator for Lithuania

	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
Employment,%	58.7	57.2	59.6	60.9	61.1	62.6	63.6
Share of enterprises using computers, %	80.2	84.4	84.8	89.7	91.7	91.7	90.5
Labour productivity, value added per working hour, Lt	15.7	17.5	18.4	20.0	21.9	23.6	26.8
Share of high technology sector value added in total value added, %	19.0	17.9	19.3	19.2	20.1	20.1	20.8
Average real wage, Lt	987.4	970.8	982.3	1013.9	1072.6	1276.2	1495.7
Emigration, capita	7000	7253	7086	11032	15165	15571	12602
GHG emissions, Mt	19.37	20.33	20.69	20.99	21.75	22.68	23.22
Human development index	0.789	0.803	0.808	0.824	0.842	0.852	0.86

Table 4. Dynamics of integrated weighted sustainability assessment indicator for Lithuania

	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*Weight*
Employment	1	0.097	0.102	0.104	0.104	0.107	0.108	0.1
The share of enterprises using computers	1	0.105	0.105	0.112	0.114	0.114	0.113	0.1
Labour productivity, value added per working hour	1	0.223	0.234	0.255	0.272	0.301	0.341	0.2
The share of high technology sector value added in total value added	1	0.188	0.203	0.202	0.211	0.212	0.219	0.2
Average real wage	1	0.098	0.099	0.103	0.109	0.129	0.152	0.1
Emigration	1	0.097	0.099	0.064	0.046	0.045	0.055	0.1
GHG emissions	1	0.095	0.0936	0.0923	0.0890	0.0854	0.084	0.1
Social development	1	0.102	0.103	0.105	0.107	0.108	0.109	0.1
Integrated weighted sustainability assessment indicator	1	1.005	1.035	1.037	1.052	1.101	1.180	1

As one can see from the data presented in table 3 just for the 2 indicators, i. e. GHG emissions and emigration, out of 8 selected structural indicators, the desirable trends are – decrease. Therefore, Formula 3 has been applied to the integration of these two indicators in a sustainability assessment indictor.

In Table 4 dynamics of an integrated sustainability assessment indicator is presented. An increase in this indicator is showing the positive trends towards sustainable development. In the last column of the weights of structural indicators representing their importance in developing the sustainability assessment indicator are presented. These weights can be evaluated by performing the surveys of stakeholders. In our example the weights are selected based on the Lisbon strategy priorities, namely, on competiveness increase, therefore the highest weights have been applied to competitiveness indicators: labour productivity and the share of high technology sector value added in total value added. The same weights have been applied to the other criteria.

As one can see from the trends of the integrated sustainability assessment indicator developed for Lithuania during 2001-2006, implementation of the targets set to the National sustainable development strategy was successful and the negative trends of some sustainable development indicators (emigration, GHG emissions) were offset by positive trends of some sustainable development indicators. Of course, selection of main indicators representing our integrated sustainability assessment indicator is the main reason for providing such conclusion. Greater emphasis should be put on the weights of indicators, and all indicators established in the National sustainable development strategy should be taken into account. The weights of indictors based on stakeholder's preferences should be selected and special surveys should be conducted.

6. Conclusions

1. The inventory of sustainability assessment tools is based on the recent scholarly literature review. The material used consists not only of literature describing each of the tools, but also of material related to the specific application of each of the assessment approaches. First, a general framework is presented and then each tool category is briefly described.
2. A sustainability assessment approach based on integrated sustainability assessment indicators has been developed on sustainability assessment tools reviewed in the paper.
3. The benefit of proposed sustainability assessment technique based on integrated suitability indicators allows for both measurement in quantitative and qualitative terms of impacts of policies on the main indicators of sustainable development and monitoring the progress towards implementation of sustainable development targets
4. Sustainability assessment of policies and measures allows harmonizing both the policies targeting at specific aims and the sectors based on their impact on strategic priorities of the country expressed in sustainable development targets, and at the same time it enables a synergetic impact of policies.
5. Sustainability assessment of policies needs to be conducted at a macro or micro level and integrated sustainability assessment indicators can be developed at both levels.
6. The presented example of integrated sustainability assessment indicator development for monitoring the National sustainable development strategy makes it possible to state that in the period of 2002-2006 implementations of sustainable development targets set in the National sustainable development strategy were successful.

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Darnumo vertinimo metodai ir jų taikymas politikos priemonėms harmonizuoti ir darnumui stebėti

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(gauta 2008 m. sausio mėn.; atiduota spaudai 2009 m. birželio mėn.)

Straipsnyje aptariami darnumo vertinimo metodai ir metodikos. Remiantis nacionaline darnaus vystymosi strategija apibrėžti valstybės politikos priemonių darnumo vertinimo kriterijai, taikomi Lietuvai. Darnaus vystymosi strategijos stebėsenos, taikant integruotus rodiklius, metodika pritaikyta Lietuvos darnaus vystymosi strategijos įgyvendinimo rezultatyvumui tirti. Darbo tikslas – remiantis įvairiais darnumo vertinimo metodais ir metodologijomis, aprašytomis kitų mokslininkų darbuose, parengti valstybės politikos priemonių darnumo vertinimo metodiką, kuria įvertinti paramos verslui darnumo vertinimą. Straipsnyje išnagrinėti ir susisteminti įvairūs pasaulyje taikomi darnumo vertinimo metodai ir metodikos. Remiantis valstybės politikos prioritetais, nustatyti valstybės politikos priemonių darnumo vertinimo kriterijai. Parengta daugiakriterinė politikos priemonių darnumo vertinimo metodika, apimanti įmonės, regiono ir šalies lygmenis. Suformuluotos šiuos lygmenis atitinkančios rodiklių sistemos, skirtos darnumui vertinti. Remiantis atlikta analize, sudaryta ir pritaikyta Lietuvai darnaus vystymosi strategijos įgyvendinimo stebėsenos metodika, paremta integruotais rodikliais.