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Transition to low carbon society. Evaluation methodology

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Abstract. The need to resolve environmental pollution and climate change issues stimulate the introduction of new legislation to further lead to technological progress in the sphere of renewable energy sources and green technology. Nonetheless, the impact of the fragmented though concrete results-oriented activities on human development and on the transition to a low carbon society is difficult to assess. The paper describes a combined methodology for evaluation of the combined efforts contributing to transition to a low carbon society. The methodology includes 11 modules and encompasses the main drivers of sustainability and the thinking of a low carbon society– policy development (legislation), education and research, projects and programmes, and interest groups (stakeholders), which includes such groups as decision-makers, industries, educators NGOs and society as a whole. The results of the comprehensive evaluation provides points from which development activities can be launched in order to form a resilient, low carbon future.

Key words: climate change, programmes, policy, education, stakeholders, capacity development.

INTRODUCTION

Low emission measures are frequently reviewed in terms of their technological characteristics: transfer to renewable energy sources, introduction of low emission fossil fuel technologies, integration of new biofuels in heating systems and transportation (Tutt et al., 2012; Barisa, et al., 2013; Beloborodko et al., 2013; Eisenhuber et al., 2013;). Duerinck (2012) analyze long-term models un their applicability as tools for measuring support of policy design to transition towards a low carbon society in 2050 for Belgium. The models analysed include: accounting models, which provide transparency and flexibility in examination of energy scenarios; macro-economic and econometric models that can be used from short- to medium- and long-term forecasts on the impact of policy; partial equilibrium models which present technologies in detail thus allowing for comparative analysis of different energy technologies.

Nonetheless, the difference between the impact assessment of these measures at the modelling and the development phase and at implementation are often very different and frequently, in the latter case (implementation and post-implementation phase), there is not an adequate assessment of the actual results and their impact on transition to a low carbon society.

In order to deduce what lifestyle changes would have the potential to impact transition to a low carbon society, Neuvonen et al., (2014) applied a backcasting scenario approach whereby first criteria are defined for the desirable future and then a series of feasible and logical steps are constructed that need to be followed from the present to that desirable future. Within their study, lifestyle backcasting made it possible to identify key actors and diverse lifestyles that support sustainability. The authors saw the communication of alternatives in lifestyles allowed those, dedicated to sustainable ways of living to expand their practices to created change on a wider scale. Similar testing to the backcasting scenario approach by Kok et al. (2011), Robinson et al. (2011), Vergragt & Quist (2011) explore the challenges in involving participants but the valuable role such an approach has. The need to have a broader look at the diversity of actors and governance in the backcasting approach which is so important in the complexity of reaching a resilient low carbon state, is noted by researches (Vergragt & Quist, 2011; Wangel, 2011a, 2011b; Király et al., 2013).

Struggles to provide accurate models which include climate policy development are discussed (Strachan et al., 2009; Calvin et al., 2012). The low carbon society methodology used by Kainuma et al. (2012) reviews potential at the country level which explore the links between policy development, and modelling the possibility to introduce reductions in emissions in critical sections of the economy, such as transportation. The low carbon society (LCS) modeling proves to be a highly integrated process which is challenging to apply due to the various actors, not always comparable data sets, necessity to illustrate both national-level and municipal-level contributions.

These intricate links and the necessity to manage the uncertainties related to their further development are discussed by Hughes et al. (2013). Since the pathway to a low carbon society is an environmental with multiple interested parties, very broad and ambiguous boundaries, long-range goals and resulting effects related to a variety of external factors, the assessment of the uncertainties is important to make sure that the scenarios and options developed and offered to policy makers are reasonable and manageable with a higher degree of certainty.

The vital importance of the policy-level contribution to succeeding in reaching low carbon societies is thoroughly reviewed by Söderholm et al. (2011) which included 16 quantitative scenario studies within their research. Under this review it is made clear that further studies need to establish more balanced synergy between quantitative and qualitative methods to better reflect the success of the dynamic relationship and influence of governance and policy instruments on developing a more sustainable society.

METHODS

A low carbon society is the definition which includes all levels and scales from each of us as individuals to the global level, that are united in the necessity to reduce impact on climate change and to adapt to the current climate changes we are already facing.

The methodology developed and presented in the paper for establishing a low carbon society allows us to progress towards this goal by applying evaluation techniques. The methodology is illustrated with the aid of an algorithm (see Fig. 1) which contains 11 modules with which various types of the following are described:

- data bases (evaluation criteria, input data);
- assumptions and boundary values;
- projects and programmes;
- capacity development (education, training, informative seminars, etc.); stakeholders and interest groups (private and public sector, civil society organizations, municipal and national level interests, commercial and industrial sector).

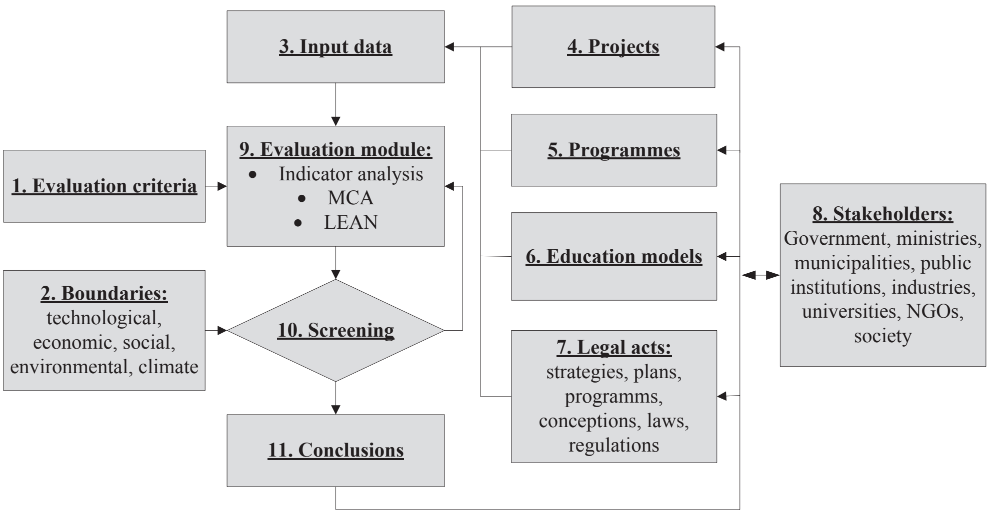

Figure 1. Algorithm for evaluation of transition to a low carbon society.

Module 1 'Evaluation criteria' include three-dimensional indicators which help to evaluate

- members of a low carbon society, beginning from each individual in society to the national-level government, the European Union (EU) and international players;
- activities of a low carbon society – projects, programmes, training, information;
- the evaluation of low carbon measures, comparison of results and conclusions, proposals, recommendations.

Module 2 'Boundaries' include restriction for the development of a low carbon society. These boundary restrictions cover several fields:

- technological – with innovative technological solutions that make is possible to reduce CO2 emissions in the energy sector, industry, agriculture, transport sector, households and the service sector;
- economic;
- social aspects;
- environment, including climate considerations.

Module 3 'Input data' that describe the current situation which include:
- information on taxes and policy (including fiscal) instruments;
- empirical models;
- data values.

Module 4 'Projects' include all types of projects implemented, including:
- on the global level;
- international;
- cross-border initiatives;
- national and municipal projects;
- institutional: projects implemented within local-governments, industry, agricultural companies, commercial enterprises, consulting and PR companies.

Module 5 'Programmes' include all types of programme that are implemented on several levels which have different goals, tasks and financial support (see Table 1).

Table 1. Description of 'Programmes' module

Level	Financing	Goals and tasks
Global	UN and its agencies World Bank EBRD Global Environmental Facility	security of global environment support to developing countries
Cross-border	EU	strengthening of cooperation among bordering countries resolution of cross-border environmental issues
Regional	EU European Economic Zone	resolution of regional environmental issues
National	State Research Programme Climate Programme Financing Instrument Latvian Environmental Protection Fund (LEPF) Grants for science National Support programmes	targeted for country-level environmental issues
Institutional	Enterprise developed support programes	targeted for sector-specific environmental issues additional motivation for private sector support in GHG emissions

Module 6 'Education models' include various forms of training, education with different objectives and goals (see Table 2).

Module 7 'Legal acts' include information and documentation on policy instruments with which it is possible to initiate activities which are directed towards low carbon solutions and measures. These include:
- strategies;

- programmes;
- action plans – recently, EU member states sign agreements with city mayors on reduction of CO2emissions. An important pre-condition to implement such agreements is the existence of energy action plans;
- concepts;
- laws;
- government regulations;
- municipal-level regulations.

Module 8 'Stakeholders' include all involved parties which can implement low carbon measures. Each of these interested parties has their own specific goals or objectives which produce their motivation on the individual-level, although the overall goal for the society is one.

Table 2. Description of 'Education models'

Organization/level	Target group	Form of training/education	Objectives and goals/tasks
Universities/ Higher education	Students, ministry representatives, local municipalities, industry, enterprises	Study courses, seminars, conferences	Scientifically based sustainability, including the development of low carbon technologies, education
Colleges/ Professional education	Students, ministry representatives, local municipalities, industry, enterprises, universities	Study courses, seminars, conferences, practice at enterprises	Sustainable use, development of low carbon technologies
Technical schools, trade schools/ Professional education	Students, ministry representatives, local municipalities, industry, enterprises, universities	Study courses, seminars, conferences, practice at enterprises	Sustainable use, applications of low carbon technologies
Schools/ General education	Colleges, technical schools, trade schools	Lessons, interest groups, seminars, summer schools	Basic concepts of sustainable use
Companies and NGOs	Ministry representatives, local municipalities, industry, enterprises, society	Study courses, seminars	Scientifically based sustainability, including the development of low carbon technologies, education

Module 9 The 'Evaluation module' includes several evaluation methods:

- simple indicator analysis – by choosing several 'transfer to low carbon' indicators, such as GHG emission factors and carbon intensity (tCO2 MWh-1), cost-efficiency (Euro (tCO2)-1), etc. Indicators currently applied measure unsustainable trends, for which actions can be identified to adjust these trends, however they do not help to define or secure sustainability. On the global level, the challenge is to find indicators of sustainability which can be used in evaluating dynamic systems, and which can help to show progress on multiple-levels: indicators that reflect global-level sustainability and against which national-level progress can be measured at the systemic level, and that on the individual level reflect progress and provide incentives to motivate further change towards sustainability. Thus, in evaluating the transition of society to one of low carbon, it is important also to develop appropriate project-level indicators that assess the results of a specific project or activity. The intensity of activities are concentrated on this level, as many systemic issues are reduced and fragmented to be resolved 'bit-by-bit' on the project-level. The evaluation and monitoring, however, of the results on this level does not always match the expectations and results to be stimulated and reached on the higher, systemic level of country- and global-level strategic goals and commitments. Due to the complexity of finding comprehensive indicators for sustainability which need to be relevant in the socio-economic and environmental context, often indicators are very specific to one sphere of specialization (Pissourios, 2013). At the same time, indicators should be oriented to five unified evaluation criteria: relevance, efficiency, effectiveness, impact and sustainability (Pissourios, 2013; Zvingule et al., 2013). Sustainability indicators are made even more complex by the different contexts in which they need to be relevant, and their values – independently comparable – governance, institutional frameworks and change, interpretations of sustainable development, etc. The perceptions of stakeholders also play a role as stakeholders are bound to interpret things differently, including what the indicators mean (Moreno-Pires & Fidélis, 2012; Mascarenhas et al., 2014).

- multi-criteria analysis (MCA). MCA is a widely used method for research on technical engineering, economic and social processes and has showed its high efficiency (Cruz, 2009; Park et al., 2011; Doukas, 2012; Jia et al., 2012; Kurka & Blackwood, 2013; Stewart et al., 2013; Liu & Rodríguez, 2014).
- environmental and energy management systems. The environmental management and energy management standards provide guidance for enterprises to develop programmes for minimizing their negative impact on the environment and optimizing energy consumption (Heras & Arana, 2010; Dörr et al., 2013; Testa et al., 2013). These systems are tailored to provide clear management through a plan-do-check-act principle with a view for continual improvement of the company's performance. The 'Check' aspect of the system is that which pertains very directly to evaluation, as companies are required to take both internal measures, and conduct independent audits to ensure that the programmes ('Plan') and their implementation ('Do') are in line with producing the desired, long-term effect on reducing pressures on the environment and climate change.
- LEAN management has been introduced in many sectors and has helped to improve results and competitiveness (Martínez-Jurado & Moyano-Fuentes, 2013). As interest in environmental issues increases from the regulatory framework and from stakeholders, the private sector needs to keep up. Thus, since lean management is an integrated management system (and fairly flexible in its ability to adapt to changing needs), increasingly there is interest to link it with environmental sustainability (see Fig. 2).

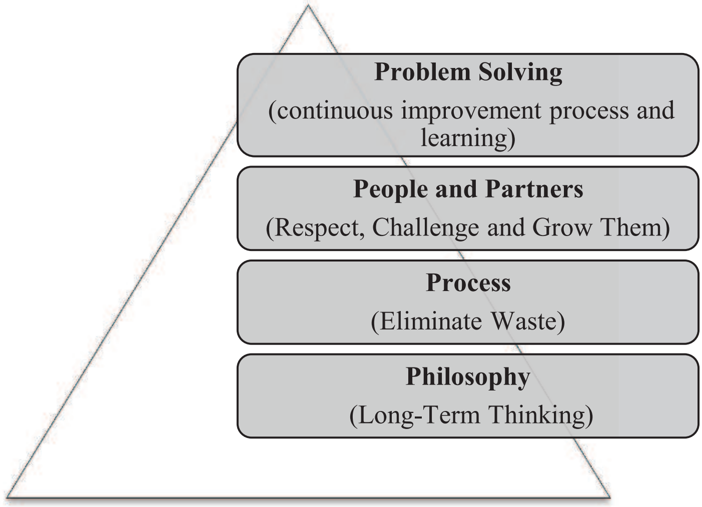

Figure 2. LEAN four aspects model (Liker's 4P model) (Dombrowski & Mielke, 2013).

Also Hajmohammad et al. (2013a; 2013b) argue that lean management and supply management impact on environmental performance via environmental practices.

Module 10 The comparative module ('Screening') is necessary in order to compare the results produced from the evaluation module to the border restrictions. Thus it is possible to determine or evaluation project and programmes on whether they have reached the defined conditions (boundary value indicators).
For instance, the results gained from the simple indicator analysis (IA) are compared with emission trading system (ETS) data. If ETS > IA, then the project has been successful, or – on the contrary, if ETS < IA, then the project has little value for impacting low carbon.

Module 11 The 'Conclusions' include essential parts for developing a low carbon society which is diverse and multi-layered

- Information on the results that have and have not been achieved by projects and programmes;
- Suggestions and recommendations that assist in developing a low carbon society on several levels;
- New projects and programmes can take into account the positive results of previous projects.

Table 3. Template for definition of evaluation results of transition to low carbon society

Information on the Component (Education, Policy, Projects and Programmes) Benefits	Shortcomings	Recommendations
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RESULTS AND DISCUSSION

The developed combined methodology is tested on the following components:

- Projects and programmes – cross border cooperation projects (ERDF, Interreg), national environmental programme (funded by the LEPF), EU IEE programme and corresponding projects (described in details in Blumberga et al., 2013; Zvingule et al., 2013).
- Education programmes – six higher education study programmes on Environmental science implemented in Latvian higher education establishments are evaluated. The results of an international audit of Latvian education study programs are used in the evaluation. The following indicators were used from the report: capacity of human resources, sustainability of the programme and financial sustainability.
- Policy – within the research, climate change policy was reviewed in particular. Climate change policy is an over-arching field which covers many sectors. A results-based approach will help to include in the evaluation both policy developed on the national level and also policy plans and actions related to other relevant sectors that may impact the goals set by the climate change policy. The evaluation is conducted presuming that climate change policy is an instrument which can help to steer the country to achieve its developmental goals. Thereby the policy shall provide information to those entities which are involved in the implementation of actions (civil servants, enterprises, society). It will also provide information on the activities which are vital for achieving sustainable development.

The relevance of each component to contributing to transition to low carbon society differs. The highest maximum theoretical potential to impact transition to a low carbon society for component 'Projects and programmes' is 10 points. This means that, if projects and programmes were implemented to their maximum potential, they would be well placed with their specifically, targeted goals, limited timeframe and focus area of activities to have large impact on changes in society as a whole. The theoretical potential of component 'Education programmes' is 8 points. The impact of education programmes can be large and can lead to sustainable results. The impact may be slower than direct actions on target sectors or policies; however the education programmes have the potential to impact to change the attitudes and ethics of a low carbon society. In Latvia's particular case, the momentum of the current education programme is large – more than 50% of the goals have been reached. However, the lowest internal assessment has been for the criteria 'sustainability'. The lowest theoretical potential is for the policy component which is attributed 4 points. Policy instruments are capable to bring results in initiating a transition, but policy instruments alone cannot maintain and monitor results in the long-term. In addition, the policy instruments which can support a transition to a low carbon society are inevitable fragmented across several sectors, periodic and not with an overall strategic or sustainable vision.

The results of the total evaluation of components are illustrated in Fig. 3.

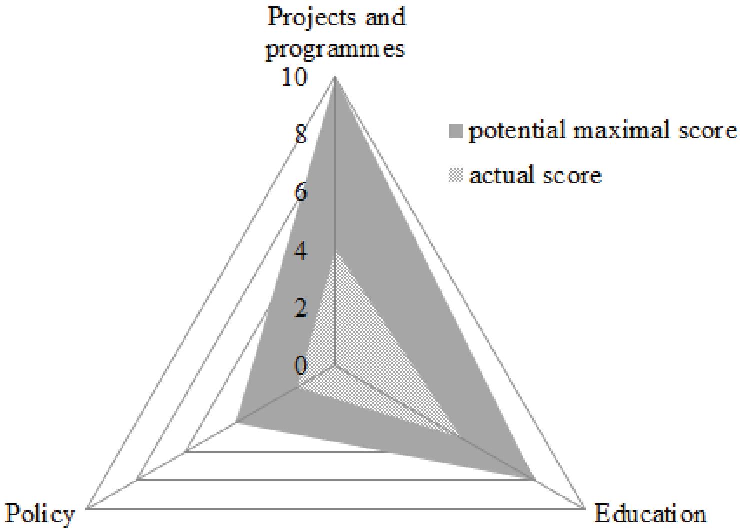

Figure 3. Results of the evaluation of Latvia's transition to low carbon society.

The actual score for each component, as illustrated above differs from the theoretical. In case of project and programmes, there are many contributed factors for the actual score (4 point) to be less than half of this component's theoretical impact. Primarily, this relates to the absence of results-oriented management of projects and programmed, which are primarily evaluated on their financial success in spending allocated budgets in the specified timeframe, and to the lack of replication of project ideas. In case of the latter, due to no formalized programme-level evaluation of project's successful results, best practices, there is no capture and transfer of knowledge from one project to other similar entities. This inability to capitalise on good results means that the potential impact of any project is limited to almost only the specific parties and enterprises directly involved in the project/programme. In case of education component, its actual score is 5 points, which is three points lower than the theoretical. Education programmes have the ability to improve their impact through more outreach activities to sectors external to their immediate institutions (industrial sector, commercial sector, municipalities, general public). The policy component has a score of 1.5 in comparison to its 4 points theoretical which is due to the limitations of policy to integrate its approaches across sectors and to engage various stakeholders in during policy development.

In summary, Latvia's journey towards a low carbon society is at half (almost 50%) of its theoretical possibilities.

CONCLUSIONS

A combined methodology for evaluation of transition to low carbon society has been developed which includes the main drivers of sustainability and a low carbon society – legislation, education and research, projects and programmes, as well as interest groups (stakeholders which include decision-makers, the industrial sector, educators, NGOs and society. The methodology has been tested to see the relevance of its application and its effectiveness in evaluating the sustainability of processes on the national, municipal and institutional levels. The results of the comprehensive evaluation provides points from which development activities can be launched in order to form a resilient, low carbon future. Such evaluations should be conducted ex-ante and ex-post in processes such as the development of country action plans (including in budget allocations) and strategic documents at the national level (both in sector and cross-sector strategies).

In further studies work needs to be done on improving the summarization of the evaluation method – in refining the point system for each component, and to expand the boundaries of the evaluation. Within the education component, it would be important to expand the study beyond the analysis of environmental programmes and also reflect the study programmes of other specialists. It would also be beneficial to review socio-economic projects and programmes that are not strictly related to the environment.

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