Energy consumption as an indicator of sustainability - the role of clusters

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Abstract: The welfare of society and the improvement of quality of life in the long run can be assured only if we integrate efforts to increase the social and economic growth with the preservation of natural heritage and resources in a sustainable way in order to achieve an eligible environmental quality. The common segment of economic and environmental strategy is the permanent improvement of the competitiveness that is based on the sustainable use of natural resources, the qualitative reproduction of the human resources and the balanced improvement of the environmental infrastructure.
In the past five years more and more environmental clusters were established to strengthen eco- and energy efficiency and the usage of renewable energy in a sustainable but also a profitable, entrepreneurial way. There are more governmental support to enhance the cooperation of the market actors and environmental thinking but recently they do not apply the material flow analysis or environmental accounting to increase the eco-efficiency.
In our study we evaluate what role an environmental clusters have on the spreading of environmental thinking and best practices between entrepreneurships that lead to greener production, waste minimalisation and to the implementation of environmental accounting in the region.

Keywords: sustainable development, environmental clusters, energy, environmental thinking, environmental accounting, LCA

1. Clusters from an average point of view

Economic, political, social tendencies in these days have attracted our attention for the upcoming huge changes in our world. The regional politics and much more the innovation is getting bigger and bigger role in the economic development of Hungary. Nowadays it seems we have to face with the tornado like globalization in lot of areas of life, but to compensate this effect, the regional cooperations are getting more and stronger.
The cluster is a special kind of network, mostly strategical alliance. From the different kind of theories the term of the cluster is the following: “A cluster is a geographic concentration of interconnected businesses, suppliers, and associated institutions in a particular field. Clusters are considered to increase the productivity with which companies can compete, nationally and

globally." (Grosz, 2004). A good working cluster has advantages for both the members of the cluster and for everyone in the region.
The clusterization got bigger role in Europe form the 90s and from 2000 in Hungary. Bigger amount of EU financing support is a great motivating power for the cluster organization. The European Union and government tenders and regional sources help the clusters. But the given supports are not enough for the long term work; the clusters have to do a really special kind of job to make others finance them. These tendencies are newborn in Hungary.

The clusters and the background of organizations show extreme differences in the certain regions of Hungary. There are huge differences between the western and eastern part of the country in topic of operating cluster or applicating clusters at all. We can clearly shout out that the territorial differences determine the number, and level of cooperation and clusters. The Hungarian corporates are really in conscious, and fear to share anything. This process is basically hinders cluster creating work and the efficient cooperation in economic processes.
This kind of organization that is much more just a regional success, by this organization a lot of countries in the world are more productive and economically successful to create a better life for the society and with the efficient and appearance of environmental clusters also a better environment.
Environmental clusters are quite new within the clusterisation the phenomenon. According to theoretical approaches we can describe environmental clusters as regional and industrial ones that builds on a tractive industry and integrate the actors of a given region.

2. Clusters and the environment

The world's concerns about environmental problems and relating climate change and other health and hygienic concerns meets with the clusterisation tendencies and also firmed by the more stronger environmental consciousness of the population arisen from the economic development.
These concerns reflect not only in the harder environmental regulation of higher developed and developing countries but also in the change in consumer thinking, and also in the more responsible thinking of entrepreneurs. By today these efforts has created a developing new industry the environmental industry. This industry tries to improve and to put more emphasise on more responsible thinking and activity with producing environmental friendly products and services and implementing more resource efficient environmental technologies and standards which can also contributes to sell and market a relative more contaminant performance and outputs by decreasing its environmental impact. The environmental protection and environmental attitudes can also contribute to more key- and competition factors: the member companies can assure that they are capable for a reform, to change and to develop to get a better social judgement and therefore they become more competitive.
The strategical alliances, networks and clusters are quiet new and young phenomenon, which helps its members to be more flexible to the changing of the market, to specialize products and services to comply with the different consumer needs in order to create a basis to compete with the fast globalizing and highly changing conditions of competition.(Lengyel, Rechnitzer, 2002) So clusters that established in environmental industry can be mentioned as new, viable phenomenon which builds on new, innovative economic preferences, and important, relevant social demands.

2.1. Founding of environmental clusters

In the recent decade in the world's economy especially in developed countries environmental factors plays a bigger role. In this context we must set off the United States of America, Canada but in case of technology development China too.[1] In the European Union's economic development plans and strategies also the environmental consideration also becoming more important: the decreasing the regional differences and improvement the quality of life can be assured in the framework of sustainable development, so the third pillar, the environmental protection is getting a bigger role.
These tendencies reflect in those objectives which aims are to decrease emissions that can increase the global worming, and to put the decrease environmental impacts forward. Most of these future objectives[2] are quite controversial and doubtful but the member states and entrepreneurs of the Union must take these objectives and observances into account because in the short future they will become slowly more actual and stricter and compulsory requirements, regulations, standards to comply with.

Environmental challenges and its side of business

The effect of the more cumulative market and innovation competition and the environmental politics is that the state the private sector – acting on the trends - has become more interested in connection with environmental protection in producing and inventing more environmental friendly products and above all huge environmental investments. To these interests the Union's and governmental call for proposals also give a big impulse too: most of the tenders and call for proposals supports investments and cooperation which can decrease the environmental impact and emissions of economic activities and developments and can strengthen the environmental thinking in the Union and in countries.

So it is a kind of natural process that efforts appeared to integrate and harmonize the members of the environmental industry. These efforts became environmental clusters, and has spread all over the world.

Characteristic features of the environmental cluster evolution

If we examine the international experiences we can define three directions how these cluster can form.

1. Clusters that is established in the administrative sector: to strengthen the average environmental responsible attitude and among people and entrepreneurs by "creating transparency, promoting awareness and raising social responsibility for the purpose of sustainable development" and developing an incentive system within the organisation (Szita Tóth, Roncz, 2007). The main goals of these clusters are to integrate administrative institutions and local governments to create a stronger regulation and incentive regulation.

- raising the funds necessary for operation,
- collecting environmental data,
- systemising the data, developing an environmental information database,
- creating an Internet surface and updating it continuously
- educational activities: public education and adult education for achieving an improving environmental attitude,

[1] E.g.: BCE cluster in San Jose in the USA, Slovenian Environmental Cluster and the Hungarian EnIn Cluster in Easter- Europe

[2] EU Climate and Energy Package 2008: Target to 2020 - A directive for renewable energy including national targets to reach 20% renewable energy in 2020 by the EU-27 in average, a 10% biofuels target in transport by 2020, sustainability criteria for biofuels/agrofuels, renewable energy (RE) certificates for RE-certificate trading mainly among countries, and others.

- organising meetings, workshops, and conferences,
- preparing and publishing environmental impact studies, research projects and expert analyses,
- creating the missing environmental protection documents through collaboration among the members, the public administration bodies, non-profit organisations and experts involved,

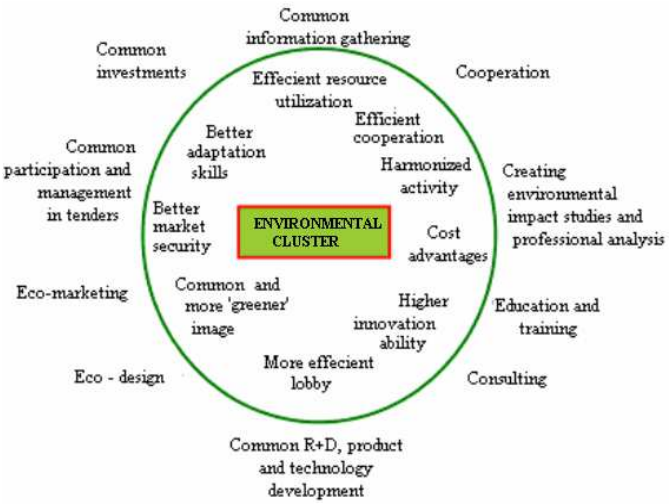
1. **Innovation centres, alongside of R&D sectors**
   New or already existing centres according to the improvement of environmental thinking have broadened its research field to environmental approaches. The name of this network often does not cover the environmental approach (industry and protection) but these can contribute to relevant environmental innovations. E.g.: in the field of biotechnology

2. **Clusters that use the flavour 'environmental friendliness' to be more competitive**
   Most of the environmental clusters belong to this group. The members of these are so companies that try to introduce a highly emitting activity in a new, more environment friendly point of view. The members widen their production with a new, greener technology or innovation. E.g: many companies in the field of waste management, energy utilization of waste, energetic utilization of waste and biomass). They often build up their network within a project and therefore they can gain quit big supports from the national government too. To the core companies later join more service company in connection with environmental consulting, marketing and accounting training and also research institutions too.

2.2. Aim and of instrument of the environmental clusters

We can say on the one hand that the biggest aims of an environmental cluster are to strengthen the eco-efficiency, the improvement of environmental quality, the support and spread of environmental friendly products and services and the innovative, environmental friendly ideas. On the other hand to socialize the environmental thinking – just from the fact that the participants want to sell their own products and services - and to integrate the researchers, academic institutions, entrepreneurs along the environmental protection.

Figure 1: Tool and advantage system of environmental clusters



Source: own compilation

The main goals of environmental clusters run as follows:

- To strengthen the eco-efficiency of products and services with the validation of the free, environmental protection, economic and technological aspects together and with the decrease of economic growth‘s environmental impact by the efficient utilization of natural resources;
- Strengthening of Life cycle thinking and implementation of monetary- flow analysis;
- Environmental friendly infrastructure development;
- Management of innovation and environmental information;
- Management of environmental industry;
- Support of environmental and innovation politics.

2.3. A Hungarian example for the environmental clusters

The EnIn Environmental Industry Cluster has been founded by the Federation of the North Hungarian Industrialists in 2007. EnIn aims to increase competitiveness in the Region of North Hungary through applying the principles of sustainable development and facilitate an effective economic development. EnIn does not only intend to play an active role in developing and implementing long-term environmental plans in Hungary, but also in neighbouring countries (Slovakia, the Ukraine, Romania). The long term goal of the cluster is to foundation an Central European environmental sample area to 2015. It is based on the innovation potential of the region. It offers long-term cooperation in the following main areas:

- waste management,
- energetic, agricultural energetic,
- chemical industry,
- water purification (sea water, sewage) and
- logistics.

Direct objectives of the cluster are based on networking:

- high level of cooperation in EnIn;
- technology development & innovation;
- setting up and implementation of collective strategies;
- to ensure the competitiveness & efficiency of the activities;
- to obtain EU founding.

The indirect goals are the following:

- raising of competitiveness of the Region;
- mending the situation of regional employment;
- implementation of a sustainable sectoral modell (sustainable development) and
- long-term Regional Development Concept for EnIn.

To this time the cluster’s main activities connected to the waste management and the field of energy. The members of the cluster are the strongest local players in the sector. Their profiles are: waste management (MSW, hazardous), district heating water supply, steel industry, chemistry, forestry, real estate business, trusteeship, business consulting, R&D but there are more and more SME’s also, as cluster members.

A cooperation agreement has been signed by Miskolc Holding Plc and ENIN Eco-Industrial Cluster on 13. December, 2008. According to this agreement, Miskolc Holding Plc.:

- contributes to the elaboration of the Regional Eco-Industrial Plan and Action Plan,
- supplies marketing tasks,
- supplies the tasks of writing applications, feasibility studies, and
- leads the Municipal Division of the Cluster.

The agreement makes a possibility for the partners to have a common representation at international events and to harmonize short-, mid-, and long term development plans.
The main aim of the cluster to built an ecological approaches cluster system for energy and waste management. It is a bottom-up initiative; professional goals are transparency and clear. The activity of the cluster involves so cooperation and development plans that can decerease the region's environmental impact which can be regarded as a big step in the field of energy and waste management practices for each, the counties, region, people and for companies too.
It has also a big opportunity to evolve and as a canal of the innovation it can be an example for other clusters and networks how to combine cooperation communication with the spreading of environmental thinking and responsibility. The governmental support and the moral influence on the members and the region can lead to the implementation of management tools and therefore this region and cluster can become a best practise territory in the country and in this European region.

3. Environmental accounting in Hungary

The field of environmental accounting has made great strides in the past two decades. One of the first countries to build environmental accounts is Norway, which began collecting data on energy sources, fisheries, forests, and minerals in the 1970s to address resource scarcity. Over time, the Norwegians have expanded their accounts to include data on air pollutant emissions. Their accounts feed into a model of the national economy, which policymakers use to assess the energy implications of alternate growth strategies. Inclusion of these data also allows them to anticipate the impacts of different growth patterns on compliance with international conventions on pollutant emissions (Hecht, 1999).
It is a new area of accounting, areas that are increasingly seen to be important tools in the drives for sustainability at the corporate level. But the idea that nations might integrate the economic role of the environment into their income accounts is neither a quick sell nor a quick process. The environmental accounting and reporting are of increasing importance for businesses. Environmental accounting deals with recognizing and disclosing a company's environmental costs and liabilities in financial reports **(**Coate et al., 1995). It includes:

- Environmental financial accounting (for external reporting to financial stakeholders),
- Environmental management accounting (for internal decision-making and reporting purposes),
- Sustainability accounting (accounting for social, economic and environmental aspects of decision-making).

Environmental financial accounting is a sub-system of environmental accounting that deals only with the financial impacts of environmental performance. It allows management to better evaluate the monetary aspects of products and projects when making business decisions.
In Hungary the implementation of the Environmental Accounting begun through TEST project by Csutora (1997-2001). She has collaborated with UNIDO within the framework of the TEST project, providing methodological inputs and practical assistance to local teams during the implementation of EMA systems at enterprise level and the preparation of the case studies and she has written a book about environmental accounting (Csutora, 2001). In that time the Hungarian companies (N=457) - were asked by the Hungarian Cleaner Production

Centre - applied this method only in 12,5 percent (Kerekes, 2003). Recently the amount of companies is increasing, mostly between big, multinational enterprises.
The forms and content of today's financial statements are determined by accounting standards set by various professional bodies globally. The domestic accounting law also from year to year requires more and more additional environmental information. The first signal of environmental aspect appeared in the accounting law in 1993.
Today the number of sustainability reporting (corporate social responsibility) and the number of the applied environmental or/and sustainability accounting are increasing in Hungary.

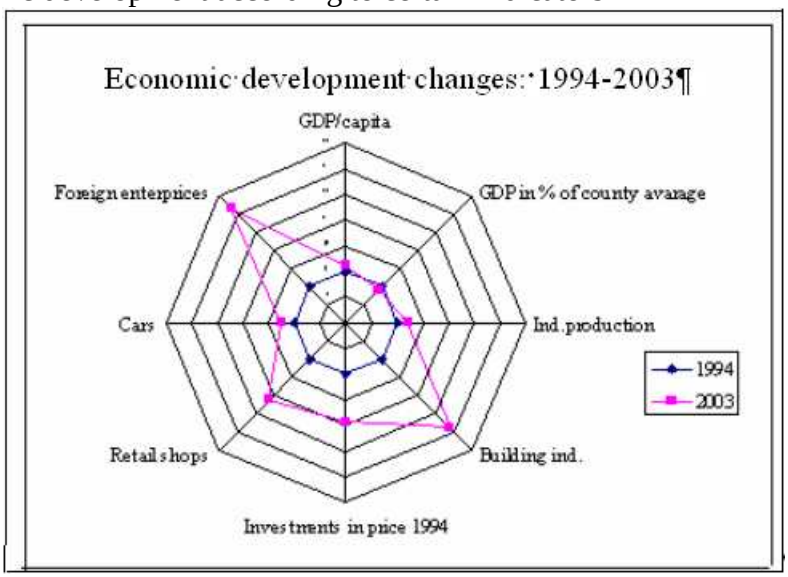
4. North Hungarian look around

The Region of North Hungary especially the county of Borsod-Abaúj-Zemplén is one of the most controversial regions in Hungary: despite its excellent natural and environmental potentials, its role in preserving traditional culture and its role as an umbilical cord, it is in a very difficult situation regarding the economy and social progress: its performance indicators or the indices related to sustainability and measuring human development cannot be claimed to be good. However, the positive changes in the recent period – e.g. in terms of the environmental compliance of the companies, waste emission, use of chemicals in agriculture, institutional development, programmed awareness raising and shaping attitudes in general and higher education – hold out hope.
The structural reforms in the early 90's shocked both the economy and the society of the county, having been former heavy industrial centre of Hungary („Hungarian Ruhr"). The socio-economic crisis caused by the dissolution of the heavy industry made one third of the settlements of the region lag behind the country average performance.
Most significant factors of the region's backwardness:

- negative demographical changes (decrease in the number of population, high rate of migration)
- low standard of living
- isolation (underdeveloped channels of telecommunication, high number of small villages and peripherial regions)
- decrease in production and in income producing capacity
- insufficient utilisation of natural resources and geopolitical opportunities
- lack of modernisation techniques (both in the industry and telecommunication)
- unbalanced environmental conditions.

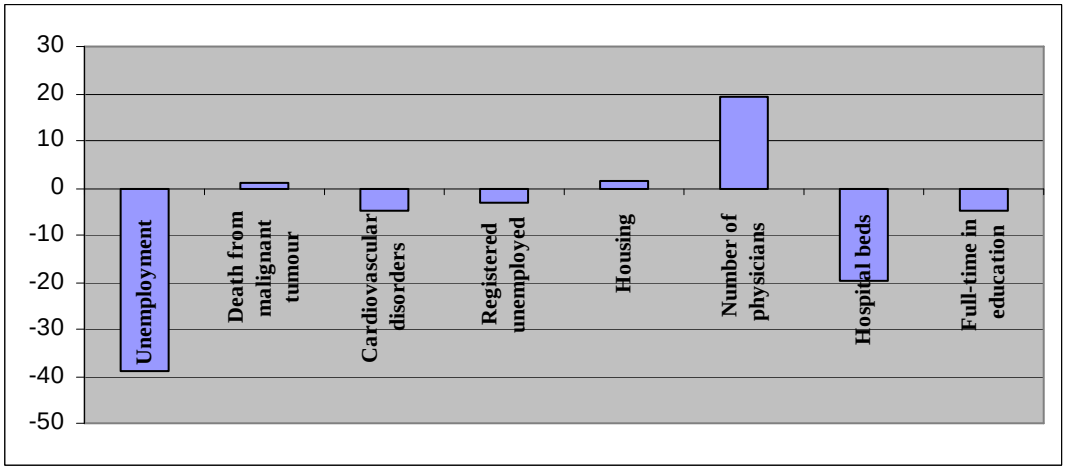
We evaluated the main factors of the three pillars of the sustainability in this Region, the following figures show the analysation results. As the Region plays an important role in the energy production and consumption we also evaluated the perfomance of the sector by LCA analysis. The energy usage and the eco-efficiency of the energy production are usable indicators to measure the sustainability.

Figure2: Economic development according to certain indicators



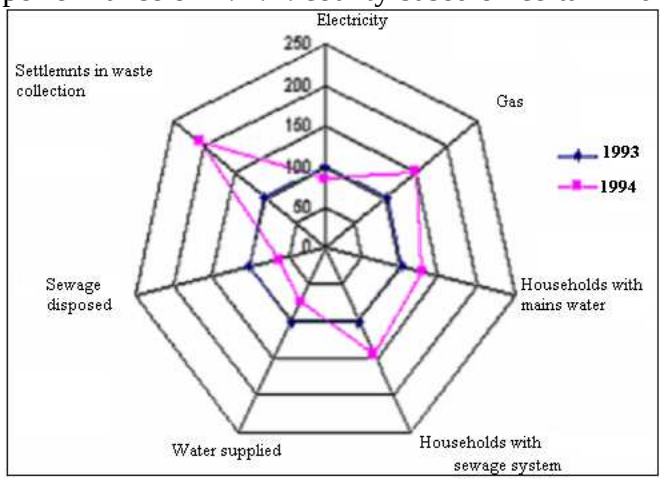
Source: Szita Tóth, Buday-Malik (2006)

Figure 3: Development of social indicators in 1993-2004 in %



Source: Szita Tóth, Buday-Malik (2006)

Figure 4: Environmental performance of B.A.Z. county based on certain indicators



Source: Szita Toth, Buday-Malik, 2006

4.1. LCA analysis of the region's energy sector

The energy consumption of a country depends on several factors: demographic conditions, economy, living standard, energy-prices, climate. The population of the world, which was 6 billion, consumed 400 EJ energy in millenary by 60 MJ/ capita/year specific consumption. In Hungary the electricity production increased from 27.463 GWh to 35.745 GWh in the period of 1990 – 2005. Obviously, there were several changes in the energy sector from 1990. According to the earlier theories, fossil energy sources would be replaced by nuclear energy, but nowadays, it is clear that, renewable should be in favour. It is important to increase the rate of renewable energy from the aspect of energy policy, rural development, environmental management and the undertaking towards to the EU. In 2002, about 1 % of electricity production came from renewable sources. According to the European Union requirements, this rate should be increased to 3,6 % by 2010. In the past few years there were several activities, investments in Hungary to increase the electricity production from renewable sources. It results the followings by 2005:

- The utilization of renewable energy sources –especially biomass- are doubled,
- Electricity production from wind power is increased (50%).

With this, Hungary fulfil the EU requirements, the rate of electricity production from renewable resources is more than 5 %.

According to IEA Energy Statistics, In Hungary the average electricity consumption is about 3.545 kWh pro capita. But data in the following figure display that, this is much lower (2.100 kWh) in the Northern Hungarian Region.

Table 1: Power Plants in the region, 2000

Power Plant	Year of establisment	Capacity (MW)	Energy source	Efficiency
Mátra Power Plant Ltd.	1968-69	200	Lignite + biomass	28,81
Mátra Power Plant Ltd.	1970-71	636	Lignite + biomass	29,76
Tisza	1976-78	860	oil	36,51
Borsodi	1954-56	137	Coal+biomass	41,47
Borsodchem	2001	49	gas	
Kisköre		160 GW	Hydro power	

Source: Energy supply in Hungary, the role of the most important energy sources in the energy supply in the world and in Hungary

Table 2: Emissions kg per 1 MJ Electricity produced by fuel

Emission	Olaj	Coal	Lignite	Gas	Biomass	Waste
CO2	0,1164	0,3176	0,2983	0,23241	0,00069	0,5122
CO	4,36e-5	1,99e-4	1,58e-4	3,52e-5	2,7e-4	5,59
NOx	1,22e-4	4,64e-4	2,9e-4	6,08e-5	6,9e-4	4,5e-4
Dust	9,48e-5	1,59e-5	3,37e-6	-	-	-
SO2	1,65e-4	5,17e-4	1,63e-4	6,08e-5	6,928e-4	3,98e-5

Source: Hungarian Energy mix, 2006

Life cycle analysis or analysis from the cradle to the grave means the measurement of materials, products or services entire environmental effects including:

- The energy which was used by the mining, production or is incorporated in the material itself,
- The effect of mining on the local environment,

- The loss of natural resources,
- The use of fields, waste disposed to the environment, and the effects of transportation during the whole life-cycle,
- Climate change and loss of the ozone layer,
- Environmental effects of use and
- Risks on health.

Several research projects have contributed to the methodological development of life-cycle analysis in the last 15 years, a standardisation process accompanied the sophistication of the measurement methods as well. (ISO 14040 standard family). Even though these analyses were mainly based on natural sciences, several of the social aspects were included in them as well. In the last years, as more and more emphasis was put on the questions of sustainability it became ore and more important to analyse the three pillars (economic, social and environmental) jointly, so it is common sense to add economic and social indicators to life-cycle analysis to form a multidimensional measurement method which brings us closer to a more perfect way of measuring sustainable development and its accomplishment, mainly if besides new kinds of eco-efficiency indicators are considered as well.

Sustainable development and life-cycle analysis are closely related t each other. Life cycle analysis is a tool which helps measuring the movements towards sustainable development. As newer and newer theories and definitions were invented to improve the achievement of objectives which were set to save the Earth, so were developed the techniques and methods of life-cycle analysis as well. In the early days the analysis of environmental effects stood in the focus of attention, by today analyses backed by mathematical models aim to estimate complex social effects too.

According to Schenck (2007) LCA can be regarded as an indicator of sustainable development as when analysing the effects by categories, changes in time can be measured well, let it be about acidity, greenhouse-effect or using natural resources. Naturally the raw could be continued as each of those categories which are parts of the chosen method give well-measurable data for the analysis.

The methods of life-cycle analysis are permanently sophisticated. On the one hand, they are made more punctual, while on the other hand new methodological directions will be worked out as well. One of the directions of development is *life-cycle management (LCM).* This is a complex method to measure the economic, social and environmental pillars of sustainable development, to which more and more factors will be integrated, and the measurement and comparison of distinct alternative's costs are also included in LCM. In several cases multivariable analysis is used when researching industrial technologies' sustainability. LCA's use in integrated product policy or in eco-design as a helping tool can be regarded as a new development. Green products or goods with eco-labels as indicators of sustainable development can be declared based on life-cycle analysis. In practice LCA can be used in each cases sustainability report are prepared on products, or production processes of goods, or environmental performance of corporations are analysed. Besides, this econometrical method can not only be used to measure environmental aspects of products, production systems or services but the environmental effects of economic growth itself. (Tóthné, Buday-Malik, 2006)

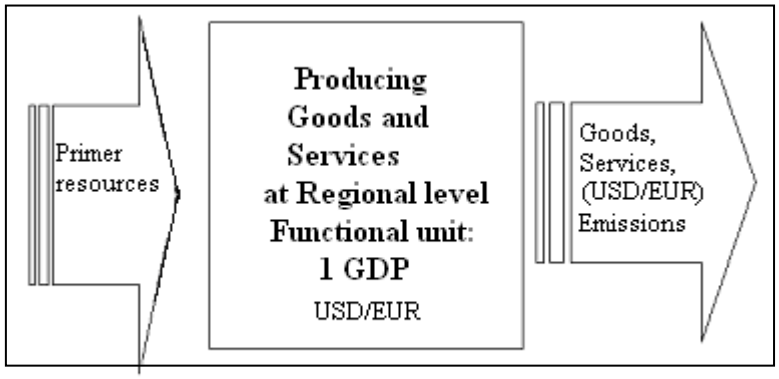
An even newer development path of life-cycle analysis is the calculation of life-cycle costs (which was known as IOLCA earlier but is rather known as LCC –life-cycle cost today).

LCC, as a tool to help decision makers was placed in a framework of several and more detailed levels by Connaughton et. al. (2007). Determining life cycle cost comes to the focus of attention in several cases when the aim is to calculate the economic costs and benefits of environmental developments or how more environment-conscious consumers will rate them. Horizontally the method considers all possible effects from the cradle to the grave while vertically the three pillars of sustainability give a framework to these calculations. Effect studies with life cycle costing, LCC can play an important role in founding decisions. Calculations like these have already appeared in power tool manufacturing, in the one-and more way beverages packing comparisons[3], in building investments etc. Actually, environmental life-cycle analysis and LCC used together optimise environment focused product planning even in during the planning process, considering both profit and environmental effects. Though the method has been known for 10 years, it has been used by an even narrower circle than life-cycle analysis in Hungary, or is used independently, only considering cost aspects.

4.2. Evaluation of the regional sustainable development

During our researches we tried to use life cycle analysis besides usual product or production process analysis for regional sustainable development analysis as well. The thought to adopt the method to measure the environmental effects of producing one unit of GDP and to compare the regional differences in their values came during the life cycle analysis of the environmental burden of the Hungarian energy mix. The analysis was made using the following model with SimaPro software.

Figure 5 – modelling LCA for regional or national levels



Source: own compilation

The adoption of LCA to regional level required (as a standardized use of LCA) to:

- Set the borderlines of the system,
- Determine the functional units,
- Determine the requirements regarding the quality of the data,
- Collection of data and finally
- Finishing the effect analysis.

[3] Effect study on the long run sustainability of beverages packing in Hungary, Summary of preliminary results, 18. 08. 2004 GUA-GVM, http://www.efosz.hu/letoltes/hatast.doc ; the paper studied the cost effects of refilling and product fee of beverages packing.

In our case the borderline of the system is the official border of the region, the functional unit is 1 GDP. Theoretically, the starting point is the value of GDP produced in a year, followed by setting the inputs with the help of the input-output matrix, and collecting output side emissions from environmental statistics. Uncertainties met during the research:

- There is no reliable statistical data on material- and energy flows. Data on energy flows' structure is not perfect, but would be essential from sustainability's point of view. As far as we know a material flow accounting process is being worked out (Kohlhéb et al., 2006), but we have not met time series like this up to now.
- Official borderlines (in case of regions) and environmental agencies territories are different from each other, so emission information is uncertain as well.

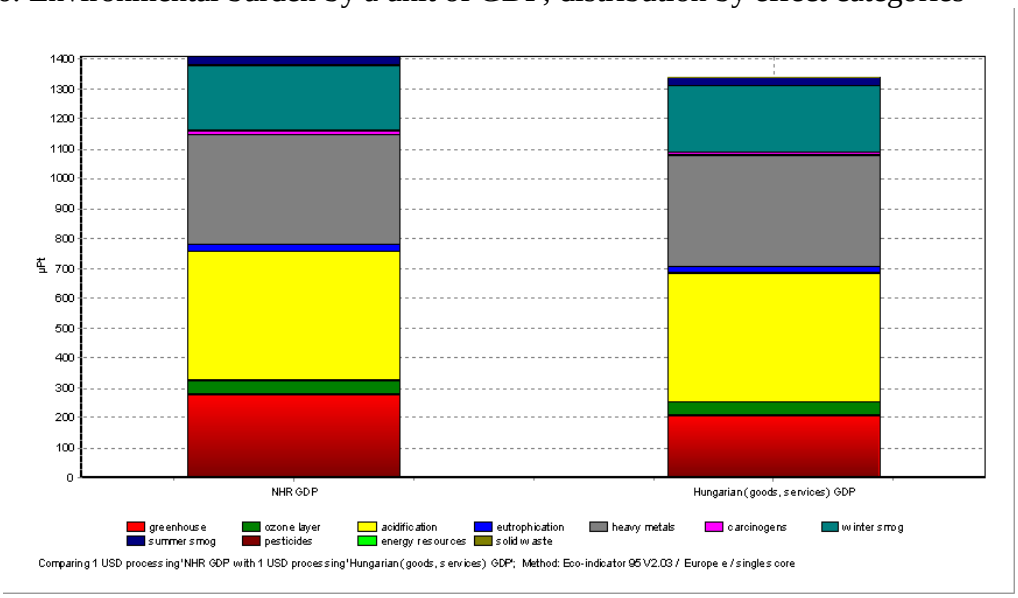
The lack of proper data made us build our analysis on industrial branches information and we have not calculated with material flows, used only energy, field, water and fertilizer as inputs, we have not considered the transportation of imported materials.

After the collection of data we made an inventory:

- Based on the national or regional material and energy flows (depending on the type of analysis) data were set in a detailed input-output table with the use of natural units;
- On the input side the quantities of materials, energy and other resources were set (field, water, energy);
- While on the output side the value of goods and services taken to the market in Ft (the produced GDP), and all of the emissions (gas, both fluid and solid) were set in kilograms

This was followed by a software helped analysis of the data.

Figure 6: Environmental burden by a unit of GDP, distribution by effect categories



Source:Tóthné Szita, 2007

Though the life cycle analysis accomplished this way can not be considered as entire, it can give interesting insight to connections in the background. The analysis showed that a higher environmental burden is set for the relatively lower level of GDP than the country average even though there are no major differences in the contribution to global problems. The major environmental effect was acidity. The analysis gives a new aspect to the economic accounting of environmental effects, so with the help of these econometrical methods we can gain a more realistic picture of development as well.

LCA can give opportunity to a special kind of analysis for sustainability's regional aspects or corporations' responsibility and steps taken towards sustainability too. It can be a basic tool to measure environmental performance or to develop eco-efficiency (factor 4, 10, 20). Analyses have shown that it can be used to measure the movements to the direction of sustainable development if time series of data stand at disposal.
In connection with sustainability we regard it very important to spread life cycle effect analysis to the field of energy production too. Energy production came to the focus of attention in a double way. On the one hand the long run secure way of energy supply, the accomplishment of both the EU's and Hungary's strategy is a major question, focusing on the ever longer stocking of fossil fuels and on the larger share use of renewable resources. On the other hand more and more emphasis is put on environmental effects, firstly on the reduction of green house gases but of other effects as well, and on the improvement of eco-efficiency too. Several effect studies were made when forming the Hungarian energy strategic concept which besides the aspect of economic efficiency put emphasis on the analysis of carbon-dioxide emission too. But to now no life cycle based comparative analysis has been accomplished the energetic use of different primary resources. This would be very useful though, when we aim to measure the average environmental effects of the domestic energy mix or the external effects of distinct energy resources. This need is emphasized even more by the analysis of alternative resources. If all input and output side effects can be analysed complexly in a life cycle framework based on 1 MJ produced energy, by their contribution to global problems, and we can compare the environmental effects of distinct resources used in energy production, and its eco-efficiency indicator. This can serve as additional information when trying to make economic regulations more perfect.

5. Opportunities to develop the environmental thinking in the region and Hungary

In the past five years more and more environmental clusters were established in order to strengthen eco and energy efficiency and to utilize renewable energy in a sustainable but also a profitable, entrepreneurial way. There are also more and more governmental supports to enhance both the cooperation of the market actors and environmental thinking but they recently do not apply the material flow analysis or environmental accounting to increase the eco-efficiency.
In our study we briefly introduced the sustainable analysis of the North-Hungarian Region and an environmental cluster in which we put emphasis on the environmental aspects. We also analyzed how clusters evolve and what effects can these organizations have on the North-Hungarian region's energy-efficiency and waste-management practices. These regional clusters can have big role on the spreading of environmental thinking and best practices between entrepreneurships that can lead to greener production, waste minimalization and also the implementation of environmental accounting.
The innovation background – research institutes and universities – give a good possibilities to spread the modern evaluating methods and practice (LCA and life cycle thinking, and environmental accounting and environmental thinking) to measure the sustainable development in the Region.

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