Developing a LCA software in Hungary

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Abstract

In Hungary the first steps of LCA application can be observed. The objectives of the project are to establish a fundamental online database of LCA compatibility with international software. This database can help designing from the aspect of environment and can be used in education and research. We have classified the domestic power plants on the basis of applied technology and energy sources. But data collection presents some difficulty. Complex analysis of electric- and electronic equipment would be another important scope of the system. And we would like to popularize the LCA application for the small and medium sized enterprises.

Keywords

LCE 2006, software development, energy- and waste management

1 INTRODUCTION

The Bay Zoltán Foundation for Applied Research in co-operation with the University of Miskolc have carried off the project "Development of a national LCA database for supporting the environmentally sound development of the Hungarian enterprises", which is financed in 75% by EU, and in 25% by the state. [1]

The aims of the project are to establish a fundamental online database of LCA, compatibility with international software, creating normalization data, respecting domestic specialities in the area of energy- and waste management, and with it the extension of existing database.

As a result of development of the fundamental database of LCA can help designing from the aspect of environment, easier availability of objective environmental assessment contributing to the use of principles of sustainable development and the development of eco-efficiency, environmentally sound products and technologies. Consequently, companies can increase position in the market competitiveness.

2 ELECTRICITY GENERATION – EUROPEAN UNION

With energy 'waste' levels in the process of electricity generation running at 66%, this sector possesses great potential. Using standard technology, only between 25 and 60 % of the fuel used in converted into electrical power. Liberalisation and stringent emission standards have brought significant benefits in terms of fuel efficiency to European electricity generation. Many old inefficient and surplus plants have been taken off the market and in most cases; it is the more fuel-efficient technology (efficiency ranging between 50 and 60 %) which is preferred as replacement.

The EU emissions trading system is an effective means to incite electricity producers to reduce emissions and improve efficiency in the most cost-effective way. The major issue of EU is to ensure that only the most fuel-efficient technology for electricity production is being used in Europe – regarding to the energy-efficiency action plan for 2006. The most efficient technology currently available has a yield close 60 %, and is mostly manufactured by European companies. However, competitors from other parts of the world now also offer similar technologies, with lower fuel efficiency of around 40 %. It needs to be considered what action might be taken to ensure that our generation in the EU is highly energy efficient.

The biggest waste in the electricity supply chain (generation – transmission – distribution – supply) is the unused heat which escapes in the form of steam, mostly by heating the water needed for cooling in the generation process. The supply chain is still largely characterised by central generation of electricity in the large power plants, followed by costly transport of the electricity to final consumers via cables. This transport generates further losses, mainly in distribution. So thus, the centralised generation results in the shape of economies of scale, also wastes energy.

Distributed generation is normally much closer to useful outlets, also for the heat which is lost in conventional generation, so increasing heat recovery fuel efficiency. This change will be a gradual process which can be facilitated at national level by using the right incentives for industry.

Cogeneration also offers a substantial potential gain in efficiency.

Most Member States of the EU – 25 have district heating systems, and especially in the new ones in central Europe with transition economies. This is a very common means of providing heat, especially to households. District heating, if managed well, can be environmentally friendly. It is estimated that even those district heating and cogeneration facilities, including industrial applications, already existing, may save 3-4 % in primary energy use as compared with separate production.

However, the main problem to be solved is how to finance the upgrading of old systems. Finally, it is very important to be determined how to support the improvement in the energy yield of coal-fired plants beyond 50 % as soon as possible by EU. [2]

3 DISPLAYING GaBi 4

The research is based on GaBi 4 software. [4]

The GaBi 4 software works with in advance filled databases, which data derives from examinations done by developing company with industrial partners, from regarding literature data, and model calculations. Also, the majority of the data are from 1996. It is important to mention that, from 1996 the energy sector has several changes not only in Hungary, but in several parts of the world. For example, thinking to that, in according to earlier theories the fossil energy sources would be replaced by nuclear energy. But nowadays it is clear that renewable resources should be in favour. At present in Hungary, about 1% (0,5-0,8%) of electricity production comes from renewable resources. This rate should be 3,6% to 2010 by EU commitment.

With updating of databases, developing the Hungarian energy-mix, it would be available to get correct results, because the currently available databases contain data regarding to non east- and central- Europe, only to west – Europe, respectively only a few data from 2000. In the course of our work it is a serious problem to get data (from power plants), but obviously, for those countries are on the top of LCA, too. For the correct evaluation of the environmental effects of the activities, it is significant to create the exact technology in GaBi 4. After the input data entry, the output values could be determined by conceded formulas. At the output side it is necessary to know the exact list of emissions.

On the other hand, for LCA analyses SimaPro software made by PRé Consultants will be applied, but details regarding to it, we do not deal with in this paper.

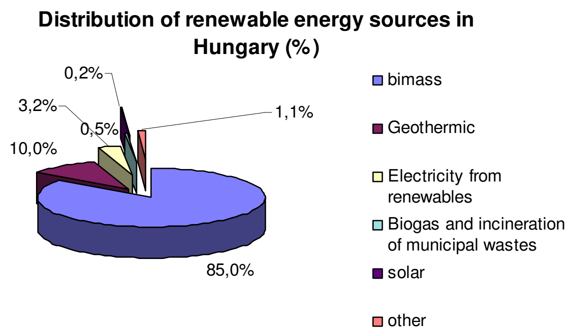

Figure 1: Distribution of renewable energy sources in Hungary
[source: IEA Energy Statistics]

4 EVALUATION OF ENVIRONMENTAL EFFECTS OF A POWER PLANT IN THE MIRROR OF GaBi 4

We are displaying the possibilities of sustainable resource management instancing to a Hungarian power plant. We got input, output data from this power plant regarding to 2004. But for the analyses the all needed data are not available from this power plant, so that it was necessary to estimate them in a few cases (by the transportation of brown coal, natural gas the distance is estimated to 1000 km, and by the wood transportation we took 200 km as a basis.), and last but not least, we used data regarding to German specialities, together with data from BUWAL database (packaging technology database from Switzerland). By all accounts, in the possessing of available data we created a model and made the LCA analyses with GaBi 4, which results are presented in the followings.

In the power plant the electricity is generated by 3 technologies. We analysed the 3 technologies, separately. At the showed models, obviously the amount of needed materials, the transportation way, and the connected energy demand. Inside a technology, the heat generated in furnaces goes to the turbines in the same steam-circulation, which delivers the electricity throw the generator. The off-gas goes off throw a chimney with electric filter. One part of the off - gas data are measured and the other part of it are calculated.

The efficiency of this power plant is low (27%). On the basis of our calculation the produced electricity was 2052 TJ (570 GWh) in 2004.

Table 1: Aggregate data of the modelled power plant – regarding to the all three technologies

Designation	Amounts	Units	Caloric value [MJ]
Brown coal	374 286 000	[kg]	4 214 460 360
Natural gas	15 059 000	[m^3]	513 511 900
Fire wood and wood waste	244 413 000	[kg]	2 872 463 783
Working hour of equipments	31 503	working hour	
Working hour of technology	23 739	working hour	
Generated electricity	2 052 117 731	[MJ]	
Generated electricity	570 032 703	[kWh]	
CO_2 emission	648 898 500,43	[kg]	
SO_2 emission	7 777 663,08	[kg]	
Dust (non-toxic)	85 877 000	[kg]	

The different phases of life cycle can be built up with GaBi 4 as separate models, irrespectively of each other can be modified, analysed. Data for effect analyses and weighting are well separated in the model. GaBi uses Shankey diagrams for the plans, in which inputs and outputs of the processes can be simply modelled, and can be visualised graphically.

In the 1st technology, 3 furnaces give the heat for the turbines firing with brown coal and natural gas. The 2nd technology works with 2 furnaces heated by fire wood and wood waste. The 3rd technology operates with 2 furnaces. One of them is natural gas, fire wood and wood waste heated, and the other one is brown coal and wood waste fired. On the Figure 2 we are displaying the LCA model of 1st technology.

5 GRAPHICALLY PRESENTATION OF ENVIRONMENTAL EFFECTS

Balances - containing material and energy data, etc. – can be done from the data of processes and methods. The balance can be displayed graphically, per diagrams.

These balances are to be appropriate for decision – making, it is needed to be normalised by the defined weights. So that, the environmental effects of the processes would be compared to each other. (The results of the balances and analyses are just as reliable as the basis data were responsible.)

The software allows so many normalisation method applications. We chose the CML 2001 method for our analyses, which permits the evaluation of the following environmental effects, and from which only a few are displayed at the following pages:

- Abiotic Depletion (ADP),
- Acidification Potential (AP),
- Eutrophication Potential (EP),
- Freshwater Aquatic Ecotoxicity Pot. (FAETP inf.),
- Global Warming Potential (GWP 100 years),
- Human Toxicity Potential (HTP inf.),
- Marine Aquatic Ecotoxicity Pot. (MAETP inf.),
- Ozone Layer Depletion Potential (ODP, steady state),
- Photochem. Ozone Creation Potential (POCP),
- Radioactive Radiation (RAD),
- Terrestric Ecotoxicity Potential (TETP inf.)

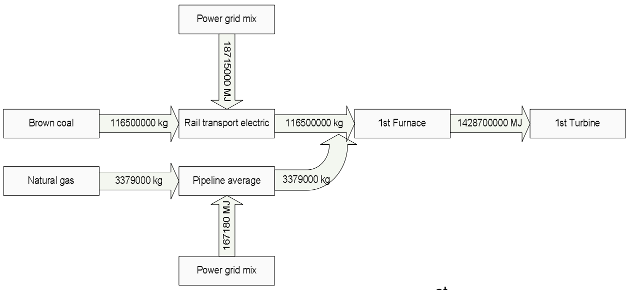

Figure 2: Elementary model of the 1st technology

Data in the following diagram indicate the utilization of non-renewable energy sources regarding to 1 kg Sb Equals. Obviously, environmental effects of the brown coal and natural gas heated 1st technology regarding to resources are much the largest, than in the other two cases.

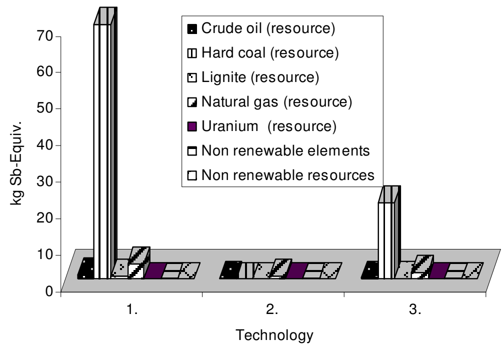

Figure 3: Abiotic Depletion (ADP), CML 2001

The figure 4 displays the environmental effects of the examined power station correlated to the European average according to the CML 2001. Data in figure show that the environmental effects of the 1st technology are the most significant. (Acidification Potencial: referenced to 1 kg SO_2; ecotoxicity: referenced to 1 m^3 polluted marine water, Radioactivity, Photochem. Ozone Creation Potential: referenced to 1 kg ethane)

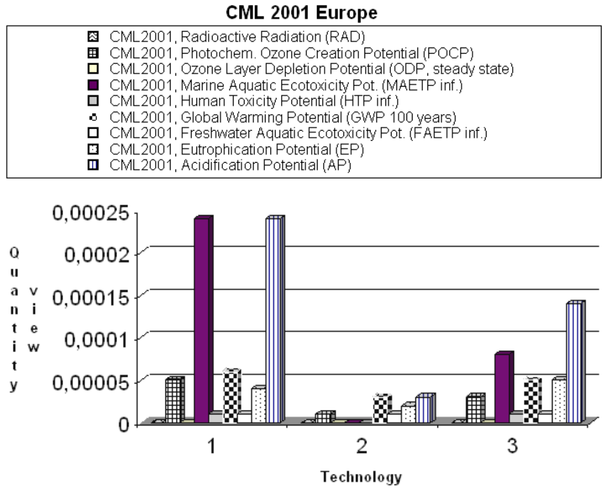

Figure 4: CML 2001 Europe

Figure 5 presents the environmental effects of the technologies applying to the global warming, correlating to the European average, using 100 years prediction, according to the CML 2001 method. Data in figure indicate that, especially CO_2 and Methane emissions contribute to global warming. It is the most significant in the case of the 1st technology. Methane emissions by natural gas and wood fired 2nd technology are not exist. Concerning to global warming, the 2nd technology can be qualified as the most environmentally friendly technology, but concerning to ozone layer depletion the analyses gave opposite results (figure 6).

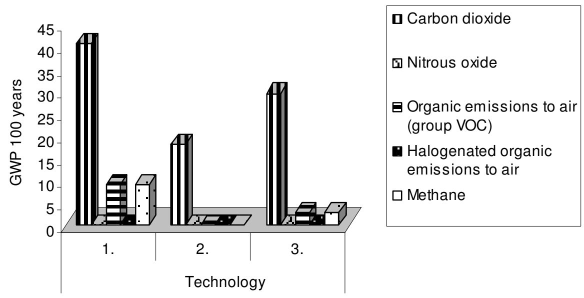

Figure 5: Global Warming Potential (GWP 100 years), CML2001

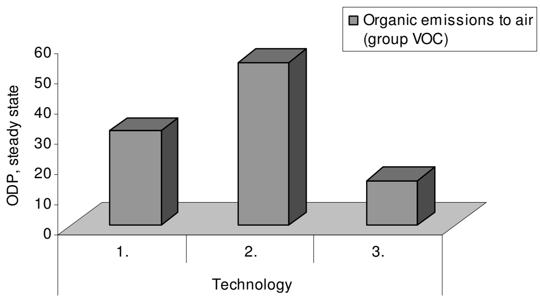

Figure 6: Ozone Layer Depletion Potential (ODP, steady), CML2001

It behoves us all to do our activities to ensure liveable healthy environment for not only us, but for the future generations; so that, it is important to analyse the harmful environmental effects of technologies for human health, displayed at the figure 7. (Environmental effects for human health are referenced to 1 kg bodyweight.) Data in figure show that, ammonia, nitrogen-gases and hydrogenfluoride mean serious problems, furthermore the 1st technology parameters are the worst in this case, too.

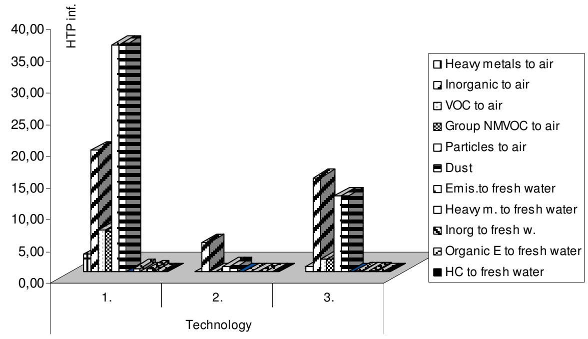

Figure 7: Human Toxicity Potential (HTP inf.), CML2001

CONCLUSION

On the whole, it could be mentioned that, the applied software enables to make comprehensive analyses of the environmental effects of (industrial) activities. The results of the analyses display that using renewable resources the environmental loading values are lower. Using the software, it is possible to find the weak-points of the activity, where in the interest of environmental effect reduction, eco-efficiency improvement; it is required to make remedial measures. However, the correct and comprehensive supply of data is essential, which causes serious problem in this project so far. But it means similarly serious challenge for those are on the top of LCA. The evidence of it is for example, the most available databases contain date during the period from 1996 to 2000.

Hungarian LCA database - will be developed in the framework of this project – could help companies working in the area of environmental protection, and could give a hand for developing of environmentally friendly products, and more clear and more sustainable technologies.

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