UTILIZATION OF LCI ANALYSIS FOR COMPARISON OF ENERGY FLOWS IN PROCESSES USING BIOMASS FOR ENERGETIC PURPOSES WITH CLASSIC ENERGETIC PROCESSES

VYUŽITÍ LCI ANALÝZ PRO PROROVNÁNÍ ENERGETICKÝCH TOKŮ PROCESŮ, ZPRACOVÁVAJÍCÍ BIOMASU PRO ENERGETICKÉ ÚČELY, S KLASICKÝMI ENERGETICKÝMI PROCESY

Christina SERAFÍNOVÁ

Ing., Institute of environmental engineering, Faculty of Mining and Geology, VSB – Technical University of Ostrava
17.listopadu 15/2172, Ostrava-Poruba, 708 33, tel. (+420) 59 732 5540
e-mail: christina.serafinova@vsb.cz

Abstract

This article outlines a possible methodology of LCI analysis utilization for comparison of processes utilizing biomass for energetic purposes, e.g. energy crop and a concrete biomass waste with selected classic energetic processes, e.g. burning of black coal. Comparison of these processes is done on the level of energy flows of given processes and energy net yields from these processes.

Abstrakt

Tento článek nastiňuje možnou metodiku využití LCI analýzy pro srovnávání procesů, zpracovávajících biomasu pro energetické účely, např. energetické plodiny a konkrétní biomasa odpadní, s vybranými klasickými energetickými procesy, např. spalování černého uhlí. Porovnání těchto procesů je v rovině energetických toků daných procesů a energetických čistých zisků z těchto procesů.

Key words: LCI analysis, biomass, energy crop

1 INTRODUCTION

The present society is standing before the problems of increasing concentration of greenhouse gases. Increasing concentration of greenhouse gases in the atmosphere may result in increasing temperature in the atmosphere, damaging human health, devaluation of food sources and a row of other negative impacts on the environment and society.

One of the possible directions, which should be aimed at lowering of greenhouse gases emissions, is utilization of renewable sources. The considered renewable source with the goal not to increase greenhouse gases emissions is an energetic utilization of biomass. Therefore in order to effectively use biomass for energetic purposes it is necessary to determine and describe all inputs and outputs of processes which use biomass for energetic purposes.

This paper is dealing with the possibility of utilization of the Life Cycle Inventory Analysis (LCI analysis) for processes using biomass and its energetic utilization. Knowledge to this paper forms a part of the research within the DeCOx research project, whose co-researcher is the VSB – Technical University of Ostrava.

2 ENERGETIC USE OF BIOMASS

In the natural conditions of the Czech Republic biomass can be used for energetic purposes, the so called energy crop or biomass waste (see Tab. 1 and Tab. 2). The following chapters are then dedicated to energy crop, plant and wood waste.

Tab. 1: Overview of energy crop [1]

Lignocellulose	woods (willows, aspens, alders, acacia)
	cereal grains (whole plants)
	grasslands (eulalia grass, reed canary grass, permanent grasslands)
	other plants (Indian hemp, sorghum, knotweed, rumex, hollyhock)
Oleaginous	rape, sunflower, flax, grourd for seed
Starch-sugar	potatoes, sugar beet, crop (grain), topinambour, sugar cane, corn

Tab. 2: Overview of biomass waste [1]

Plant wastes from agricultural primary production and environment control	rape and corn straw, grain straw, hay, remains after brush control and control of airborne woods, wastes from gardens and vineyards, wastes from control of greenery and grasslands.
Wood wastes after timber harvest	stumps, roots, bark, tree tops, branches, cones and woody biomass from first thinning and cleaning
Industrial organic waste	trimmings, sawdust, shavings, bark, wastes from plants for processing and storage of crop production (sugar refineries), wastes from slaughterhouses, diaries, distilleries, canning factories.
Wastes from animal production	dung, manure, feed remains, etc.
Municipal organic wastes	sludge, organic municipal solid waste (MSW).

Type of produced energy crop is determined by a number of factors: type of soil, method of utilization and purpose, harvest possibilities and transportation, surrounding species composition. Growing and production costs (energy consumption) and energy yield (profit) need to be compared beforehand and at the same time operating costs of combustion operations and other used facilities need to be considered, etc. [1,2]. We should also be able to formulate the same for plant and wood wastes. This can be determined quantitatively from the available knowledge, for example as a percentage share or weight share from a given harvest, timber harvest, etc. Currently it is necessary to solve the question which methodology to use for the mentioned balancing. Utilization of principles of the LCI analysis seems to be appropriate. However it will be necessary to elaborate the analysis to an appropriate methodology applicable to processes which use energy crop.

3 LCI ANALYSIS

LCI analysis is according to the Czech Standard ČSN EN ISO 14040 defined as: „Inventory of input and output data in reference to the considered system [3].“

Simply said, the LCI analysis provides a detailed description of a concrete process consisting of unit processes in reference to its all inputs and outputs. This is a completely sufficient analysis in a moment when we need to learn and describe a process. Evaluation of influence of individual processes (of the LCA analysis) is not the subject of formulation of a methodology.

If we relate the above presented definition to the proposed methodology of evaluation of energy crops, plant and wood wastes, then it is an evaluation of all unit processes which process this biomass up to its energetic use. It is obvious that there are many processes processing biomass. The target effort is however to create such methodology which will be able to provide guidelines on how to conduct LCI analysis for these processes and not to evaluate each individual process.

It is obvious that many problems have arisen already at the beginning of the decision to use the LCI analysis which it will be necessary to solve in the future.

4 ANTICIPATED PROBLEMS AND CONDITIONS FOR USE OF LCI ANALYSIS

The first problem is a fact that LCI analyses are predominantly applied to products. During this evaluation it was quite easy to evaluate inputs and outputs, question of energy crops processing brings a lot of difficulties. The only "tangible" input is the energy crop, other inputs and outputs are not so "tangible". These include an amount of consumed energy for soil cultivation, fuels and energy spent on transportation and biomass processing, amount of emissions generated in this process, energy yield, etc. The question is what unit to use for evaluating the whole system? The easiest way seems to be the use of the unit Joule or kWh. In this unit it is possible to express the amount of solar energy needed for biomass growth, amount of human as well as machine labor, etc.

The second problem which it will be necessary to deal with within the formation of methodology is a question of limits of the system under consideration for LCI analysis. This is the biggest difficulty of this work. Setting up the system's limits is often discussed. Where does the system actually start and where does it end? Resolving this problem will be the basis for the whole methodology. Considerations about setting up system's limits may take two directions, either we will be setting up the system's limits by beginning from tillage of agricultural land, over sowing, to harvesting and further to energy yield and social benefit, or we will take harvesting as the beginning. The second procedure could however lead to a fatal error within the system, because energy which the plant needs to grow up wouldn't be included. This assumption is grounded on findings which were published in a collective study of the Cornell University and the University of California-Berkeley [4]. This study is dedicated to growing corn, soya and sunflower and its transformation to bio-fuels and in the conclusion it evaluates the great energetic demand during the growing process up to the final energetic utilization of bio-fuels. This energetic demand in the final consequence surpasses the net energetic yield from such acquired bio-fuel. For formulation of methodology it is therefore highly appropriate to avoid inaccuracies which could occur by incorrect configuration of system's limits.

The third problem is directly related to the problem of setting up system's limits for the LCI analysis. This problem lies in comparability of LCI analysis of energetically grown crop and LCI analyses of plant and wood wastes. Therefore in order to come to this comparison, it is necessary to realize that organic and wood wastes do not stand at the beginning of the LCI analysis, however they are part of LCI analysis of agricultural primary production or timber harvest and processing, where the subject of interest of the considered methodology will only be the processes using organic and wood wastes for energetic utilization. All other processes of this analysis will therefore be out of system's limits. For the comparability of LCI analyses of energy grown crop and LCI analyses of plant and wood wastes it is therefore highly appropriate to determine the same starting process (e.g. tillage or preparation of soil for sowing).

5 PRINCIPLES OF THE CONSIDERED METHODOLOGY

The principle of the considered methodology comes from different ways of biomass processing. For comparison of applicability of a given energy process and a considered fuel it is therefore necessary to construct and evaluate LCI analyses by classifying fuel into the following groups:

a) energy crop suitable for processing by a given process
b) plant and wood wastes suitable for a given process
c) comparative classic fuel

The subsequent comparison of individual LCI analyses in this pre-determined group should be concluded in the following way. Already at the beginning we should realize that what we are leading to is comparing different input raw materials which we process to gain an equivalent energy amount. Therefore the principle is to determine the differences in energy dodations among individual processes for gaining e.g. 1000 J of energy or 1 kWh, determine what the energy yield is.

Let's take the combustion process as an example. In this case the procedure could be the following:

a) determination of LCI of the energy crop – sorghum, eulalia
b) LCI determination of wood waste after timber harvest
c) LCI determination of fossil fuels – black coal

By recognizing all inputs and outputs and its evaluation and subsequent modelling in the SimaPro software, the individual LCIs are visualized and the comparison of energy flows and energy yields is possible.

6 CONCLUSION

The goal of this paper is to set out a possible methodology for evaluation of LCI analyses in processes which use biomass for energy purposes. Presented here are possible difficulties during utilization of these analyses as well as methodologies for its comparison. It is necessary to realize the following thing. While evaluating the net energy yield of individual processes we cannot forget about another important fact that the process with a large net energy yield doesn't have to be the best. It is also necessary to consider the amount of emissions which are generated during the process, use of non-renewable resources during the processes, etc. Then we can come to a conclusion that a more suitable process for required energy yield might also be the one which has a lower net energy yield, but also lower emissions, lower demands on input of non-renewable resources. My effort in the further work should be incorporating these aspects as evaluation criteria into the methodology of assessment of LCI analyses.

REFERENCES

[1] Energie biomasy. *i-EKIS.cz.* [Online] [Quotation: 15. April 2008.] http://www.i-kis.cz/?page=biomasa.

[2] Výroba energie z biomasy. *Alternativní zdroje energie.* [Online] [Quotation: 15. April 2008.] http://www.alternativni-zdroje.cz/vyroba-energie-biomasa.htm.

[3] ČSN EN ISO 14044. *Environmentální management - Posuzování životního cyklu - Požadavky a směrnice.* Praha : Czech office of standards, 2006.

[4] LANG, S.,. Cornell University News Service. *Cornell ecologist's study finds that producing ethanol and biodiesel from corn and other crops is not worth the energy.* [Online] 5. 07 2005. [Quotation: 10. 07 2008.] http://www.news.cornell.edu/stories/July05/ethanol.toocostly.ssl.html.

RESUMÉ

Snahou tohoto článku je přiblížit možnou metodiku pro hodnocení LCI analýz procesů zpracující biomasu pro energetické účely. Jsou zde zmíněná možná úskalí těchto analýz i metodika pro jejich porovnávání. Je třeba si uvědomit následnou věc. Při hodnocení čistého energetického zisku jednotlivých procesů nesmíme zapomínat na další důležitý fakt, to že proces s velkým energetickým čistým ziskem nemusí být tím nejlepším. Je nutno brát ohled i na množství emisí, jež procesem vznikají, užívání neobnovitelných zdrojů při procesech, atd. Pak můžeme dojít k závěru, že výhodnějším procesem pro zisk požadované energie může být i ten, který má menší čistý energetický zisk, ale také menší emise, menší nároky na vstup neobnovitelných zdrojů. Snahou v mé další práci by mělo být začlenění těchto aspektů do metodiky posuzování LCI analýz, jako hodnotících kriterií.