LCA on energy carriers for road transport in Denmark

C. F. Brams and L. S.Skau

DTU Environment, Technical University of Denmark

To decrease the greenhouse gas (GHG) emissions from the transport sector, the Renewable energy directive (Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009) sets a target for incorporation of 10% renewable fuels by 2020. In Denmark this is obtained by addition of biofuels to conventional petrol and diesel, making bioethanol and biodiesel increasingly important energy carriers. To quantify the environmental performance related to the production and use of these fuels, life cycle assessments (LCA) modelling tools are needed for best approximation.

This project builds two models in the LCA software EASETECH; one for production of bioethanol from wheat straw, and one for production of biodiesel from rapeseeds. The advantages of modelling biofuel production in EASETECH compared to SimaPro and GaBi, are that it is mass and energy balanced which enables the flows of substances and energy to be tracked all the way through the model. This also entails that the model automatically will recalculate the output if any change in substrate composition or process efficiencies are made. Compared to the other commercial softwares, this allows for greater transparency in the modelling, which is often a lacking quality in LCAs on biofuels.

The biodiesel model, which apply production of dedicated energy crops, includes the impacts of indirect land use change (iLUC). This results in a more comprehensive and complete assessment, since iLUC is often not accounted for, but is a large contributor to GHG emissions.

Six scenarios are created for an LCA on the biofuels, as the co-products from the systems have different utilisation possibilities. The main processes and steps in the models that contribute to environmental savings and burdens are identified and evaluated. The environmental performance of the two energy carriers is compared to their fossil alternative, petrol and diesel. The overall assessment gives rise to rank the fuels as 1) production of 2nd generation bioethanol and 2) production of 1st generation biodiesel.
The outcome of the ranking was expected, due to the difference in classification of the substrates used i.e. energy crops for production of 1st generation biodiesel and waste crops for production of 2nd generation bioethanol.

The focus is on GHG gas savings, assessed in CO2-eq., but other impact categories in the LCA methodology shows burdens when producing the biofuels. However, as the political agenda is to lower the CO_2-emissions and to curb global warming, this is a necessary trade-off.

The production demand of bioethanol and biodiesel in 2020 is estimated to be 15 PJ in total. 13% of Denmark's arable land is needed to fulfil the demand for straw for bioethanol production and 6% correspondingly for cultivation of rape for biodiesel production. As wheat production currently occupies 25% of the arable land and rape cultivation occupies 6%, it is possible to reach the production of 15 PJ by use of Danish biomass.