Environmental assessment of electricity scenarios with Life Cycle Assessment

Touria Larbi, Isabelle Blanc

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Touria Larbi[1], Isabelle Blanc[1]

MINES ParisTech, CS 10207, F-06904 Sophia Antipolis Cedex, France

E-mail contact: isabelle.blanc@mines-paristech.fr

1. Introduction

The environmental impacts of existing electricity generation systems have already been assessed with Life Cycle Assessment (LCA) studies [1], [2], [3] and [4]. However environmental impacts assessment of scenarios is very rarely evaluated through a life cycle perspective partly because of the complex parameters it involves, such as the temporal technology variation and the spatial dependency per country. Moreover some studies only analyze the effect of limited indicators variation [5].Considering these parameters is however crucial when steering and evaluating policy options with regards to the possible environmental consequences.

The main objective of this paper is to present the methodology undertaken to perform an LCA for energy scenarios through the analysis of environmental impacts. Such methodology has been applied to a specific scenario, a ”Renewable” scenario and results are analysed for Austria. This scenario has been developped within EnerGEO European project [6].

2. Methodology

The methodology relies on the following assumptions and steps:

1. The share of energy pathways for electricity production have been considered in line with the scenario definition.
2. The current country-specific technical parameters (efficiency, lifetime, etc...) of each energy pathway have been modeled.
3. The temporal evolution of future energy performances have been considered.
4. LCA for each energy pathway has been performed for each year based on ecoinvent database.
5. Ecoinvent 2.2 database implemented in Simapro 7.1 and Impact 2002+ v2.06 method have been used.

3. Results and discussion

We apply this methodology to evaluate the impacts on climate change and human health of our renewable scenario (100% RE) for Austria. In this scenario, electricity generation in Austria increases from 87 TWh in 2000 to 137 TWh in 2050. The renewable energy sources share, mainly wind and biomass, increases from 50.34 % to reach 80 % for the same period. Figure 1 reports the evolution from 2000 till 2050 of GHG contribution to climate change while Figure 2 reports the evolution from 2000 till 2050 of pollutants contributing to human health expressed in Disability of Life Years (DALY). Oppposite trends are to be found : a substantial decrease of GHG by 75 % due to the decline of fossil energy sources share (as reported in Figure 3 giving the process contribution) and a major increase by tenfold of DALYs due to biomass combustion (as reported in Figure 4).

These first results are based accounting for (1) restricted data corresponding to the foreseen future technological performances for this scenario and (2) unknown shares of sub-categories for some energy pathways such as biomass where we had to sort between wood, agricultural crops, biogas...etc.. We therefore propose to customize ecoinvent 2.2 data with additional data from other sources: IEA [7] and NEEDS [8]. With this strategy the unavailability restriction is outstripped.

4. Conclusions

The LCA methodology to generate environmental impacts for a country according to a specific scenario has been established and enhanced with time-dependant data. Several assumptions had to be taken to overcome difficulties related to unavailbaility of data. LCA can play a key role in supporting policy makers to best assess the future-oriented scenarios based on more accurate knowledge of environmental impacts. LCA results enabled the sourcing of responsible polluting substances and energy pathways.

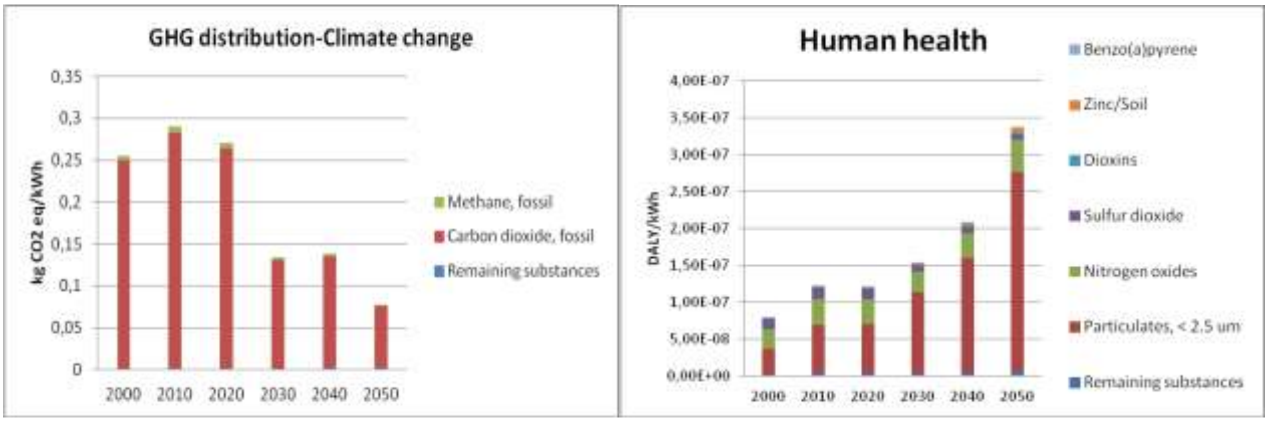

Figure 1 & 2 : Climate Change and Human Health Impacts for Austria (100% RE scenario)

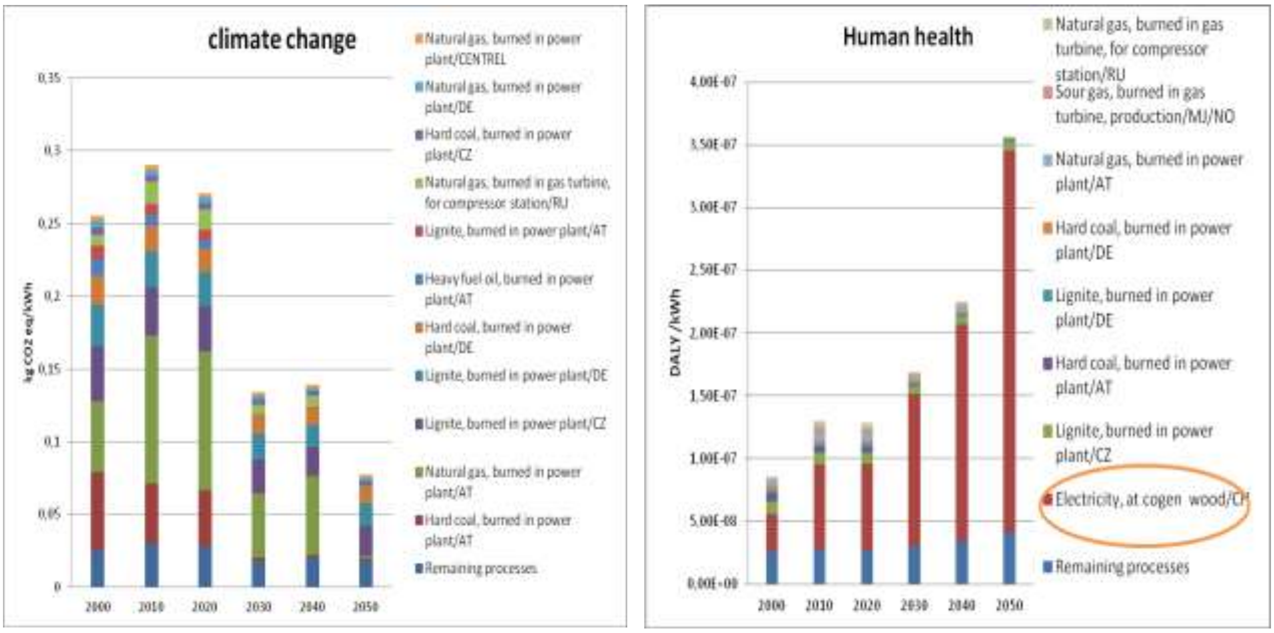

Figure 3 & 4: Process contribution to Climate Change and Human Health for Austria (100% RE scenario)

5. References

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Acknowledgement :

This paper has been made within the European project EnerGEO and co-funded by the 7th Framework Program of the EC.