

Poul Erik Grohnheit¹, Ingeborg Callesen^{2,3}, Hanne Østergård³

BIOENERGY YIELDS IN DENMARK IN THE RES2020 PAN EUROPEAN TIMES MODEL

Risø DTU, Systems Analysis Division, Roskilde, Denmark, Tel + 45 4677 5107, pogr@risoe.dtu.dk

² DTU Management, Lyngby, Denmark, Tel + 45 4525 4672, inca@man.dtu.dk

³ Risø DTU, Biosystems Division, Roskilde, Denmark, Tel + 45 4677 4111, haqs@risoe.dtu.dk

THE PAN EUROPEAN TIMES MODEL

The Pan European TIMES model that was developed as a part of the EU research projects NEEDS (www.needs-project.org/) and RES2020 (www.res2020.eu/) now covers more than 30 countries. These projects are now finished, and results from the RES2020 project have become available online. Further applications of the model are now being developed under various projects, e.g. REACCESS, PLANETS (www.feem-project.net/planets), and “Storage Utsira” on carbon capture and storage in the five countries around the North Sea.

This paper describes a national application focusing on the potential for bioenergy in Denmark, which is based on a simplified spreadsheet model that was developed as one of the results of a 3-year post doc project [1,2].

BIOENERGY YIELD FROM CULTIVATED LAND IN DENMARK

Given the assumption that biomass resources are limited, optimization of the biomass production from land resources is desirable. The biological production potential of cultivated land is a combination of physiographic conditions (soil quality and climate), crop type, seed material, cultivation method, fertilizer and irrigation. Assessment of the potential sustained biomass supply is needed in order to evaluate the possibility of switching from fossil-based carbon to actual biomass sources for energy and goods.

For Denmark, energy policy goals have been set by the Danish Government [3]. By 2011, the Danish energy supply from renewable energy sources should be 20%. The utilization of biomass is closely linked with the structure of the Danish bioenergy sector. The combustion of biomass for district heating and combined heat and power (CHP) is well developed as technology and infrastructure. There is no pulp and paper industry in Denmark, and by 2005, a fuel ethanol industry was non-existing.

Estimation of biomass feedstock potentials from energy crops and crop residues in future scenarios may be based on various modelling approaches, taking into account environmental concerns such as biodiversity and water quality in the agricultural landscape [4]. Since biomass is all kinds of photosynthetic tissue, potential bioenergy crops may for simplicity be grouped into starch, oil, sugar, grassy and woody biomass products like in two recent projects under Intelligent Energy Europe, REFUEL [5,6] and RES2020 [7]. REFUEL includes an assessment of biomass potentials for biofuel feedstock production in Europe, which is based on IIASAs agro-ecological zones modeling framework. It has been updated and expanded for biofuel productivity assessments. RES2020, “Monitoring and Evaluation of the RES directives [8] implementation in EU27 and policy recommendations for 2020” aims at examining the implications of the achievement of these targets to the European economy using a technology-rich energy model in a tradition that dates back to the first oil shock in the 1970s.

SIMPLE OPTIMISATION MODEL

The aim of the work within the 3-year post doc project was to provide a simple transparent analysis of bioenergy yields from crops that are suitable for bioenergy in Denmark. The use of material and monetary inputs for each crop, constraints in resource availability such as area of cultivated land, and crop rotation requirements are considered.

The model explores links between energy demand, bioenergy and food&feed supply via the price of fossil oil. This simple approach serves the purpose of creating overview of primary bioenergi potentials, food&feed production and consequences for land use. Constraints to biomass production are often included in bioenergy potential modeling e.g. by excluding biomass extraction from protected nature types. The outcome of the model is a crop area distribution of Danish cultivated land and an assessment of the biomass feedstock available for conversion to heat, electric power and transport fuels. The model is purely static with no endogenous investment in conversion technologies.

IMPLEMENTATION INTO THE RES2020 TIMES MODEL

The assumptions made for the simple model described above will be implemented into the national model, which is included in the RES2020 Pan European model. In contrast to the simple model described above this is a dynamic model covering the period 2005-2020 with model calculations until 2025. The results will be tested against the simple model and the final results from the RES2020 project.

REFERENCES

1. Callesen, C., Grohnheit, P.E., Østergård, H. (2010). Optimization of bioenergy yield from cultivated land in Denmark. *Biomass and Bioenergy*, (Submitted).
2. Grohnheit, Poul Erik (2008), Using the IEA ETSAP modelling tools for Denmark, Risø-R-1656.
3. Danish Energy Agency. Denmark's Energy Projection up to 2030. Copenhagen: Danish Energy Agency. [In Danish]. Available from <http://ens.netboghandel.dk/publ.asp?page=publ&objno=16331559>.
4. EEA. How much bioenergy can Europe produce without harming the environment. Report no.7/2006. Copenhagen: EEA; 2006.
5. Fischer G, Prieler S, van Velthuizen H, Lensink SM, Londo M, de Wit M. Biofuel production potentials in Europe: Sustainable use of cultivated land and pastures. Part I: Land productivity potentials. *Biomass and Bioenergy* 2010; 34(2):159-72. DOI: 10.1016/j.biombioe.2009.07.008
6. Fischer G, Prieler S, van Velthuizen H, Berndes Gr, Faaij A, Londo M et al. Biofuel production potentials in Europe: Sustainable use of cultivated land and pastures, Part II: Land use scenarios. *Biomass and Bioenergy* 2010; 34(2):173-87. DOI:10.1016/j.biombioe.2009.07.009
7. Anon. Res2020 Monitoring and evaluation of the RES directives implementation in EU27 and policy recommendations for 2020. Deliverable D.4.2. Intelligent Energy Europe; 2009.
8. European Commission. Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market. Brussels: Commission of the European Communities; 2001.