Conference Programme
Gesamt-Konferenzprogramm

World Sustainable Energy Days 2014

26 – 28 February 2014
26. – 28. Februar 2014

WELS, AUSTRIA

EUROPEAN PELLET CONFERENCE
EUROPÄISCHE PELLETSKONFERENZ

NEARLY ZERO ENERGY BUILDINGS
NIEDRIGSTENERGIE-GEBÄUDE

WSED NEXT – YOUNG RESEARCHERS
WSED NEXT – JUNGE FORSCHER/INNEN

EUROPEAN ENERGY EFFICIENCY POLICIES
EUROPÄISCHE ENERGIEEFFIZIENZ-STRATEGIEN

INNOVATIVE BUILDING TECHNOLOGIES
INNOVATIVE GEBÄUDETECHNOLOGIEN

B2B-MEETINGS & SITE-VISITS
B2B-MEETINGS & FACH-EXKURSIONEN

TRADESHOW
ENERGIESPARMESSE

WWW.WSED.AT

LAND OBERÖSTERREICH

World Sustainable Energy Days 2014

OÖENERGIESPARVERBAND

WSED next Biomass Young Researchers

A conference to present the work of young researchers in the field of biomass (in English only)

27 February

14.00 Opening & welcome

Gerhard Dell/Christiane Egger, OÖ Energiesparverband

Oral presentations

Chairperson:
Walter Haslinger, Bioenergy 2020+, Austria

Comparative analysis of US and EU public policies promoting wood energy
- *Satu Lantiainen, University of Missouri, USA*

Renewing towns: establishing energy security in Northern BC through bioenergy
- *Sean Carlson, University of Northern BC, Canada*

Eco-energy aspects of production and utilisation of agripellets ▪ *Viktória Papp, University of West Hungary*

Agronomic evaluation of switchgrass on marginal vs. prime farmland ▪ *Sergio J. Sosa, Rutgers University, USA*

Deployment scenarios of biomass-to-end-use chains for torrefied biomass
- *Fabian Schipfer/Lukas Kranzl, Vienna University of Technology, Austria; Kathrin Bienert, DBFZ, Germany; Rita Ehrig, Bioenergy 2020+, Austria; Markus Meyer, Helmholtz Centre for Environmental Research, Germany*

Assessing the availability of biomass residues for energy conversion ▪ *Johannes Lindorfer, Johannes Kepler University Linz, Austria*

Subcritical hydrothermal liquefaction of barley straw
- *Zhe Zhu, Aalborg University, Denmark*

Process synthesis of industrial symbiosis in palm-based bioenergy systems ▪ *Rex T.L. Ng/Denny K.S. Ng, The University of Nottingham, Malaysia Campus, Malaysia; Raymond R. Tan, De La Salle University, Philippines*

Biofuel from lignocellulosic biomass liquefaction in waste glycerol and its catalytic upgrade
- *Miha Grilc/Blaž Likozar/Janez Levec, National Institute of Chemistry, Slovenia*

H_2 from SERP: double hydroxide CO_2 sorbents at low and high temperatures
- *Francesca Micheli, University of L'Aquila, Italy*

The effects of torrefaction on the thermochemical properties of Jatropha curcas ▪ *Buddhike Neminda Madanayake, The University of Nottingham, UK*

Reve: versatile continuous pre/post torrefaction unit for pellets production ▪ *Nicolas Doassans-Carrère, Revtech Process Systems, France*

Grass energy for residential heating – emissions and efficiency characterisation ▪ *Sriraam R. Chandrasekaran/ Philip K Hopke, Clarkson University, USA*

Energy centre Bracak – an information, training and show case centre ▪ *Marko Vlainić, North-West Croatia Regional Energy Agency, Croatia*

Pipeline hydro-transport of agricultural biomass
- *Mahdi Vaezi, University of Alberta, Canada*

19.00 End of the conference day

19.30 Evening programme

World Sustainable Energy Days 2014

Date
26 – 28 February 2014

Venue
Stadthalle Wels, Austria
Pollheimer Strasse 1, 4600 Wels

Conference languages
English, German, Russian

Organisation and conference office
OÖ Energiesparverband,
Landstrasse 45,
4020 Linz, Austria,
Tel. +43/732/7720-14386,
office@esv.or.at, www.esv.or.at
ZVR171568947, ATU 39283707

Registration
Please register online at www.wsed.at

How to reach Wels?
by railway: direct connections from Vienna, Linz, Salzburg, Munich, Paris, Brussels, etc.
by road: A1 and A25 motorways
by air: airports in Linz (17 km from Wels), Vienna (222 km), Salzburg (110 km), Munich (247 km)

Datum
26. – 28. Februar 2014

Ort
Stadthalle Wels, Österreich
Pollheimer Straße 1, 4600 Wels

Sprachen
Deutsch, Englisch, Russisch

Organisation und Tagungsbüro
OÖ Energiesparverband,
Landstraße 45,
4020 Linz, Österreich,
Tel. +43/732/7720-14386,
office@esv.or.at, www.esv.or.at
ZVR171568947, ATU 39283707

Anmeldung
Bitte verwenden Sie die Online-Anmeldung auf www.wsed.at/dt

Wie kommen Sie nach Wels?
Bahn: direkt von Wien, Linz, Salzburg, München, Berlin, Brüssel etc.
PKW: Autobahnen A1 & A25
Flugzeug: Flughäfen Linz (17 km von Wels), Wien (222 km), Salzburg (110 km), München (247 km)

WWW.WSED.AT

OÖ ENERGIESPARVERBAND

Bundesministerium für Wirtschaft, Familie und Jugend

Co-funded by the Intelligent Energy Europe Programme of the European Union

Deployment scenarios of biomass-to-end-use chains for torrefied biomass

Fabian Schipfer[1], Kathrin Bienert[3],Rita Ehrig[4], Lukas Kranzl[2], Stefan Majer[3],Julian Matzenberger[2],Christoph Strasser[4],Martin Svanberg[6], Markus Meyer[5], Jörg Priess[5]
[1]Energy Economics Group, Institute of Energy Systems and Electrical Drives, Gusshausstraße 25-29, A-1040 Vienna, schipfer@eeg.tuwien.ac.at, phone: +43 1 58801 370363, fax:+43 (0) 1 58801 370397;
[2]Energy Economics Group, kranzl@eeg.tuwien.ac.at; matzenberger@eeg.tuwien.ac.at; [3]Deutsches Biomasseforschungszentrum gemeinnützige GmbH kathrin.bienert@dbfz.de, stefan.majer@dbfz.de; [4]Bioenergy 2020+ GmbH, christoph.strasser@bioenergy2020.eu, rita.ehrig@bioenergy2020.eu; [5]Helmholtz-Zentrum für Umweltforschung GmbH, markus.meyer@ufz.de, jörg.priess@ufz.de; [6]Umeå Universitet, martin.svanberg@chalmers.se

ABSTRACT: Increasing demand for biomass asks for a higher mobilisation and thus for innovative preparation and densification technologies for this commodity. Market diffusion potentials of torrefaction products and possible impacts on several social and environmental aspects have to be addressed before recommendations are forwarded to policy makers and stakeholders. This paper describes and compares biomass-to-end-use chains for torrefied biomass and illustrates deployment scenarios for this commodity and the torrefaction technology itself. A biomass-to-end-use chain simulation tool (*BioChainS*) was developed which is capable of assessing the high number of production and utilisation pathways that could become relevant in the near future. The paper gives an insight into this approach and shows how biomass availability, technological development and biomass demand policies could influence torrefied biomass deployment.

1 INTRODUCTION

1.1 Objectives of this research

To investigate the possible market diffusion of the torrefaction technology under strict sustainability boundary conditions, the experimental work done within the FP7 SECTOR project[1] is accompanied by extensive desk studies and modelling work presented in this paper. This work has the objective i) to identify and define relevant biomass-to-end-use value chains for torrefaction-based bioenergy carriers and ii) to illustrate deployment scenarios based on these chains.

1.2 Key structure of this paper

To calculate deployment scenarios of biomass-to-end-use chains for torrefied biomass a thorough assessment of the different production and utilisation pathways that could become relevant in the near future is necessary. The following chapter illustrates the theoretical background and the software tool BioChainS, which was developed to tackle this challenge. The first result, a comparative chain assessment is formulated in chapter 3 and gives the basis for the deployment scenarios presented in chapter 4. A short insight into how these results are further processed in the SECTOR project for a full sustainability assessment including socio-economic-, life cycle- (in terms of energy and GHG balances) and a full environmental assessment can be found in the last chapter.

1.3 System boundaries

Biomass-to-end-use chains start at the biomass feedstock production site. For the economic assessment a detailed investigation of biomass production and harvesting is beyond the scope of this work. Prices and physical properties for the biomass obtained in the forest, the plantation site or at the biomass processing industry will be sufficient for the calculation. As fuel properties can have an effect on the end-use, the system boundary at the other side of the biomass-to-end-use chain at least has to consider the combustion efficiency of those biofuels for the generation of heat and electricity, or the production efficiency of other end-user types and resulting retooling costs. Costs of providing the produced renewable heat and electricity or the produced bio-chemical to the consumers will not be included in this investigation, because it is not relevant for the objective of this research.

Deployment potentials are derived econometrically by comparing torrefied biomass supply costs with supply costs of coal and untorrefied biomass. Torrefaction technologies are assumed to be available commercially at the end of the current decade. Therefore the temporal horizon for the deployment scenario calculation will cover the time range beginning with 2020 and ending with the year 2030.

2 THEORETICAL BACKGROUND

The objective of this part is to give an insight into the theoretical approach behind the calculation of diffusion potentials of the, not yet commercially available torrefaction technology. To assess the high number of production and utilisation pathways that could become relevant in the near future the biomass-to-end-use chain simulation tool BioChainS was developed and equipped with highly up-to-date data from the partners of the SECTOR-project. In the next paragraphs the functionality of this model will be illustrated and the used methods capable of dealing with emerging uncertainties and variabilities will be explained.

2.1 General structure of the tool BioChainS

The statistical programming environment of R (RStudio, 2012) was used to connect the different parts of the model shown in figure 1. The first part mainly consists of the cost summation of biomass supply including the purchase of the feedstock, its preparation to a high-energy dense solid biofuel, its consumption (e.g. combustion) at the end user and every single transportation step that occurs within this biomass-to-end-use chain. The chain links are allowed to form all possible combinations as long as

[1] The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 282826.

no linkage restriction is violated (see chapter 3). Technological and economic data of the solid biofuel preparation steps, the consumption and handling properties and physical properties of the feedstock were obtained from the experimental research of the project partners. Regional costs of feedstocks, labour, fossil fuel, electricity, interest rates and taxes were gathered in extensive literature researches and from internal sources. The uncertainties of the data were addressed by error

Comparative supply chains without torrefaction are simulated considering specific linkages and restrictions for this commodity. The whole set of biomass-to-end-use chains can now be assessed to derive first conclusions and recommendations for torrefaction based solid biofuel production and trade (see chapter 3).

In the market diffusion model coal prices and cost effects of different policies are used to evaluate the

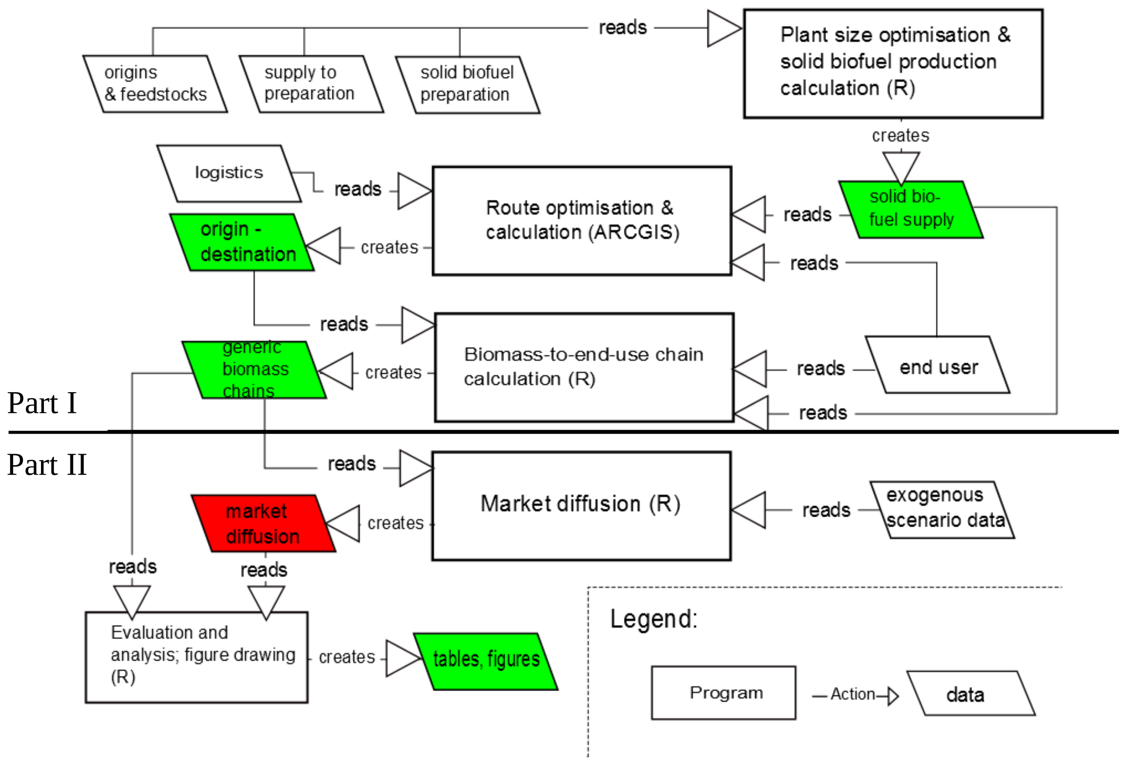

Figure 1: Main structure of BioChainS: Parallelograms indicate data bases while squares stand for single programs executed with different software named in brackets

propagation. In *figure 1* the data discussed above is indicated as parallelograms.

In contrast to the variation of the results induced by uncertainties, variations caused by variabilities were treated differentially in this model. As a "variability refers to natural variation in some quantity" (Van Belle, 2008) the selection of possible future torrefaction plant sizes that could occur on the market give a good example for this term. Its process energy mix and the location of the preparation plant, thus distances and vehicles used for transport as well as whether a mobile chipper is used or not in case of woody biomass is also seen as a natural variation in future bioenergy markets. Monte Carlo simulations are used to correlate these variabilities in the form of probability functions. Therefore it is assumed, that the mean values for these functions, thus the most likely constellation can be evaluated by cost optimisation. These optimisations are explained in more detail in the next paragraphs.

By including regional potentials into the simulation in the first part, cost-supply curves can be generated for the single biomass-to-end-use chains. deployment potentials of selected biomass-to-end-use chain cluster. The development of the exogenous price data will be defined for different storylines (see chapter 4) and the potentials are recalculated for the time range beginning with 2020 and ending with the year 2030.

2.2 Preparation plant size optimisation

to be updated in the full paper

2.3 Route optimisation and calculation

to be updated in the full paper

3 COMPERATIVE BIOMASS-TO-END-USE CHAIN ASSESSMENT

to be calculated and updated in the full paper

4 DEPLOYMENT SCENARIOS

Based on a discussion during an expert workshop[2] held within the project SECTOR, we identified the

[2] Expert workshop with SECTOR partners from different disciplines and technology fields on 15 May 2013, Vienna.

following main aspects to be modified for different deployment scenarios: Biomass availability, demand for (torrefied) biomass and technological development. All these dimensions may be strongly affected by policies, which therefore form a higher-level aspect to be discussed separately.

Using these dimensions four storylines were drawn to facilitate the quantification of the model input data as well as the discussion. These storylines are illustrated in *figure 2* and will form the main paths of the different deployment scenarios of torrefied biomass and the torrefaction technology in this work.

4.1 Storylines

- Ambitious torrefaction growth
  This storyline is driven by a strong EU policy for bioenergy. This includes the development of logistic infrastructure in order to increase the availability of biomass, also with respect to imports. Other world regions do not follow the EU in its ambition which leads to only moderate global competition for biomass resources. At the same time, the EU implements support policies for biomass in all end-use sectors. This leads to a high economic efficiency of biomass, supported by a favourable ratio of biomass prices to fossil fuel prices.
  The EU policies include a strong support for technology development. Thus, high cost reductions for torrefaction occurs combined with a high technological quality of the torrefaction process leading to high energy densities of torrefied products. A strong market growth of torrefied material is expected and leads to a significant share of torrefied biomass until 2030.
  The role of biomass in different end-use sectors etc. will be investigated in terms of different scenarios within this storyline.

- Resource constraints, High-Tech
  Due to the global climate mitigation strategy (and/or strong increase in fossil fuel prices) the global and EU biomass demand strongly increases. Due to this strong competition for biomass (both for energetic and non-energetic purposes) the biomass price increases. However, the policies in place keep the demand in all end-use sectors high.
  Due to the high global efforts in climate change mitigation, high technological progress is achieved. This results in high cost reductions for torrefaction combined with a high technological quality of the torrefaction process leading to high energy densities of torrefied products.
  A moderate market growth of bioenergy and torrefied biomass is expected for the European Union. However, due to the global competition this growth is slower than for other renewables. The role of biomass in different end-use sectors etc. will be investigated in terms of different scenarios within this storyline.

- Conventional biomass growth
  Due to the global climate mitigation strategy (and/or strong increase in fossil fuel prices) the global and EU biomass demand strongly increases. Due to this strong competition for biomass (both for energetic and non-energetic purposes) the biomass price increases. However, the policies still keep the demand in all end-use sectors high.
  No real technological breakthrough is achieved in torrefaction. Costs are high and technological quality and reliability is low. Only moderate energy densities can be achieved by torrefaction.
  The demand for bioenergy grows. However, due to the global competition this growth is slower than for other renewables. Torrefaction is expected to only cover small niches of the bioenergy sector. The scenarios will focus on the question how these niches could look like and what are most promising niches.

- Grey storyline
  No ambitious climate mitigation policies are implemented, neither at the global nor at the European scale. No strong effort is taken in mobilising additional biomass resources and no major investments in biomass logistics occur. Together with low competition for biomass resources, this results in medium availability of biomass. There is no major resource constraint of fossil fuels and therefore price levels for fossil and biomass resources remain moderate.
  No real technological breakthrough is achieved in torrefaction. Costs are high and technological quality and reliability is low. Only moderate energy densities can be achieved by torrefaction.
  Renewable energy and biomass in particular shows only very low growth. Torrefaction does only play a minor role in small niches of the bioenergy sector. The scenarios will focus on the question how these niches could look like and what are most promising niches.

4.2 Results

This part of the work is based on the economic comparison of the biomass-to-end-use chains illustrated in chapter 3. Chains are clustered according to their similarities in supply cost ranges, region and technology specific properties. Supply costs of the reference products namely coal and different sorts of untorrefied material are used to evaluate the deployment potentials of the various clusters. Scenarios for the uptake of torrefied biomass and the torrefaction technology can now be calculated under the conditions defined in the storylines. In the following paragraphs the impact of the development of fossil fuel-, labour prices and other crucial economic aspects (e.g. interest rates, taxes) on the diffusion of the torrefaction sector are examined. Different policies on biomass demand, availability, research and development are simulated and discussed to identify most promising paths.

to be updated in the full paper

5 CONCLUSIONS AND OUTLOOK

Supply chain scenarios can give an insight on the impact of political, environmental and economic diversification on the utilisation and development of upcoming biomass preparation technologies. This chapter will highlight the most important impact parameters that could become crucial for the development of a torrefaction sector. Furthermore we will give an insight into how the results are further processed in the SECTOR project to produce a full sustainability assessment including socio-economic-, life cycle- (in terms of energy and GHG balances) and a full environmental assessment. Deployment strategies resulting from this cooperation will be available in summer 2014 to support investment projects and policymakers.

to be updated in the full paper

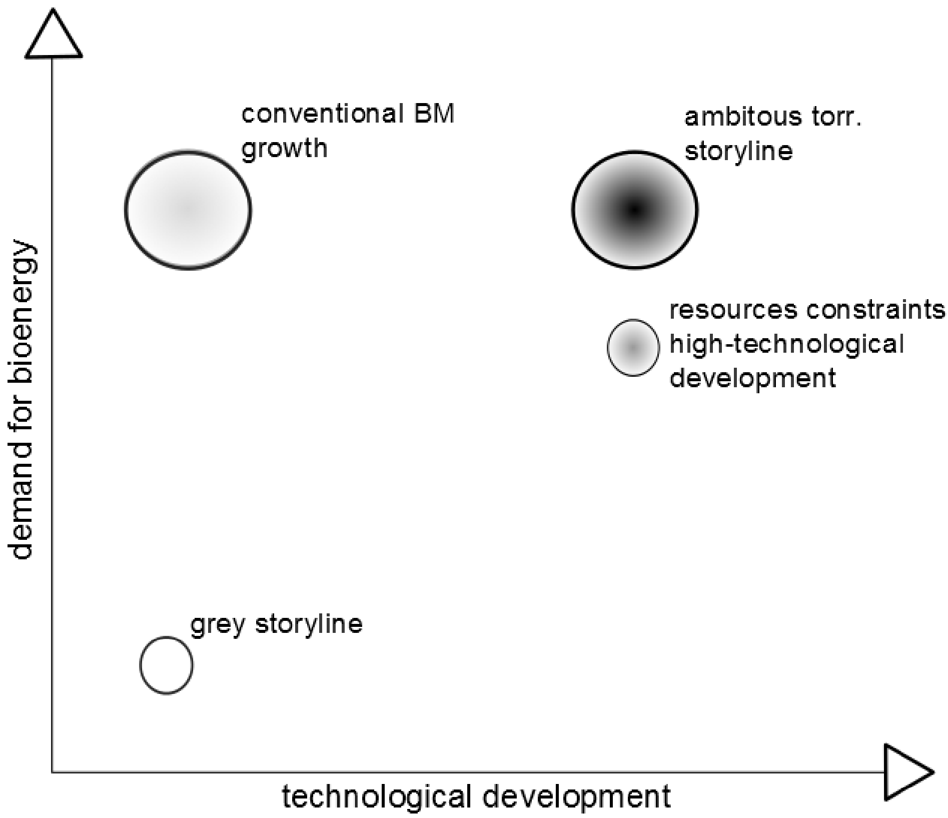

Figure 2: Key dimensions of torrefaction storylines: Biomass availability is indicated as third dimension: Smaller object size for storylines represent lower biomass availability. Furthermore the shading of the filling indicates the grade of market penetration of torrefied biomass in the bioenergy sector.

6 REFERENCES

Bergman, P.C. (2005): “Combined torrefaction and pelletisation. The TOP process,” Energy Research Centre of the Netherlands (ECN), Petten.

Ehrig, R., Behrendt, F., Strasser, C. and Wörgetter, M., (2013): „Price risks in international pellet supply chains“, submitted journal paper.

European Commission (EC, 2012): “TRANS-TOOLS Version 2.5” Joint Research Centre, Institute for Prospective Technological Studies, Seville.

ESRI, (2012): “ArcGIS Version 10.1”.

Hamelinck, C. N., R. A. A. Suurs, and A. P. C. Faaij (2005): “International Bioenergy Transport Costs and Energy Balance.” Biomass and Bioenergy 29 (2): 114–134.

Kranzl , L., Bienert, K., Chand, T., Ehrig, R., Majer, S., Matzenberger, J., Meyer, M., Priess, J., Svanberg, M. (2012): „Description of the relevant biomass-to-end-use chains, including torrefied biofuels”. Deliverable 9.1 from the project SECTOR.

Koppejan, J.,Sokhansanj, S., Melin, S. and Madrali, S. (2012): “Status overview of torrefaction technologies. IEA Bioenergy Task 32 report. Final report.,” Procede Biomass BV, Enschede.

Kumar, A., Cameron, J. B., Flynn, P. C., (2003): “Biomass Power Cost and Optimum Plant Size in Western Canada.” Biomass and Bioenergy 24 (6): 445–464.

Maderthaner, E.. (2012):, “Comprehensive assessment of the pellet supply chain from Romania to Austria”, Master thesis at University of Applied Sciences Wels and Bioenergy 2020+.

Moser, W., Strasser, C., Jungmeier, G., Lingitz, A., Canella, L. and Könighofer, K., (2010): „Endbericht BioHeatLABEL,“ Bioenergy2020+, Wieselburg.

Obernberger, I., Thek, G.,(2010):“The Pellet Handbook”, Earthscan. London/ Washington.

RStudio, (2012): Inc., “RStudio Version 0.97.314”.

Suurs, R. “Long Distance Bioenergy Logistics (2002):” University of Utrecht, Copernicus Institute, Department of Science Technology and Society.

Svanberg, M, Olofsson, I, Flodén, J and Nordin, A, (2013), "Analysing biomass torrefaction supply chain costs", Bioresource Technology, Vol. 142, pp.287–296

Umweltbundesministerium (BMU),(2010): „Leitstudie 2010 - Langfristszenarien und Strategien für den Ausbau der erneuerbaren Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und global. Datenanhang II. Dezember 2010.,“ Stuttgart, Kassel, Teltow.

Uslu, A., Faaij, A., Bergman, P. (2008): Pre-treatment technologies, and their effect on international bioenergy supply chain logistics. Techno-economic evaluation of torrefaction, fast pyrolysis and pelletisation. Energy 33 (2008) 1206 – 1223.

Suurs, R. “Long Distance Bioenergy Logistics (2002):” University of Utrecht, Copernicus Institute, Department of Science Technology and Society,

Van Belle (2008), Statistical Rules of Thumb, Wiley, pp. 99 - 100