

BIOMITRE Deliverables 3 and 4:

(D3) Collation of Existing Data

(D4) Summary Report of Case Studies

BIOMITRE Deliverable 3: COLLATION OF EXISTING DATA

BIOMITRE Work Package 2, the responsibility of VTT Processes, led to the production of two deliverables; D3 (Database of Case Studies, completed 14 October 2003) and D4 (Summary Report of Case Studies, completed 23 October 2003). The Case Study Database contains 22 references (see Appendix C.1). These particular case studies were summarised by means of a format provided by WP3 and evaluated against criteria formulated by WP4 in the Case Study Report (see Appendix C.2). The summary format provides concise information on the year of publication, the author(s), the full reference, the systems considered, the processes included, the strengths, the weaknesses and the key citations. A summary table records the results of the evaluation of the case studies against the criteria, indicating specifically the coverage of results (energy inputs, CO₂ emissions, other GHG emissions, and total GHG emissions), the issues considered and/or represented (costs, flow charts, timing dynamics, and reference system), transparency, and the specific country to which the case study refers.

Database of Case Studies

Final Version 14.10.03

- Alakangas, E., Vesterinen, P. (2003). Trade of Solid Biofuels in Europe. In: Bioenergy 2003, International Nordic Bioenergy Conference from 2nd to 5th September 2003 Proceedings. FINBIO - The Bioenergy Association of Finland, 2003. pp 129–135.
- Asikainen, A. (2003). Productivity, Cost and Availability Factors of Forest Chip Production. In: Bioenergy 2003, International Nordic Bioenergy Conference from 2nd to 5th September 2003 Proceedings. FINBIO - The Bioenergy Association of Finland, 2003. pp 221–224.
- Börjesson, P., Gustavsson, L. (2000). Greenhouse Gas balances in Building Construction: Wood versus Concrete from Lifecycle and Forest Land-Use Perspectives. *Energy Policy*, Vol.28, No. 9, pp 575–588.
- Damen, K. and Faaij, A. (2003). A Life Cycle Inventory of existing biomass import chains for “green” electricity production, Universiteit Utrecht, Copernicus Institute, Department of Science, Technology and Society, January 2003.
- Elsayed, M. A., Matthwes, R., Mortimer, N. D. (2003). Carbon and Energy Balances for a Range of Biofuels Options. Project Number B/B6/00784/REP. URN 03/836. Resources Research Unit, Sheffield Hallam University, March 2003. Available online: <http://www.shu.ac.uk/rru/projects/biofuels/biofuels.html>
- Fossdal, S. (1995). Energi- og miljøregnskap for bygg (Energy and Environmental Accounts of Building Construction). Report 173, The Norwegian Institute of Building Research, Oslo.
- Gustavsson, L. (1997). Energy Efficiency and Competitiveness of Biomass-Based Energy-Systems. *Energy*, Vol. 22, Iss. 10, pp 959–967, 1997.
- Gustavsson, L., Karlsson, Å. (2002). A System Perspective on the Heating of Detached Houses. *Energy Policy*, Vol. 30, pp 553–574.
- Gustavsson L. and Karlsson Å. (2003) Heating Detached Houses in Urban Areas. *Energy-The International Journal*. Vol. 28, pp 851-875.
- Jungmeier, G., Resch, G., Spitzer, J. (1998). Environmental Burdens Over the Entire Life Cycle of a Biomass CHP Plant. *Biomass and Bioenergy*, Vol. 15, No. 4/5, pp 311–323, 1998.
- Jungmeier, G., Hausberger, S. (2003). Greenhouse Gas Reduction and Costs of Implementing the EC Biofuel Directive in Austria. In: Bioenergy 2003,

- International Nordic Bioenergy Conference from 2nd to 5th September 2003 Proceedings. FINBIO - The Bioenergy Association of Finland, 2003. pp 371–375.
- Karlsson, Å., Gustavsson, L. (2003). External Costs and Taxes in Heat Supply System. *Energy Policy* Vol. 31, pp 1541-1560.
- Mortimer, N.D., Cormack, P., Elsayed, M.A., Horne, R.E. (2003). Evaluation of the Comparative Energy, Global Warming and Socio-Economic Costs and Benefits of Biodiesel. Final Report, for the Department of the Environment, Food and Rural Affairs. Contract Reference No. CSA 5982/NF0422. Report No. 20/1, January 2003.
- Mäkelä, K., Tuominen, A., Rusila, K. (1999) Työkoneiden päästömalli TYKO 1999 (Emission Calculation Model for Work Machines in Finland). Technical Research Centre of Finland, Communities and Infrastructure, Contractor report 546/2000. (Revised version 9.9.2002). 49 p. + apps. 30 p.
- Mäkelä, K., Tuominen, A., Pääkkönen, E. (2003). Suomen tieliikenteen päästöjen laskentajärjestelmä LIPASTO 2002 (Lipasto 2002 Calculation System for Traffic Emissions and Energy Consumption). Technical Research Centre of Finland, Building and Transport, Research Report RTE 1378/03, Espoo 2003. 36 p. + apps. 6 p.
- Mäkinen, T., Sipilä, K. (2003). Liquid Biofuels for Transportation: Production Costs in Scandinavia. In: *Bioenergy 2003, International Nordic Bioenergy Conference from 2nd to 5th September 2003 Proceedings*. FINBIO - The Bioenergy Association of Finland, 2003. pp 376–382.
- Mälkki, H., Virtanen, Y. (2001). Hakkuu- ja sahatähteiden energiakäytön elinkaariarviointi. Elinkaari-inventaario ja ympäristövaikutusarvio (Life Cycle Analysis on Energy Use in Logging and Saw Residues. Life Cycle Inventory and Environmental Impact Assessment). Puuenergiaketjujen ympäristönäkökohtien hankekokonaisuus (PUUT11). Tekes Puuenergian teknologiaohjelma, 2001.
- Ohlström, M., Mäkinen, T., Laurikko, J., Pipatti, R. (2001). New Concepts for Biofuels in Transportation. Biomass-Based Methanol Production and Reduced Emissions in Advanced Vehicles. Technical Research Centre of Finland, VTT Research Notes 2074. Espoo, 2001. 94 p. Available online: <http://www.vtt.fi/inf/pdf/tiedotteet/2001/T2074.pdf>
- Palosuo, T., Wihersaari, M. (2000). Energy Use of Forest Residues - Impact on Soil Carbon Balance (in Finnish, with English abstract). VTT Energy reports 9/2000. VTT Energy, Espoo, Finland.
- Pingoud, K., Mälkki, H., Wihersaari, M., Hongisto, M., Siitonen, S., Lehtilä, A., Johansson, M., Pirilä, P., Otterström, T. (1999). ExternE National Implementation Finland. Technical Research Centre of Finland, VTT Publications 381. 119 p. + app. 131 p.
- RTS (1997–2000). Environmental Labels on Buildings and building parts (In Finnish). The Building Information Foundation RTS. 1997–2000, done by VTT Building and Transport. Available on URL: <http://www.rts.fi/rt-ymparistoselosteet.htm>.
- Schlamadinger, B., Spitzer, J., Kohlmaier G.H., Lüdeke, M. (1995). Carbon Balance of Bioenergy from Logging Residues. *Biomass and Bioenergy*, Vol. 8, No. 4, pp 221–234, 1995.
- Siemons, R.V. (2003). Biomass Availability in the EU. In: *Bioenergy 2003, International Nordic Bioenergy Conference from 2nd to 5th September 2003 Proceedings*. FINBIO - The Bioenergy Association of Finland, 2003. pp 34–41.
- Stockinger, H. (1996). Life Cycle Analysis of District Heating with Biomass. Annual Report of the Institute of Chemical Engineering, University of Technology Graz, Austria, 1996.

- Suurs, R. (2002), Long Distance Bioenergy Logistics. An Assessment of Costs and Energy Consumption for Various Biomass Energy Transport Chains. Universiteit Utrecht, Copernicus Institute, Department of Science, Technology and Society, January 2002.
- Tyson, K.S., Riley, C.J., Humphreys, K.K. (1993). Fuel Cycle Evaluations of Biomass-Ethanol and Reformulated Gasoline, Volume II, Appendices. National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory, Pacific Northwest Laboratory, 1993, 129 p., Report No. NREL/TP-463-4950, DE 94000227
- Vedrova, E.F. (1997). Organic-Matter Decomposition in Forest Litters. Eurasian Soil Science, Vol. 30, Iss. 2, pp 181-188, 1997
- Wihersaari, M., Palosuo, T. (2000). Greenhouse Gas Emissions from Final Harvest Fuel Chips Production (in Finnish, with English abstract). VTT Energy reports 8/2000. VTT Energy, Espoo, Finland.
-

Deliverable 4: SUMMARY REPORT OF CASE STUDIES

The purpose of WP2 is to collect, evaluate and summarise case study material for evaluating greenhouse gas balances and emissions-saving cost-effectiveness of prominent biomass energy technologies relevant to the EU. Deliverable D3 of WP2 was the Database of Case Studies. Deliverable D4 is the Summary Report of Case Studies, which represents the findings of this collation activity. It was agreed in Kick-Off Meeting for the BIOMITRE project at the University of Utrecht on 6 June 2003 that the focus of the collation activity would be four selected cases from IEA Task 38:

- *Finnish and Swedish* case studies which look at the links between increased use of construction wood and the use of biomass-fired cogeneration plants in comparison to fossil fuel use.
- *Croatian* case study which focuses on assessment of greenhouse gas emissions reduction potential through biodiesel in the context of a potential Joint Implementation project.
- *Netherlands* case study which examines the international trade of biofuels in the case of importing wood pellets from Canada and palm kernel shells from Malaysia to the Netherlands for green energy production.
- *United Kingdom* case study which compares small-scale bioenergy solutions for a rural community to centralised systems of energy and heat generation, as well as bioenergy crops to short-rotation crops, and further to long-rotation crops.

The case study material was collected around these subjects. The review process was carried out using evaluation criteria, which were agreed to be:

- transparency,
- system boundary,
- process chain,
- reference system,
- carbon stocks,
- land-use allocation,
- sub-processes,
- process flows,

- timing of inputs and outputs,
- product allocation,
- data sources,
- process technology,
- accounting,
- risks and uncertainty, and
- presentation.

Addressing all these criteria was, however, a very difficult and slow process, resulting in a need to focus on key issues, which were considered to be:

- flow chart data,
- calculation of the energy inputs and greenhouse gas outputs, including the effect of timing and the adoption of comparative reference systems, and
- evaluation of cost-effectiveness.

Initially, 29 case studies were collected into database, of which 7 were found to be irrelevant for the project or include unhelpful data, and therefore were eliminated. Summary table of the case studies describes which kind of relevant results are represented, which key issues are considered/represented, as well as a roughly assessment of transparency associated with the study reviewed. Separate summaries of the case studies are then presented, covering the following aspects:

- year of publication,
- authors,
- full reference,
- system considered,
- processes included,
- strengths,
- weaknesses, and
- key citations.

The review summaries are organised by alphabetical order of the first author of the study. No case study were found which considers and represents every relevant issue and data that will be needed to demonstrate some selected case with the BIOMITRE software tool which is being developed. Consequently, integration of the data found from different studies will be needed. Furthermore, significant problems may arise if data to be integrated are not completely transparent. Only a few studies reviewed, however, satisfied this criterion.

Summary of Case Studies

Study	Results				Issue Considered/Represented				Transparent	Country
	Energy	CO ₂	Other GHG	Total GHG	Costs	Flow charts	Timing Dynamics	Reference System		
Alakangas & Vesterinen 2003	No	No	No	No	Yes	No	No	Yes	Partly	Finland
Asikainen 2003	No	No	No	No	Yes	No	No	No	Partly	Finland
Börjesson & Gustavsson 2000	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Sweden
Damen & Faaij 2003	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Netherlands
Elsayed et al. 2003	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	Great Britain
Fossdal 1995	Yes	No	No	Yes	No	Yes	Partly	No	Yes	Norway
Gustavsson & Karlsson 2002	Yes	No	No	Yes	Yes	Yes	Partly	Yes	Partly	Sweden
Gustavsson & Karlsson 2003	Yes	No	No	Yes	Yes	Yes	Partly	Yes	Partly	Sweden
Helynen et al. 2002	Yes	Yes	No	No	Yes	No	Partly	Partly	Partly	Finland
Jungmeier et al. 1998	Yes	Yes	Yes	Yes	No	No	Partly	No	Partly	Austria
Jungmeier & Hausberger 2003	No	No	No	Yes	Yes	No	No	Yes	No	Austria
Karlsson & Gustavsson 2003	Yes	No	No	Yes	Yes	Yes	No	Yes	Partly	Sweden
Mortimer et al. 2003	Yes	Yes	Yes	Yes	Partly	Yes	No	Yes	Yes	Great Britain
Mäkinen & Sipilä 2003	No	No	No	No	Yes	No	No	No	No	Finland
Mälkki & Virtanen 2001	Yes	Yes	Yes	Yes	No	Yes	No	Partly	Yes	Finland
Ohlström et al. 2001	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Finland
Palosuo & Wihersaari 2000	No	Yes	No	No	No	Yes	Yes	Yes	Partly	Finland
Pingoud et al. 1999	Partly	Yes	Yes	Yes	No	Yes	No	Yes	Partly	Finland
RTS 1997-2000	Yes	No	No	Yes	No	No	No	No	No	Finland
Schlamadinger et al. 1995	No	Yes	No	No	No	Yes	Yes	Yes	Partly	Austria
Suurs 2002	Yes	No	No	No	Yes	Yes	No	Yes	Partly	Netherlands
Wihersaari & Palosuo 2000	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	Finland

Year of Publication: 2003
Authors: Alakangas, E. and Vesterinen, P.
Publication Type: Proceedings paper
Full Reference: Alakangas, E., Vesterinen, P. (2003). Trade of Solid Biofuels in Europe. In: Bioenergy 2003, International Nordic Bioenergy Conference from 2 nd to 5 th September 2003 Proceedings. FINBIO - The Bioenergy Association of Finland, 2003. pp 129–135.
Systems Considered: Prices of wood chips, pellets, coal, sod peat, milled peat, light fuel oil, heavy fuel oil, biodiesel for heating, and natural gas, in different European countries.
Processes Included: -
Strengths: Updated data relevant to the EU.
Weaknesses: The structure of prices is not represented.
Key Citations: 1. EUBIONET – Fuel prices in Europe (2002/2003). National co-ordinators of EUBIONET Solid Biofuels. March 2003. 18 p.

Year of Publication: 2003
Authors: Asikainen, A.
Publication Type: Proceedings paper
Full Reference: Productivity, Cost and Availability Factors of Forset Chip Production. In: Bioenergy 2003, International Nordic Bioenergy Conference from 2 nd to 5 th September 2003 Proceedings. FINBIO - The Bioenergy Association of Finland, 2003. pp 221–224.
Systems Considered: Variables related to selected machine and work site conditions that affect the productivity of machinery. The impacts of availability and the mix of raw material on cost structure of different supply chains.
Processes Included: Cost and availability analysis of procurement of logging residue chips in Joensuu area in Finland.
Strengths: Impacts of different factors have on costs and availability of logging residues clearly represented.
Weaknesses: Organisational cost factors were not considered. Data relatively country and area specific. Lack of transparency related to some results. Emissions and energy consumption are not considered.
Key Citations: 1. Asikainen, A., Ranta, T. (2001). Hakkuutähdehakkeen kustannustekijät ja suurimittakaavainen hankinta (Cost Factors and Large Scale Procurement of Logging Residue Chips). Research Notes 131. Faculty of Forestry, University of Joensuu. 170 p.

Year of Publication: 2000
Authors: Börjesson, P. and Gustavsson, L.
Publication Type: Journal paper
Full Reference: Börjesson, P. and Gustavsson, L. (2000) Greenhouse Gas balances in Building Construction: Wood versus Concrete from Lifecycle and Forest Land-Use Perspectives. <i>Energy Policy</i> , Vol.28, No. 9, pp 575–588.
Systems Considered: Primary energy use as well as CO ₂ and CH ₄ emissions from the construction of a multi-storey building, with either a wood or a concrete frame, calculated from life-cycle and forest land-use perspectives.
Processes Included: The complete life cycle of the construction materials, from the recovery of raw materials, via manufacturing of building materials, to the handling of demolition waste.
Strengths: System boundary clearly defined and fairly transparent calculations (represented or cited). Timing issues have been taken into account and are accounted explicitly. Flow charts are represented.
Weaknesses: Energy used in the construction or demolition process as well as in transportation of demolition waste have not been included. Costs are not included.
Key Citations: 1. Adalberth, K. and Persson, S. (1997) Written information in form of data files. Department of Building and Construction, Lund Institute of Technology, Lund University, Lund, Sweden. 2. Fossdal, S. (1995). Energi- og miljøregnskap for bygg (Energy and Environmental Accounts of Building Construction). Report 173, The Norwegian Institute of Building Research, Oslo.

Year of Publication: 2003
Authors: Damen, K. and Faaij, A.
Publication Type: Contract report
Full Reference: Damen, K. and Faaij, A. (2003), A Life Cycle Inventory of existing biomass import chains for “green” electricity production, Universiteit Utrecht, Copernicus Institute, Department of Science, Technology and Society, January 2003.
Systems Considered: A Life Cycle Inventory (LCI) on two existing wood energy import chains (wood pellets from Canada and palm kernel shells (PKS) from Malaysia to the Netherlands)
Processes Included: Full process chain including biomass production/collection, pre-treatment, local and international transport and conversion of the biomass into electricity.
Strengths: Most of calculations are transparent with explicit representation on how calculations are made. Reference systems considered are relevant. Very detailed references to data sources behind calculations.
Weaknesses: Cost data and time-dependent parameters are not considered in the study.
Key Citations: 1. GEMIS and SIMAPRO 5.0 LCA databases 2. Boudewijn, R. and Koopmans, WF. (2002), Milieu-effectrapport (MER). Mee- en/of bijstoken van secundaire brandstoffen op het Amercentralecomplex te Geertruidenberg, Essent Energie Productie B. V.

Year of Publication: 2003
Authors: Elsayed, M.A, Matthews, R. and Mortimer, N.D.
Publication Type: Contract report
Full Reference: Carbon and Energy Balances for a Range of Biofuels Options. Project Number B/B6/00784/REP. URN 03/836. Resources Research Unit, Sheffield Hallam University, March 2003. Available online: http://www.shu.ac.uk/rru/projects/biofuels/biofuels.html
Systems Considered: Energy balances and greenhouse gas outputs of 18 separate biofuel technologies, consisting production of biodiesel, combined heat and power, electricity, ethanol, heat, and rapeseed oil.
Processes Included: Provision, transport, storage, processing, plant construction, maintenance, and decommission.
Strengths: Flow charts covering essential stages are represented. Very detailed and transparent data on energy requirement and greenhouse gas emissions (CO ₂ , CH ₄ , N ₂ O) provided in the form of spreadsheets. Includes an updated review on proper studies concerning energy balances and associated greenhouse gas emissions for a range of biofuel options. Allocation procedures clearly indicated.
Weaknesses: Cost, timing issues and reference systems are not considered.
Key Citations: Numerous

Year of Publication: 1995
Authors: Fossdal, S.
Publication Type: Contract report
Full Reference: Fossdal, S. (1995). Energi- og miljøregnskap for bygg (Energy and Environmental Accounts of Building Construction). Report 173, The Norwegian Institute of Building Research, Oslo.
Systems Considered: Energy consumption and emissions associated with production of more than 30 different building materials in Norway.
Processes Included: Production of raw materials, manufacturing of building products, transportation to consumer.
Strengths: Fairly transparent calculations and flow charts are represented. Energy consumption is separated and expressed as electricity and fossil fuels.
Weaknesses: The report is written in Norwegian. CO ₂ is the only greenhouse gas considered in the study. Energy consumption and emissions from disposal of buildings have not been studied. Costs are not included in the analysis.
Key Citations:

Year of Publication: 2002
Authors: Gustavsson, L., Karlsson, Å.
Publication Type: Journal paper
Full Reference: Gustavsson, L., Karlsson, Å. (2002). A System Perspective on the Heating of Detached Houses. <i>Energy Policy</i> , Vol. 30, Issue 7, pp 553–574.
Systems Considered: Primary energy use, emissions and costs of heating detached houses in rural areas in Sweden. Both electricity and local fuel-based systems have been included in the analysis.
Processes Included: Whole energy system chains from natural resource to end-user. A reference entity has been defined as one unit of heat (1 MWh).
Strengths: Clear definition of system boundary and explicit explanation of what is ignored. Flow charts are provided for different heating systems. Primary energy use, associated emissions and costs are all considered. Fairly transparent methods on how calculations are made. Changes in carbon stocks in the biological systems are considered. A sound basis for the selection of reference systems.
Weaknesses: Lack of transparency associated with some calculations. Greenhouse gas emissions are expressed as CO ₂ equivalents only. The data probably relatively country specific.
Key Citations: many

Year of Publication: 2003
Authors: Gustavsson, L. and Karlsson, Å.
Publication Type: Journal paper
Full Reference: Gustavsson, L., Karlsson, Å. (2003). Heating Detached Houses in Urban Areas. <i>Energy</i> 28, pp 851–875.
Systems Considered: Primary energy use, emissions and costs of heating detached houses in urban areas in Sweden. District heating systems using cogeneration, as well as electricity and local fuel-based systems have been included in the analysis.
Processes Included: Whole energy system chains from natural resource to end-user. A reference entity has been defined as one the sum of 1 MWh heat used in a detached house and the maximum amount of electricity that could be cogenerated from any of the systems being compared when producing 1 MWh of heat to be consumed.
Strengths: Clear definition of system boundary and explicit explanation of what is ignored. Primary energy use, associated emissions and costs are all considered. Fairly transparent methods on how calculations are made. A sound basis for the selection of reference systems.
Weaknesses: Lack of transparency associated with some calculations. Greenhouse gas emissions are expressed as CO ₂ equivalents only. The data probably relatively country specific. Some uncertainty associated with the emissions of CH ₄ and hydrocarbons due to classification in sources used. The changes in carbon stock in the biosphere was only estimated roughly.
Key Citations: 1. Gustavsson, L., Karlsson, Å. (2002). A System Perspective on the Heating of Detached Houses. <i>Energy Policy</i> , Vol. 30, Issue 7, pp 553–574. and many others

Year of Publication: 2002
Authors: Helynen, S., Flyktman, M., Mäkinen, T., Sipilä, K. and Vesterinen, P.
Publication Type: Contract report
Full Reference: Helynen, S., Flyktman, M., Mäkinen, T., Sipilä, K., Vesterinen, P. (2002). The Possibilities of Bioenergy in Reducing Greenhouse Gas Emissions (in Finnish, with English abstract). VTT Research Notes 2145. 110 p. + app. 2 p.
Systems Considered: Regional economic production and large-scale (> 1 MW) utilisation potential of solid biofuels using industrial wood residues, logging residues, and thinnings as raw material in Finland by 2025. Achievable CO ₂ emission reductions by substituting fossil fuels and peat with biofuels. Economic competitiveness of biofuels in small-scale (< 1 MW) heating systems compared to oil-fuelled systems.
Processes Included: Price level of biofuels production and corresponding procurement potentials. Increase potential of biofuels utilisation in existing or planned large-scale (>1 MW) power plants fuelled by wood fuels or peat and in pulverised coal boilers. Heating costs of using wood pellets, wood chips, pyrolysis oil or domestic fuel, in small-scale (< 1 MW) boilers.
Strengths: Average production costs estimation for wood chip production from final-harvest forest fellings using terrain chipping, roadside chipping, loose residue chipping or bale chipping, in the function of long-distance transportation range have been represented. Both currently existing and under development energy production technologies with associated investment and operation cost estimates have been considered. Assessments of investment and operation costs for different types of large- and small-scale energy production technologies have been represented.
Weaknesses: Lack of transparency associated with some calculations. System boundary in emission reduction calculations is unclear. Emissions from fuel production chains have not been considered. Only CO ₂ emissions from combustion have been included. Link between production and use potential of biofuels is unclear. Transparent cost structures are only represented for some chosen case. References of some numbers are unclear.
Key Citations: many

Year of Publication: 1998
Authors: Jungmeier, G., Resch, G. and Spitzer, J.
Publication Type: Journal paper
Full Reference: Jungmeier, G., Resch, G., Spitzer, J. (1998). Environmental Burdens Over the Entire Life Cycle of a Biomass CHP Plant. Biomass and Bioenergy, Vol. 15, No. 4/5, pp 311–323, 1998.
Systems Considered: A life cycle inventory on a 1.3 MW _e biomass CHP plant located in Austria.
Processes Included: Entire life cycle of the plant including construction, operation and dismantling.
Strengths: Different environmental burdens over the entire life cycle evaluated and represented. Relatively detailed data on characteristics of the plant.
Weaknesses: Lack of transparency. Only some parts of the life cycle inventory are represented resulting in a demand to refer key studies behind calculations. Costs are not considered. Data relatively case specific.
Key Citations: 1. Müller, R., Riegler, J., Jungmeier, G., Spitzer, J., Kostal, T., Obermann, G., Klimbacher, J., Pree, K., Pirker, O., Anwander, B. (1999). The National Implementation of the ExternE Accounting Framework – The Austrian Case Study. JOS-CT95-0010. 163 p. 2. Resch, G. (1997). Life Cycle Inventory of a Biomass Fired Combined Heat and Power Plant. Technical University of Graz. Vol 80. 1997.

Year of Publication: 2003
Authors: Jungmeier, G. and Hausberger, S.
Publication Type: Proceedings article
Full Reference: Jungmeier, G., Hausberger, S. (2003). Greenhouse Gas Reduction and Costs of Implementing the EC Biofuel Directive in Austria. In: Bioenergy 2003, International Nordic Bioenergy Conference from 2 nd to 5 th September 2003 Proceedings. FINBIO - The Bioenergy Association of Finland, 2003. pp 371–375.
Systems Considered: The effects on GHG emissions and costs of implementing the EC Biofuel Directive in the Austrian transportation sector. 101 transportation systems with biofuels and 40 systems with fossil fuels.
Processes Included: entire life-cycle including land use change and by-products as well as construction and dismantling of the production facilities.
Strengths: Data considered probably updated.
Weaknesses: The results represented are not directly useful resulting in a demand to refer the study (written in German) behind the article.
Key Citations: 1. Jungmeier, G., Hausberger, S., Canella, L. (2003). Treibhausgas-Emissionen und Kosten von Transportsystemen – Ein Vergleich von biogenen und fossilen Treibstoffen (Greenhouse Gas Emissions and Costs of Transportation – A Comparison of Fossil and Biogenic Fuels). Joanneum Research. April 2003. 2. Hausberger, S. (2003). Simulation of Real World Vehicle Exhaust Emissions. VKM-THD Mitteilungen, Heft/Volume 82. Verlag der Technischen Universität Graz, 2003.

Year of Publication: 2003
Authors: Karlsson, Å., and Gustavsson, L.
Publication Type: Journal paper
Full Reference: Karlsson, Å., Gustavsson, L. (2003). External Costs and Taxes in Heat Supply Systems. Energy Policy, Vol. 31, pp 1541–1560.
Systems Considered: External costs and taxes of heating detached houses by district heating, electric heat pumps, electric boilers, natural-gas-, oil- or pellet-fired local boilers in Sweden.
Processes Included: Whole energy system chains from natural resource to the required energy services, including the extraction, transportation and refining of fuels. A reference entity has been defined as one unit of heat (1 MWh).
Strengths: Clear definition of system boundary and explicit explanation of what is ignored. Primary energy use, associated emissions, as well as direct and external costs are all considered. Fairly transparent methods on how calculations are made. A sound basis for the selection of reference systems and the cost allocation.
Weaknesses: Lack of transparency associated with some calculations. Most of the data probably relatively country specific.
Key Citations: 1. Gustavsson, L., Karlsson, Å. (2002). A System Perspective on the Heating of Detached Houses. Energy Policy, Vol. 30, Issue 7, pp 553–574. 2. Gustavsson, L., Karlsson, Å. (2003). Heating Detached Houses in Urban Areas. Energy 28, pp 851–875 and many others

Year of Publication: 2003
Authors: Mortimer, N.D., Cormack, P., Elsayed, M.A and Horne, R.E.
Publication Type: Contract report
Full Reference: Mortimer, N.D., Cormack, P., Elsayed, M.A., Horne, R.E. (2003). Evaluation of the Comparative Energy, Global Warming and Socio-Economic Costs and Benefits of Biodiesel. Final Report, for the Department of the Environment, Food and Rural Affairs. Contract Reference No. CSA 5982/NF0422. Report No. 20/1, January 2003.
Systems Considered: Evaluation of energy, global warming and socio-economic costs and benefits of producing biodiesel from oilseed rape in the United Kingdom, compared to low sulphur diesel, ultra low sulphur diesel and compressed natural gas.
Processes Included: Full process chain from provision to final product, and to comparison of final fuel use.
Strengths: Clear definition of system boundary, allocation procedures and reference systems considered. Fairly transparent calculations with very detailed and well-cited data. Clear representation of flow charts. Conventional and modified production of biodiesel from oilseed rape considered.
Weaknesses: Costs examined and cost-effectiveness results are based on the government subsidies.
Key Citations: 1. IFEU (1997). Nachwachsende Energieträger - Grundlagen, Verfahren, Ökologische Bilanzierung (Renewable Energy Sources, Basis, Processes and Ecological Balance). Kalschmitt, M., Reinhardt, A. (eds.). Institut für Energie- und Umweltforschung Heidelberg GmbH. Germany, 1997.

Year of Publication: 2003
Authors: Mäkinen, T. and Sipilä, K.
Publication Type: Proceedings article
Full Reference: Mäkinen, T., Sipilä, K. (2003). Liquid Biofuels for Transportation: Production Costs in Scandinavia. In: Bioenergy 2003, International Nordic Bioenergy Conference from 2 nd to 5 th September 2003 Proceedings. FINBIO - The Bioenergy Association of Finland, 2003. pp 376–382.
Systems Considered: Production potential, utilisation and production costs of liquid biofuels in Scandinavia.
Processes Included: -
Strengths: Updated data on production costs (€/MWh) of methanol and ethanol.
Weaknesses: Lack of transparency. Cost-structure is not represented.
Key Citations: many

Year of Publication: 2001
Authors: Mälkki, H. and Virtanen, Y.
Publication Type: Contract report
Full Reference: Mälkki, H., Virtanen, Y. (2001). Hakkuu- ja sahatähteiden energiakäytön elinkaariarviointi. Elinkaari-inventaario ja ympäristövaikutusarvio (Life Cycle Analysis on Energy Use in Logging and Saw Residues. Life Cycle Inventory and Environmental Impact Assessment). Puuenergiaketjujen ympäristönäkökohtien hankekokonaisuus (PUUT11). Tekes Puuenergian teknologiaohjelma, 2001.
Systems Considered: Environmental burdens and impacts of the logging and sawmill residues throughout the whole fuel chain from the forestry to energy production. Terrain and roadside chipping chains for fresh and dry logging residues as well as small-scale and industrial sawmill residue chains were considered.
Processes Included: Forestry, provision, transport, processing, combustion.
Strengths: Allocation factors and input parameters explicitly represented, resulting in fairly transparent calculations. CO ₂ , CH ₄ and N ₂ O emissions are represented separately. Combustion emissions are based on measurements.
Weaknesses: Many important issues, such as the processes and the time span of the forestry, nutrient economy of the forests including various options of nutrient generation, recycling and compensating fertilisation, soil emissions, carbon cycle, biodiversity, storage of chips and sawmill residues, as well as plant construction, maintenance and decommission, have not been considered. Data relatively country and area specific. Costs are not considered. Reference systems considered probably outdated. The source for some parameters is not clear.
Key Citations: many

Year of Publication: 2001
Authors: Ohlström, M., Mäkinen, T., Laurikko, J. and Pipatti, R.
Publication Type: Contract report
Full Reference: Ohlström, M., Mäkinen, T., Laurikko, J., Pipatti, R. (2001). New Concepts for Biofuels in Transportation. Biomass-Based Methanol Production and Reduced Emissions in Advanced Vehicles. Technical Research Centre of Finland, VTT Research Notes 2074. Espoo, 2001. 94 p. Available online: http://www.vtt.fi/inf/pdf/tiedotteet/2001/T2074.pdf
Systems Considered: New concepts for methanol and hydrogen production from wood-based biomass and achievable GHG emission reductions from the use of these fuels in advanced vehicles. Methanol or hydrogen production has been integrated to CHP production of an existing pulp mill in Finland or Far East.
Processes Included: Fuel chain from provision of raw material to use of produced fuels in vehicles.
Strengths: Fairly transparent calculations and relatively detailed data represented. 7 individual use cases for family car and urban commuter considered. Methanol production from natural gas as well as gasoline and diesel production from crude oil considered and compared. Assumptions and cost estimates of methanol production from woody biomass are represented explicitly.
Weaknesses: Costs of vehicles and fuel distribution are excluded. Cost factors are only represented for methanol production from biomass. Land use change issues and timing of inputs and outputs not considered.
Key Citations: many

Year of Publication: 2000
Authors: Palosuo, T. and Wihersaari, M.
Publication Type: Contract report
Full Reference: Palosuo, T. and Wihersaari, M. (2000). Energy Use of Forest Residues - Impact on Soil Carbon Balance (in Finnish, with English abstract). VTT Energy reports 9/2000. VTT Energy, Espoo, Finland.
Systems Considered: The effect of the collection of harvest residues to the carbon reservoir in Finnish upland forest soils.
Processes Included: Model calculations of decomposition of the harvest litter and development of the soil carbon reservoir after the final harvest of Scots pine and Norway spruce stands at the age of 100 years.
Strengths: The basis of calculations is fairly transparent. Flow charts are provided and reference system is comparable.
Weaknesses: CO ₂ is the only greenhouse gas considered in the analysis (N ₂ O is excluded due to lack of data). Recalculations with various parameters without the model are likely difficult to implement.
Key Citations: Wihersaari, M. and Palosuo, T. (2000). Greenhouse Gas Emissions from Final Harvest Fuel Chips Production (in Finnish, with English abstract). VTT Energy reports 8/2000. VTT Energy, Espoo, Finland.

Year of Publication: 1999
Authors: Pingoud, K., Mälkki, H., Wihersaari, M., Hongisto, M., Siitonen, S., Lehtilä, A., Johansson, M., Pirilä, P., Otterström, T.
Publication Type: Contract report
Full Reference: Pingoud, K., Mälkki, H., Wihersaari, M., Hongisto, M., Siitonen, S., Lehtilä, A., Johansson, M., Pirilä, P., Otterström, T. (1999). ExternE National Implementation Finland. Technical Research Centre of Finland, VTT Publications 381. 119 p. + app. 131 p.
Systems Considered: External costs and emissions of the power production in three different power plants in Finland, fuelled by coal, peat and biomass.
Processes Included: Provision, storage, transportation, processing, combustion.
Strengths: Relatively detailed and transparent calculations related to GHG emissions. All systems considered are actual.
Weaknesses: Costs of the power production have not been considered. The results of the study are case specific. Lack of transparency associated with emissions coming from transportation of fuels. Emissions coming from coal production chain have been considered only in general level and results are not represented separately. Construction and demolition of power plant facilities have not been considered.
Key Citations: many

Year of Publication: 1997–2000
Authors: RTS
Publication Type: Document
Full Reference: RTS (1997–2000). Environmental Labels on Buildings and building parts (In Finnish). The Building Information Foundation RTS. 1997–2000, done by VTT Building and Transport. Available on URL: http://www.rts.fi/rt-ymparistoselosteet.htm .
Systems Considered: Energy consumption and emissions associated with production, use and disposal of different types of building parts in Finland.
Processes Included: Production, use and disposal of building parts.
Strengths: Evaluations are based on International Standard ISO 14040 and ISO/DIS 14041 on life cycle assessment.
Weaknesses: Only results are represented resulting in significant lack of transparency over assumptions and calculations. Energy consumption is only separated to renewable and non-renewable, and greenhouse gas emissions are represented only in terms of CO ₂ -eq. per weight or functional unit. Caloric value of the building materials has been included in the numbers, and is not represented separately. Time period used in calculations is unclear.
Key Citations: Many (depending on environmental note)

Year of Publication: 1995
Authors: Schlamadinger, B., Spitzer, J., Kohlmaier, G.H., Lüdeke, M.
Publication Type: Journal paper
Full Reference: Schlamadinger, B., Spitzer, J., Kohlmaier G.H., Lüdeke, M. (1995). Carbon Balance of Bioenergy from Logging Residues. Biomass and Bioenergy, Vol. 8, No. 4, pp 221–234, 1995.
Systems Considered: Changes in carbon storage in three soil carbon pools and the carbon fluxes to and from these pools, resulting from harvesting of logging residues. Two extreme cases where logging residues and processing waste from wood industry are or are not used for energy production.
Processes Included: Carbon cycle from the atmosphere to living biomass and through litter, humus, soil and landfill/bioenergy production to the atmosphere.
Strengths: Biospheric carbon pool sizes is the key issue. System boundary and calculation methodology clearly defined. Flow charts are represented.
Weaknesses: Differences in energy production efficiencies, auxiliary fossil energy consumptions, and in carbon emission rates has not been considered.
Key Citations: many

Year of Publication: 2002
Authors: Suurs, R.
Publication Type: Contract report
Full Reference: Suurs, R. (2002), Long Distance Bioenergy Logistics. An Assessment of Costs and Energy Consumption for Various Biomass Energy Transport Chains. Universiteit Utrecht, Copernicus Institute, Department of Science, Technology and Society, January 2002.
Systems Considered: Calculations of costs and energy consumption of various long distance bioenergy transport chains from Europe and Latin America to the Netherlands. Biomass is assumed to be converted to power or methanol.
Processes Included: Four system components are distinguished with a number of choices for each: biomass production (from forestry residues, energy crops by felling, chipping or baling), pretreatment (storage, chipping, drying, pelleting), transport (truck, train, ship), and energy conversion (power, methanol, pyrolysis oil).
Strengths: Fairly transparent calculations. Many reference systems are considered.
Weaknesses: Lack of data related to storage and transport of liquid fuels. Emissions are not concerned and energy sources are not represented separately resulting in uncertain applicability for emission reduction calculations.
Key Citations:

Year of Publication: 2000
Authors: Wihersaari, M. and Palosuo, T.
Publication Type: Contract report
Full Reference: Wihersaari, M. and Palosuo, T. (2000). Greenhouse Gas Emissions from Final Harvest Fuel Chips Production (in Finnish, with English abstract). VTT Energy reports 8/2000. VTT Energy, Espoo, Finland.
Systems Considered: Wood chip production from final-harvest forest fellings (terrain chipping, roadside chipping, terminal chipping, loose residue chipping and bale chipping).
Processes Included: Full process chain from forest to point of use.
Strengths: Fairly explicit calculations done by model (Excel). Clear definition of system boundary and representation of flow charts with detailed data. Recalculations and modifications easily feasible. Data sources are well cited. Although the effect of the collection of harvest residues to the carbon reservoir has not been taken into account, it has been well cited (see key citations).
Weaknesses: Estimates of biomass losses and emissions during possible storage of chips are based on data from composting biowaste. Some of key data used for bale chipping chain could likely be outdated due to development in this field. Costs are not considered. Input data possibly relatively country specific.
Key Citations: Palosuo, T. and Wihersaari, M. (2000). Energy Use of Forest Residues - Impact on Soil Carbon Balance (in Finnish, with English abstract). VTT Energy reports 9/2000. VTT Energy, Espoo, Finland.