Optimizing Resource Efficiency and Carbon Intensity in the Wood Processing Sector in Austria

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Resource efficiency

- Getting the most out of what you have (very general and simple definition) – very crude!

- Resource efficiency (resource productivity) – efficiency with which we use energy and materials throughout economy, i.e. the value added per unit of resource input (analogously to labour productivity) - EU COM (2003) 572

- Material efficiency: material input per product output (no indicator for environmental impact)
Material efficiency over time (1980-2000) – EU 15

- DMC
- Material efficiency (EUR/kg)
- GDP
- Population
- Material consumption per capita

EU COM (2003) 572
Change of share of materials – timber in construction

Province of lower Austria (Niederösterreich)
Teischinger et al. 2008

Average agricult. funct. building based on functional area (m²) single family homes public buildings

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2001</th>
<th>1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>average</td>
<td>37</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>agricult. funct. building based on functional area (m²)</td>
<td>45</td>
<td>30</td>
<td>39</td>
</tr>
<tr>
<td>single family homes</td>
<td>34</td>
<td>28</td>
<td>24</td>
</tr>
<tr>
<td>public buildings</td>
<td>8</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
## Value added by various value chains

<table>
<thead>
<tr>
<th></th>
<th>Sawlogs</th>
<th></th>
<th></th>
<th>Pulpwood</th>
<th></th>
<th></th>
<th>Forest Residues</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PER UNIT</td>
<td>PRODUCT</td>
<td>PER UNIT</td>
<td>PER H-yr</td>
<td>PER UNIT</td>
<td>PER UNIT</td>
<td>PER H-yr</td>
<td>PER UNIT</td>
<td>PER UNIT</td>
</tr>
<tr>
<td>Ethanol (GJ)</td>
<td>-1.4</td>
<td>-0.6 (-4)</td>
<td>-9</td>
<td></td>
<td>2.7</td>
<td>1.1 (7)</td>
<td>11</td>
<td>3.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Methanol (GJ)</td>
<td>2.0</td>
<td>1.3 (9)</td>
<td>21</td>
<td></td>
<td>4.5</td>
<td>3.1 (20)</td>
<td>30</td>
<td>4.8</td>
<td>3.0</td>
</tr>
<tr>
<td>Fischer-Tropsch-diesel (GJ)</td>
<td>-0.4</td>
<td>-0.2 (-1)</td>
<td>-3</td>
<td></td>
<td>2.9</td>
<td>1.5 (10)</td>
<td>15</td>
<td>3.4</td>
<td>1.6</td>
</tr>
<tr>
<td>Pellets (GJ)</td>
<td>-1.0</td>
<td>-0.9 (-6)</td>
<td>-14</td>
<td></td>
<td>0.8</td>
<td>0.8 (5)</td>
<td>8</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Electricity (GJ)</td>
<td>-1.0</td>
<td>-0.5 (-3)</td>
<td>-8</td>
<td></td>
<td>2.3</td>
<td>1.2 (8)</td>
<td>12</td>
<td>2.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Co-generation heat &amp; power (GJ)</td>
<td>1.6</td>
<td>0.7 (5)</td>
<td>12</td>
<td></td>
<td>5.2</td>
<td>2.5 (16)</td>
<td>24</td>
<td>5.8</td>
<td>2.5</td>
</tr>
<tr>
<td>Market pulp (t)</td>
<td>191</td>
<td>5.3 (34)</td>
<td>84</td>
<td></td>
<td>252</td>
<td>7.0 (45)</td>
<td>69</td>
<td></td>
<td></td>
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<tr>
<td>Newsprint (t)</td>
<td>186</td>
<td>12 (75)</td>
<td>185</td>
<td></td>
<td>214</td>
<td>13 (86)</td>
<td>132</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LWC(^1) paper (t)</td>
<td>449</td>
<td>34 (220)</td>
<td>331</td>
<td></td>
<td>472</td>
<td>35 (230)</td>
<td>348</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particleboard (m(^3))</td>
<td>169</td>
<td>18 (120)</td>
<td>283</td>
<td></td>
<td>185</td>
<td>20 (130)</td>
<td>193</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sawn lumber (m(^3))</td>
<td>222</td>
<td>17 (110)</td>
<td>267</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sawn lumber + particleboard (m(^3))</td>
<td>318</td>
<td>24 (160)</td>
<td>383</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glued laminated beams (m(^3))</td>
<td>1010</td>
<td>63 (400)</td>
<td>990</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Sathre R, Gustavsson L (2009)
Austrian wood process chain model\(^1\)

The model should allow
- assessing a situation for resource and energy efficiency
- evaluating effects of new technologies on the economic and ecological performance
  - technical improvement
  - changed framework conditions
  - structural changes
- identifying synergies between the process chains (i.e. wood, pulp/paper, energy sector)
- revealing potentials of the wood processing sector to provide the energy sector
- unambiguous decisions for further steps

\(^1\) Project within the Austria Research Promotion Programme “Factory of Tomorrow”, BMVIT/FFG
System boundaries

saw log

industrial roundwood

surplus to energy sector

construction

furniture

packaging

other

wood-based panels

chem. pulp

mech. pulp

pulp

office

print/news

packaging

tissue

surplus to energy sector

use phase

collection recycling recovery

wood

paper

A. Teischinger et al.

EFORWOOD 2009, Upsalla
Description of the model (1)
vertical assembly – hierarchic structure

Modelling tool GaBi4 (2007): Powerful tool and databases for product and process sustainability analyses

- boundary crossing flows (resources, emissions,..) are added on upper level
- process lines are assembled to product groups (office, print, timber in construction, ...)
- processes are assembled to process lines in companies
- processes are composed of “unit process” (cooker, evaporator, dryer,..)
Description of the model (2)
horizontal assembly - paper sector

input-flows (green arrows)

intermediate products (orange and white)

companies

combustion processes

energy (red)
Model structure - wood processing (horizontal assembly, wood processing sector)

- Saw mill primary processing
- Wood processing lines
- Wood based panels
- Veneer
- Energy
- Recovered wood
Wood "quality" flow – product data sheets

The diagram illustrates the flow of wood quality and product data sheets through various stages of the wood industry, including production, packaging, and distribution. It highlights the importance of maintaining high quality standards throughout the process to ensure the product meets the required specifications.

Author: A. Teischinger, June 2009
Wood „quality“ flow – product data sheets

ÖNORM EN 1927-1: Qualitative classification of softwood round timber - Part 1: Spruces and firs
ÖNORM EN 1927-2: Qualitative classification of softwood round timber — Part 2: Pines
ÖNORM EN 1927-3: Qualitative classification of softwood round timber - Part 3: Larches and douglas firs
ÖNORM EN 1316-1: Hardwood round timber - Qualitative classification - Part 1: Oak and beech
ÖNORM EN 1316-2: Hardwood round timber - Qualitative classification - Part 2: Poplar
ÖNORM EN 1316-3: Hardwood round timber - Qualitative classification - Part 3: Ash and maples and sycamore

ÖHNU austria grading rules:
A: hochwertige Verwendungszwecke  
B: gute Standardqualität  
C: mindere Verwendungszwecke  
Cx: mindere Qualität, noch für Sägeverschnitt geeignet

ÖNORM L 1021: Measurement of round timber
ÖNORM EN 1315-1: Dimensional classification - Part 1: Hardwood round timber
ÖNORM EN 1315-2: Dimensional classification - Part 2: Softwood round timber

ÖNORM M 7132: Energy-economical utilization of wood and bork as fuel - Definitions and properties
ÖNORM M 7133: Chipped wood for energetic purposes - Requirements and test specifications ÖNORM M 7135: Compressed wood or compressed bark in natural state - Pellets and briquettes - Requirements and test specifications
ÖNORM M 7136: Compressed wood in natural state - Woodpellets - Quality assurance in the field of logistics of transport and storage
ÖNORM M 7137: Compressed wood in natural state - Woodpellets - Requirements for storage of pellets at the ultimate consumer
ÖNORM 51731: Testing of solid fuels - Compressed untreated wood - Requirements and testing

Pellets
Chips
Bark
Wood „quality“ flow – product data sheets
Where are the data derived from?

- available information for the production sites and processes in Austria
  - from inventories
  - from literature
  - Interviews with managers etc.
- pre-defined processes of Databases (ECOINVENT, PE-GABI)
- additional BRef-data (Best Available Techniques in P & P)
Target parameters

- **resource efficiency**
  - input: CO$_2$ fixed, m$^3$ wood, water
  - output: products and function

- **energy efficiency**
  - fossil and bio-based energy carrier use relative to output
  - potential flows to energy sector

- **C/CO$_2$ balance**

- **emissions**
  - conventional emissions to air (CO$_2$, NO$_x$, SO$_2$, dust)
  - water: BOD$_5$, COD (AOX, heavy metals,…….)
Current model Paper Industry
sensitivities and first results

- model of paper industry and its sensitivities were tested.
- results fit for
  - material input, material flows, produced goods
- figures do not fit for
  - energy demand
  - emissions
- reasons:
  - lack of company data, BRef poorly reflect Austrian situation
  - provision of additional energy demand – gas or biomass !?!
- sensitivity behavior on impacts could be verified, but reflection of the real situation needs some revising
Next steps and expected results

- **next**
  - interlinkage of the two models

- **further**
  - balance of the total system
  - evaluate and adjust the model to the real situation

- **finally**
  - assessment of the influence of technical innovation on the environmental characteristics and the value creation of the whole system and of single process chains

- to be established as a tool for decision makers, how can the developments be achieved that are aimed at
Thank you for your attention
Plan of the wood-flow in Austria

Model still under examination

- CO2 emission biogenic
- CO2 emission fossil
- Water emission

Wood

- Products
  - Brettschichholz
  - Schalung
  - Konstruktionsholz
  - Parkett
  - Massivholzplatte
  - Mobelholz
  - Profilholz
  - Furnierholz
  - Verpackungsholz
  - Spanplatte
  - MDF-Platte
  - Polol

- Matured timber

- Paper
  - Papier (office)
  - Verpackung (d)

- Wood chips

- Recovered paper

- Wood

- Wood products

- CO2 emissions
  - Fossil
  - Biogenic