Domestic Heating with Biomass
State-of-the-Art and Strategic Research Needs

Walter Haslinger
Vice Chair of Biomass Panel of RHC-Platform
Issue group II – Residential Technologies
Content of presentation

- Background and relevance
- Vision
- State-of-the-art
- Strategic R&D needs
- Summary
Background and relevance – Bioenergy

- **Bioenergy** – most relevant renewable energy source
- **Bioheat** – most relevant application of bioenergy
- **Residential heating** – most relevant bioheat application
- **Residential heating** – biggest absolute potential to contribute to 20/20/20 goals

Source: Sanner, Burkhard; Bilbao 2010
Background and relevance – Small scale biomass heating

- Biomass for household energy ~ 200 Mm³ = 35 Mtoe (excl. DH)
  - Target for 2020: > 400 Mm³ = 70 Mtoe
  - 86% of household energy consumption used for heat
  - Biomass covers 97% of renewable heat market

- Market: small scale combustion systems:

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Stock</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fireplaces</td>
<td>30 Mio.</td>
<td>1.7 Mio.</td>
</tr>
<tr>
<td>Stoves</td>
<td>25 Mio.</td>
<td>1.3 Mio.</td>
</tr>
<tr>
<td>Cookers</td>
<td>7.5 Mio.</td>
<td>0.5 Mio.</td>
</tr>
<tr>
<td>Boilers</td>
<td>8 Mio.</td>
<td>0.3 Mio.</td>
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LOT 15 Preparatory study, Bio Intelligence Service, 2012
A simple vision for 2020

• For **residential heating** with bioenergy
  – Solid biofuels replace heating oil totally
  – … and **strongly compete with natural gas**
The vision for 2050

• 100 % renewable heat – no fossil energy for space heating anymore
• No biomass combustion without power production
• Smart energy houses integrate sun & biomass & geothermal sources
  – Energy use
  – Energy recovery
  – Energy for smart grid
  – Heat and power store
• High hanging fruits to be planted now
Biomass fuels for domestic heating

- **Standardized fuels** – EN 14961-\(x\)
  - Fire wood
  - Wood pellets
  - Wood chips
  - ...
  - incl characterization methods

- National standards and technical guidelines for **pellets logistics and storage**

- Quality label for wood pellets - **ENplus**
Biomass combustion technologies for domestic heating

- Big variety of technologies available
  - Central heating
  - Room heating
  - Cooking
  - Combinations
  - Lifestyle and well-being

- Good performance under steady state operation

- Well established standards
  - EN 303-5
  - EN 13240
Status of μCHPs based on solid biomass fuels

• Component and system development
• First demo units in operation
• Technologies under development
  – Steam cycle technologies
  – Stirling engine
  – Thermoelectrics

www.okofen-e.com

www.buttonenergy.at
Our final goal for biomass combustion systems
Isn't it simple?

Biomass combustion systems:
- 100% Efficiency
- 100% Renewable
- Zero Emission
→ In real life operation
→ Triple A++
→ Reliable
→ At competitive prices

\[
\text{C}_6\text{H}_{10}\text{O}_5 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 5 \text{H}_2\text{O} \\
\Delta H = -18 \text{kJ/kg}
\]

Subtitles for Non-Chemists:
Biomass combustion systems:
- 100% Efficiency
- 100% Renewable
- Zero Emission
→ In real life operation
→ Triple A++
→ Reliable
→ At competitive prices

Energie und Umwelt

<table>
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<tr>
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<tr>
<td>besser</td>
<td>A++</td>
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<td>schlechter</td>
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Brennstoff: □ Scheitholz □ Pellets □ Hackgut

Wärmeleistungsbereich kW 1 – 500

Ein Datenblatt mit weiteren Geräteangaben ist in den Prospekten enthalten.

Norm EN xxx, Ausgabe MMM 201y
BioHeatLABEL-Richtlinie zz/a/EG
R&D for biomass fuels (supply) and characterization methods

- **Sustainability criteria**
- **New resources and fuels**
  - High-quality agro fuels and mixed resource fuels
  - SRF and energy crops
  - Upgraded biomass fuels (torrefied materials, biochar,…)
- **Advanced and new characterization methods**
  - Ash melting / slagging
  - Off-gassing
- **Fuel indexes**
  - PM and NOx emissions
  - Corrosion
  - Ash melting
R&D for domestic biomass heating systems

Method Development

Lab-testing methods boilers
- annual efficiency testing
- emission factor testing
- evaluation methods for hybrid systems
- field measurements for evaluation

Lab-testing methods stoves
- real life testing
- measurement methods (e.g. dust)
- efficiency testing

Other methods
- field testing methods
- methods for evaluation of secondary measures

Combustion Technology

Primary measures
- fuel feeding
- grate / pot
- combustion chamber
- air flow
- heat exchanger
- combustion control

Secondary measures
- secondary combustion
- catalysts
- particle filters
  - ceramic
  - electrostatic
  - fabric filters

Advanced control systems
- central control systems for all HVAC components
  - model based
  - intelligent

System Approach

Integration in buildings
- load control
- heat storage concepts
- external combustion air supply
- airtight combustion appliances
- chimney system development

Combination with other systems
- hybrid systems
- HVAC – all in one solutions
- heat storage control
- central control systems

Lab-testing methods stoves
- real life testing
- measurement methods (e.g. dust)
- efficiency testing

Basic research

Demonstration
Summary of strategic R&D needs

- New fuels and new characterization methods
- Fuel flexible combustion technologies
- Zero emission technologies
  - Advanced load control
  - Heat storage
- (Hybrid) systems and integrated heating systems
  - All-in-one HVAC solutions
  - Heat storage
  - Common control concepts and solutions
- µCHP
  - Material research
  - Component and system development and demonstration

Accompanied by (further) development of standards for
- assuring quality and safety along the supply chains
- characterizing fuels
- testing of appliances and systems
- more realistic system behaviour
Scientists from the RAND corporation have created this model to illustrate how a „home computer“ could look like in the year 2004. However the needed technology will not be economically feasible for the average home. Also the scientists readily admit that the computer will require not yet invented technology to actually work, but 50 years from now scientific progress is expected to solve these problems. With teletype interface and the FORTRAN language, the computer will be easily to use.
Thank you for your attention!