Bioenergy

a complex matrix, full of opportunities – and dependent on policy instruments

Björn Telenius
Outline

• Bioenergy
  - current role
  - drivers & barriers
  - many options
• Heat & Electricity
  - end-use sectors
  - conversion technology
  - feedstock
• International collaboration
Bioenergy’s current role in OECD countries

- **Gas**: 21.42%
- **Oil**: 40.90%
- **Coal**: 20.51%
- **Nuclear**: 11.64%
- **Renewables**: 5.53%
- **Biomass & Waste**: 2.96%
- **Hydro**: 2.01%
- **Other**: 0.56%
### Current use and future potential

- **Current use:** 50 EJ/a of 440 EJ/a total world energy consumption (2001)
- **Future potential (EJ/a)**

<table>
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<tr>
<th>Scenario</th>
<th>2025</th>
<th>2050</th>
<th>2100</th>
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<tr>
<td>IPCC (1996)</td>
<td>72</td>
<td>280</td>
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<td>Greenpeace (1993)</td>
<td>114</td>
<td>181</td>
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<td>Johansson et al. (1993)</td>
<td>145</td>
<td>206</td>
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<td>Dessus et al. (1992)</td>
<td>135</td>
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<td>Lashof and Tirpak (1991)</td>
<td>130</td>
<td>215</td>
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<td>Fischer and Schrattenholzer (2001)</td>
<td>350 – 450</td>
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The bioenergy matrix

- Agricultural products
- Forest products
- Waste
- Industrial by-products

- Pyrolysis
- Gasification
- Combustion
- Fermentation

- Anaerobic digestion

- Heat
- Electricity
- Transport fuels

Björn Telenius, Swedish Energy Agency, 14/06/05
Driving forces

• Energy and environmental policy objectives
  - Security of energy supply
  - Reduction of GHG emissions
  - Reduced environmental impact from waste treatment

• Other policy areas
  - Agricultural policy objectives
  - Rural development objectives
  - Industry and economic growth objectives
Barriers

- Bioenergy is and will be more expensive than fossil energy sources, i.e.:
  - Market penetration will be determined by political decisions, aiming for security of supply, environmental objectives, etc.
  - Legal instruments influencing the demand side, GHG emissions, or enabling international mechanisms, will be the most powerful instruments – driving R&D investments and cost reduction
  - R&D success will provide new options and cost reductions, but not introduce bioenergy on the markets
Drivers & Policy instruments

- Agricultural products
- Forest products
- Waste
- Industrial by-products

Pyrolysis
- Anaerobic digestion
- Combustion
- Gasification
- Fermentation

End-use
- Heat
- Electricity
- Transport fuels
Drivers & Policy instruments

Feedstock

- Agricultural products
- Forest products
- Waste
- Industrial by-products

Conversion processes:

- Pyrolysis
- Anaerobic digestion
- Gasification
- Combustion
- Fermentation

Final products:

- Heat
- Electricity
- Transport fuels
Potential for technical improvement

- Forest products
- Waste
- Industrial by-products
- Agricultural products

= global R&D focus

- Pyrolysis
- Gasification
- Combustion
- Anaerobic digestion
- Fermentation

R&D success ≠ market penetration

- Heat
- Electricity
- Transport fuels
Where is bioenergy attractive?

- Agricultural products
- Forest products
- Waste
- Industrial by-products

- Pyrolysis
- Gasification
- Combustion
- Fermentation

- Anaerobic digestion

- Heat
- Electricity
- Transport fuels
Bioenergy is not a local issue

Agricultural products

Forest products

Waste

Industrial by-products

Heat

Electricity

Transport fuels
After hydro power bioenergy is the dominating RES. It is one of the most cost efficient RES alternatives.

(As all other RES) The degree of market deployment is determined by political decisions and driven by policy instruments. The strongest instruments are:

- Demand side regulations, e.g. fuel mandates and taxation-based instruments
- Instruments overcoming geographical barriers, i.e. stimulating international trade, certificates, CDM etc.

The bioenergy matrix’ complexity offers most regions excellent opportunities to develop cost efficient options meeting varying policy objectives.
Heat & Electricity

Agricultural products

Forest products

Waste

Industrial by-products

Pyrolysis

Gasification

Combustion

Anaerobic digestion

Heat

Electricity

Transport fuels

Björn Telenius, Swedish Energy Agency, 14/06/05
End-use sector: Heat

- The most important end-use sector in countries/regions where bioenergy has played a significant role
- The most cost efficient end-use sector to introduce bioenergy in
- The end-use sector where one unit of bioenergy substitutes most fossil fuels, i.e. of importance where energy policy is driven by environmental objectives
- Often heat demand defines bio-electricity production
- Strategically important factors & opportunities:
  - Industrial biomass by-products and industry’s need for steam
  - District heating networks
  - Small scale domestic heaters
End-use sector: Electricity

- Often produced as CHP in either process industry or dedicated CHP plants
- In several ways electricity from cheap and readily available biomass takes an intermediary position between heat and transportation fuels
- In many countries co-utilization with fossil fuels is the quickest and easiest strategy to increase electricity from RES. Very strong driver for feedstock supply development. Public perception may be an issue
Conversion technologies: Combustion

- Direct combustion of solid fuels and, if electricity is produced, a rankine cycle dominate. Efficiency and cost vary with type of fuel, scale, product and degree of process integration.

- Leading hardware producers have excellent commercial technology available for most “conventional” fuels, e.g. waste, wood chips or pellets, straw, etc. No emission problems with modern technology.

- Co-utilization with fossil fuels is more cost and energy efficient than stand-alone units.

- Process integration and polygeneration are more cost and energy efficient than stand-alone or one product systems.

- Wood pellet market has introduced a revolution in both large and small scale bioenergy conversion systems.

Björn Telenius, Swedish Energy Agency, 14/06/05
Conversion technologies: Gasification

- A shift from combustion to gasification will be a major technology leap, influencing both feedstock and products.
- High priority in public R&D; but technologies are not yet enough competitive (compared to combustion and distillery based systems) to mobilise industry for large scale development.
- First commercial large scale opportunities may be in e.g.:
  - Integrated processes where production of energy products are combined with production of high value products, e.g. black liquor gasification.
  - Integrated processes which build on existing infrastructure, e.g. co-utilisation with coal.
Feedstock

• An increase in production of (bio) heat and electricity is not limited by feedstock availability. Most regions have access to cheap and readily available biomass.

• A future, policy driven, substantial increase in bioenergy demand will:
  - Increase current feedstock supply capacity
  - Support development of regional and international trade
  - Create feedstock competition among bioenergy end-use sectors
  - Mobilise more expensive production systems, e.g. agriculture

• The strongest policy instrument for feedstock supply are instruments creating an end-use sector.
Our objective
Support member countries’ objectives and efforts. New and added values are created by linking the national programmes and expertise.

Values and deliverables
Information exchange and syntheses based on R&D results and policy experiences; Platform for collaborative projects and informal contacts;

Participation
21 countries participate in 12 Tasks with an overall budget of 1.4 million USD.
The Tasks of IEA Bioenergy

- **Feedstock**
  Forest and agricultural products, municipal solid waste and recovered fuels

- **Conversion**
  Combustion, gasification, pyrolysis, anaerobic digestion, fermentation

- **Integrating research themes**
  Greenhouse gas balances, Socio-economic impact, International trade, System analysis
For long, and regardless of public R&D, all forms of renewable energy will be dependent on policy instruments.

Substitution of fossil fuels with bioenergy for heat and electricity production is a cost and energy efficient strategy to support security of supply and environmental objectives.

In most regions the bioenergy matrix offers opportunities with significant volume potential and which are competitive to most renewable energy sources.