IEA workshop on Biomass CHP
Technology status and market opportunities

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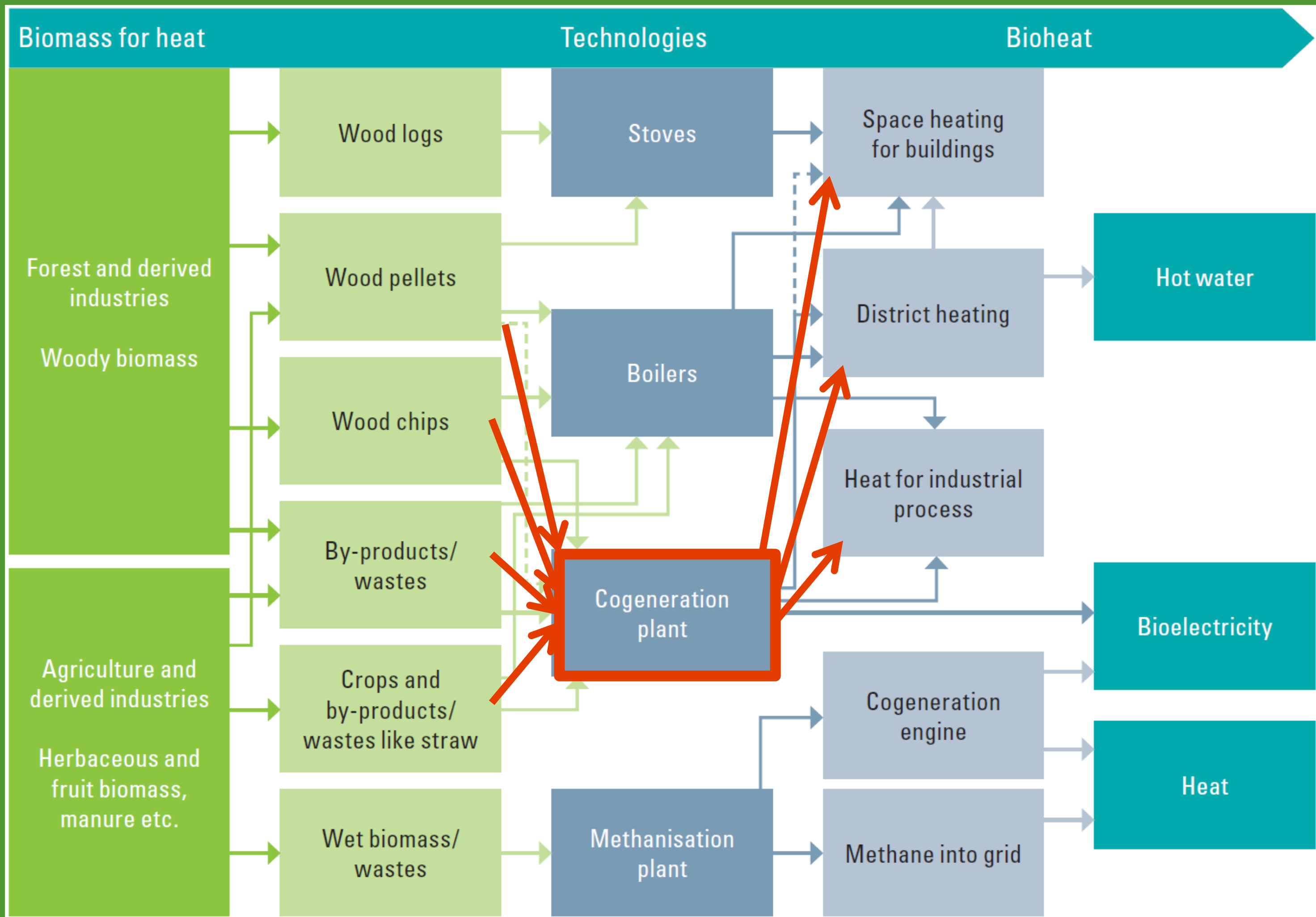
IEA Bioenergy Task 32: Biomass Combustion and Co-firing

- **Experts from 13 countries:**
  Austria, Canada, Denmark, Finland , Germany, Ireland, Italy, Netherlands, Norway, Sweden, Switzerland, Turkey, United Kingdom

- **Working together in:**
  - **Cooperative projects**
  - **Meetings, Workshops, Conferences, Excursions**
  - **Cooperation with other Networks**

- **Reports etc. can be found on our website:**
  www.ieabioenergytask32.com

Where is the market for biomass CHP?



Development of the heat market

2020:

- increased oil prices makes biomass heat much more popular for households
- Bioenergy = 60% of 2020 targets (EREC)

2030:

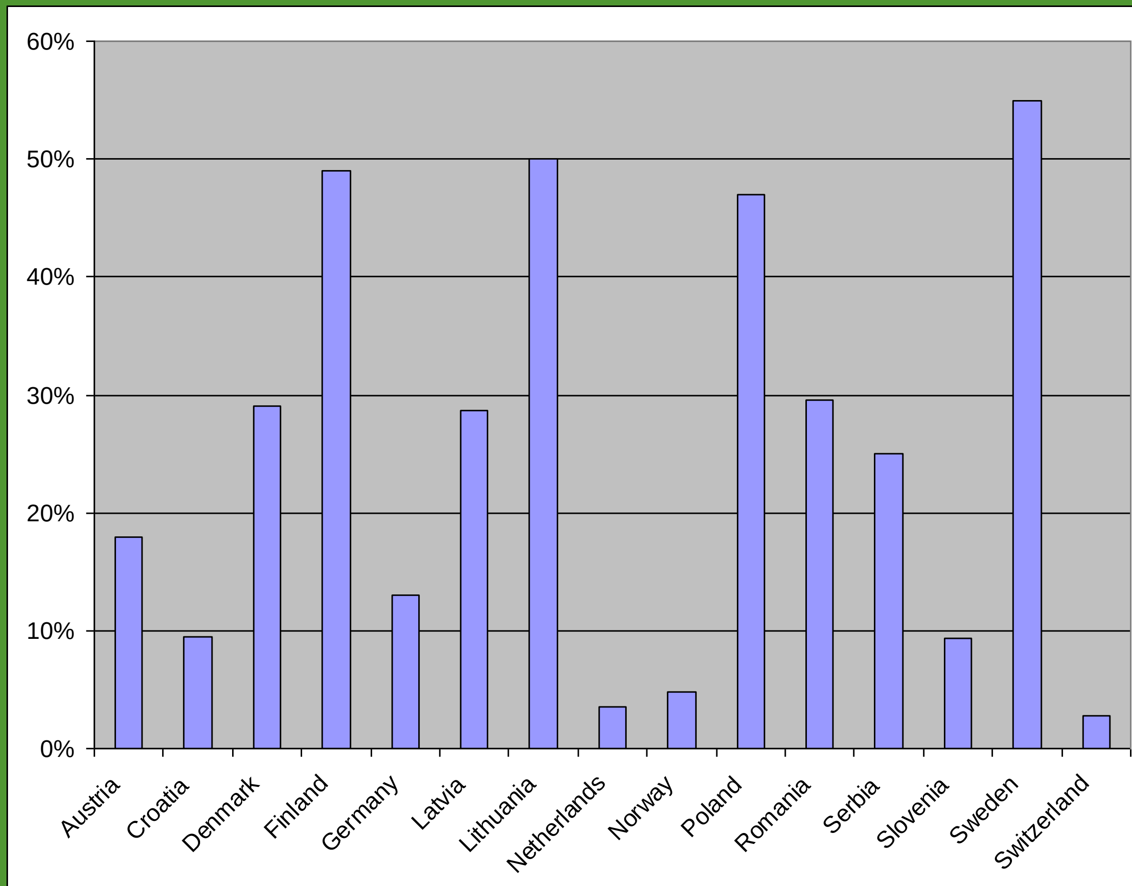
- pellets, chips and wood logs are important energy sources for individual heating
- CHP will be available from household level upwards
- DHC will be much more renewable

2050:

- Scarcity, policital tensions, make bioenergy even more popular
- No power without heat utilisation
- No heat without power production
- DHC even in rural areas

Source: Biomass For Heating & Cooling - Vision Document – Executive Summary, July 2010, ETP-RHC

Penetration of district heating in residential heating market



Source: Euroheat and Power – Country statistics on district heating, 2010

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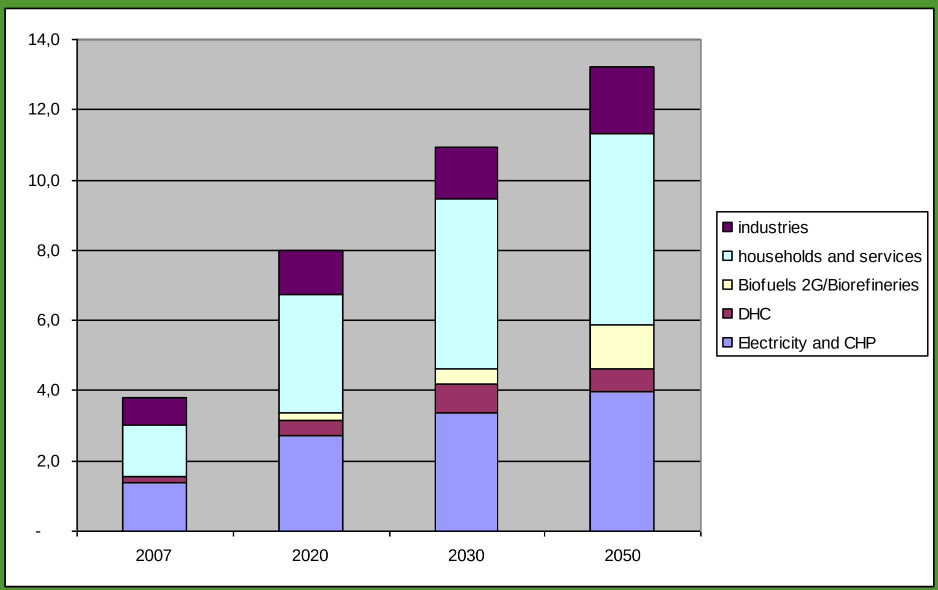
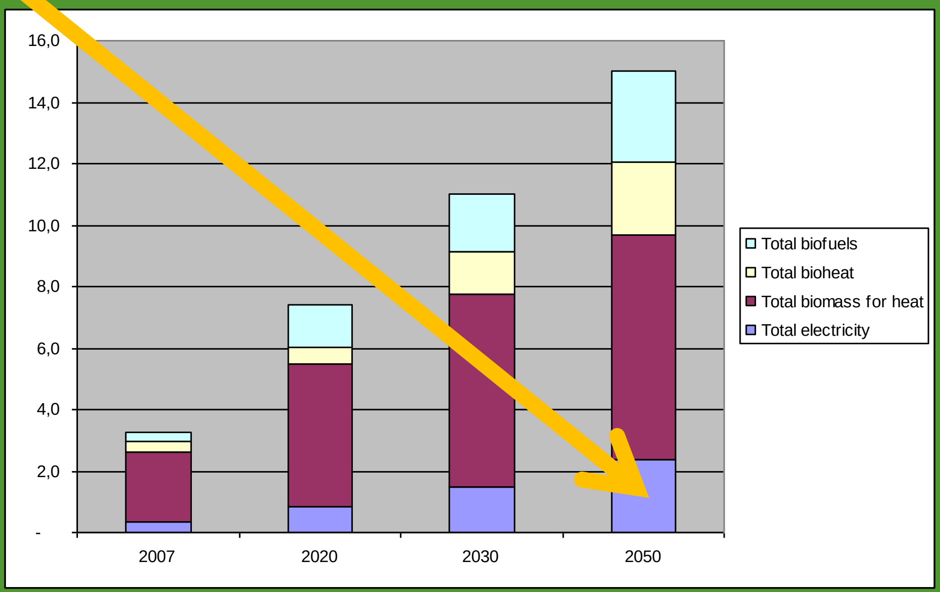
Electricity and heat from biomass will grow!

Approx 100.000 MWe!

Biomass utilisation (EJ) by end user



Final energy from biomass (EJ) by energy type



Source: All figures in EJ. Biomass For Heating & Cooling - Vision Document – Executive Summary, July 2010, ETP-RHC

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Considerations for an investor

- What is the aim of the project: commercial operation, demonstration or R&D on a pilot plant?
- Demonstrated reliability?
- Automatic operation and manpower requirements?
- Fuel flexibility?
- Electric efficiency?
- Heat efficiency and heat utilization/temperature match?
- Other synergetic aspects to consider?

Technologies: maturity stage

Technology / Presenter	Maturity	Commercial status		Comments
		# of companies	# of plants	
Thermoelectric conversion	Experimental	6	0	One producer of stoves, three of boilers, two developing companies (furnaces and thermoelectric generators)
Stirling engine w. gasifier	Commercial	1	10	Stirling.dk supplies and develops biomass fuelled CHP plants.
Gas engine w. staged gasifier	Demonstration	1	2	Operational hours: Hadsund: 1000 h, DTU-plant: 4000 h
Steam engine w. steam boiler	Commercial	1	200-300	Fully commercial technology
ORC w. hot-oil boiler	Commercial	2	150	About 10 plants installed by other companies
Gas engine w. downdraft gasifier	Commercial	Several	5	5 Pyroforce plants between 3500 to 16000 engine hours each. Globally, hundreds of similar plants exist.
Gas engine w. updraft gasifier	Commercial	Several	5	First plant in Harboøre: 120000 op. hours, including more than 80000 hours of gas engine operation
Gas engine w. indirect gasifier	Commercial	2	2	Active companies: 1) Ortner Anlagenbau 2) Repotec. Another 4 plants in construction, engineering or commissioning.
Steam syst. w. LT-CFB gasifier	Demonstration	1	2	500 kW test plant total running hours approx. 500 hours, plus 6 MW demo plant (under construction)
Gas engine w. BFB gasifier	Demonstration	1	1	10730 engine hours in the Skive plant
Steam turbine w. steam boiler	Commercial	Several	100's	Fully commercial technology

Capacity ranges

Technology	Lower MWe	Typical MWe	Higher MWe
Thermoelectric conversion	0.0001	0.0002	0.005
Stirling engine w. gasifier	0.035	0.1	0.5
Gas engine w. staged gasifier	0.2	0.5	1
Steam engine w. steam boiler	0.15	0.4	1
ORC w. hot-oil boiler	0.2	1	3
Gas engine w. downdraft gasifier	0.15	0.6	1.2
Gas engine w. updraft gasifier	1	2	5
Gas engine w. indirect gasifier	2	2.8	5.5
Steam syst. w. LT-CFB gasifier	6	25	100
Gas engine w. BFB gasifier	-	6	-
Steam turbine w. steam boiler	0.045	5	>500

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Capacity ranges

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Gas engine w. BFB gasifier	-	6	-
Steam turbine w. steam boiler	0.045	5	>500

Investment (Euro/kWe)

Technology / Presented by	Specific costs Lower €/kWe	Specific costs Higher €/kWe	Comment
Thermoelectric conversion Bioenergy 2020+	8,000	14,000	Estimate of present extra costs of thermoelectric conversion for end user compared to normal stove or boiler. Reductions expected through further R&D.
Stirling engine w. gasifier Strling.dk	3,000	6,000	Complete CHP plant
Gas engine w. staged gasifier Weiss A/S	4,000	6,200	Complete CHP plant. The lower figure represents a 1.0 MW(e) plant; the higher figure a 0.5 MW_e plant.
Steam engine w. steam boiler Spilling	500	1,000	Spilling engine alone; for complete CHP unit multiply by 3 to 3.5
ORC w. hot-oil boiler Turboden	800	2,000	ORC engine alone
Gas engine w. downdraft gasifier Pyroforce	3,500	4,000	Complete CHP plant
Gas engine w. updraft gasifier Vølund	4,000	6,000	6000 is for a 1 MW(e) turnkey plant, electromechanical scope
Gas engine w. indirect gasifier TU-Wien	5,700	6,500	Complete CHP plant
Steam syst. w. LT-CFB gasifier DONG Energy	500	1,700	As add-on gasification; excl. steam cycle; lower figure represents a large plant 100 MW thermal
Gas engine w. BFB gasifier Aaen Consulting	3,700	5,600	Investment figures refer to the derated power in the Skive plant. The lower figure refers to original budget; the higher to actual costs
Steam turbine w. steam boiler Siemens	350	850	Steam turbine unit alone. Lower figure is for approx 10 MW_e; higher for approx. 1 MW_e

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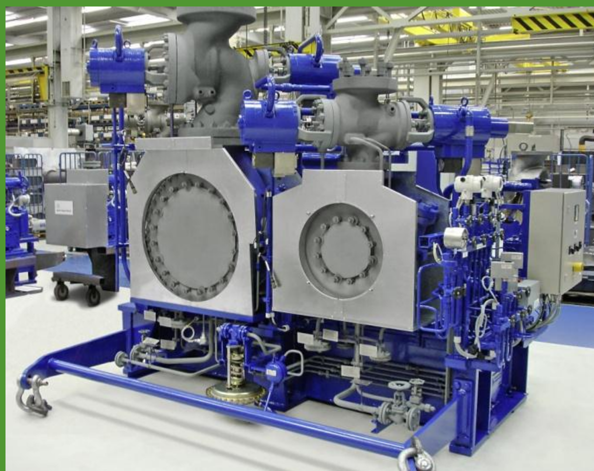
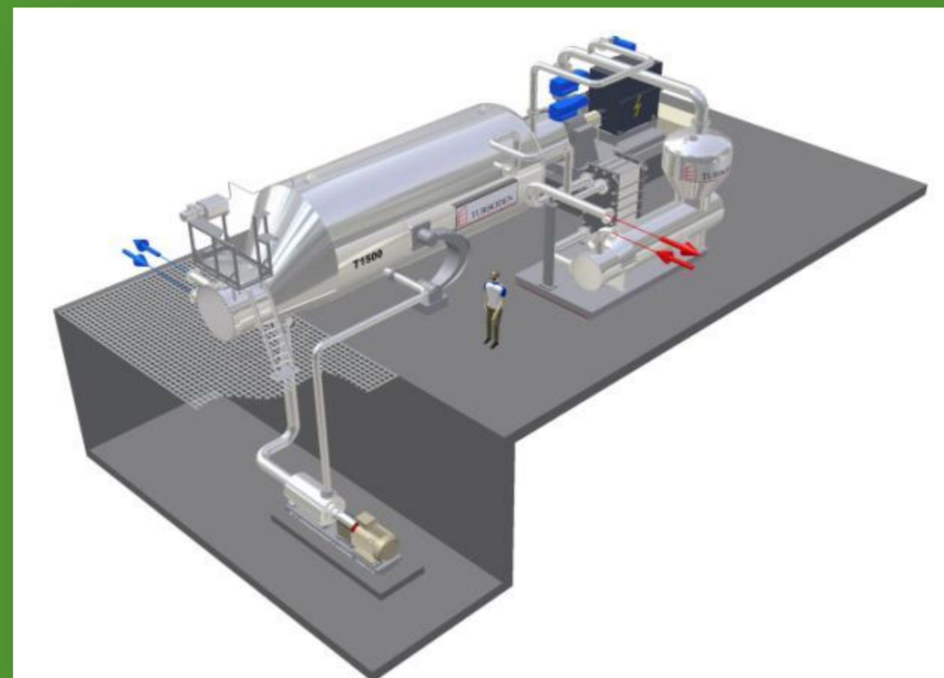
Currently commercial biomass CHP technologies



Steam turbines

Steam engines



Organic Rankine Cycle

R&D needs for biomass CHP

- Steam turbines, steam engines and ORC are mature technologies for power from biomass
- Many other technologies still need to be demonstrate operational stability on several plants and in thousands of hours
- For the smallest scale technologies, unmanned operation should be possible
- Electric efficiency is key to economic performance, and the efficiency still needs significant improvement
- Investments need to be reduced