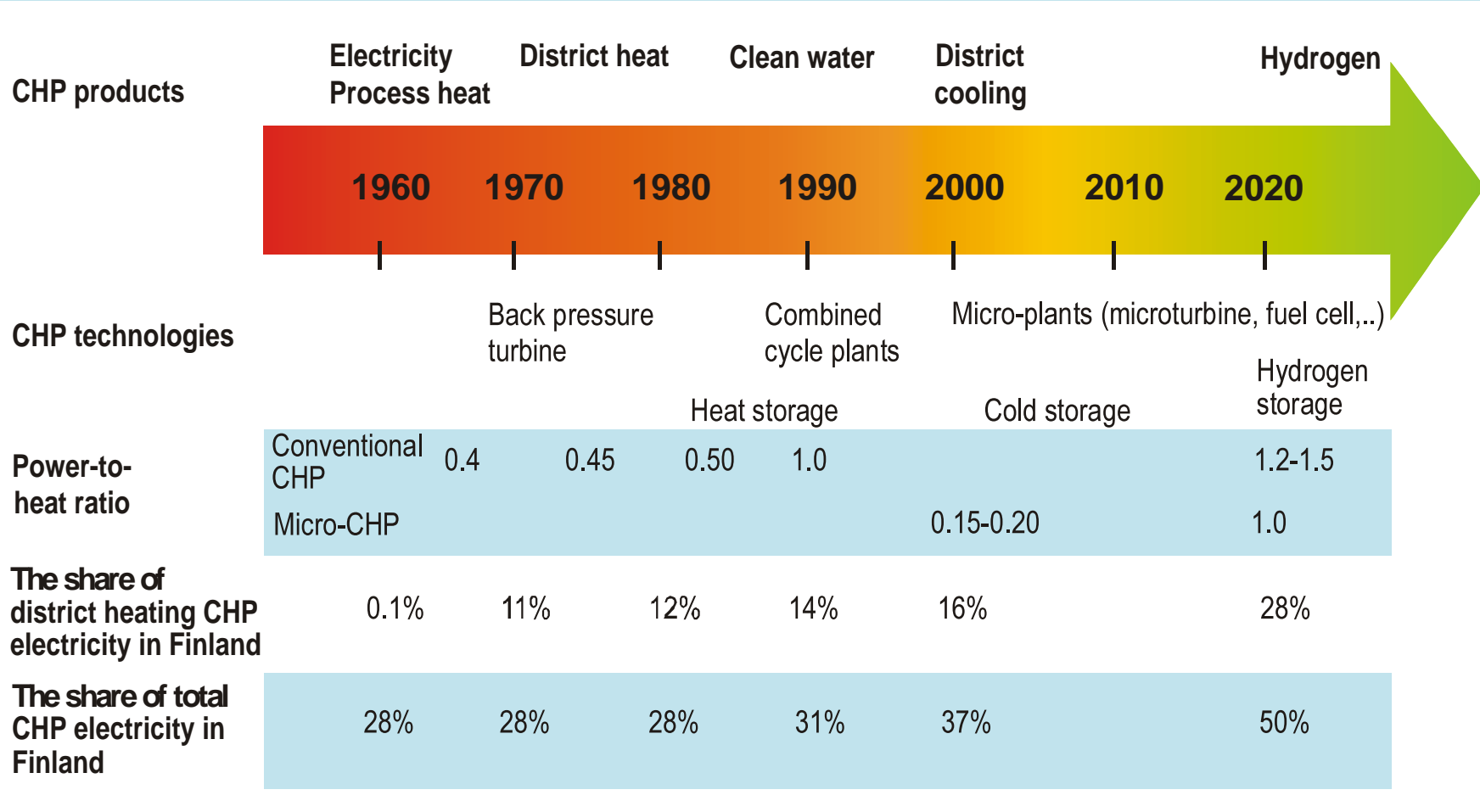


Small-scale CHP in the Future

Jari Kostama
Finnish District Heating Association

15.6.2004
Nordic District Heating Symposium
Ålesund

Development of combined heat and power production (CHP)



Source: Energy Visions for Finland 2030, VTT 2001

9.6.2004/JKo

Technologies 1(2)

- Steam turbines and engines
- Gas turbines
- Diesel and gas reciprocating engines

⇒ Well-established technology (not engines!)

⇒ However, difficulties with economy

Technologies 2(2)

- Organic Rankine cycle (ORC) turbines
 - Stirling engines
 - Microturbines
 - Fuel cells
- ⇒ No commercial impact today
- ⇒ High capital costs
- ⇒ Significant investment cost reductions as manufacturing volume increases (not ORC)

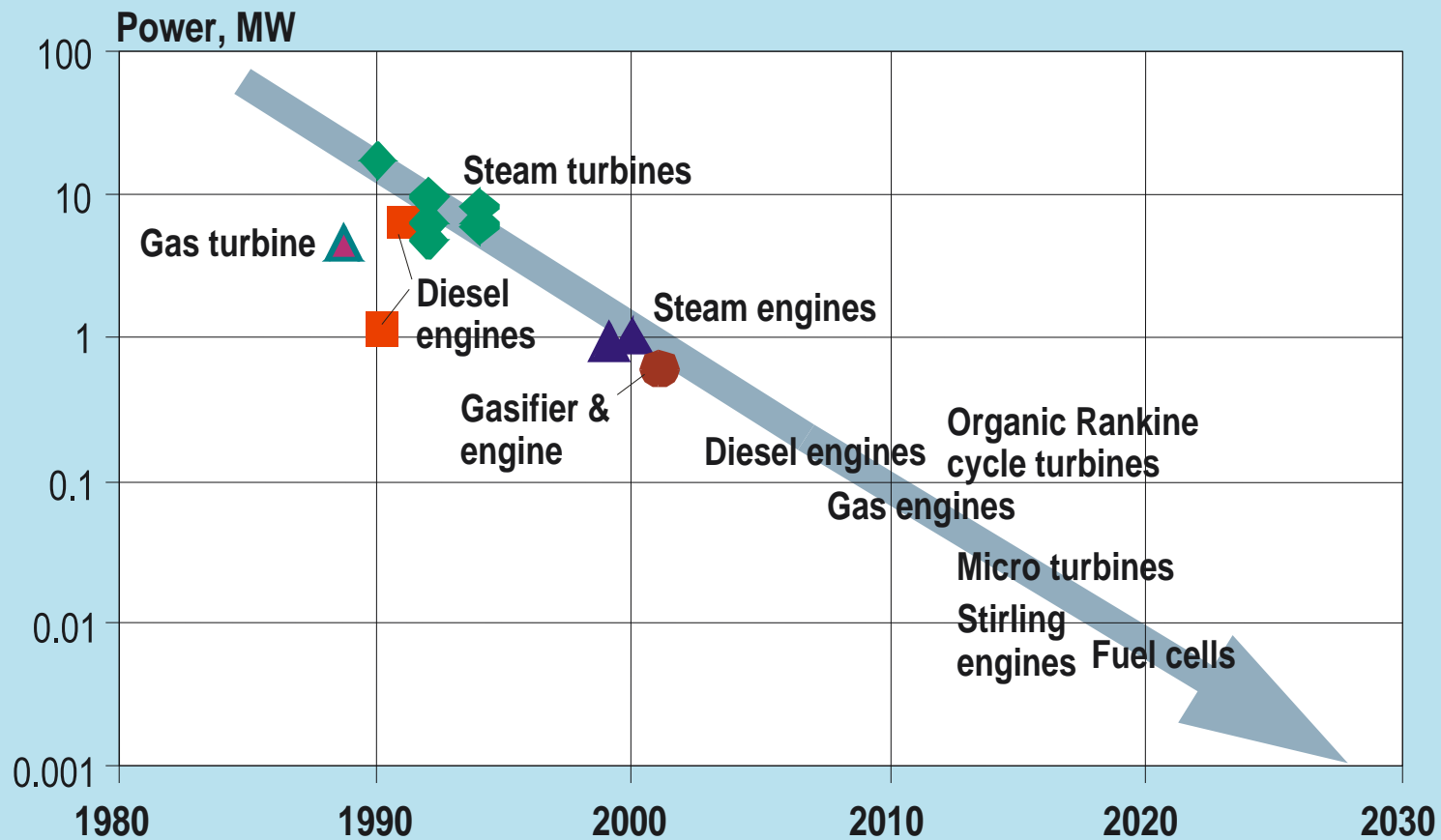
Small Scale CHP Technology Data

Technology	Diesel/Gas Engine	Steam turbine/ Engine	Stirling Engine	Gas Turbine	Micro-turbine	Fuel Cell
Size (kW)	20-10000+	0,2-10000+	2-20	500+	30-200	50-1000+
Efficiency (%)	28-43	15-35	15-35	21-40	25-20	35-54
Overall efficiency (%)	75-90	75-85	75-85	75-90	75-85	70-95
Investment cost (USD/kW)	350-1000	1500-3000	1700-3500	650-900	1000-1300	1900-3500
O&M cost (USD/MWh)	5-15	0,5-1	2-4	3-8	5-10	5-10
CO2 emissions (kg/MWh)	500-650	n.a.	n.a.	560-680	720	430-490
NOx emissions (kg/MWh)	0,2-10	n.a.	n.a.	0.3-0.5	0.1	0.005-0.01

Sources: IEA Distributed Generation in Liberalised Electricity Markets, 2002, Gaia Group Oy 2002

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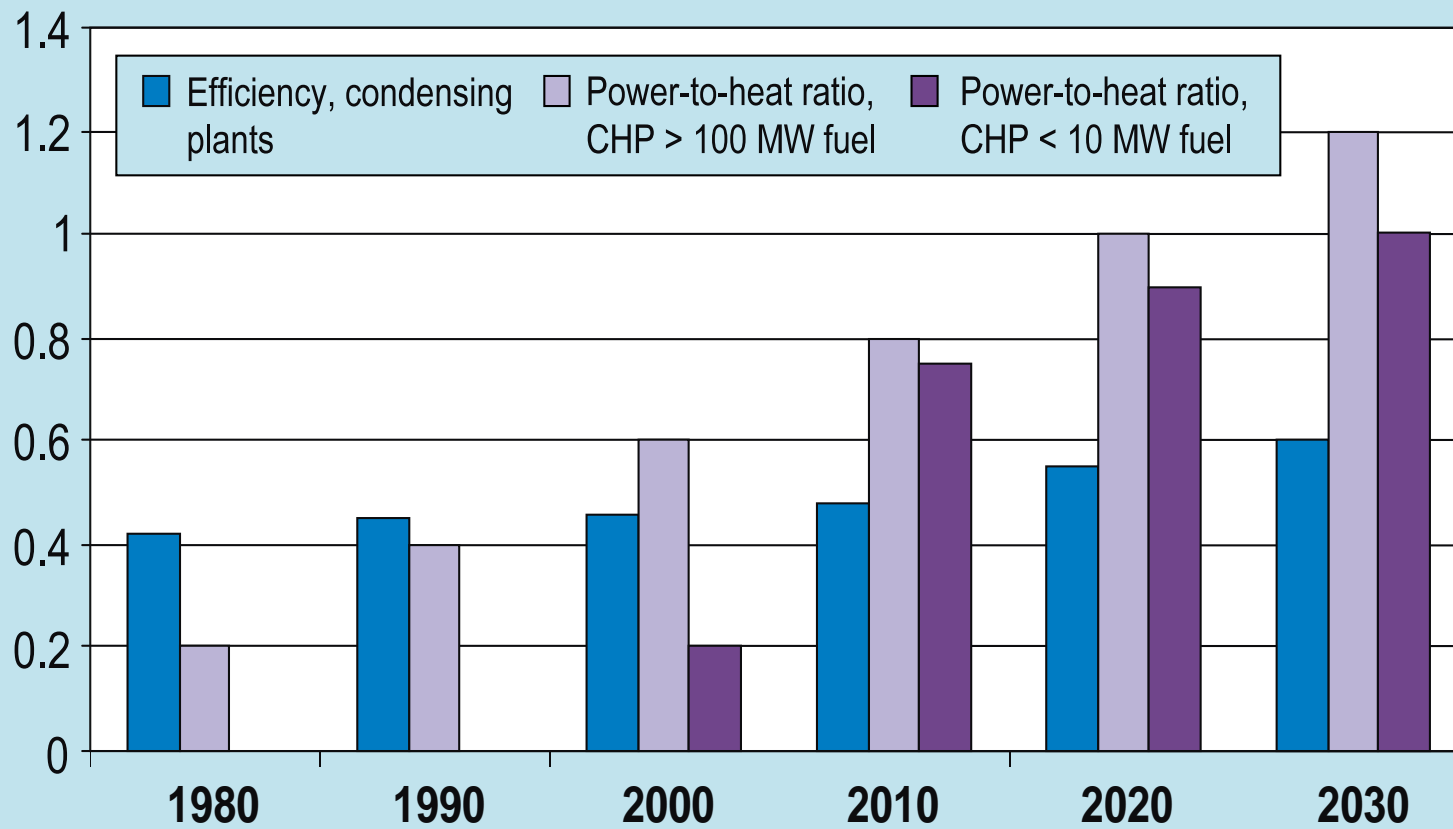
Development of competitive CHP plant size



Source: Energy Visions for Finland 2030, VTT 2001

9.6.2004/JKo

Development of solid fuel power plant performance

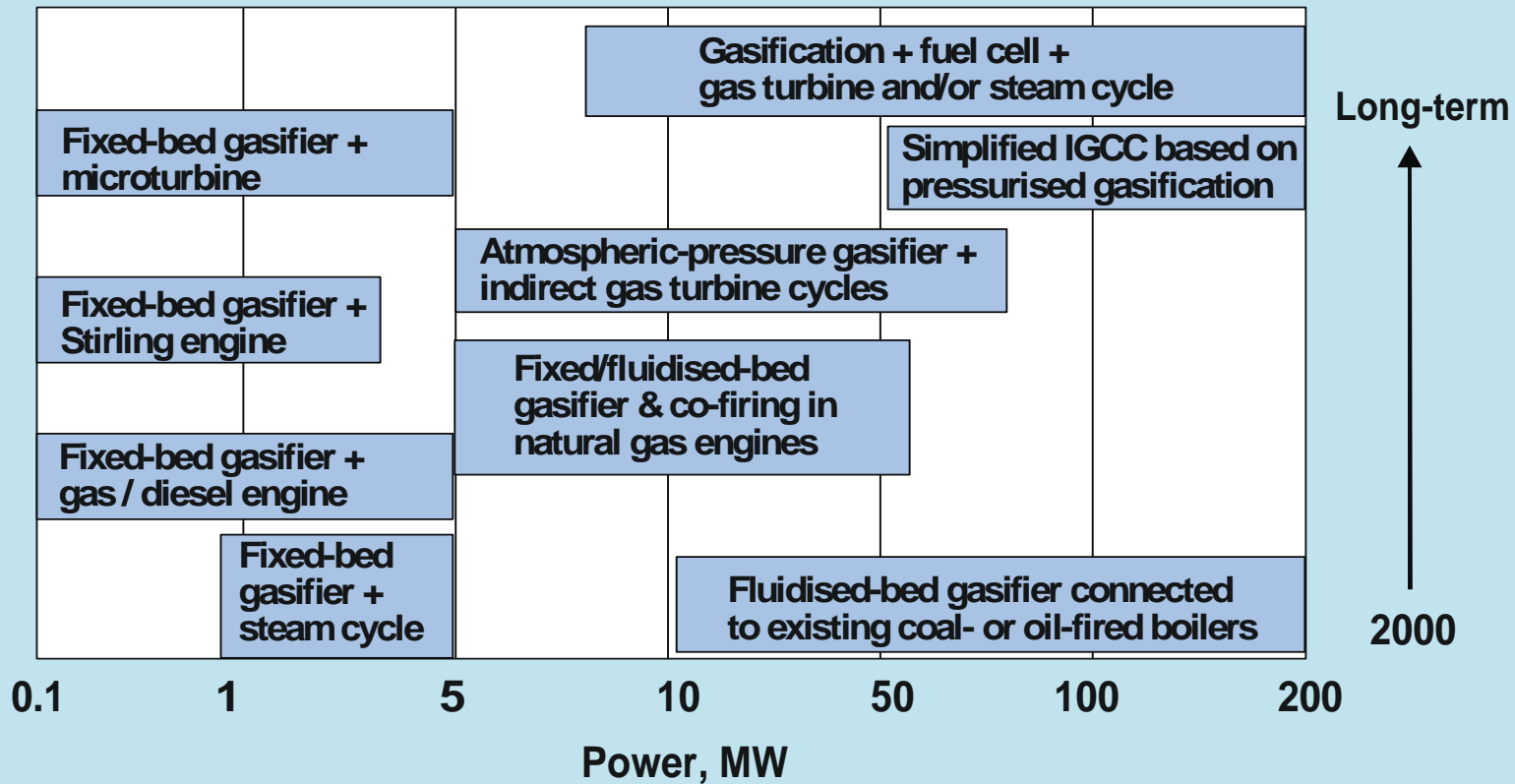


Source: Energy Visions for Finland 2030, VTT 2001

9.6.2004/JKo

Power production from biomass

Gasification-based systems for different size classes



Source: Energy Visions for Finland 2030, VTT 2001

9.6.2004/JKo

Strengths of small scale CHP

- Traditional CHP benefits
- Political desire
- Avoided electricity transmission and distribution costs (up to 30%)
- Possibility to use local fuel and natural gas
 - Considered environmentally friendly (are they?)
 - Biomass, biogas, digester gases, bio diesel, etc.
 - Different waste fractions from the industry
- Possibility to utilise local heat loads
- Security of electricity supply
- Short construction times, easier to match future energy demand

Barriers for small scale CHP ¹⁽²⁾

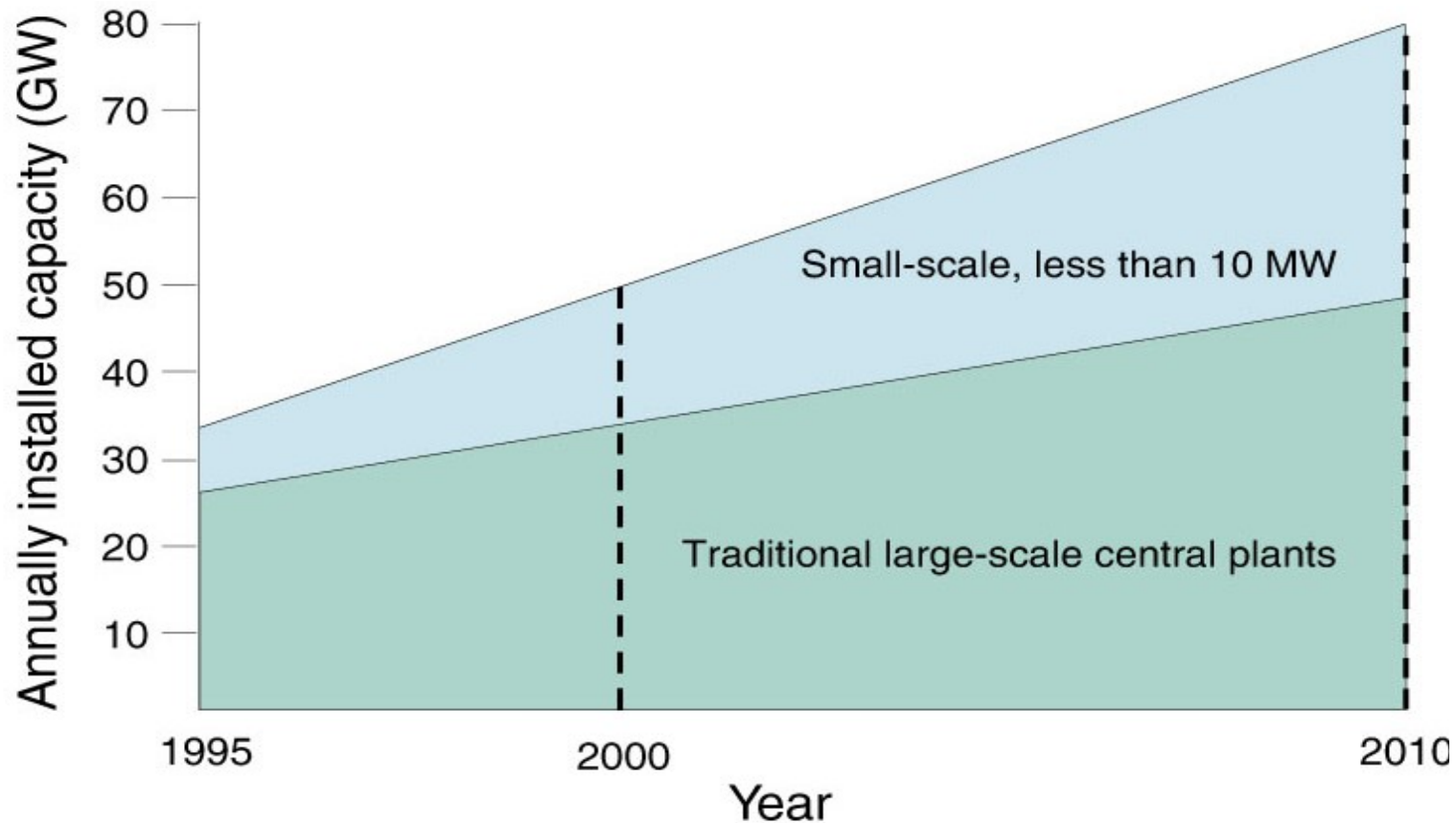
- Economies of scale matter; higher unit capital costs than for a large plant
- Poor feasibility of the technology with the current electricity prices
- Lack of competitive priced fuels
 - Biomass, natural gas, oil,...
- Administrative barriers
 - E.g. land use and building permits
- Environmental permits; the emission limits become too tight
 - Traditional emissions, CO₂, small particles, ...?
- Changes in energy policy
 - E.g. EU's Waste Incineration Directive
 - Emission trading? Subsidies?

Barriers for small scale CHP ²⁽²⁾

- Regional distribution tariffs can be unfair
- Connection to grid is technically difficult⁽¹⁾
 - Problematic or more complex protection
 - Uncertainty of power production
 - Voltage level control
 - Power quality
 - Possible negative impact on reliability
 - Increase of fault levels
 - Etc.

(1 Source: Connection of Distributed Energy Generation Units in the Distribution Network and Grid, CODGUNet Final report 2003

Developing Markets of Distributed Electricity Generation, incl. Small Scale CHP



Source: ABB

9.6.2004/JKo

Small scale CHP (<10 MWe) potential in Nordic Countries

Market forecast (Frost & Sullivan 2002, Gaia Oy 2002)

	2001 MW	2007 MW
• Denmark	189	385
• Finland	152	270
• Iceland	n.a.	n.a.
• Norway	38	85
• Sweden	96	200
• Nordic countries	475	940

Future of small scale CHP

- Small scale CHP is and will complete the Nordic electricity market
- However, no huge expansion in sight
- Market share depends essentially on
 - energy and environmental policies
 - technological development
- Steam and gas turbines, diesel and gas engines dominate the small scale CHP market
- It still remains to be seen what will be the future of micro-CHP for domestic use and when?
 - Microturbines, natural gas?
 - Fuel cells, hydrogen society?

Thank you for your
attention!

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