Energy supply of communities facing challenge of Climate Change

Energia yhdyskuntasuunnittelussa –seminaari
UP-RES -projekti
Spring 2011

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13.4.2011

INTELLIGENT ENERGY EUROPE

SITRA

Energiatehokkuus alkaa kaavoituksesta

Structure of community influences both direcly and indectly on emissions

- Directly: Dense community with less distribution infra and road km's
- Indirectly: energy supply changes which may have about 30% impact on emissions

Without emission analysis the communal decision makers are not aware of impacts of their planning seclections on energy and emeissions. Such selections have long lasting impact, even up to 100 years ahead

- Energy supply and GHG emission analysis has tobe incorporated to spatial planning and be carried out together withe Environmental Impact Analysis
- Often this should lead to more effective use of land and reduction of emissions

Source: J. Kurnitski, Sitra

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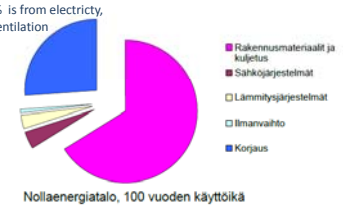
Construction materials will dominate life-cycle costs in the future

About life-cycle costs of of zero energy building (100 year life-cycle):

- 2/3 are from construction materials
- ¼ are from repairs
- The balance of some 5% is from electricty, peak time heating and ventilation



Nollaenergiatalo, 100 vuoden käyttöikä

Source: Miimu Airaksinen, VTT

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Växjö, Sweden: Multi-storey building with wood structure

The relative importance of GHG emissions of construction materials and components increases while energy efficiency get's improved.

Lähde: J. Noponen, Sitra

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Freiburg: Forerunner in Germany

All construction will be on passive-energy level from now on (2011)

Requirements will be included in the city plans and in the sales conditions of building lots

No shopping centers outside the urban areas will be allowed

Light and public transport will prioritized in traffic planning

Source: J. Noponen, Sitra

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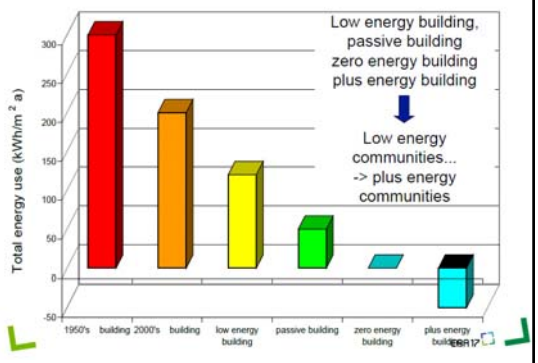
Energy revolution of building sector



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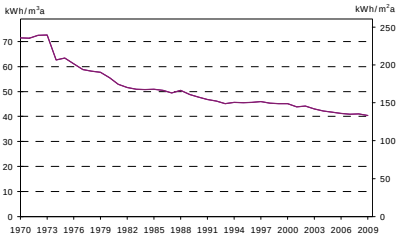
Specific heat load of all buildings connected to DH in Finland

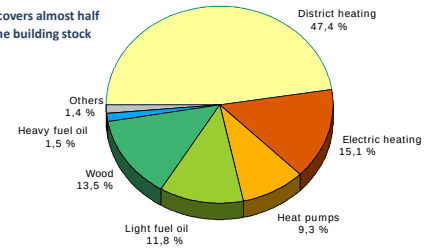


Source: Finnish Energy Industries

Market shares of heating in Finland in 2008 Residential and public buildings

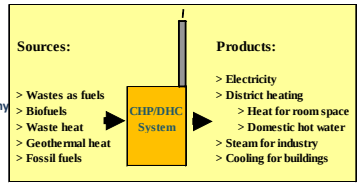
Lähde: Tilastokeskus

- DH covers almost half of the building stock



Sources and products of CHP

- Process integration yields a high overall efficiency and several energy products.
- CHP is the most efficient way to use any fuel in electricity generation

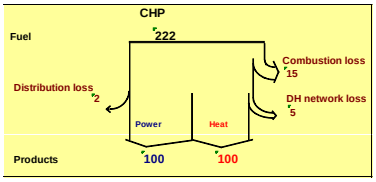


BUT:

- DH and industrial heat load are pre-conditions for CHP.
- DH system, for instance, can be considered as a water fall. You need to have a water fall to produce hydro power, and analogically, you need to have DH load to generate CHP!

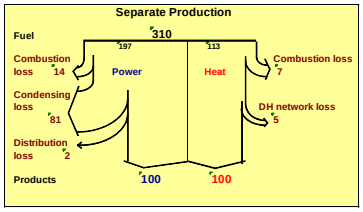
Fuel balance – CHP

Modern CHP saves about 30% of primary energy (e.g. fuel) compared with separate production of power and heat, regardless of type of fuel.



Fuel balance – Separate production

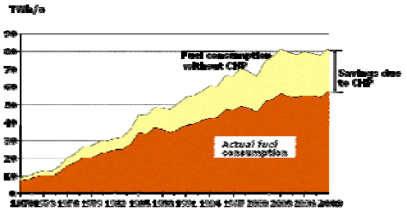
- In separate production electric power is generated by condensing power plants or gas turbines whereas heat byheat-only-boiler plants using the same fuel.
- The largest energy loss component is the process loss of power generation.



Finland: achieved fuel savings of CHP

In year 2009 the fuel savings of about 22 TWh were equal to 3 million metric tonnes of hard coal!

Such savings amounted to 600 kg of coal equivalent saved per inhabitant.



Lähde: Energiateollisuus ry

Finland: achieved CO2 emission reduction due to CHP

Regarding the previous slide, in year 2009 CO_2 –emission reduction - thanks to CHP - was 7,2 million tonnes of!

The reduction amounted to about 1400 kg of CO_2 savings per inhabitant in Finland.

Lähde: Energiateollisuus ry

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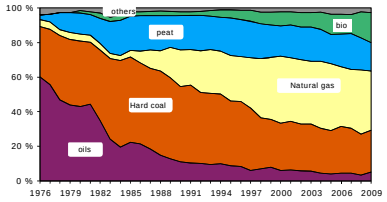
Fuels used for DH and related CHP power production - Finland

Bio fuel share is increasing

Fossil share declining



Source: Finnish Energy Industries

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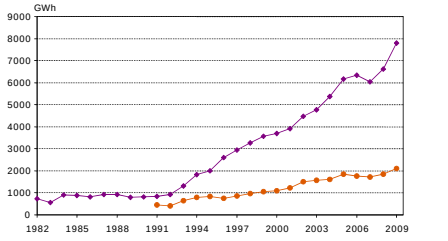
Wood as fuel used for DH and related CHP power production – Finland



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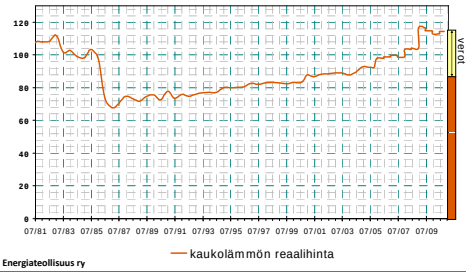
DH consumer price development in real terms

Consumer price index, 1.1.1981 = 100, including taxes



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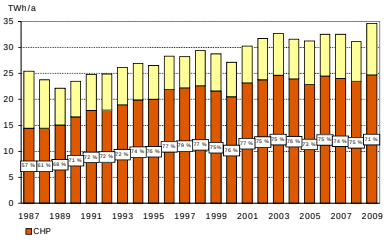
Finland -DH energy production and share of CHP



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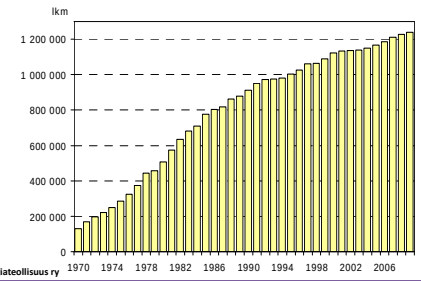
Number of apartments heated by DH in Finland



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Drivers and barriers of DH in USA

A large number of small DH systems in public buildings, not residential

Driver:
- Extension of fuel mix

Barriers
- Weak municipalities cannot support DH development
- Long-pay back times do not attract private sector

Drivers of DH – EU

Drivers:
- Preventing energy import to EU to grow from the current 50% to 70% by year 2020
- Reduction of energy related emissions

Development:
- New member countries: Rehabilitation of extensive and old DH systems (PL, HU, RO,…)
- Older member countries and Norway: Fast development of DH (DE, NO, IT, FR,..)
- Nordic countries and Austria: Increased fuel flexibility of modern DH systems (FI, SE, DK, AU)

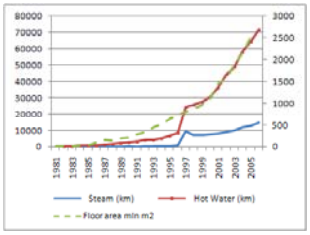
Vienna, Austria: from waste to energy

- Three waste incineration plants
- Muncipal waste as fuel
- Wien Energie –company handles 800.000 tonnes of various waste annually
- The plants are situated inside the city area

- The waste incineration plant in picture on right was designed by Architect Hundertwasser
- The plant is located near to a large hospital (200 m)
- Tourist attraction

Lähde: www.wienenergie.at

Drivers of DH in China



DH growth more than 10% a year (in 2008: 3 bln m² heated area and 80 000 km of DH networks)!

Two strong drivers:
- Improvement of air quality while replacing small and polluting boilers with DH, CHP and advanced flue gas cleaning
- Strong urbanization that requires new apartment to be built, and heated

In China, there are about 100 million people served by DH systems already.

DH drivers and barriers in Russia

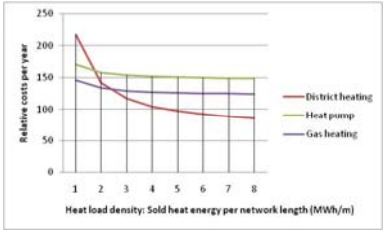
Driver:
- Rehabilitation need of outdated and inefficient but extensive DH systems

Several barriers:
- Lack of DH law
- Lack of law on house owner associations

DH extent
- Length of DH networks 186 ooo km (Finland 12 ooo km)
- Population served by DH almost 100 million

Example 1: Heat load density relative to heating mode

- Economy of DH depends on the length of the DH network
- Examples (MWh/m): Helsinki: 6 Seoul: 8



Example 2: Primary energy factors

Average primary energy factors used in Finnish energy industry

Electricity	2,0
District heating	0,7
District cooling	0,4
Fossil fuels	1,0
Renewable fuels	0,5

Source: (Raportti B85, Rakennusten energiatehokkuuden osoittaminen kiinteistöveron porrastusta varten. Teknillinen korkeakoulu, LVI-tekniikka, Espoo 2009)

Example 3: Primary energy calculation with average Finnish parameters

Let us say the heat load of a small house is set as 10 kW.

At 85% efficiency, the house needs to buy 11,8 kW of heating energy

The heating energy is generated by means of a geothermal heat pump with power factor (energy outlet per energy inlet) being typically 3,5. Thus, energy purchase would be only 3,4 kW.

Purchased energy electricty from the grid that has required primary energy of 6,8 kWh (primary energy factor=2)

As conclusion, the heat pump seems to be energy efficient on average conditions.

Example 4: Heat pumps in CHP driven systems (1)

As driving force, for the heat pump electricity is needed that is factually generated by the local CHP plant – even though purchased from the grid.

The heat energy produced by the heat pump reduces the heat production of the CHP plant

A part of the CHP power turns to separate (condensing) power due to reduced CHP heat production

The heat pump needs electric energy to generate heat

As conclusion: the primary energy consumption increases while the heat pump takes over heat load from the CHP plant.

In the next slide: a CHP plant of 40 units of electricity and 100 units of heat production is assumed as base case.

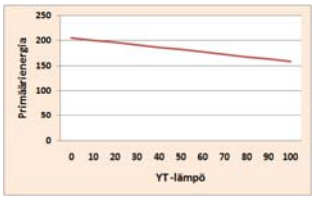
Example 4: Heat pumps in CHP driven systems (2)

Electricity				Heat			Primary
Total	CHP	Separate	Heat pump	Total	CHP	Heat pump	energy
40	40	0	0	100	100	0	158
43	36	4	3	100	90	10	163
46	32	8	6	100	80	20	168
49	28	12	9	100	70	30	172
51	24	16	11	100	60	40	177
54	20	20	14	100	50	50	182
57	16	24	17	100	40	60	187
60	12	28	20	100	30	70	191
63	8	32	23	100	20	80	196
66	4	36	26	100	10	90	201
69	0	40	29	100	0	100	206

Explanations:

CHP: power to heat ratio=	0,4	
Heat pump: heat/power=	3,5	
Boiler efficiency of the CHP plant	90 %	
CHP electrcity used for internal process in CHP =	6 %	of CHP electricity generation
Separate electricity generation: efficiency =	33 %	

Example 4: Heat pumps in CHP driven systems (3)



While CHP heat expands, the primary energy consumption declines.

Increased right to construct additional floors will help finance major thermorenovation of the old building

Source: Neapo Oy, Architect bureau Hedman & Matomäki ALAKIVENTIE 3, MYLLYPURO, HELSINKI

Lähde: J. Noponen, Sitra

Systemic changes are needed:

- Carbon thinking to be introduced at all branches of living → carbon free society
- More dense communities without compromising living comfort
- Dropping energy consumption of buiildings to lower than a quarter
- Jumping to zero emission construction
- Wellfare up – energy consumption and emissions down!

More is less!