ENERGY INFRASTRUCTURE OPTIONS

Presented by

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What I shall talk about

- Some strategic energy issues
- Heat planning in Denmark since 1979

To Improve Energy Efficiency

- Match the energy quality supplied to that needed in accordance with the second law of thermodynamics. For example, utilise reject heat for heating rather than (a) burning fuel (flame temperature 1500^{o}C) to maintain a building at 10 or 20K above ambient (second law efficiency 6%) or (b) burning fuel to make steam to turn a turbine to generate electricity for resistive heating (second law efficiency 2%).

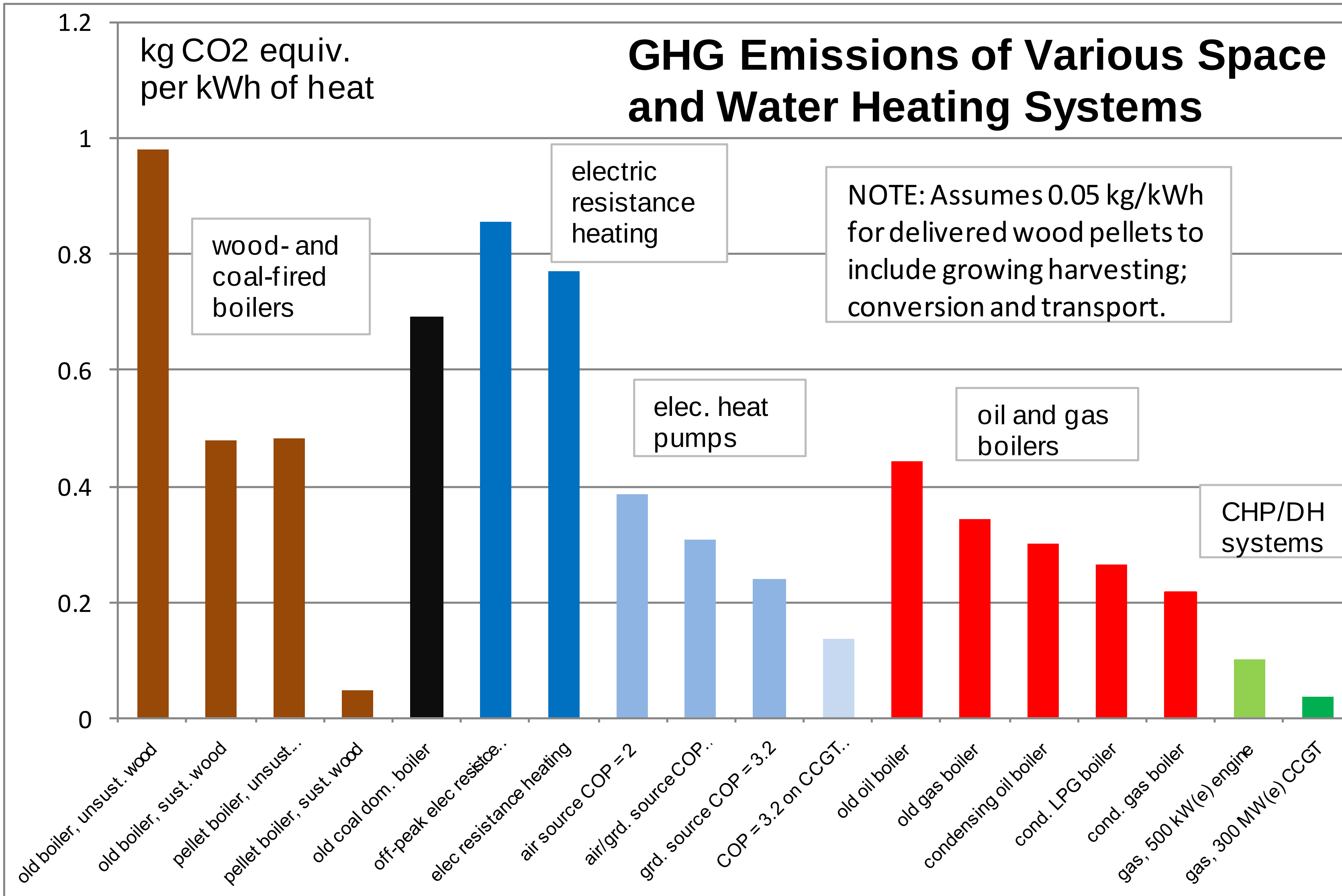
  Savings potential about 80%

and

- Where possible, reduce the quantity of energy needed. For example, insulate and draughtproof buildings to better levels. Be aware that the average new UK home is draughtier than a Swedish, German, Swiss or Canadian home built before the Second World War!

  Savings potential about 85%, more on new construction and less on retrofit

CO_2 emissions of different fossil-fuelled heating methods vary about 20-fold



Heat Supply in Denmark

65% district heating, mostly CHP

20% piped gas

15% electric heat pumps, oil and LPG, biomass heat-only boilers

Heat Supply in the UK

82% piped gas

2% district heating

8% electric resistance heating

5% oil and LPG

3% coal and wood

87% is in the so-called gas supply area

Heat Planning in Denmark

“The objective of this Act is to promote the most economically-advantageous and environmentally-beneficial utilisation of energy for heating buildings and supplying them with hot water, while reducing the dependency of the Danish energy system on oil. …

Article 3. It is the duty of each district council, in consultation with the supply companies and other interested parties, to prepare a plan for the supply of heat in the [district]. …

The Minister of Energy and Environment shall give an account of the more important measures planned in accordance with this Act to the Parliamentary Energy Committee. …

The Minister of Energy and Environment may establish rules on the distribution of costs between electricity and heat production at biomass-fired CHP plants. …”

Extracts from the Danish Heat Supply Act, July 2000, unofficial English translation.

Heat Planning in Denmark

The country is divided into zones:

(1) Built-up areas and some villages on the outskirts of towns and cities:

(a) A heat supply area in which the preferred energy carrier for space and water heating is piped hot water (roughly 65% of building floor area).

(b) A gas supply area in which, while Danish North Sea gas lasts, the preferred energy carrier for space and water heating is piped gas (roughly 20%). Long term, this area may be suited to heat mains as long as suitable techniques are used to restrain costs: improved pipes, low temperatures and direct connection.

(2) Low-density areas

Here it is uneconomic to lay either gas or heat mains. Various other technologies are in use including oil, LPG, electric heat pumps and biomass boilers (roughly 15%).

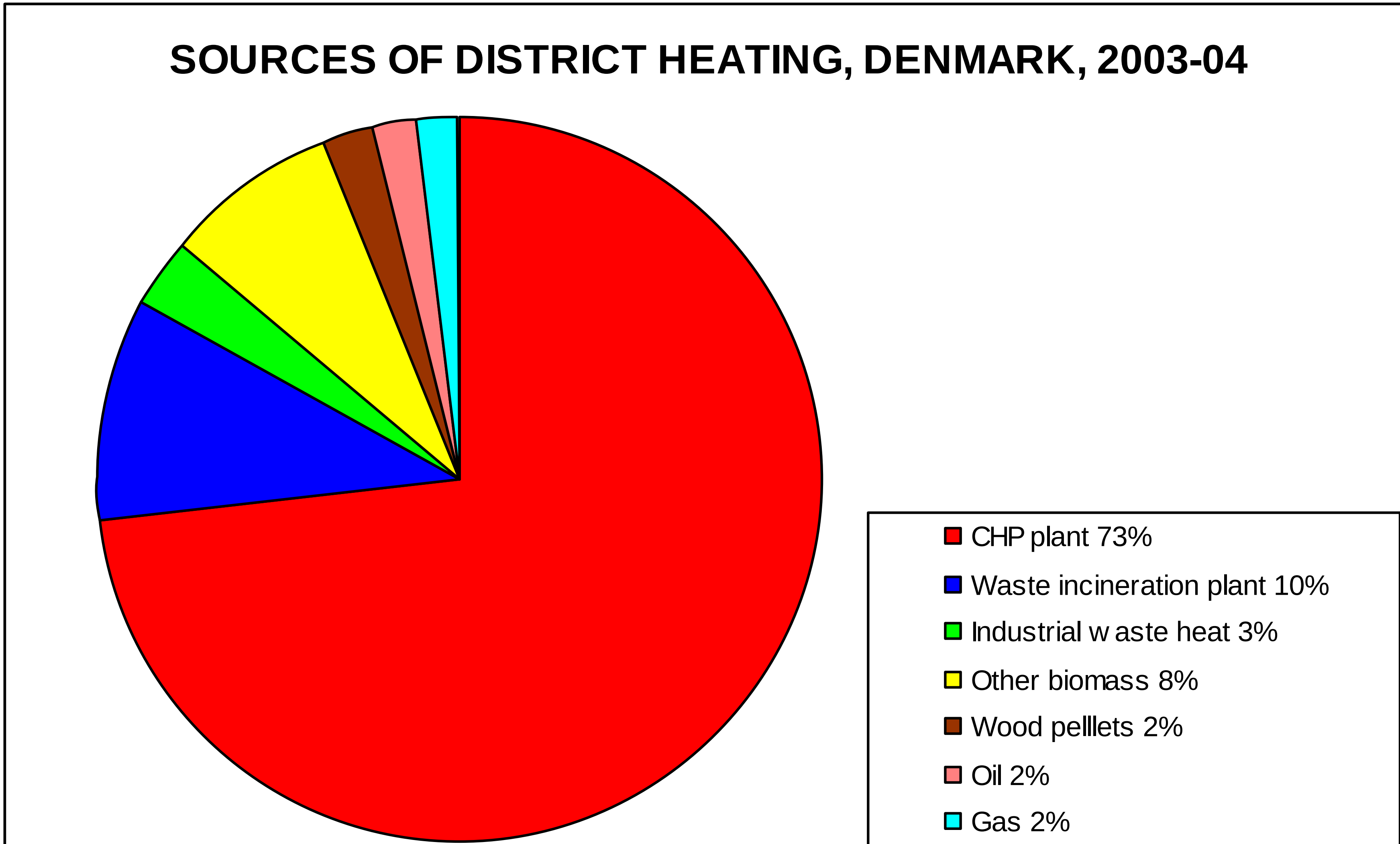
In accordance with the Danish National Heat Plan 1979 and subsequent legislation.

Map of Danish District Heating Systems

Denmark's population is 5M, similar to that of Scotland, the West Midlands or South West England.

Picture and figures courtesy Danish Board of District Heating (DBDH).

Where the Heat Comes From



Source: DBDH.

Solar Collectors, Denmark

18,000 m^2 collectors help to heat the small town of Marstal, popn. 3,000. Large solar collector fields produce heat at one-fifth the cost of heat from collectors on house roofs.

Courtesy Leon Miller.

Solar Collectors, Sweden

10,000 m^2 of solar collectors were retrofitted to the district heating system of Kungalv, 20 km N of Gothenburg in 2001. There is 1,000 m^3 of buffer heat storage. Biomass and oil are also used. The supply temperature is 70ºC in summer and mild winter weather (5ºC), rising to 90ºC on very cold days (-10ºC). The return temperature is 40ºC all year round. At an annuity factor of 0.08 the solar heat input costs 3 p/kWh, lower than biomass or oil heat-only plant.

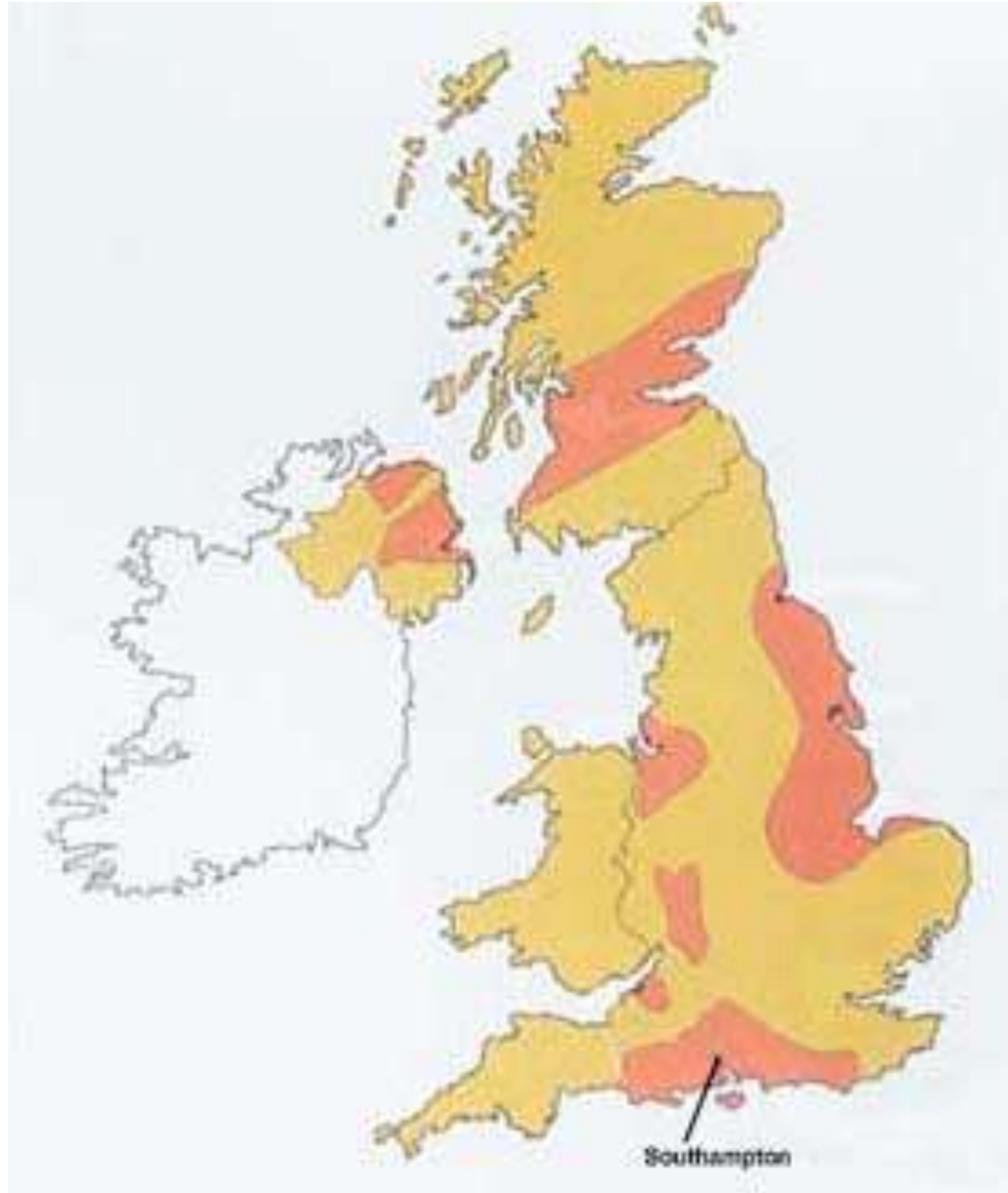
Courtesy: Kungalv Energi AB

UK Geothermal Aquifers

In these areas hot water may be available c. 2 km deep; e.g., the 1 km deep potash mine at Boulby, Cleveland is at 40ºC. Bath has hot water near the surface.

Water at 76ºC has helped to heat central Southampton since 1981. Since 2004 it has heated 5000 houses near Copenhagen.

Geothermal district heating was first used in France in the 1300s. Today it heats much of high-rise Paris.



District Heating for Low Energy Buildings?

The marginal cost of reject heat is lower than heat supplied by; e.g., a gas-fired heat only boiler or an electric heat pump. Optimum levels of insulation and draughtproofing differ between heating systems. So do an optimisation. A building using say 6,600 kWh/yr of heat which emits 0.05 kg per kWh still produces *55% less CO_2* (330 kg) than one using 4,000 kWh/yr of heat which emits 0.18 kg/kWh (720 kg).

DH has continued to expand throughout Denmark, whose new buildings have had 125-200 mm wall insulation since 1980. Danish DH technology uses low supply and return temperatures and direct connection and is relatively suited to low heat densities, typified by small detached houses on large plots; about 40% of Danes live in detached houses.

Kronsberg, nr Hanover, Germany, contains homes to the Low Energy & Passivhaus Standards & is heated by a gas-fired CHP plant. New Passivhaus flats in Vienna are being connected to the city's DH system, not given individual heating systems.

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