

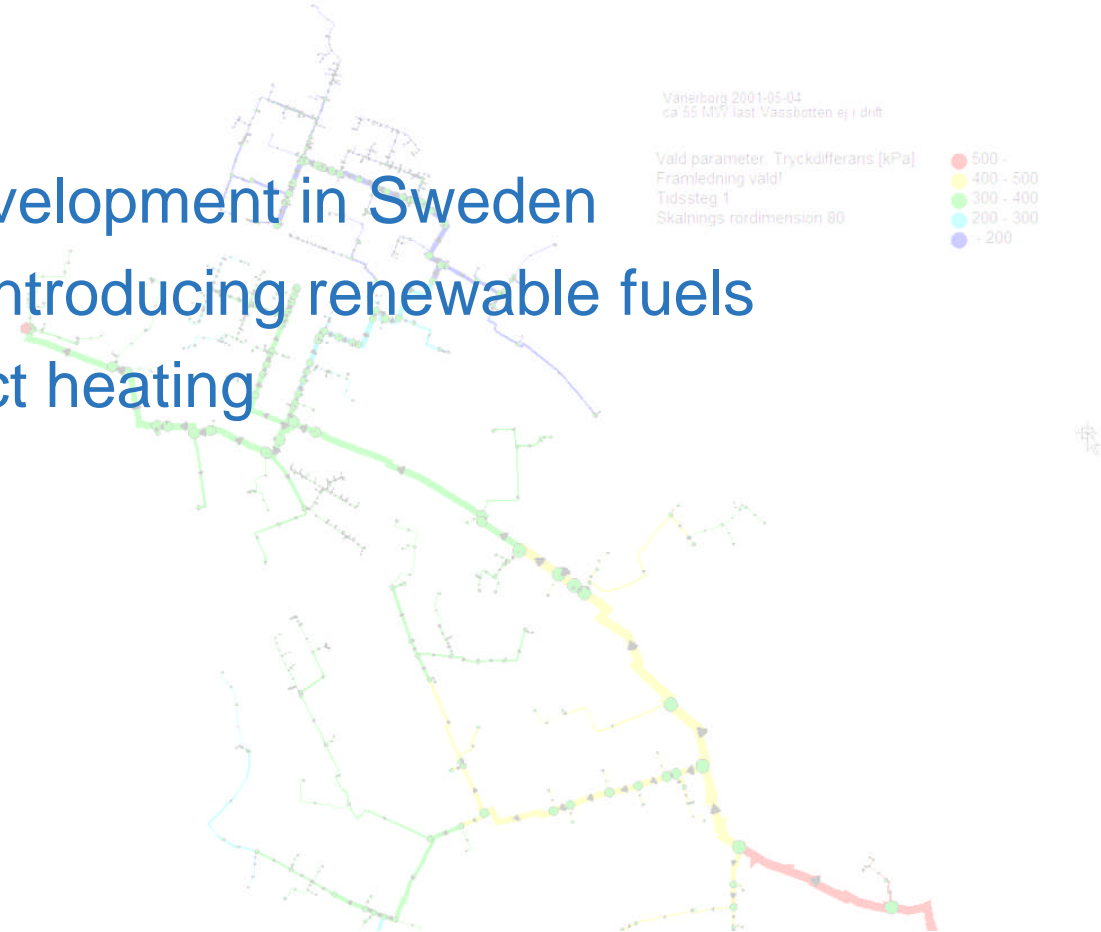
# District heating in Sweden - From fossil fuels to renewable heat

Per-Axel Nilsson

Vattenfall Power Consultant AB

# From fossil fuels to renewable heat

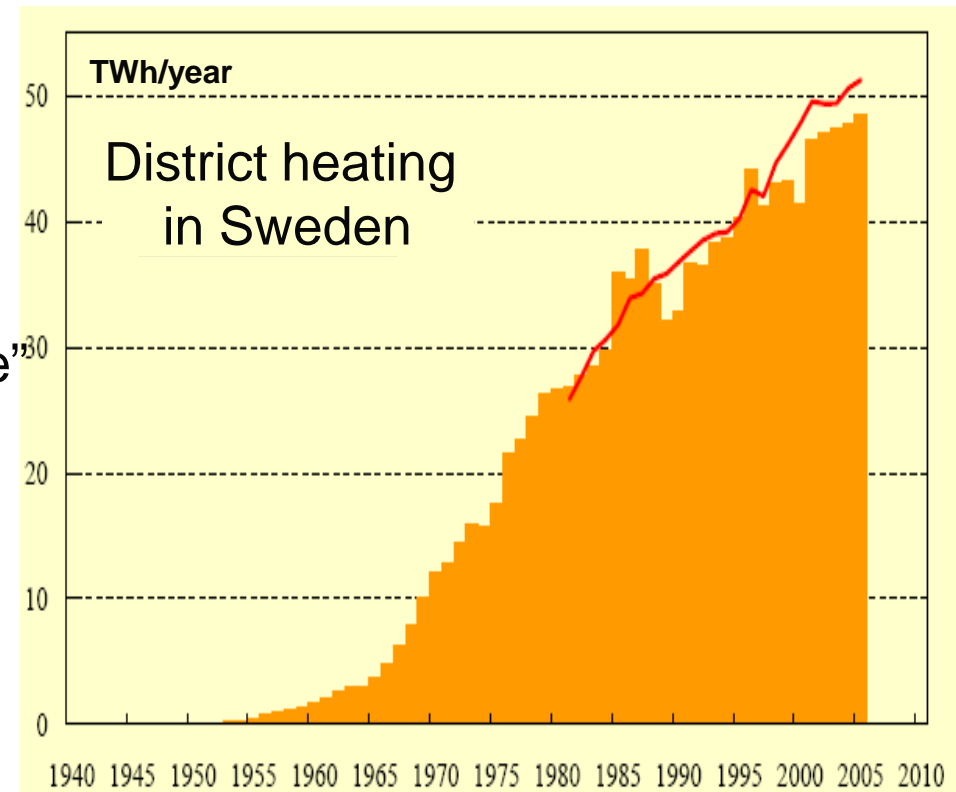
- District heating development in Sweden
- Driving forces for introducing renewable fuels
- Key factor – District heating
- Examples



## District Heating in Sweden – Driving forces

### Development phases:

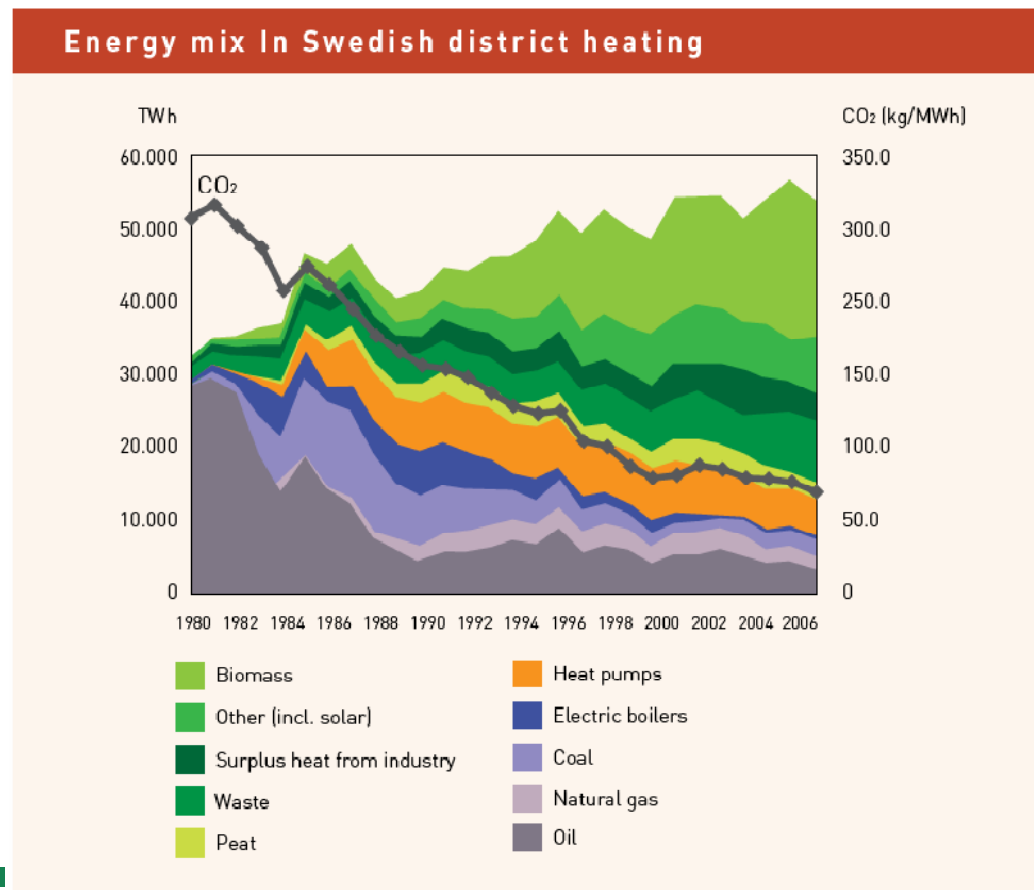
- 1948-1970: Municipal electricity boards started district heating as basis for Combined Heat and Power.
- 1965-1974: The "Million programme" - 1 million new flats.
- 1980's: National programme to minimize oil dependence.
- 1990's: National programme to reduce CO<sub>2</sub>.



Source: Sven Werner, Chalmers

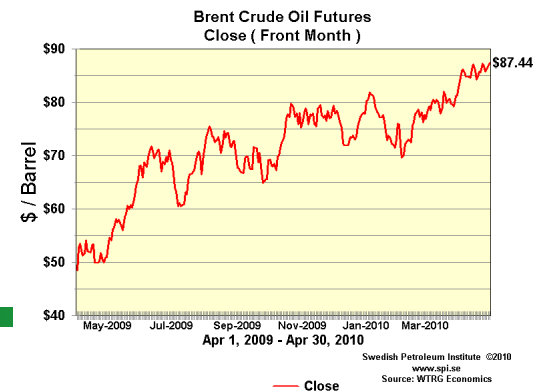
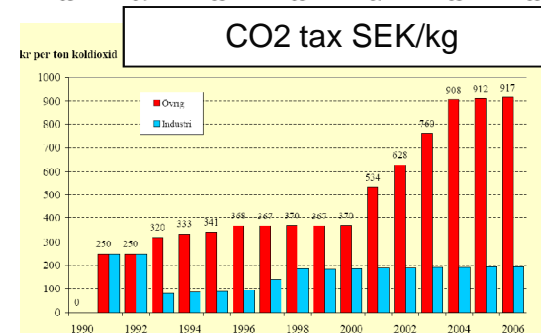
# District heating in Sweden – Market and Energy sources

- Total heating market close to 100 TWh
- District heating supply more than 50%
- District heating - major heat supply in 247 of 290 municipalities (supply in 540 cities and villages)
- 2008
  - Fossil fuels - 10%
  - Biomass 48%
  - Peat 6%
  - Waste heat from industry 6%
  - Waste-to-Energy 16%

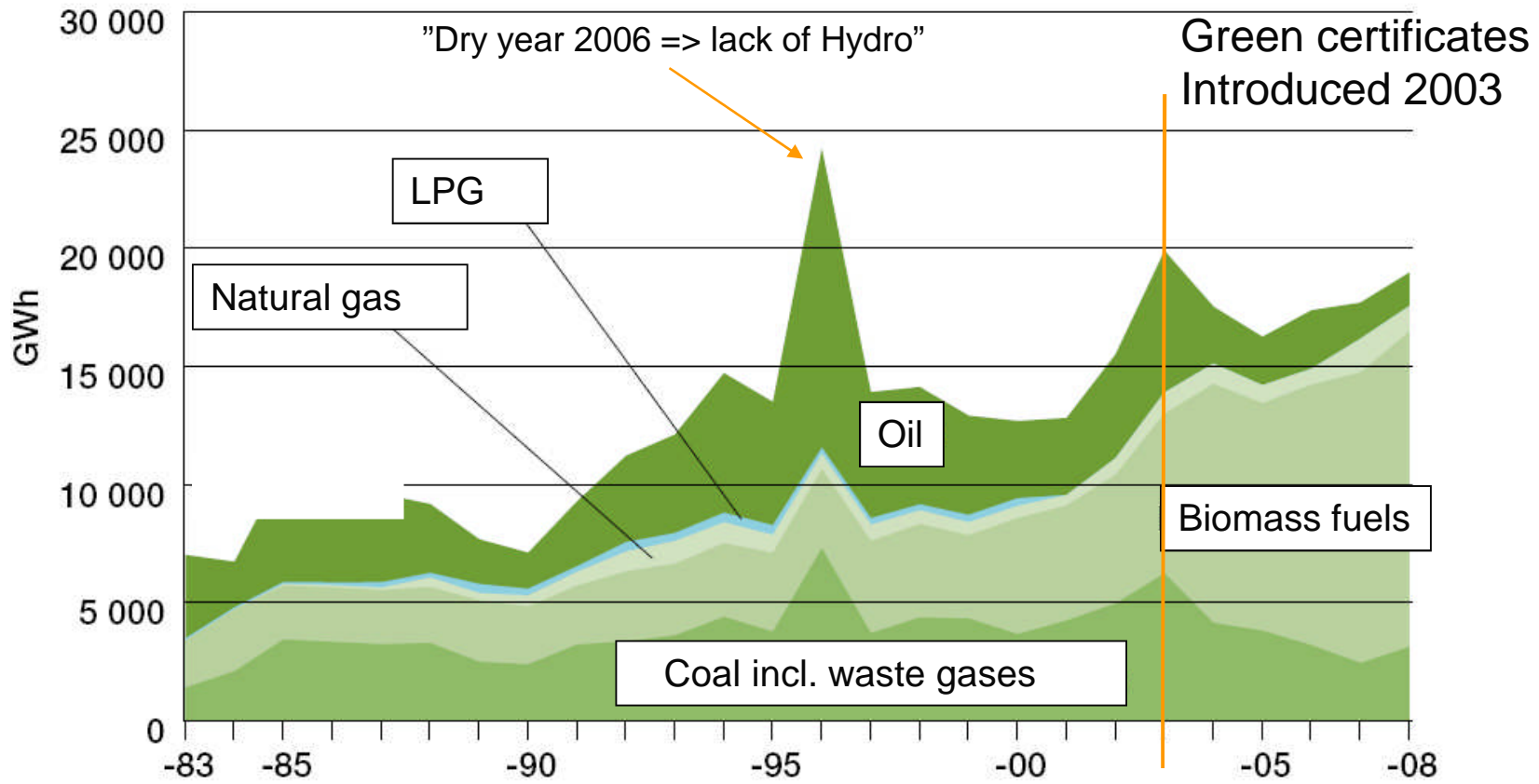


# Driving forces for renewables (Sweden)

- Green certificates for renewable power generation, since 2003 – market prices 2,2-3,2 c/kWh
- High energy and CO2 taxes on fossil fuels 10 c/kg – => NG 2,1 c/kWh, Fuel oil 4 c/kWh (reduction for industry)
- Increasing oil, natural gas prices and electricity prices
- Emission allowances for climate gases (EUAs)



# Fuels for power generation (excl hydro and nuclear)



Source: SCB & Swedish Energy Agency

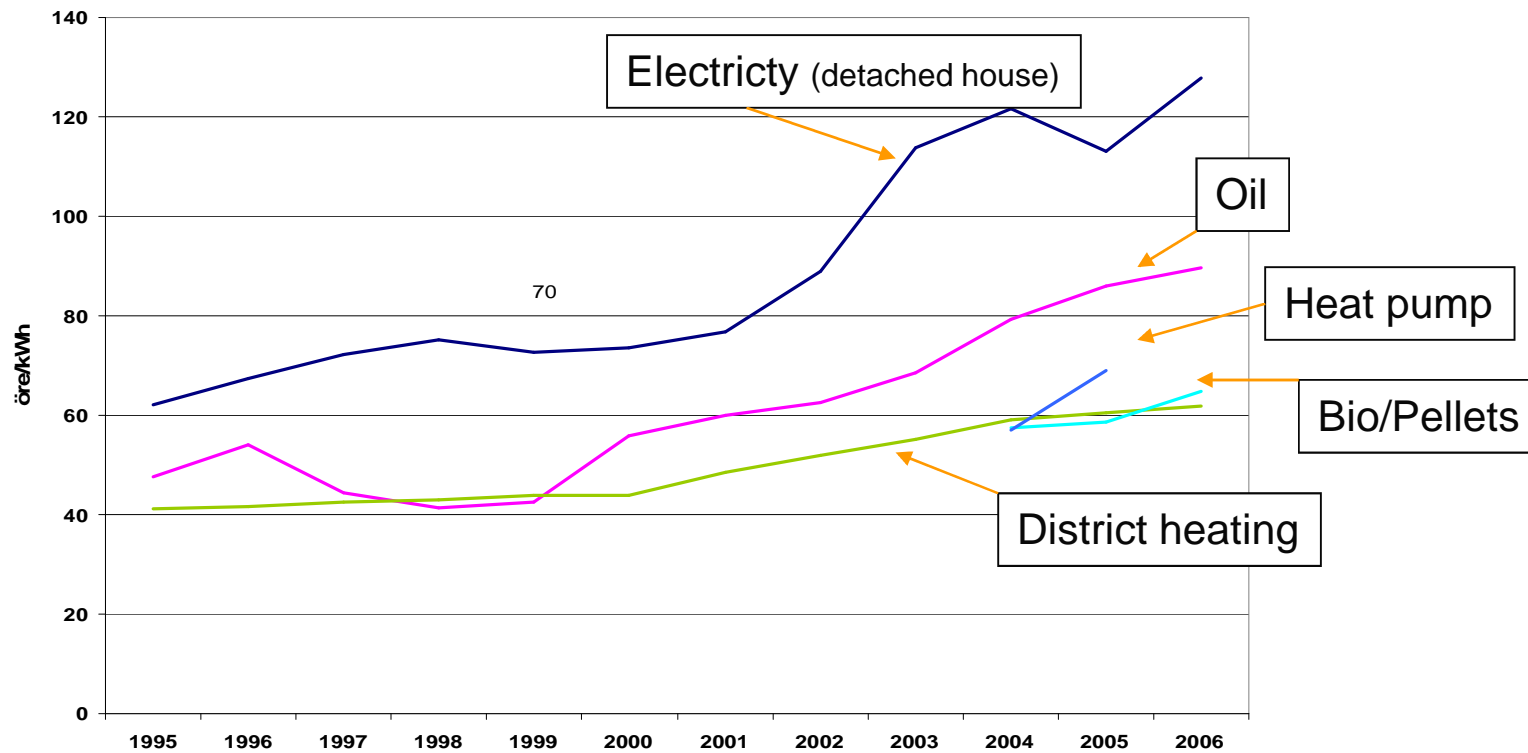
## Key factor – District heating



- Local sources - industrial waste heat, biomass, agro fuels, recycled wood, geothermal sources
  - Heat sink for CHP – increasing fuel efficiency
  - Heat from waste incineration
  - Scale benefits – technical and economical for more difficult fuels
- 
- District heating offers a flexibility in heat production which facilitates a diversity of primary energy carriers
- =>
- Adjust to a changing market and keep a better security of supply and a price stability

# Key factor – District heating

- Price stability for consumer



Source: Swedish Energy Agency, Nils Holgersson

# Fuels - Virgin Biomass

- Wood pellets/briquettes (diff. sources)
- Forestry fuels
  - Wood chips
  - Forestry residues
  - Saw dust
  - Bark
- Municipal biomass
  - Park residue
- Agriculture and SRC fuels
  - Straw
  - Willow, poplar, etc



# Fuels - Waste Fuels

- Recovered wood
- Refused Derived Fuels
  - RDF/REF
- Waste
  - Municipal
  - Industrial



# Fuels – Bio-oil, Bio-diesel

- Vegetable oils
  - Ex. Rape oil, palm oil, soy oil
- Bio-diesel – FAME
  - "Fuel oil standard" EN 14213, RME
- MFA – Mixed Fatty Acids
  - "Cocktails" – Mixture of vegetable, marine, animal fats and residues
- Tall oil
  - By-product from paper mill industries



# Example - From natural gas and oil to district heating in Trelleborg (40.000 inhabitants)

## Background

- Heat supply based on Natural Gas (grid developed since 1980) and oil
- Increasing oil and natural gas prices =>
- Municipality decided to introduce district heating based on local energy sources

## District heating and biomass introduction

- 2003 Pre-feasibility study and strategic heat plan
- 2006 1:st step 25 GWh/a - 4 MW biomass + FGC\* and peak/reserve units
- 2007 2:nd step 65 GWh/a - 8 MW biomass fuelled boiler with FGC\*
- 2010 Plans for expanding the system to >100 GWh/a by 2015
- 2015- Possible CHP introduction



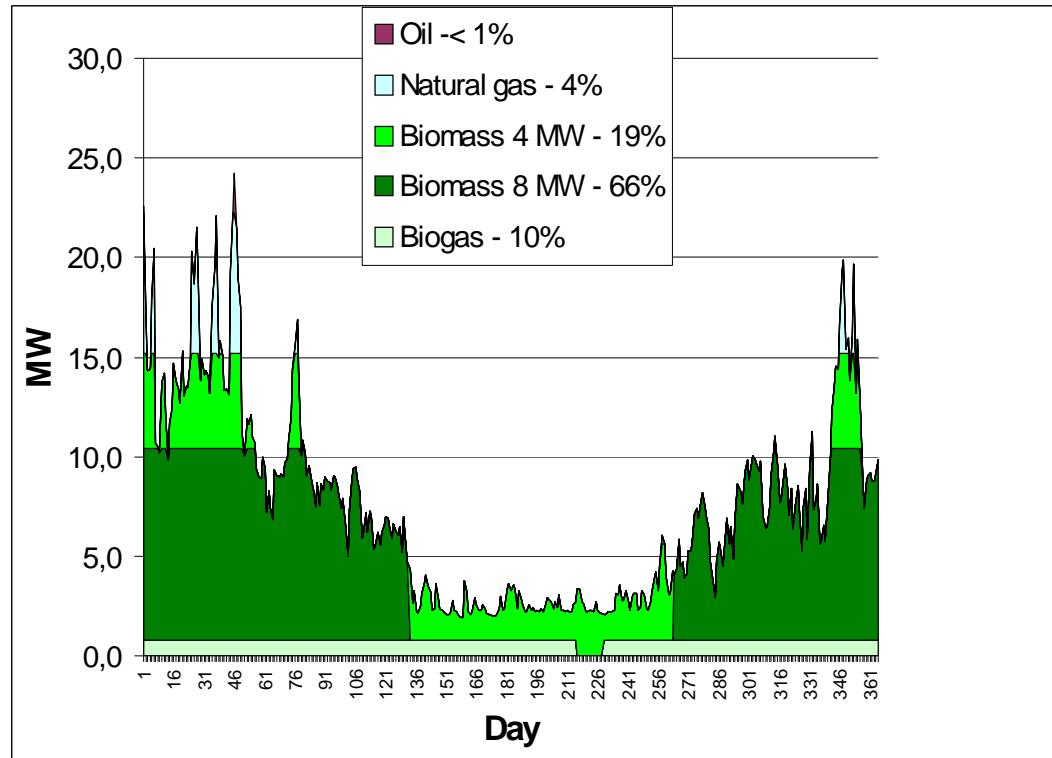
\*FGC = Flue Gas Condensor, EIA = Environmental Impact Assessment

# Example - From natural gas and oil to district heating in Trelleborg (40.000 inhabitants)

- **Oil & gas 5% 2010**
- **CO2 reduction**
  - 2010/11 -12500 ton/år
  - 2015/16 -20000 ton/år



Annual heat production 65 GWh



## Example – From natural gas and oil to district heating in Lund (110.000 inhabitants)

### **Background**

- New Well-established d.h. system
- 1050 GWh district heating sales
- 194 GWh electricity sales (CHP)
- 66 GWh district cooling
- Main production from geothermal heat, biomass, natural gas
- Increasing demand and fossil fuel consumption, increasing prices



### **New local energy sources**

- New industrial waste heat recovery from a Sugar Mill
- Planned CHP based on biomass, recycled wood, straw and agro fuels
- => => reduction of **350.000 ton CO2/a**
- => > 90% of the production based on renewable energy

## Example 3 - From oil to district heating in Uppsala (130.000 inhabitants)

### **Background**

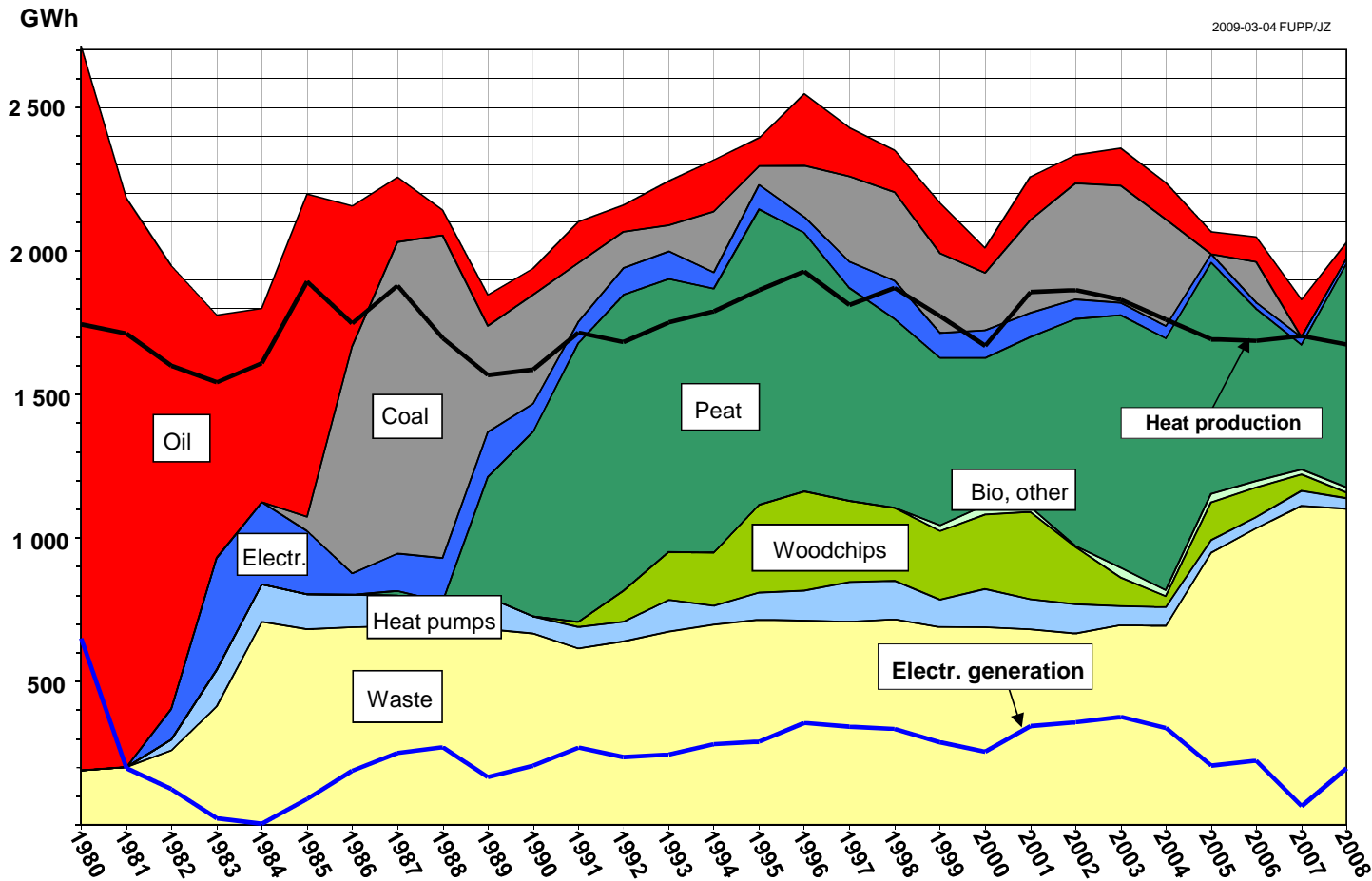
- 1960 District heating in Uppsala starts
- 1970 95% based on oil
- 1980 Peat and waste as primary energy
- 2005 New waste incineration unit 5
- 2008 5% based on oil
- DH network 450 km



<b>PRODUCT</b>	<b>VOLUME</b>	<b>CUSTOMERS</b>
District heating	1 500 GWh	7 600 customers
Process steam	90 GWh	8 customers
District cooling	30 GWh	8 customers
Electricity	170 GWh	Nordpool
Waste	350 kton	35-40 customers
Peat/wood	150 kton	

# Fuel mix Uppsala

## Heat production, co-generation of electric power



**Today:**  
 > 50% of the fuel is now waste fuels from areas around Uppsala.  
 => Oil – only 2%.

# Strategy for a diversified and flexible heat supply



- Master plan for long-term goals for heat supply
- Feasibility studies, incl.
  - Survey of heat demand - consider demand-side energy conservation – identify areas suitable for district heating
  - Local sources – fuels and usable waste heat
  - Assessment of conversion technologies and CHP
- Important
  - Information in all levels, marketing
  - Aim for reliable and fuel flexible heat production
  - Early start for localisation and permit processes
  - Realisation in steps, each economical viable
  - Demonstrate competitiveness and real advantages
- Plan for economic CHP when heat demand is secured

# Reflections

- UK:s Green certificates “ROC” – for renewable power and CHP and
- Renewable Heat Incentive programme – support for renewable heat and district heating (2011)
  - ⇒ Significantly improves the driving forces for introducing district heating systems and renewable fuels in UK (Swedish level?)
  - ⇒ District heating is a key factor for increased utilisation of
    - ⇒ Biomass (especially difficult fuels)
    - ⇒ Agro fuels incl short-rotation fuels and agro residues (straw, etc)
    - ⇒ Excess heat / Recovered heat (industries, sewage, etc)
    - ⇒ Waste fuels
    - ⇒ High efficient CHP

# Vattenfall Power Consultant

- Hydro, Nuclear, Thermal, Wind and Power Networks
- Approx. 800 employees, December 2009
- Turnover in 2009: 1000 MSEK (100 MEURO)
- Our services include technical, management and environmental consulting
- Approx. 3,000 assignments per year
- Offices in Sweden, Germany, Norway, UK, Poland





# District heating in short

