

Bio-Energy from the Swedish Forest

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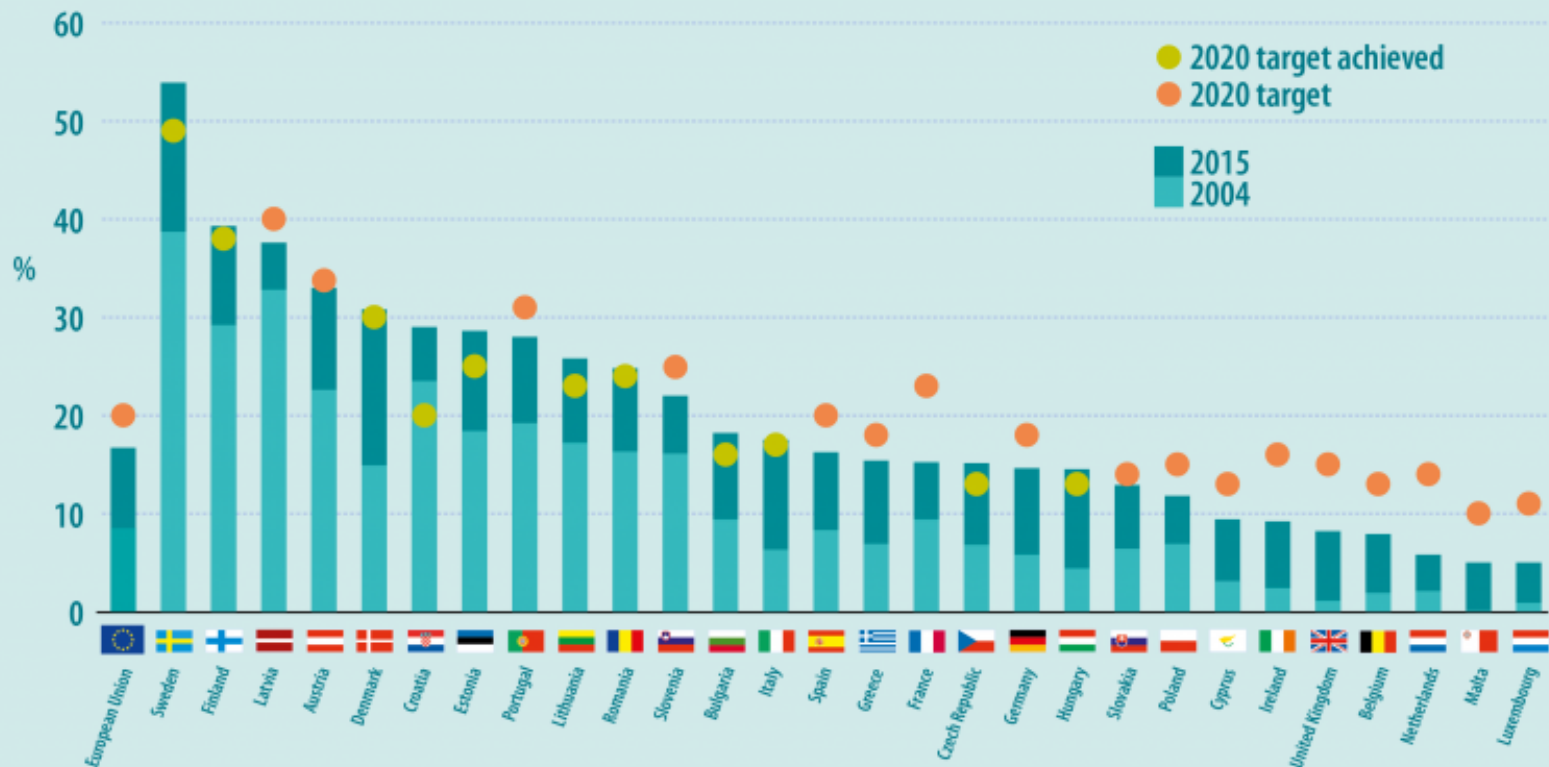
Road map

- Bio-energy in Sweden today
- Bio-energy tomorrow
- Conclusion



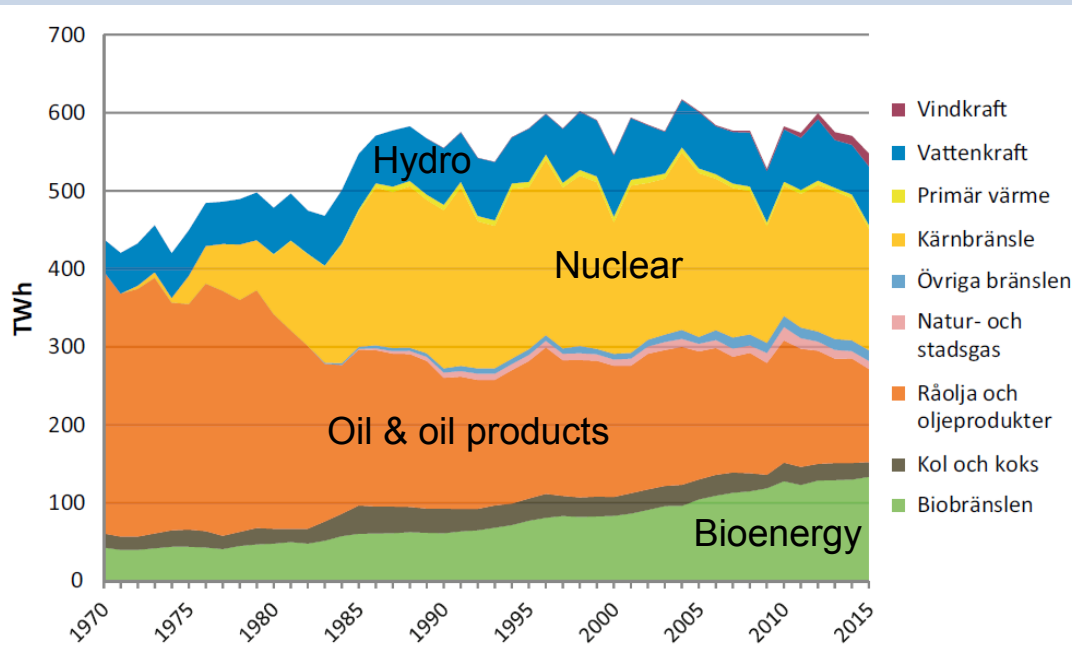
Share of energy from renewable sources in the EU Member States

(in % of gross final energy consumption)



eurostat

Swedish energy supply 1970-2015



Figur 2 Total tillförd energi 1970–2015, TWh.

Källa: Energimyndigheten och SCB.

Status 2015:

Biofuels: 134 TWh

Crude oil: 119 TWh

Hydropower: 75 TWh

Nuclear: 54 TWh_{el} (155 TWh)

Coal: 19 TWh

Wind: 16 TWh

Natural gas: 10 TWh

Bioenergy:

- Tripling during the last 40 years
- CO₂-tax and green electricity certificates have made it profitable to replace oil



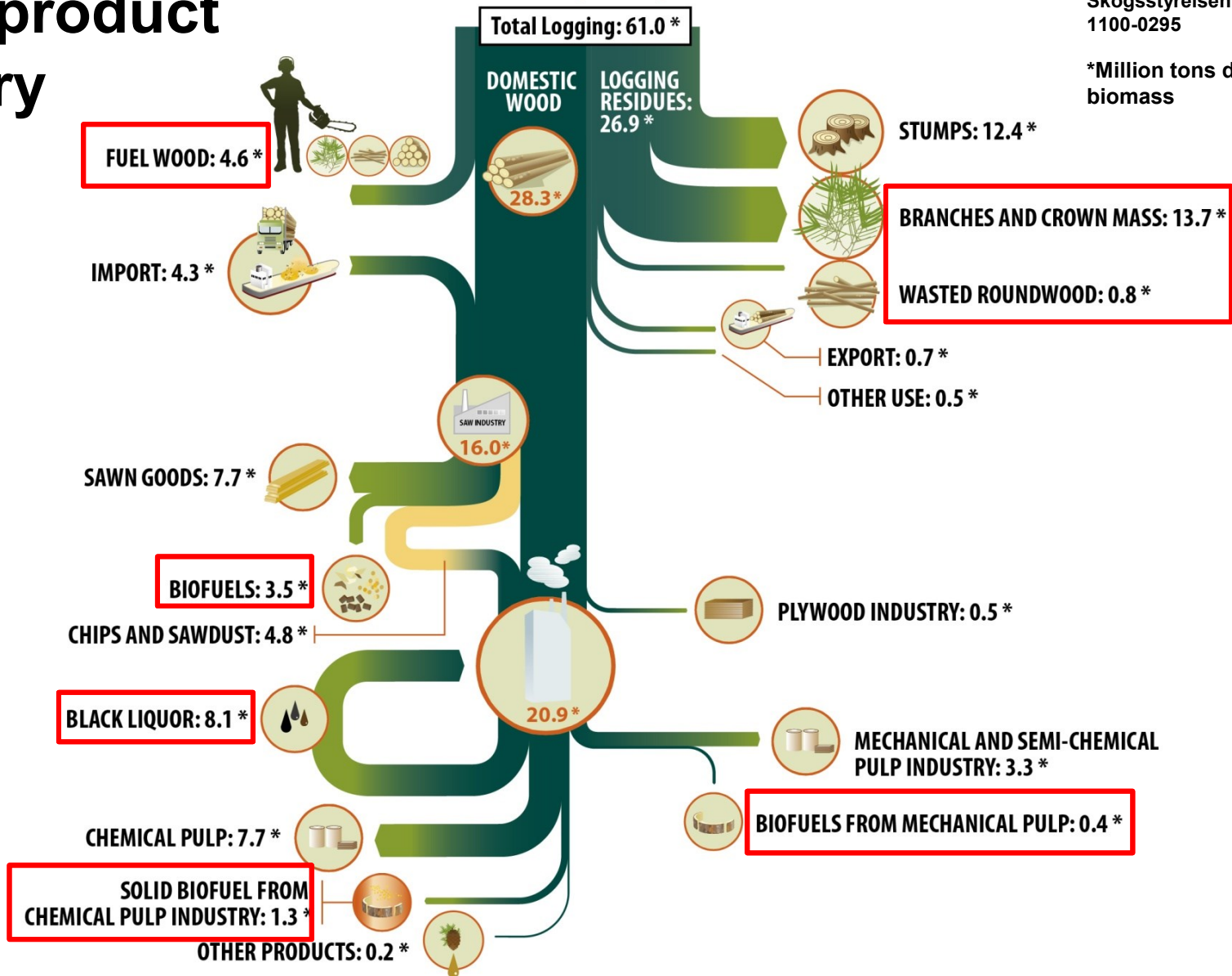
Swedish bioenergy is integrated with the forest product industry



Harvesting is app. 30% lower than growth

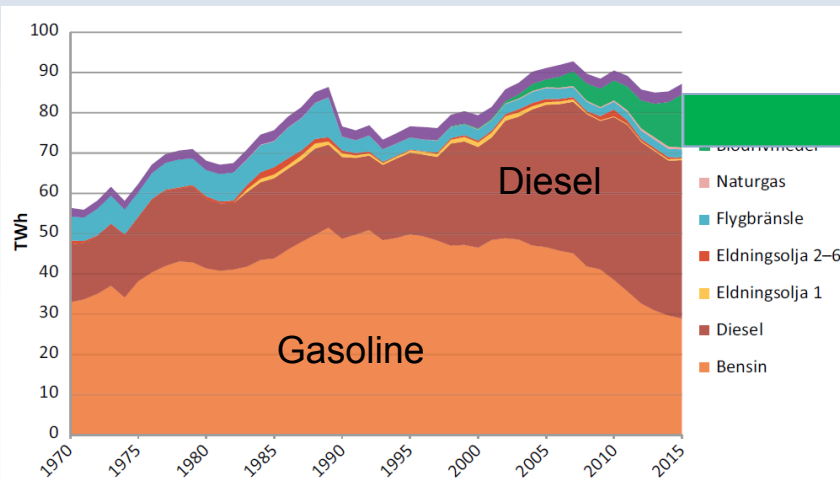
Source:
Biomassaflöden i svensk skogsnäring 2004,
Per Olov Nilsson.
Rapport 23-2006
Skogsstyrelsen ISSN
1100-0295

*Million tons dry biomass



Remaining energy challenge is transports

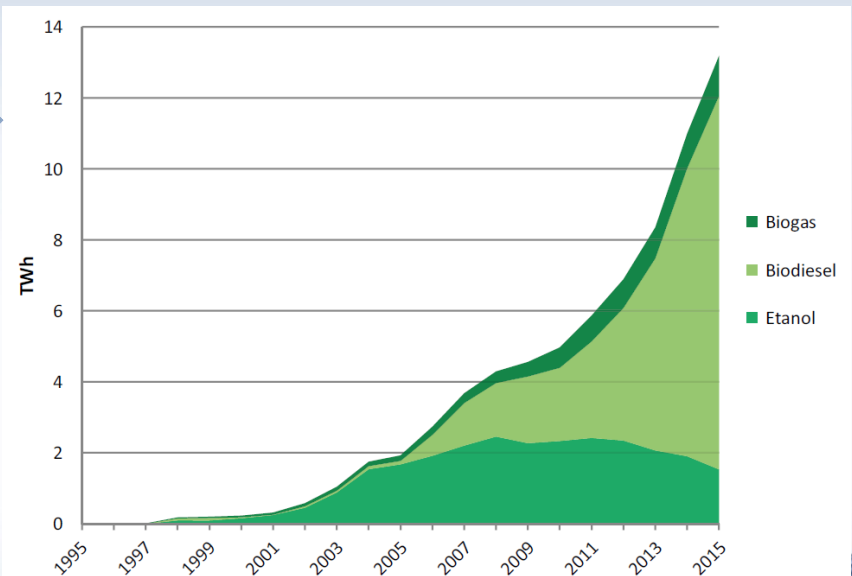
Energy use in the transport sector



Figur 14 Slutlig energianvändning i transportsektorn, inrikes, 1970–2015, TWh⁴¹.
Källa: Energimyndigheten och Transportstyrelsen.

- >80% fossil!
- A large part of the biodiesel is based on tall oil from pulp mills

Biofuel use in the transport sector



Figur 15 Användning av biodrivmedel i transportsektorn, inrikes, 1995–2015, TWh⁴⁹.
Källa: Energimyndigheten.

- >600% increase during last ten years!
- A large fraction of the biodiesel is made from tall oil from pulp mills

The solution is a combination of energy savings, electrification and **biofuels from forest residues**

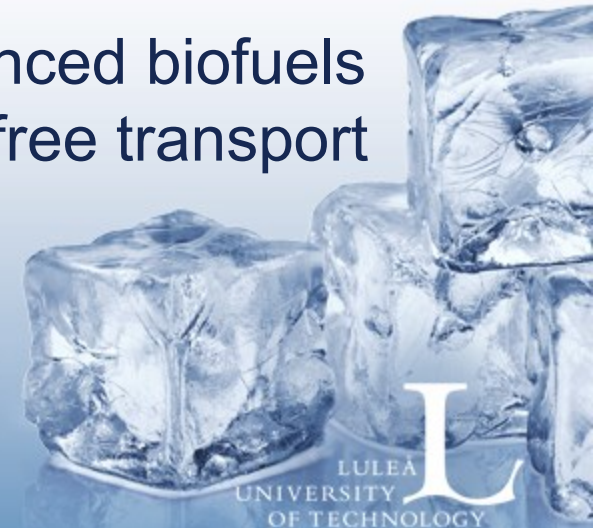
Integration of motor fuel production in the pulp&paper industry



- Black liquor is a by-product from pulping
- Excellent as gasification feedstock
- The mill can use all waste heat from the process
- Demonstration of methanol and DME production >12 000 h
- Long term testing of BioDME in 10 commercial trucks >1 500 000 km

Conclusion

- Bioenergy is a crucial part of the Swedish energy system
- The use of bioenergy has made it possible to reduce the use of fossil fuels dramatically compared to the 70's
- The best parts of the trees are used for building materials and paper products
- Only the residues from forestry and the forest product industry are used for energy
- Energy savings, electrification and advanced biofuels from forest biomass are keys to a fossil free transport system in the Nordic region



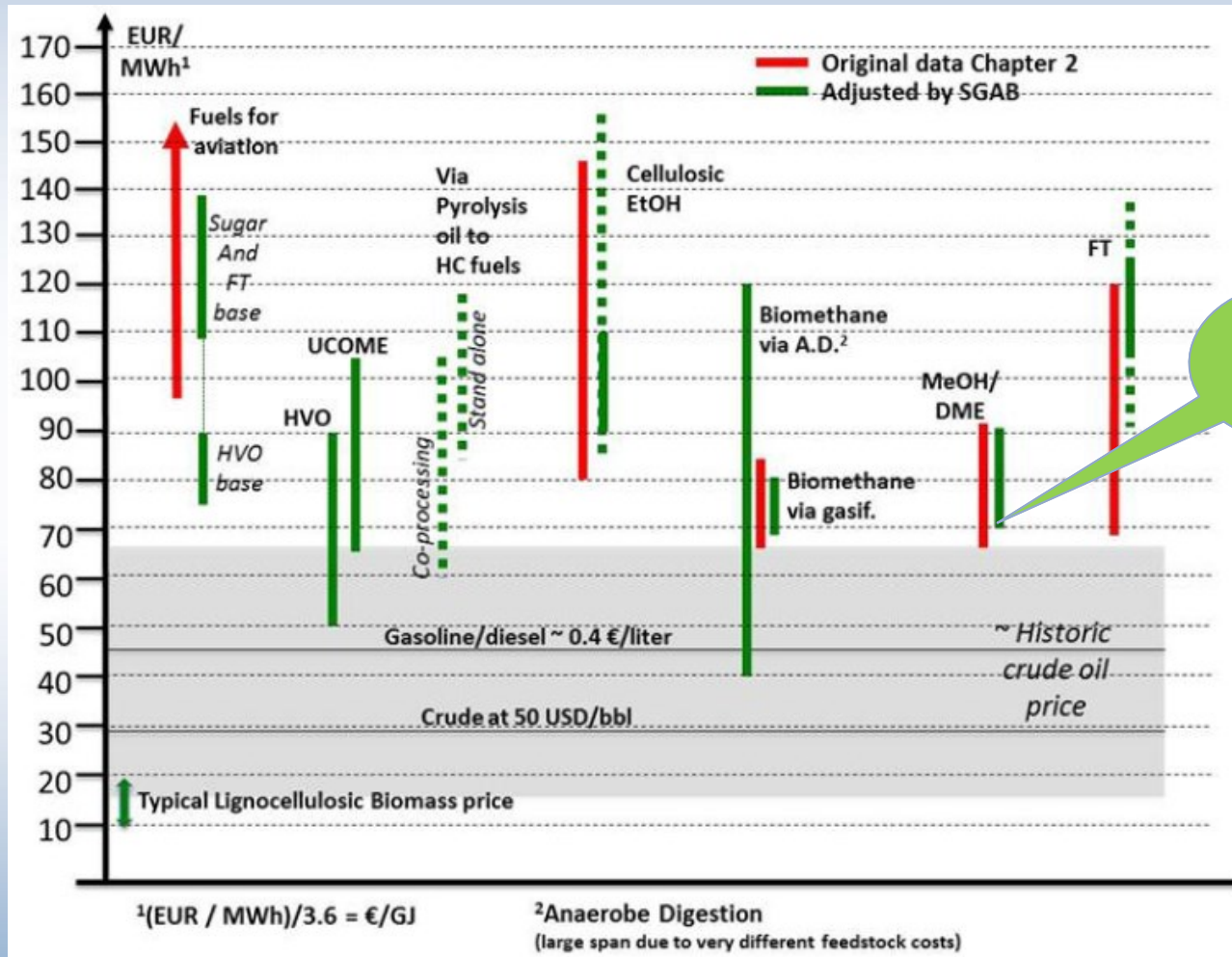




Extras



Cost of biofuels and fossil fuels



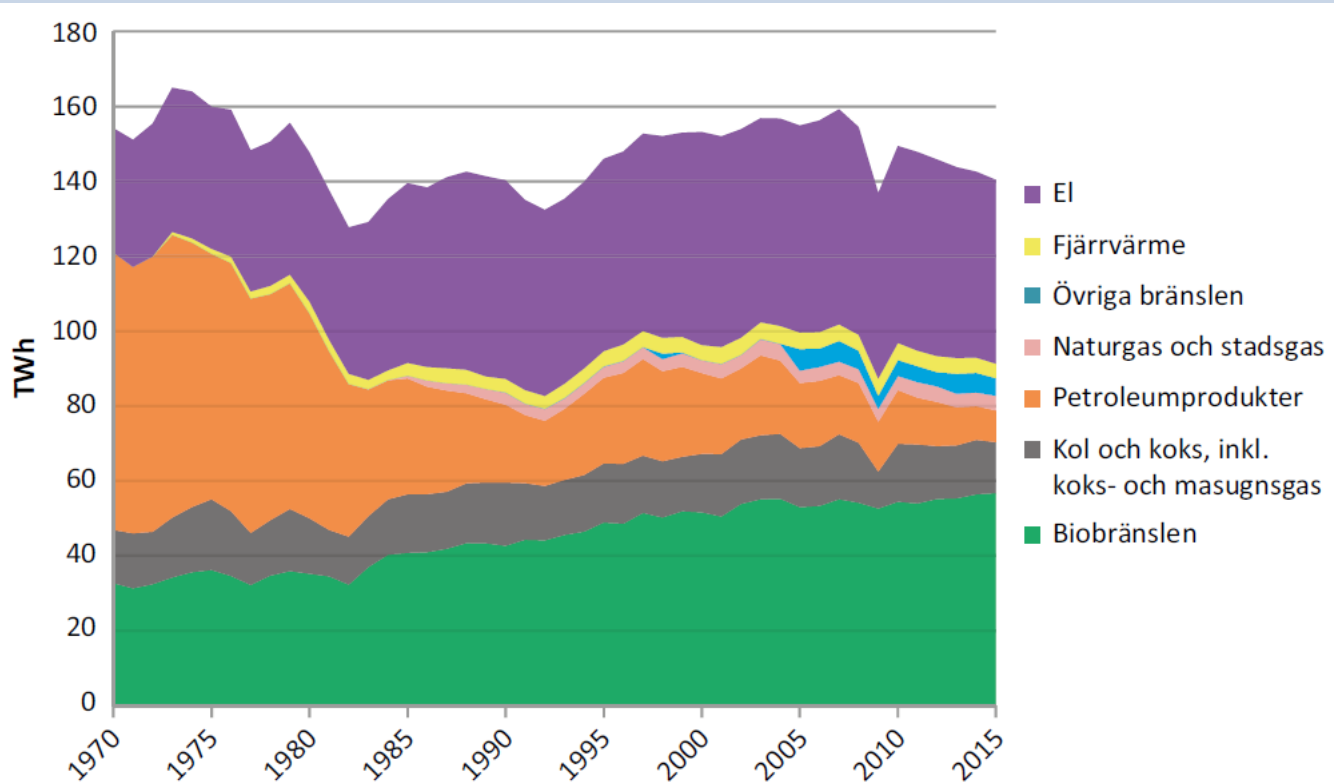
Swedish use of energy

- Industry sector (140 TWh/y*)
 - Fossil oil has been almost completely displaced by bioenergy
 - >90% of the biofuel is used for own heat&power in the pulp & paper industry
- District heating (58 TWh/y*)
 - 63% of the total comes from bioenergy
 - Bioenergy doubled last 15 years
- Transport sector (85 TWh/y*)
 - > 80% comes from fossil fuels
 - Biofuels are growing rapidly

* Source: Swedish Energy Agency 2015



Use of energy in the industry sector

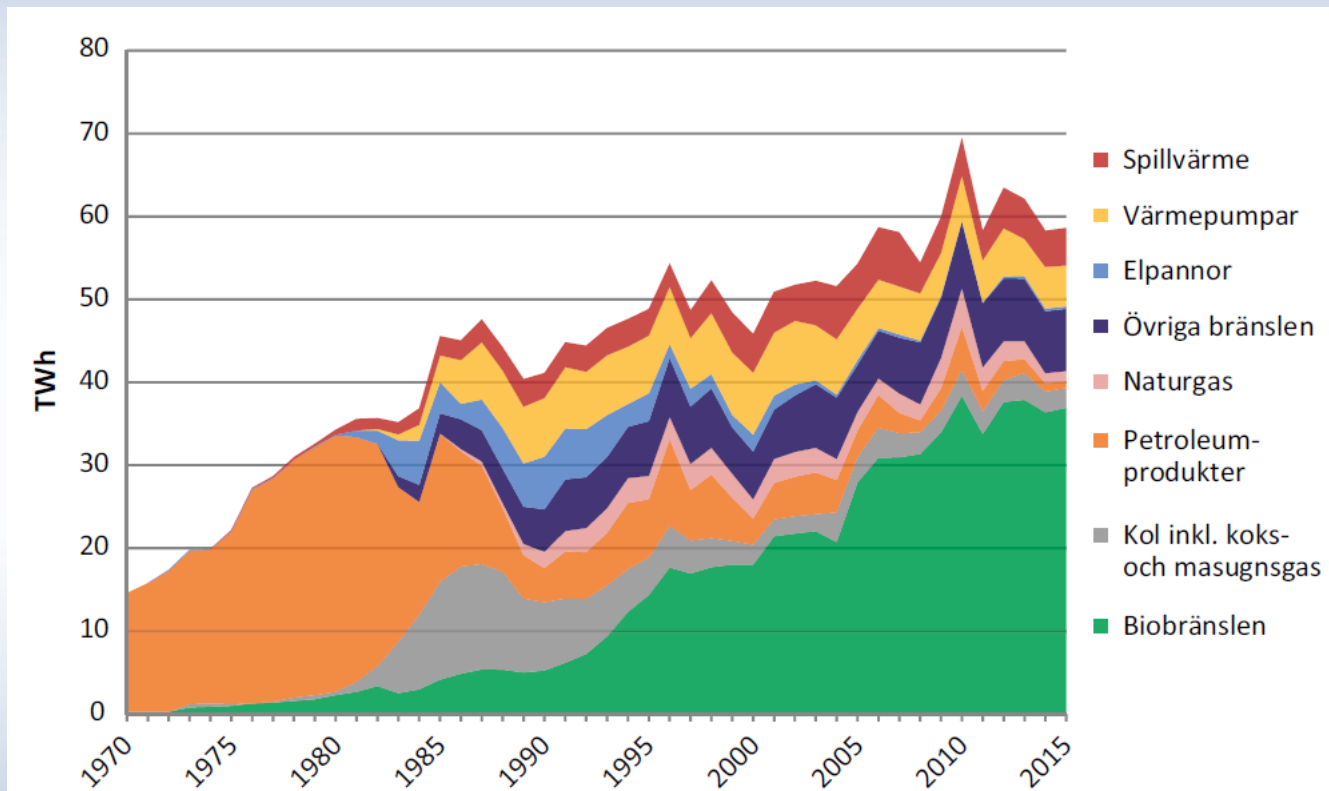


Figur 10 Industrisektorns slutliga energianvändning per energibärare 1970–2015, TWh.

Källa: Energimyndigheten.

- Fossil oil has been almost completely displaced by bioenergy
- >90% of the biofuel is used in the pulp & paper industry

Use of energy for district heating of buildings

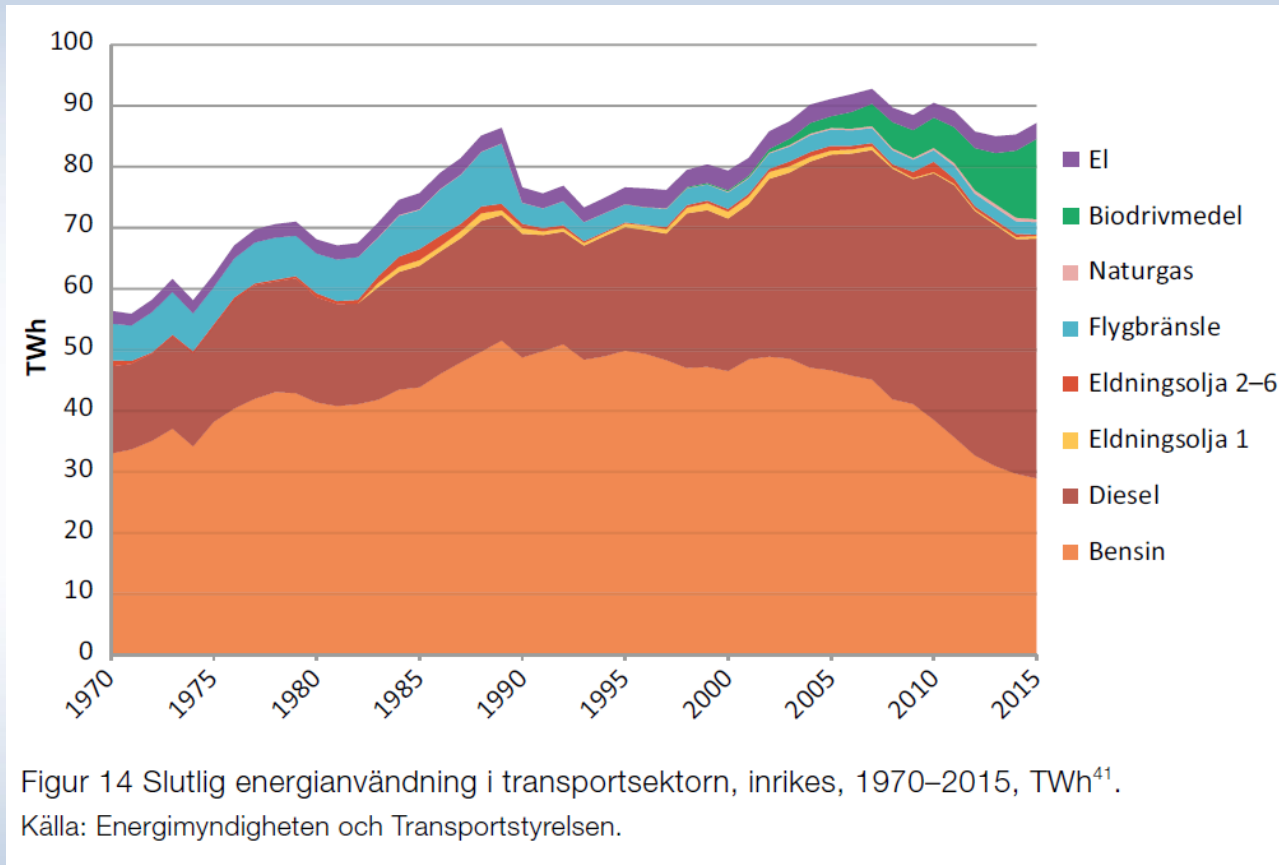


Figur 24 Tillförd energi för fjärrvärmeproduktion 1970–2015, TWh.

Källa: Energimyndigheten.

- 63% of the total comes from bioenergy
- Bioenergy doubled last 15 years but growth is slowing down

Energy use in the transport sector



- > 80% comes from fossil fuels
- Biofuels are growing rapidly
- Electricity is still small in comparison to biofuels

Forest industry and/or agricultural residues



Fast pyrolysis to bio-oil



CO2-neutral power



Boosting the forest biorefinery with renewable power

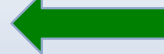
Use of methanol in HD trucks, cars, marine diesel engines and high value chemicals



Co-gasification of bio-oil with black liquor and MeOH synthesis

2.5 times more fuel than from biomass only

Direct use



Upgrading



e.g. MTG or DME

