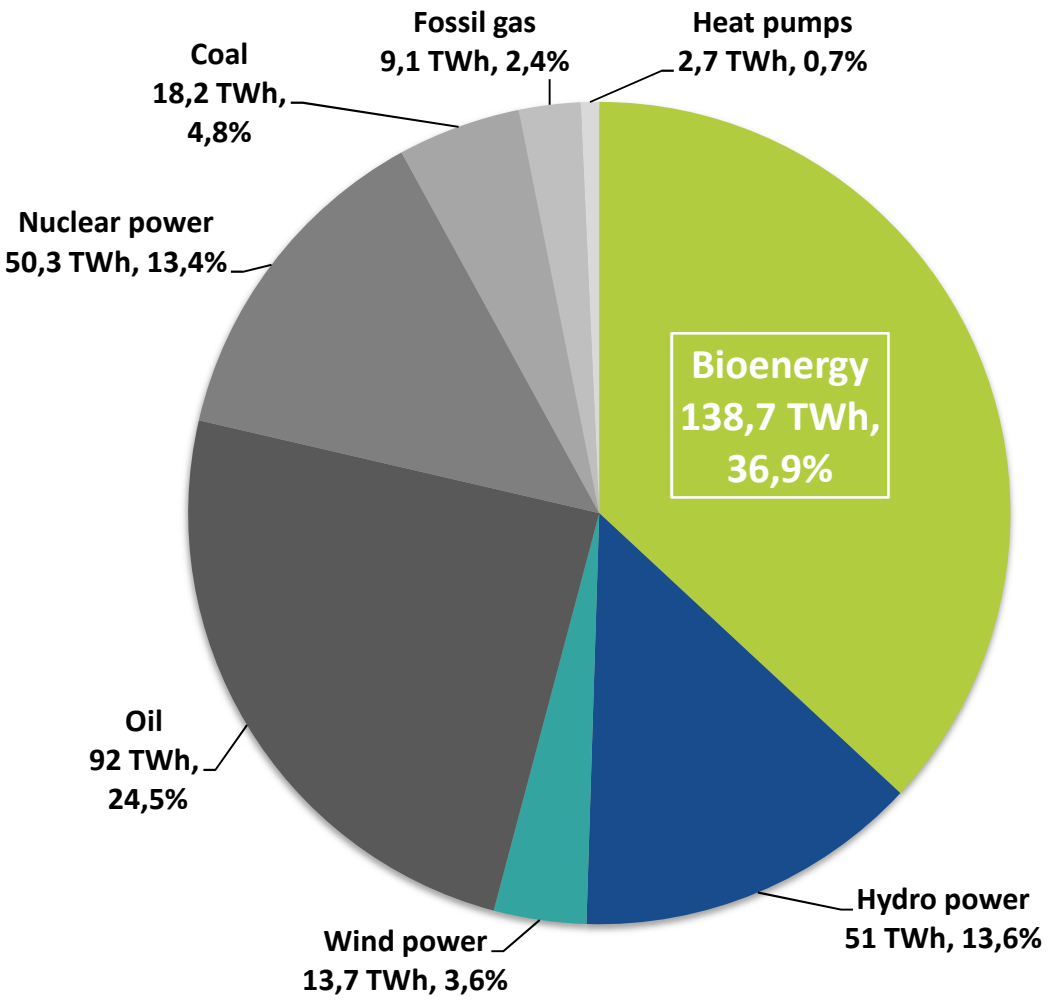
The bioenergy landscape in Sweden

Kjell Andersson, Svebio

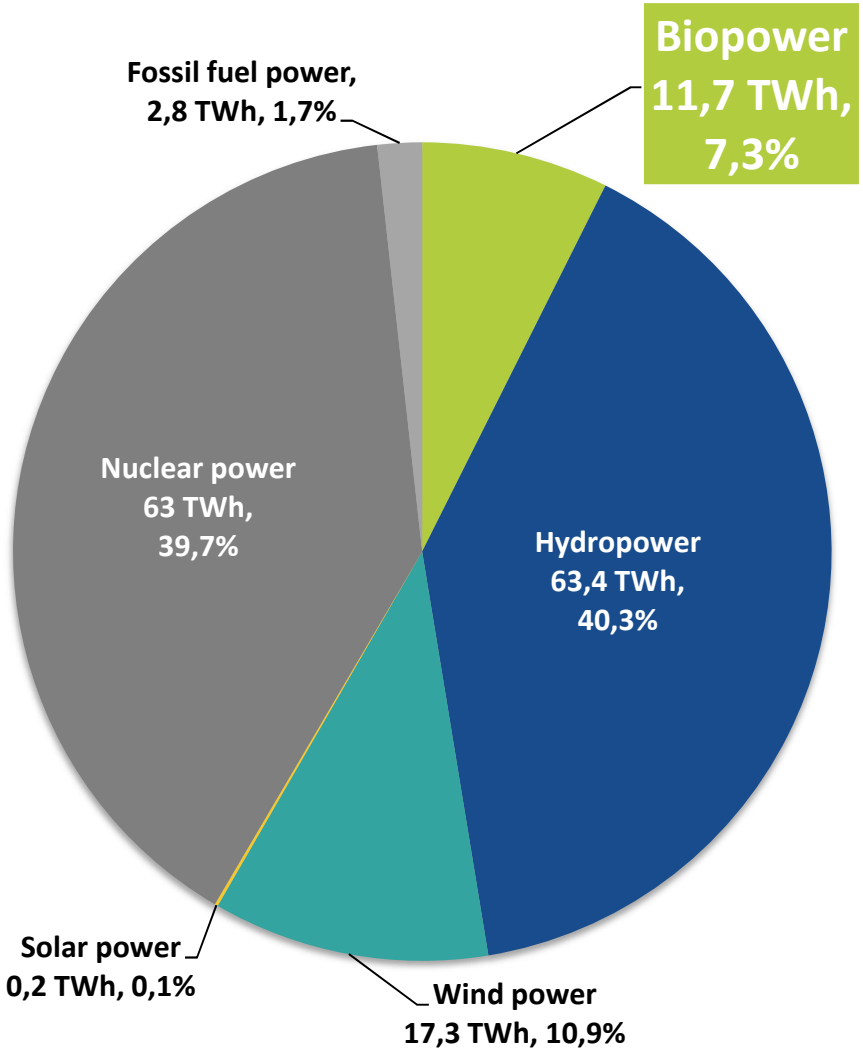
Energy use in Sweden 2017



Bioenergy is the leading energy source in Sweden

Final use of energy (heat, electricity, transport fuels, all sectors). Based on Statistics Sweden and the Swedish Energy Authority.

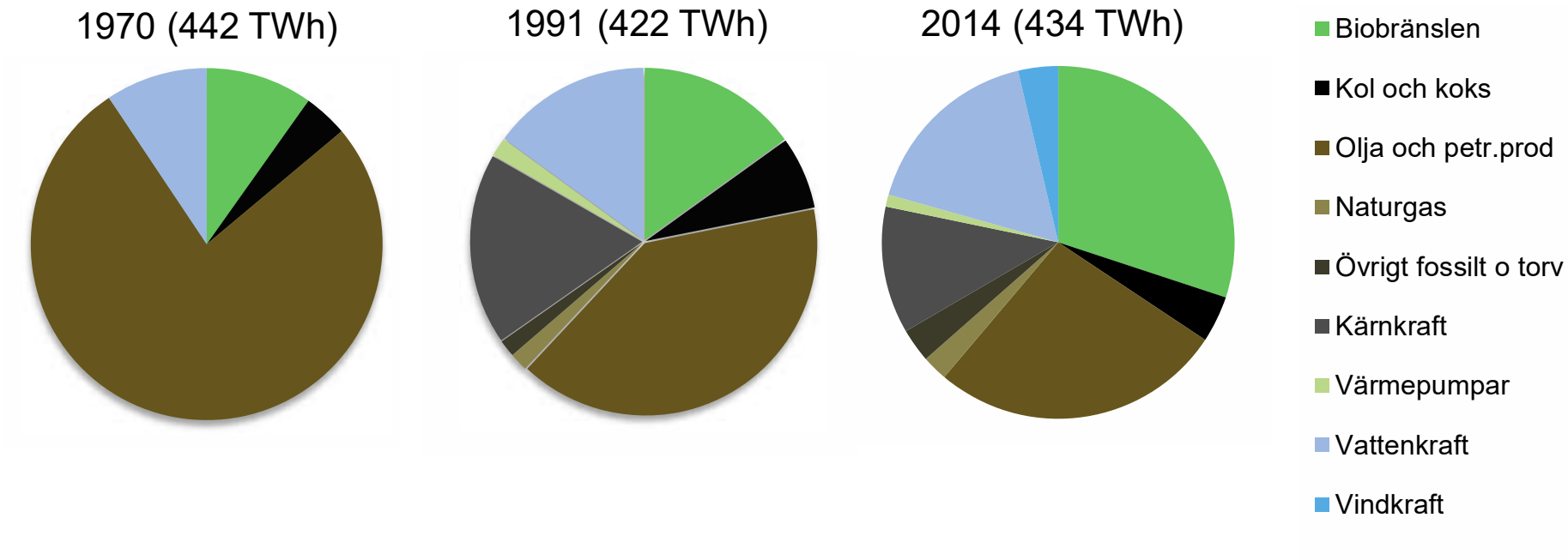
Power production in Sweden 2017



Biopower is the fourth biggest power source

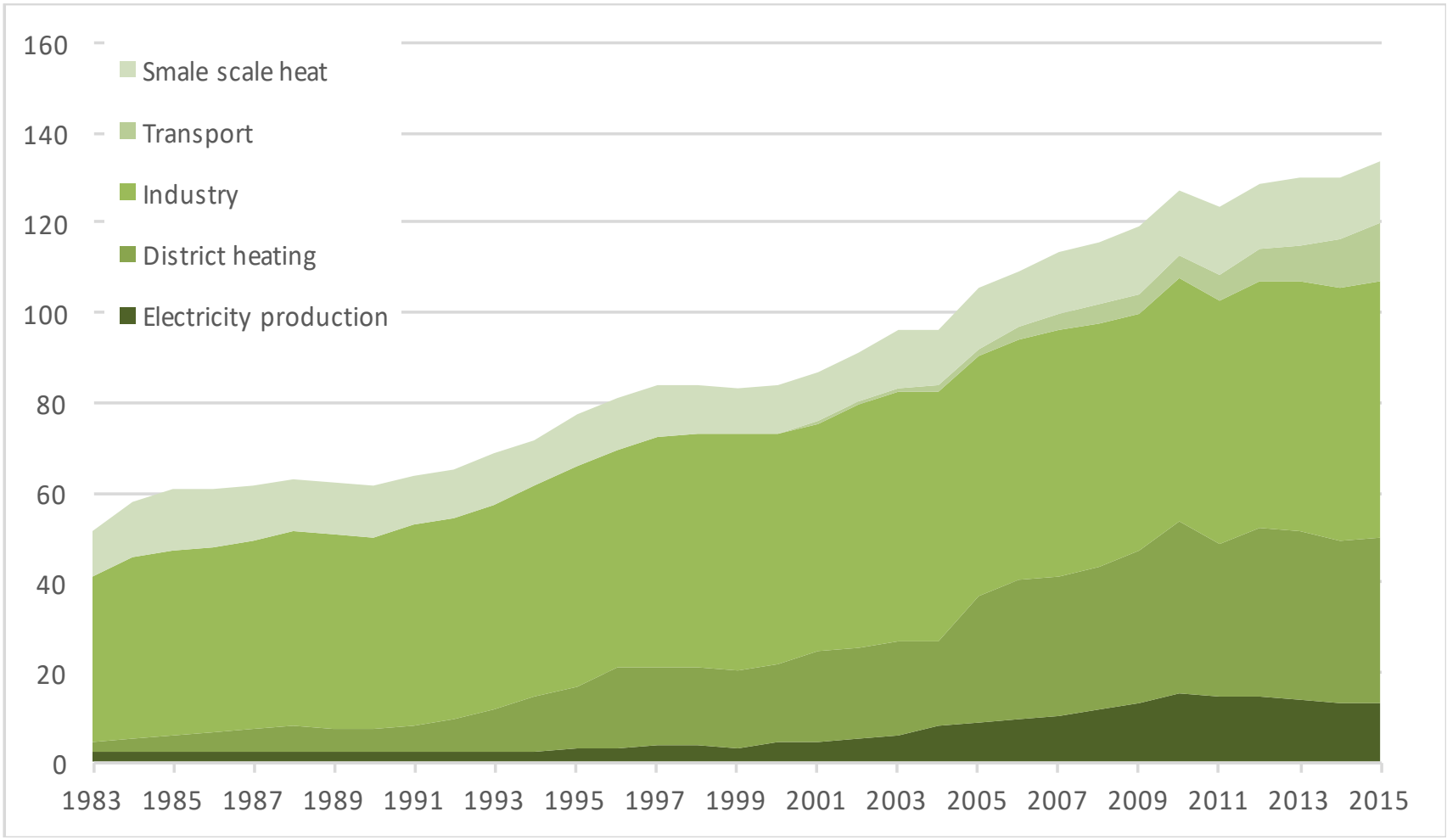
Half of the biopower is produced in district heating, half in the pulp industry.

Based on statistics from Statistics Sweden and the Swedish Energy Agency.



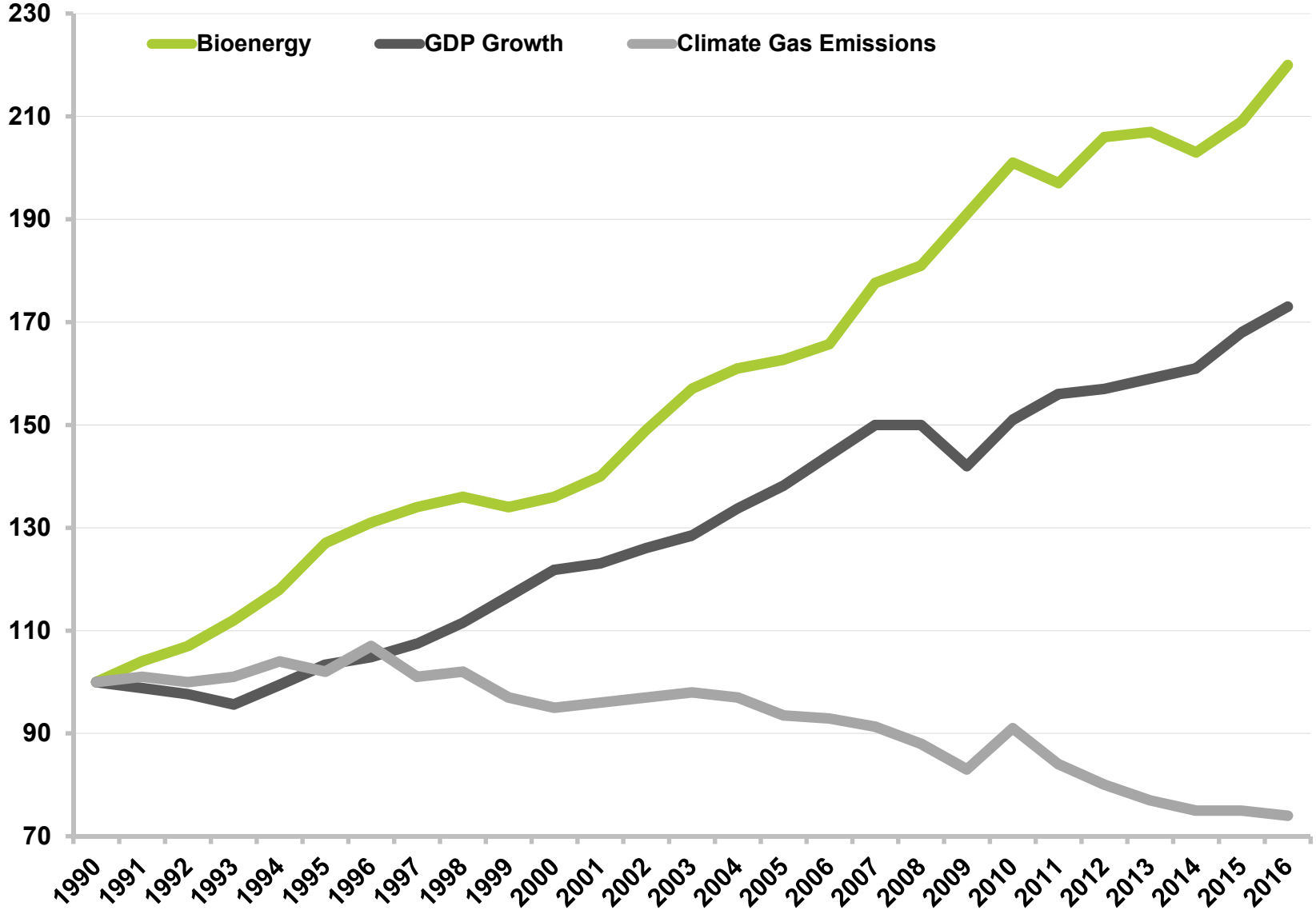
Energitillförseln i Sverige under åren 1970, 1991 och 2015, exklusive kärnkraftens värmeförluster. Den totala energitillförseln är någorlunda konstant, medan bioenergin har ökat från 43 TWh 1970 till 134 TWh 2015. Oljan har samtidigt minskat från 336 till 119 TWh. Uppgifterna för kärnkraft avser enbart el och inte spillvärme. Källa: Energistatistik, Energimyndigheten

Use of bioenergy 1983–2015 (TWh)



The use of bioenergy in Sweden almost tripled in 30 years time, with growth in all sectors.
Source: Swedish Energy Agency.

Decoupling of emissions and growth, driven by bioenergy



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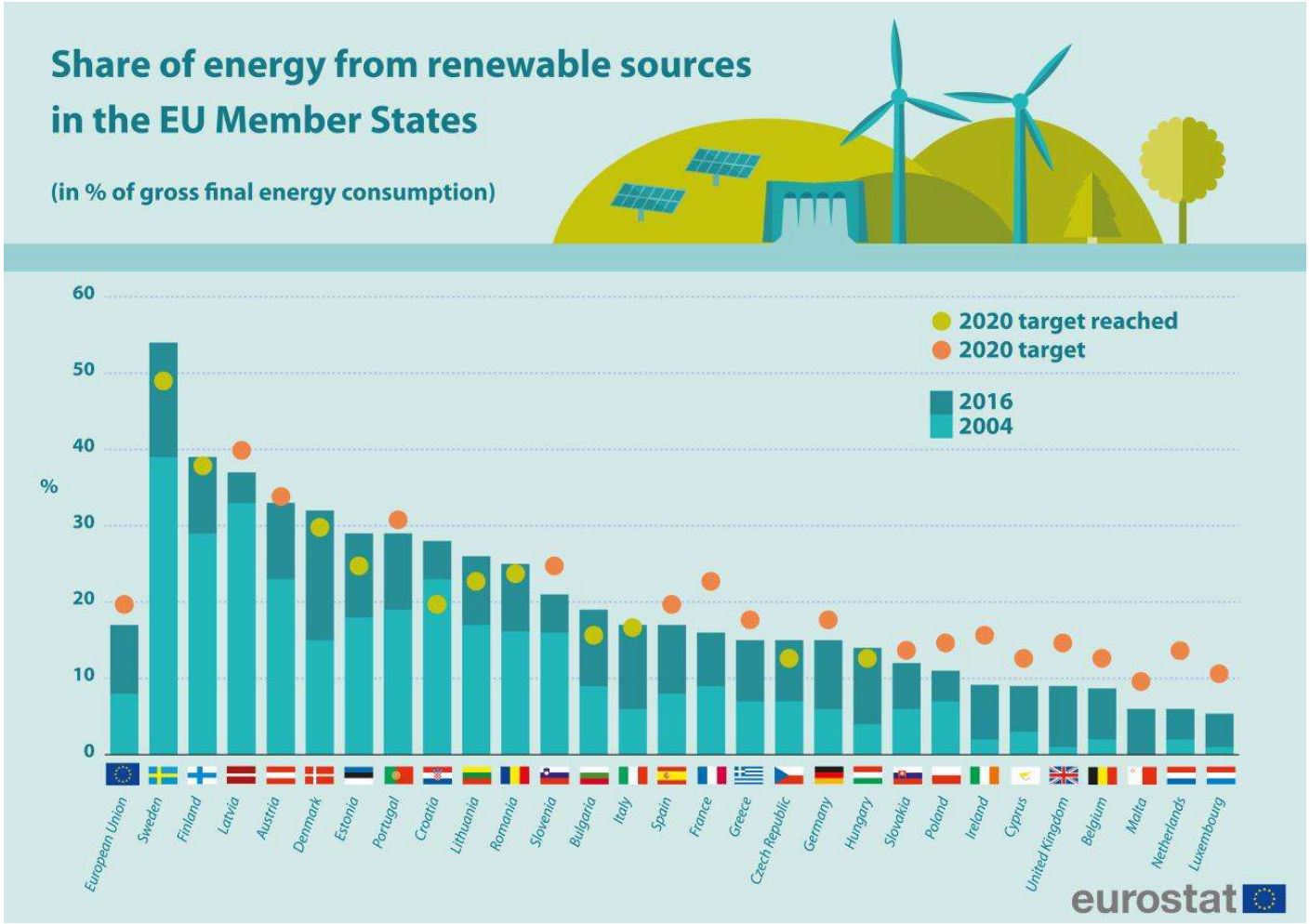
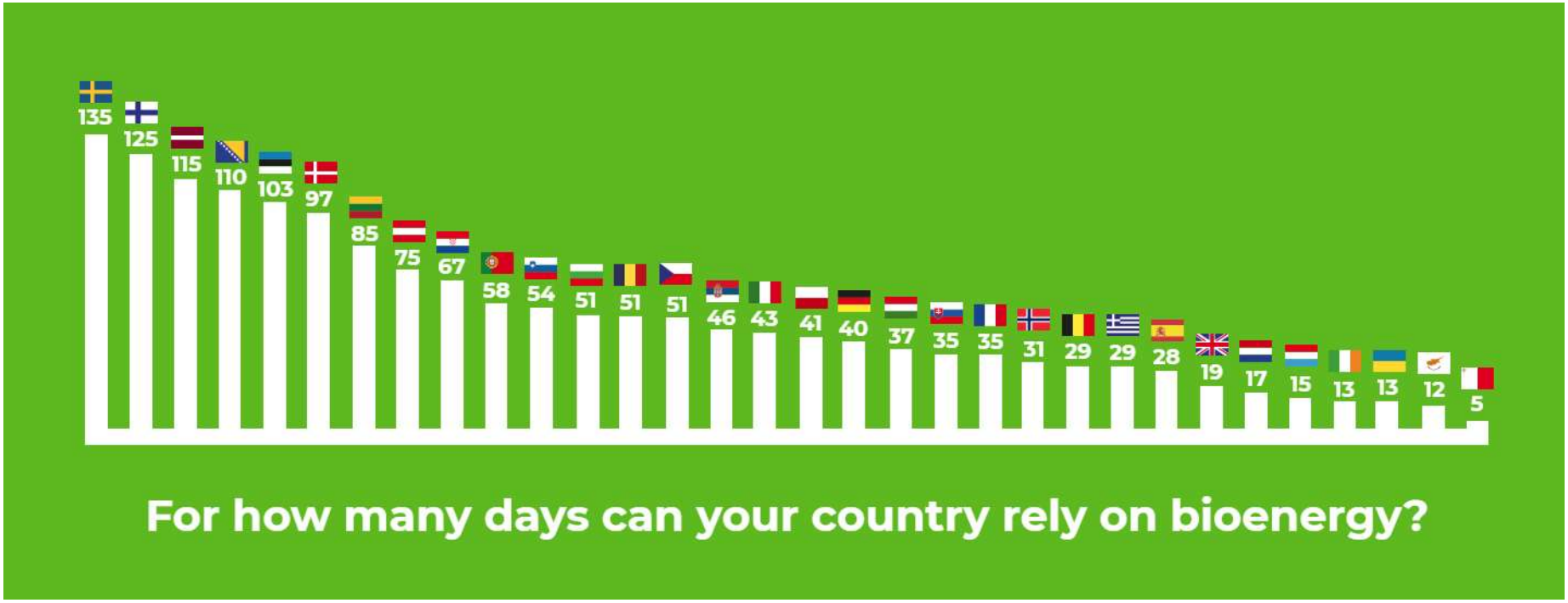
Fulfillment of renewable energy targets in EU

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For how many days can your country rely on bioenergy?

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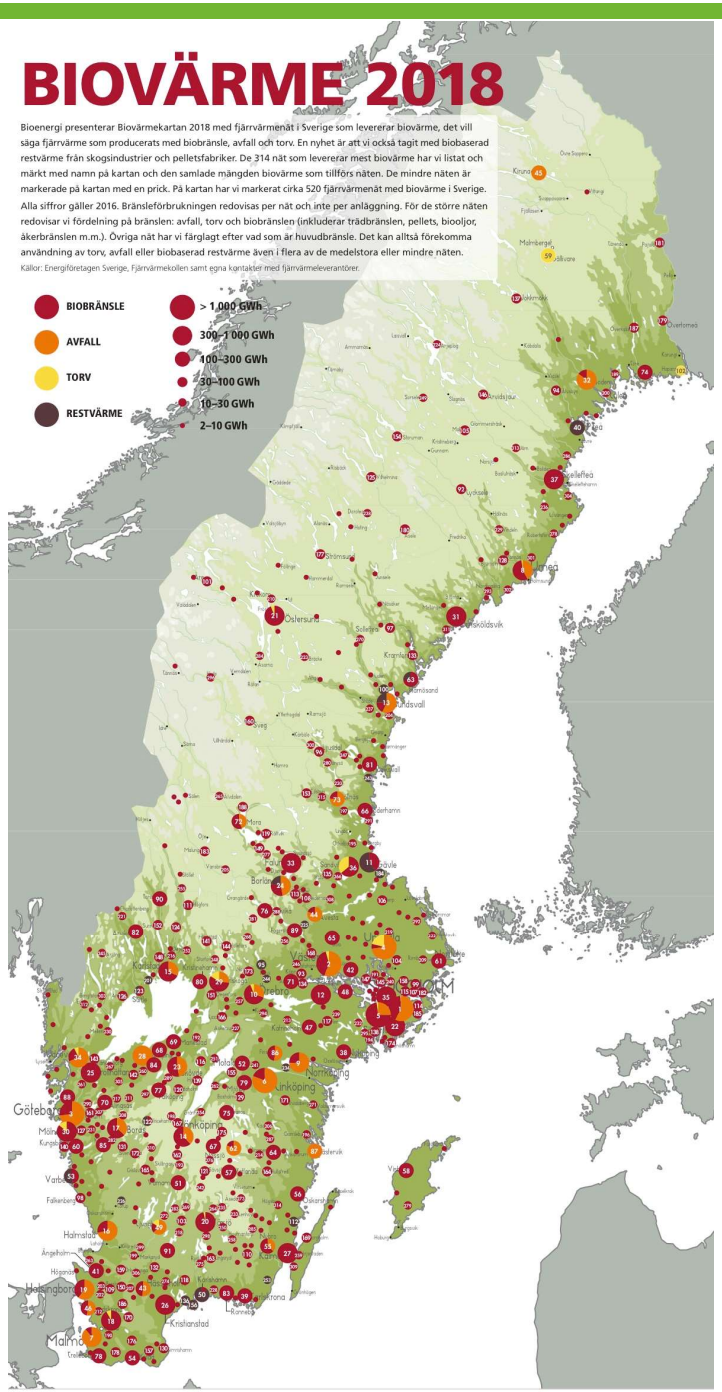
What made this development possible?

- Long-term and stable incentives.
- Broad political support across the party lines.
- Carbon tax based on the Polluter Pays Principle PPP.
- Limited use of direct subsidies. Trusting the market forces.
- No fossil fuel sources in Sweden. No strong fossil fuel lobby.
- Strong forest industry and strong forest owner's association.
- District heating well developed.

The city of Sundsvall in middle Sweden is located between two mountain ranges. Before district heating was introduced, smoke from hundreds of chimneys and smoke stacks caused serious air pollution, particularly on cold winter days.
Today almost all of the houses are connected to the district heating grid, supplying 80 000 people with heat. And the air quality has improved accordingly.

Pictures supplied by Sundsvall Energi.

Photo: Torbjörn Bergkvist



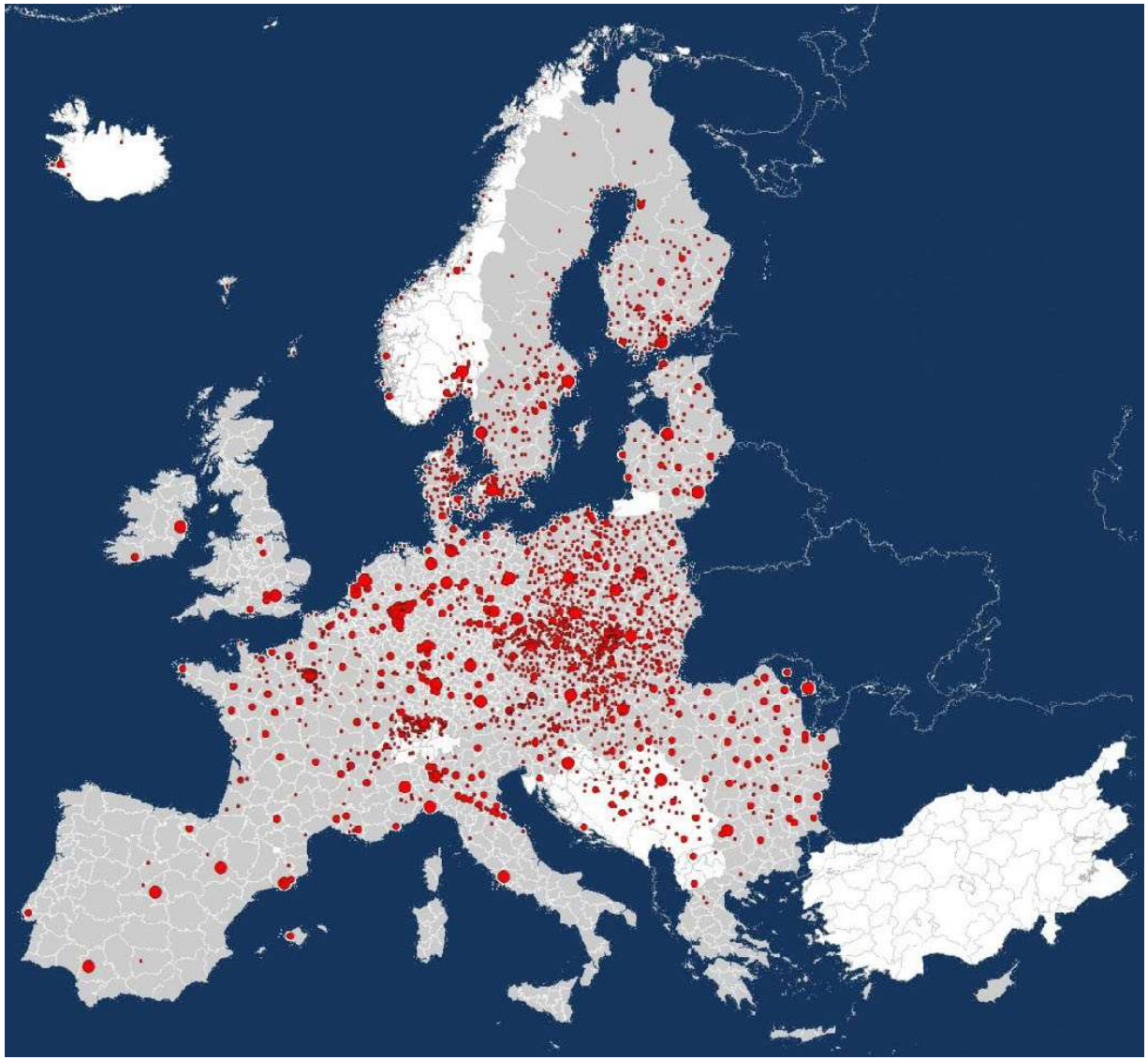
Bioheat in Sweden

520 heat plants using biomass (red) or municipal waste (orange).

Biomass is primarily locally sourced biomass from forestry and forest industries. Some of the biomass is transported long-distance by train or boat.

The map is published yearly by Svebio's magazine Bioenergi.

HEAT ROADMAP EUROPE 2050



Report written by:
Aalborg University and
Halmstad University
for Euroheat & Power,
Brussels

- Shows that Europe can save €14 billion per year if using current waste heat from power production in district heating.
- Pay back time is 2-3 years and investment would create thousands of profitable jobs in Europe.

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Reduced oil use and emissions from heating

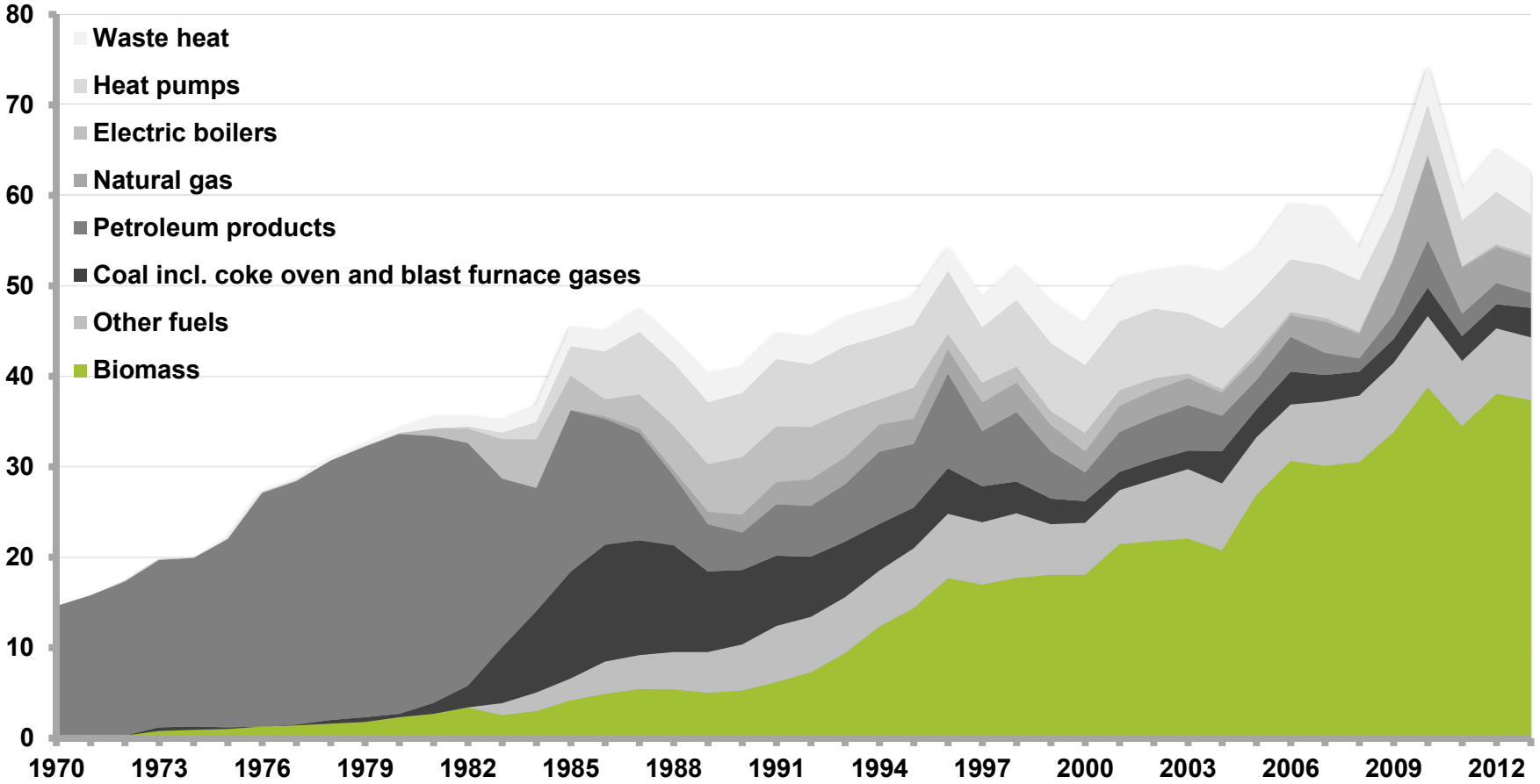
450 heat plants for district heating – 90 of them with electricity production (CHP).

The use of oil for heating of buildings decreased from 30,9 TWh 1990 to 1,6 TWh 2014.

The emissions decreased from 9.48 Mton CO_2 in 1990 to 1.34 Mton CO_2 in 2014.

Total reduction of GHG emissions 85 %.

Energy supplied to district heating, 1970–2013 (TWh)



During the previous 30 years, biomass has taken over as fuel in Swedish district heating. Fossil fuels dominated in the 1980s, but today bioenergy and "other fuels" (peat and waste) account for 75 percent of consumed fuels.
Source: Swedish Energy Agency and Statistics Sweden.

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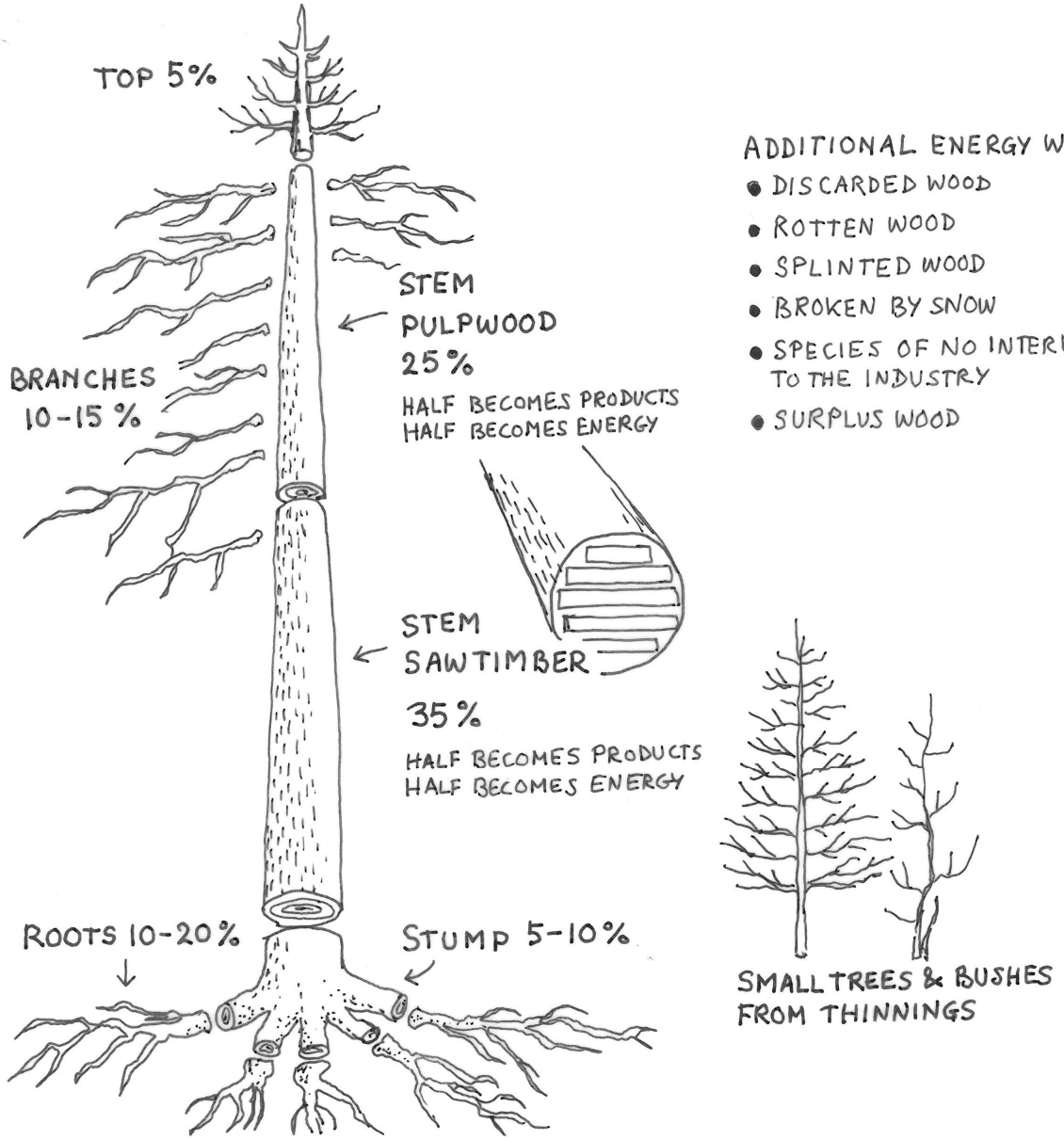
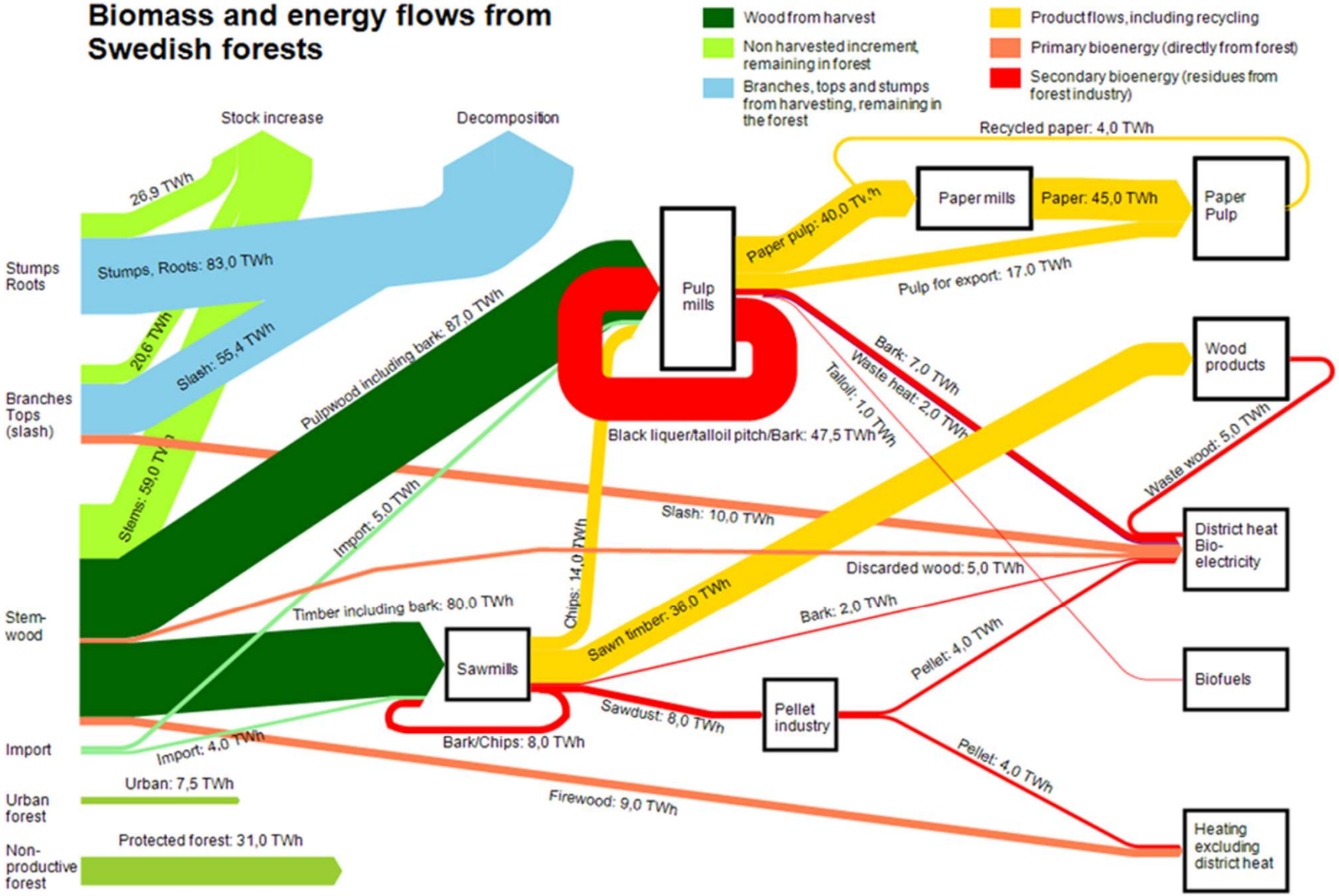


ADDITIONAL ENERGY WOOD:

- DISCARDED WOOD
- ROTTEN WOOD
- SPLINTED WOOD
- BROKEN BY SNOW
- SPECIES OF NO INTEREST TO THE INDUSTRY
- SURPLUS WOOD

More than 50% of the tree harvest ends up as energy – in the end almost 100%

Biomass and energy flows from Swedish forests



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Biomass for district heating

By-products from sawmills and pulp factories:
bark, sawdust, chips, discarded wood, shavings

Forest residues:
tops, branches, stumps, small trees from thinnings, trees of low value

Material from parks and gardens, landscaping wood

Pellets, briquettes, wood powder

Recycled wood

Bio-oil, tall oil

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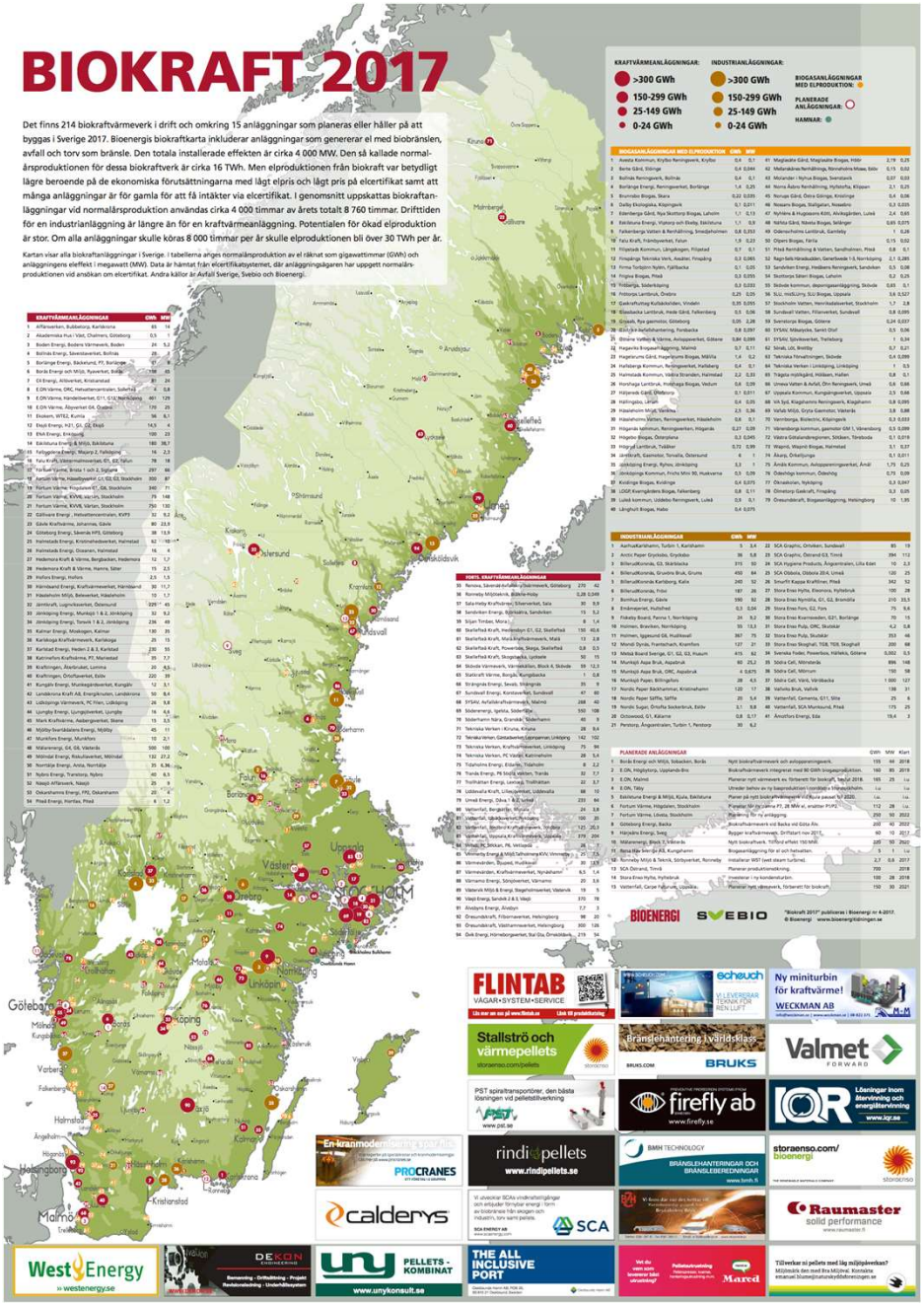
The biomass from forestry is mainly residues

Chips, bark, sawdust, low-quality and rotten wood, etc


Huggbilen
PWH 132



Biopower in Sweden

Every year Svebio and the magazine Bioenergi produce a map of all bio-power production units in Sweden. The map from 2017 shows biopower production at 214 locations, and another 15 planned units.

This includes:
94 CHP plants in district heating
41 units in industries
79 small plants using biogas for electricity.

Total installed capacity 4 000 MW
Production today 12 TWh, 16 TWh at a "normal" price level.
Could produce 30 TWh if used all year around.

The map is available for download on www.svebio.se or www.bioenergitidningen.se. It is also possible to order printed copies.

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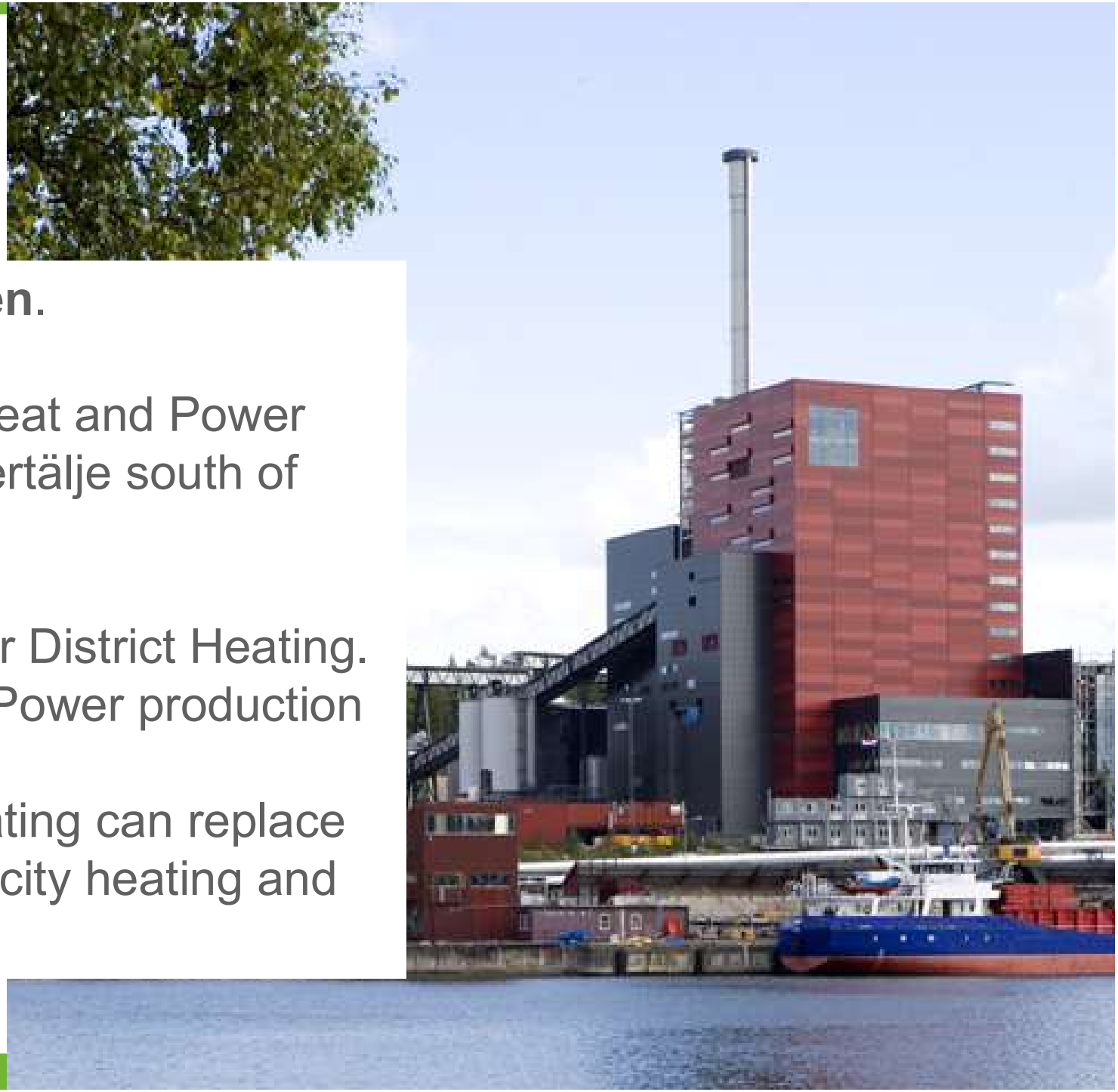


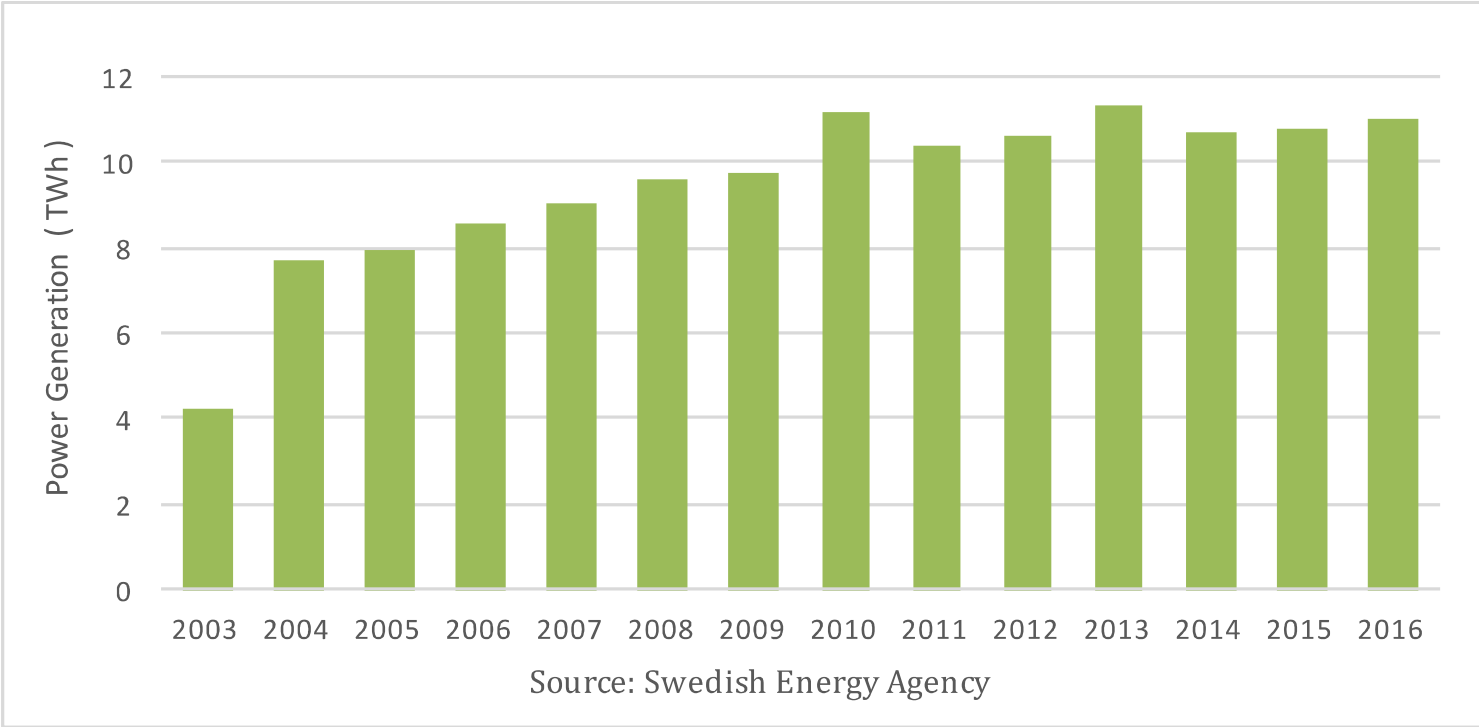
Igelstaverken.

Combined Heat and Power plant in Södertälje south of Stockholm

200 MWth for District Heating.
85 MWe for Power production

Biomass heating can replace direct electricity heating and heat pumps.

Bio-electricity production, 2003-2016 (TWh)



The production of bio-electricity receiving green certificates. After 2012 more than half of the production was phased out of the support system, and the statistics are since then uncertain.
Source: Swedish Energy Agency

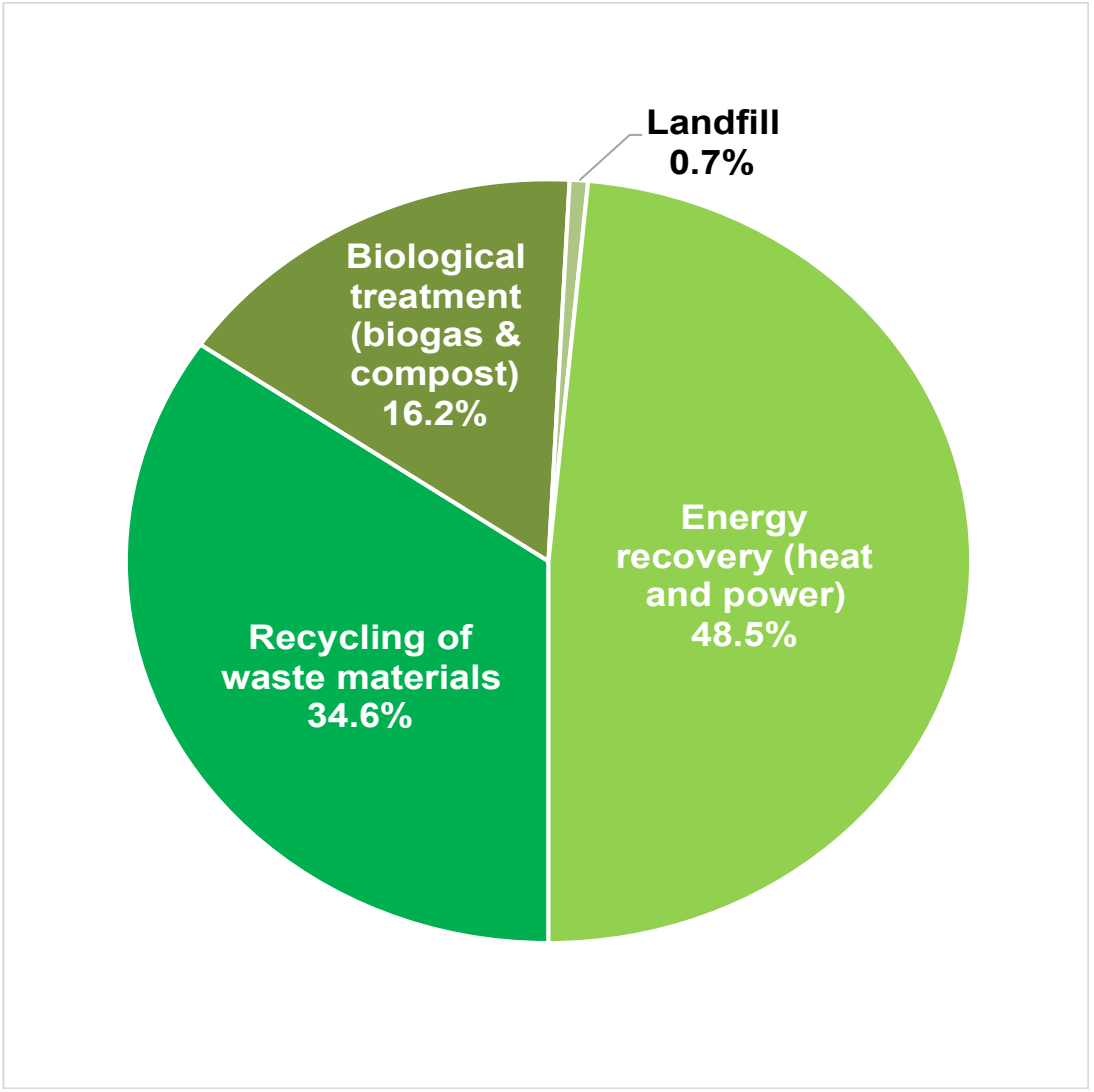
Recycled wood

Increased trade in post-consumer wood.
Sweden has many boilers with permits to use this fuel.

Use of household waste 2016

Only 0.7 percent of all household waste in Sweden was taken to landfill in 2014. Half of the waste was used to produce heat and power.

Source: Avfall Sverige



Municipal waste

Import of waste to Sweden:
- 213,000 tonnes in 2005
-1,421,000 tonnes in 2014.

Today the share of imported waste is 25%.

Main suppliers:
Norway
UK
Ireland
Italy

Agricultural fuel Salix

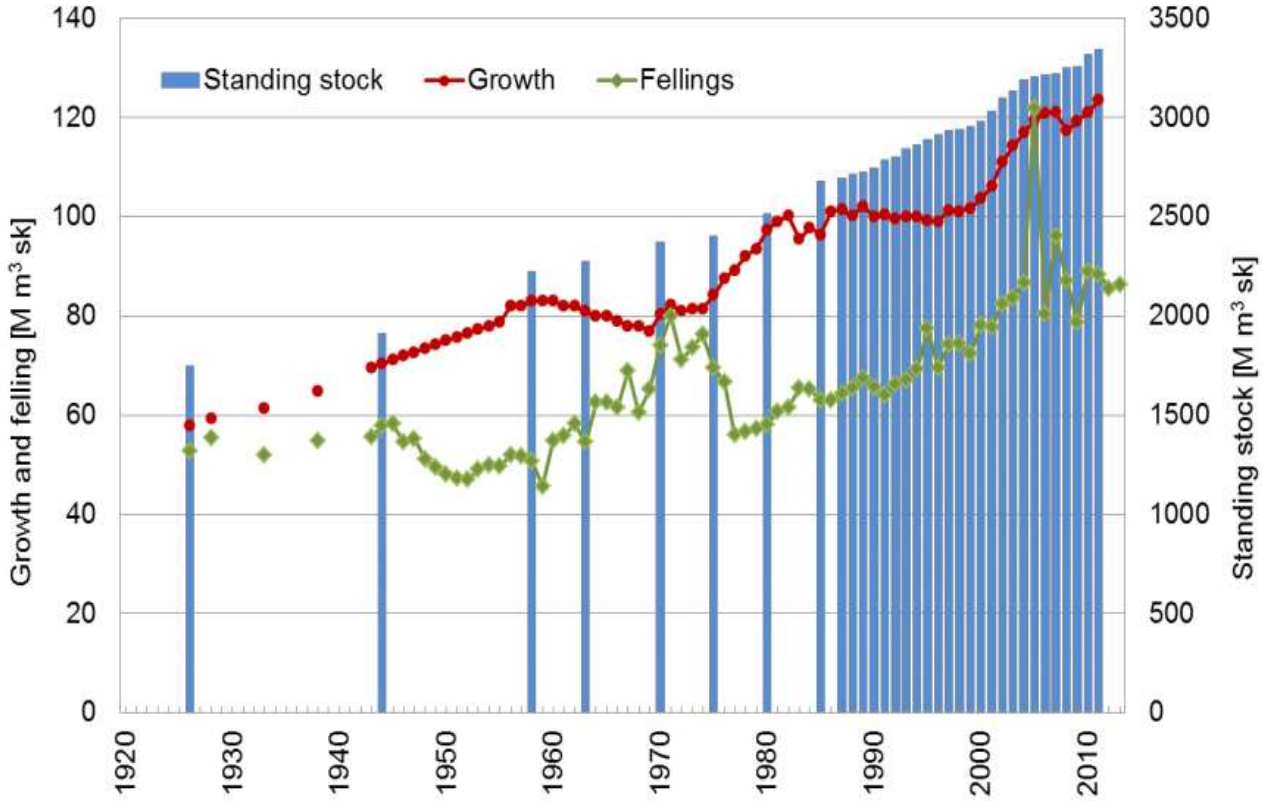
Short rotation coppice (SRC) using willows, Salix, for energy production was developed at the Swedish Agricultural University SLU around 1980.

12,000 hectares have been planted.

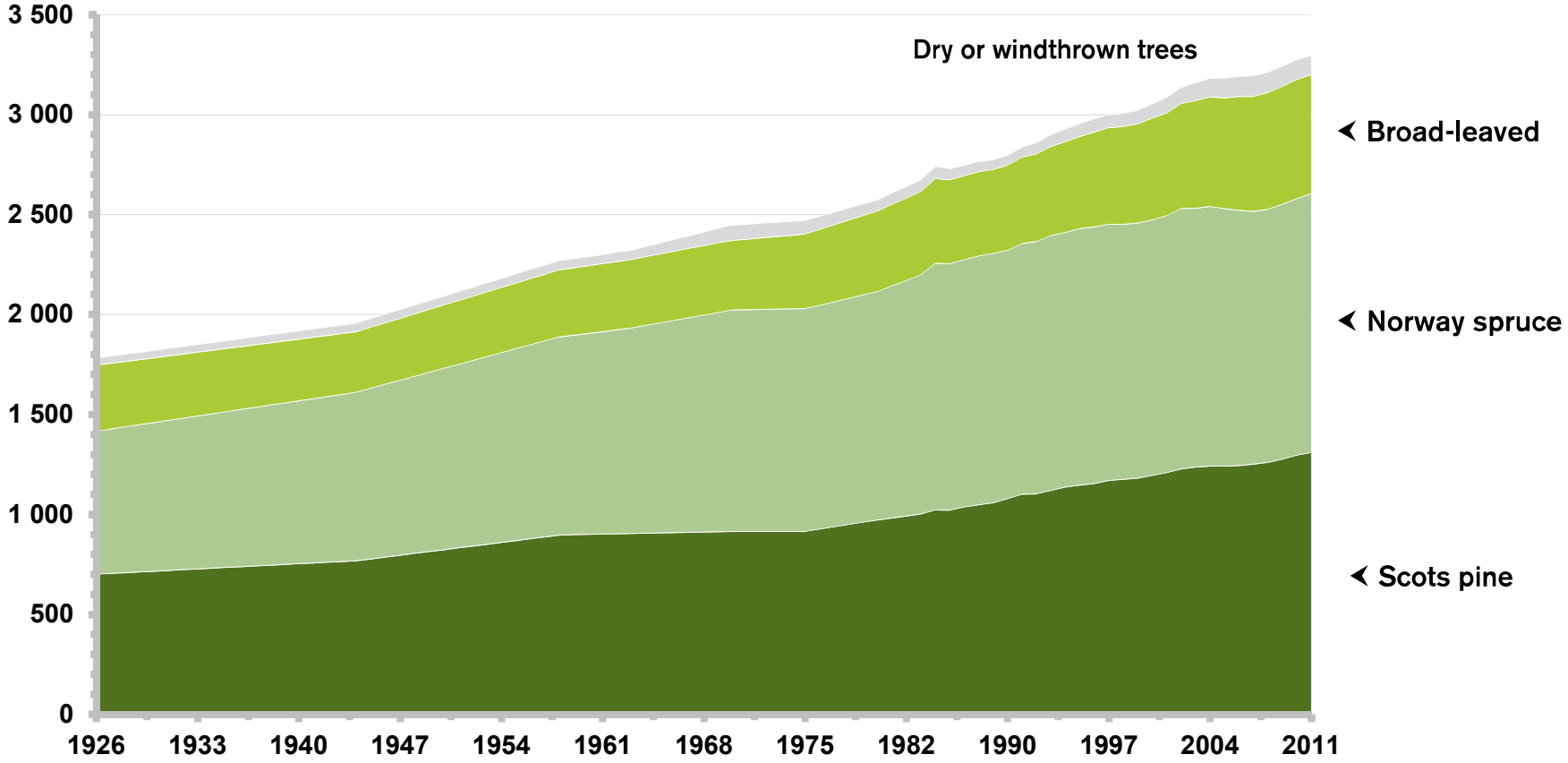
Can produce 10 tonnes OBD per hectare.

Harvested every 3 – 4 years.

Swedish forests during 100 years:
. increased growth (red)
. increased harvests (green)
. increased standing stock (blue)

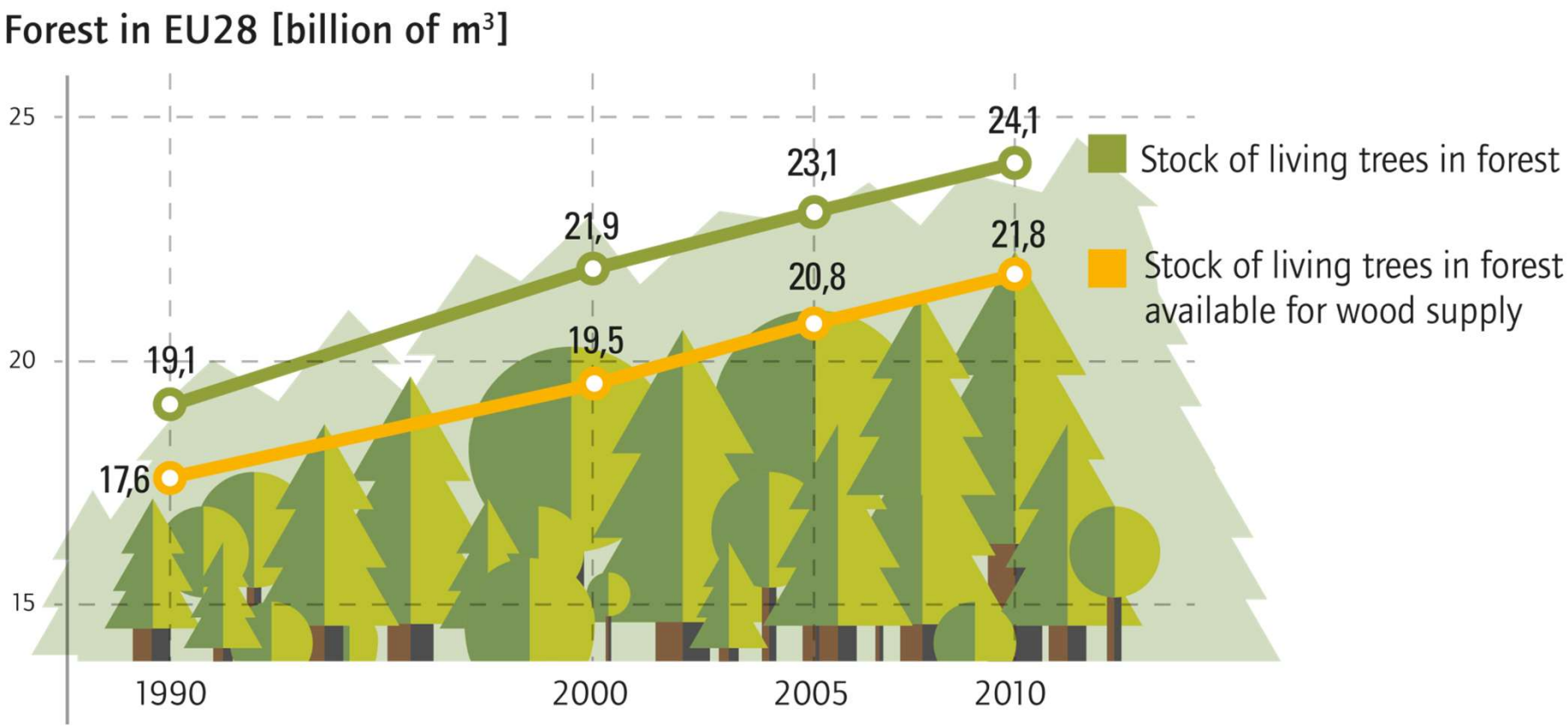


Trend for total standing volume in forests, 1926–2011



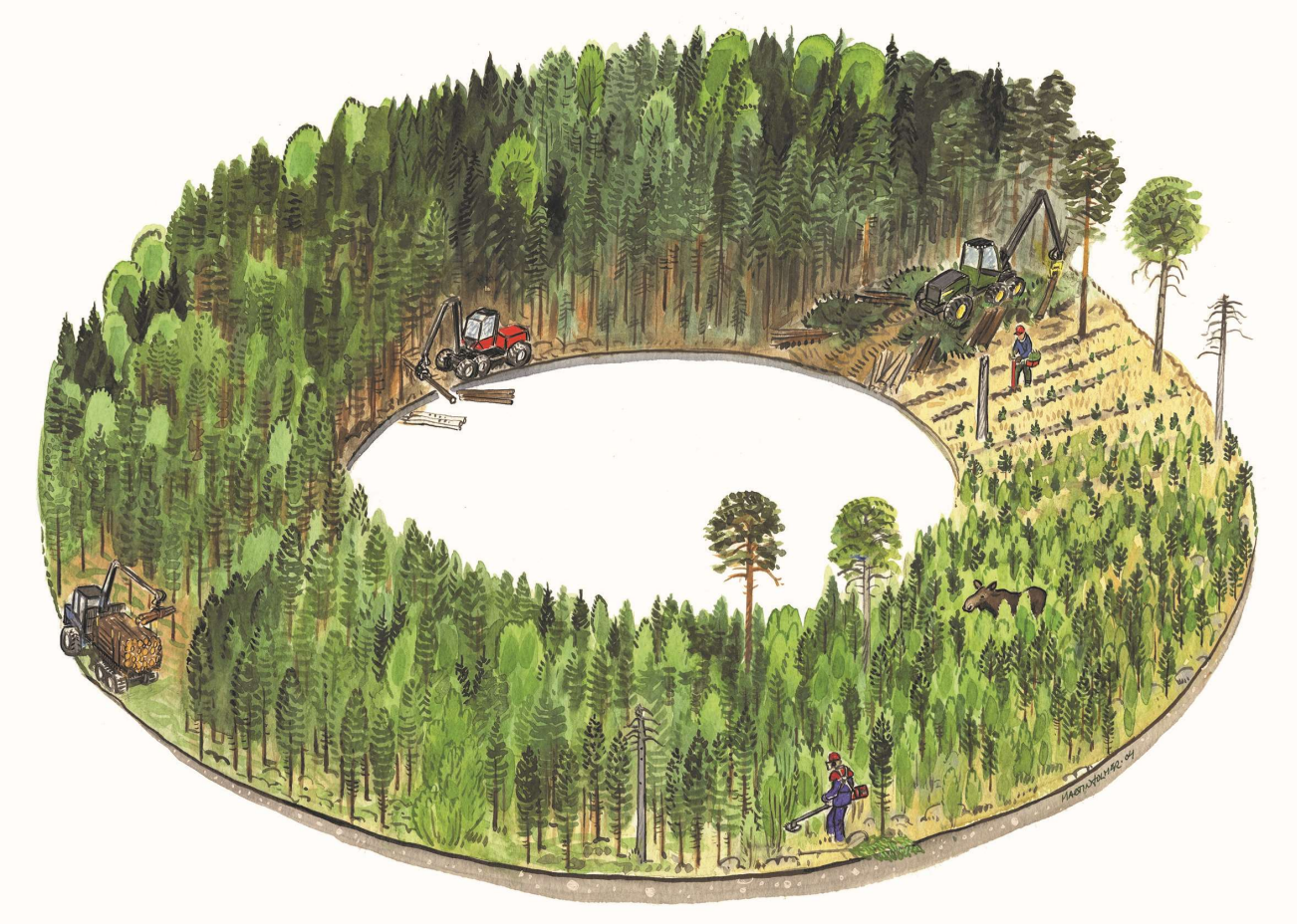
The total standing volume, and thus the amount of stored carbon, has doubled in Sweden's forests in the previous hundred years, thanks to reforestation and good forest management.
Source: Derived from official statistics from Swedish University of Agricultural Sciences, Swedish National Forest Inventory

Trend of standing volume in European forests



Source: AEBIOM, European Bioenergy Outlook 2014

Managed forestry is carbon neutral
– 1% harvested every year in a 100 year long rotation



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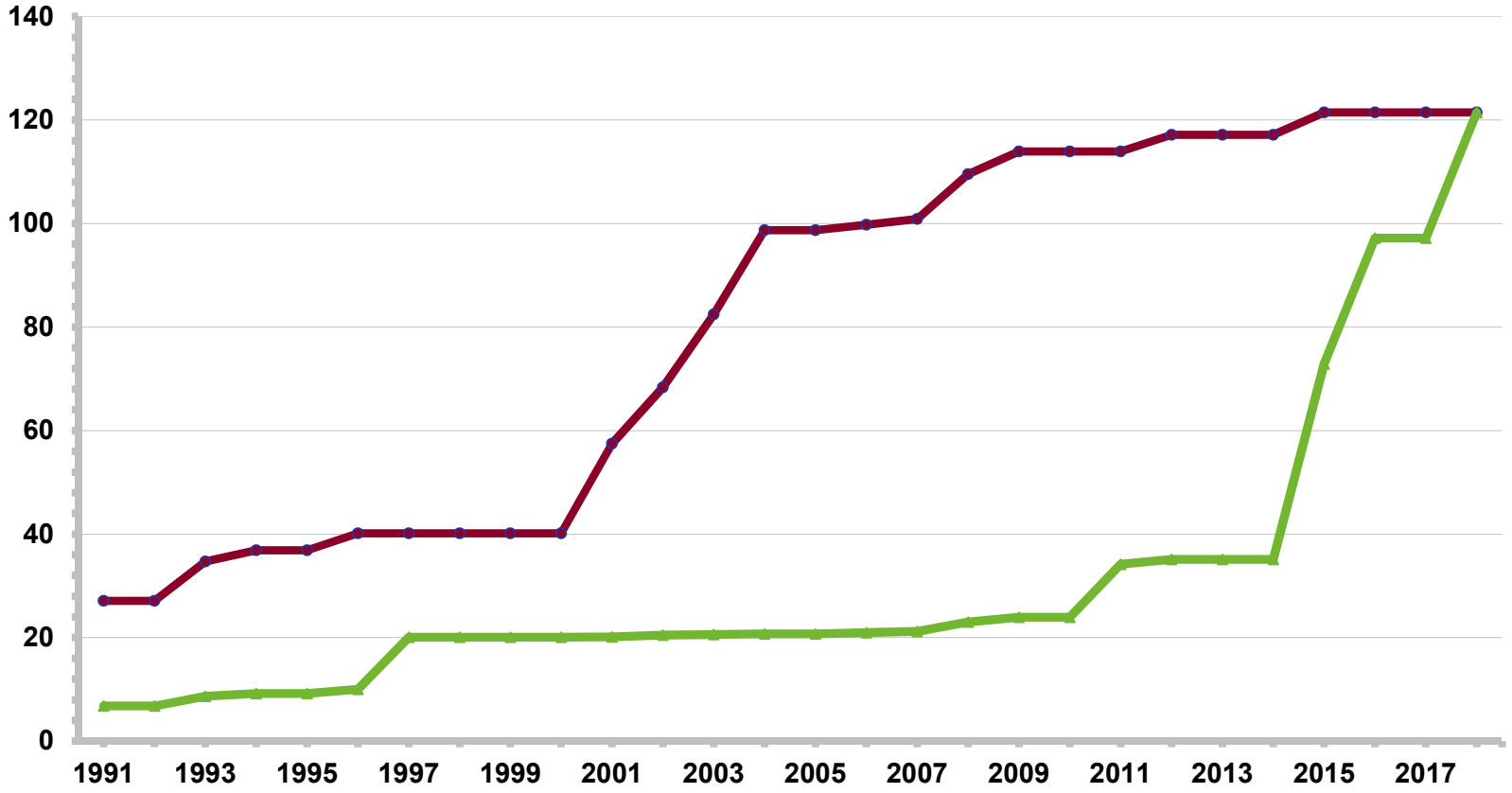
Regrowth after harvest

New forest is established within a few years either by planting (like the spruce plant in the forground), or by natural seeding from trees that are left at the site.

The requirement to establish new forest after harvest was made mandatory in the Swedish forest legislation in 1905.

Planting can be done qucker if the slash in the clear-cut area is removed.

The Swedish carbon tax 1991–2018



The carbon dioxide tax was introduced in 1991, and has been increased in several steps since then.
Red: the general carbon dioxide tax level, paid by the residential and service sector.
Green: The tax paid by industries outside ETS that are not required to have emission allowances.
Source: Swedish Finance Ministry / Svebio

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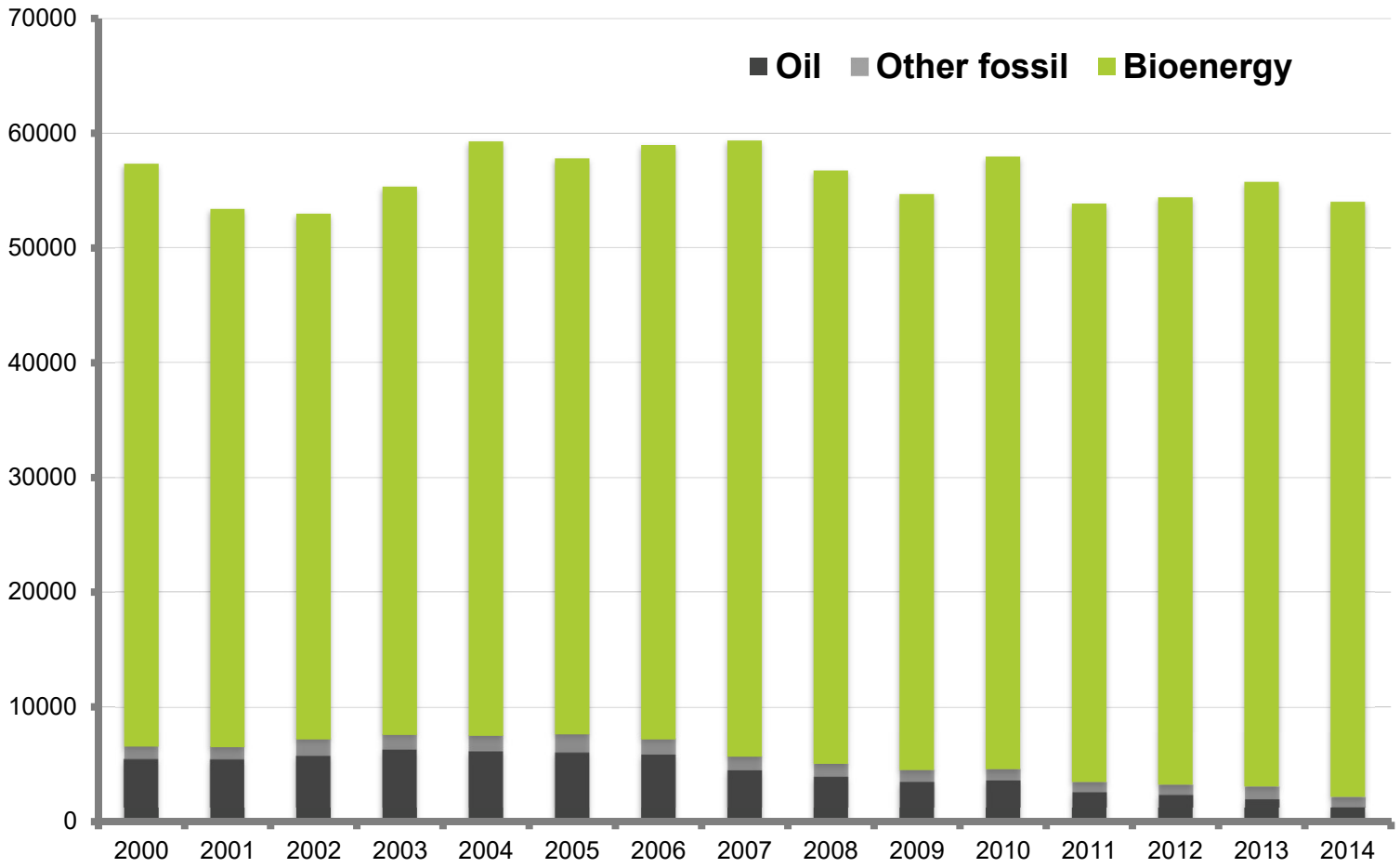
Greenhouses – from fossil fuels to biofuels and waste heat

Use of fossil fuels decreased by 83 % between 2002 and 2014.

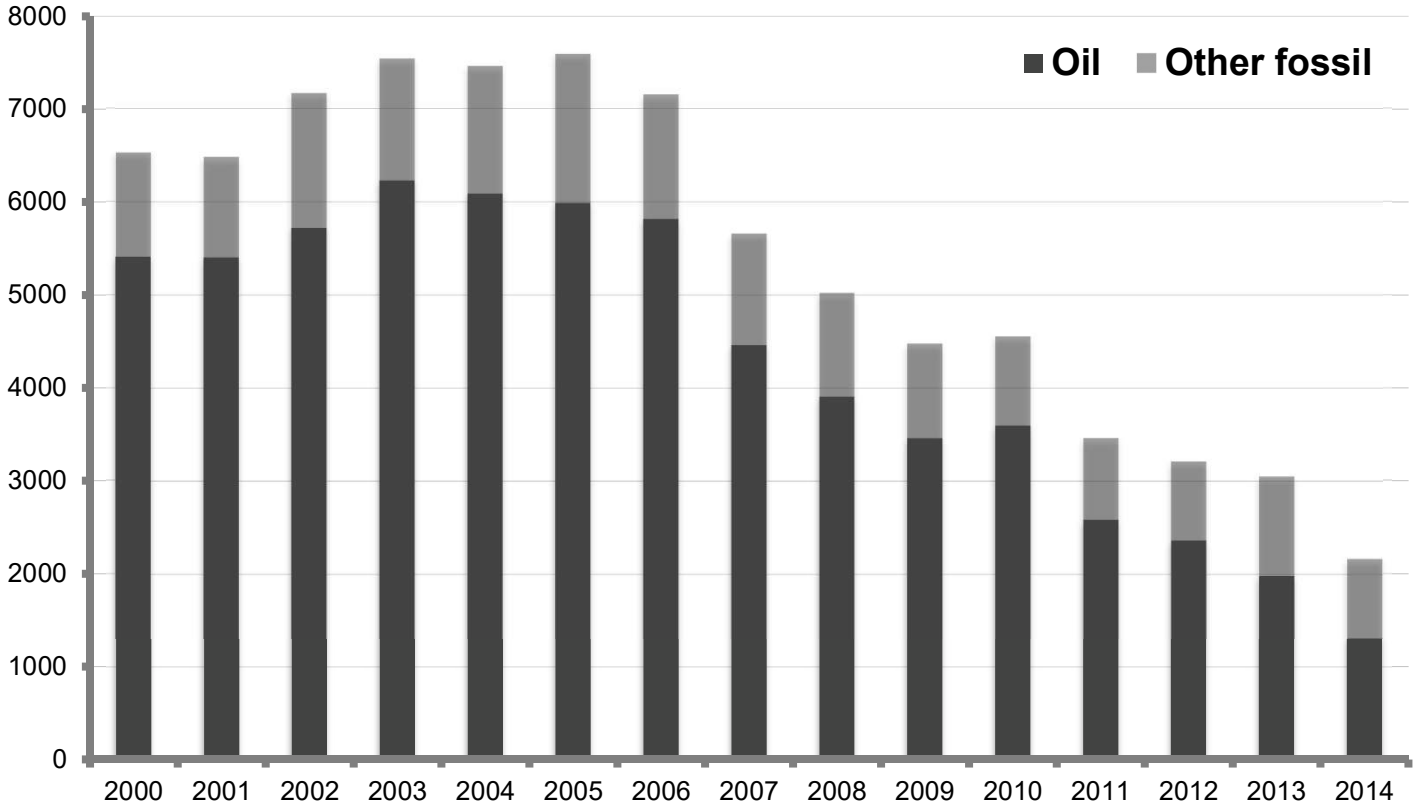
Use of biomass (woodchips and pellets) increased five-fold, and is today the leading fuel in greenhouses.

One of the largest tomato greenhouses uses waste heat from paper pulp factory.

Use of fuels in the Swedish forest industry



Use of fossil fuels in forest industry 2000 - 2013, GWh/year.



Minskningen har skett främst för eldningsolja (mörk del av stapel), medan användningen av övriga fossila bränslen, som gasol och naturgas (ljus del av stapel) har minskat mindre.
Källa: SCB, Sveriges officiella statistik, EN 31, Leveranser och förbrukning av bränsle.

Fate of anthropogenic CO_2 emissions (2007–2016)

Sources = Sinks

34.4 $GtCO_2$/yr

88%

12%

4.8 $GtCO_2$/yr

17.2 $GtCO_2$/yr

46%

30%

11.0 $GtCO_2$/yr

24%

8.8 $GtCO_2$/yr

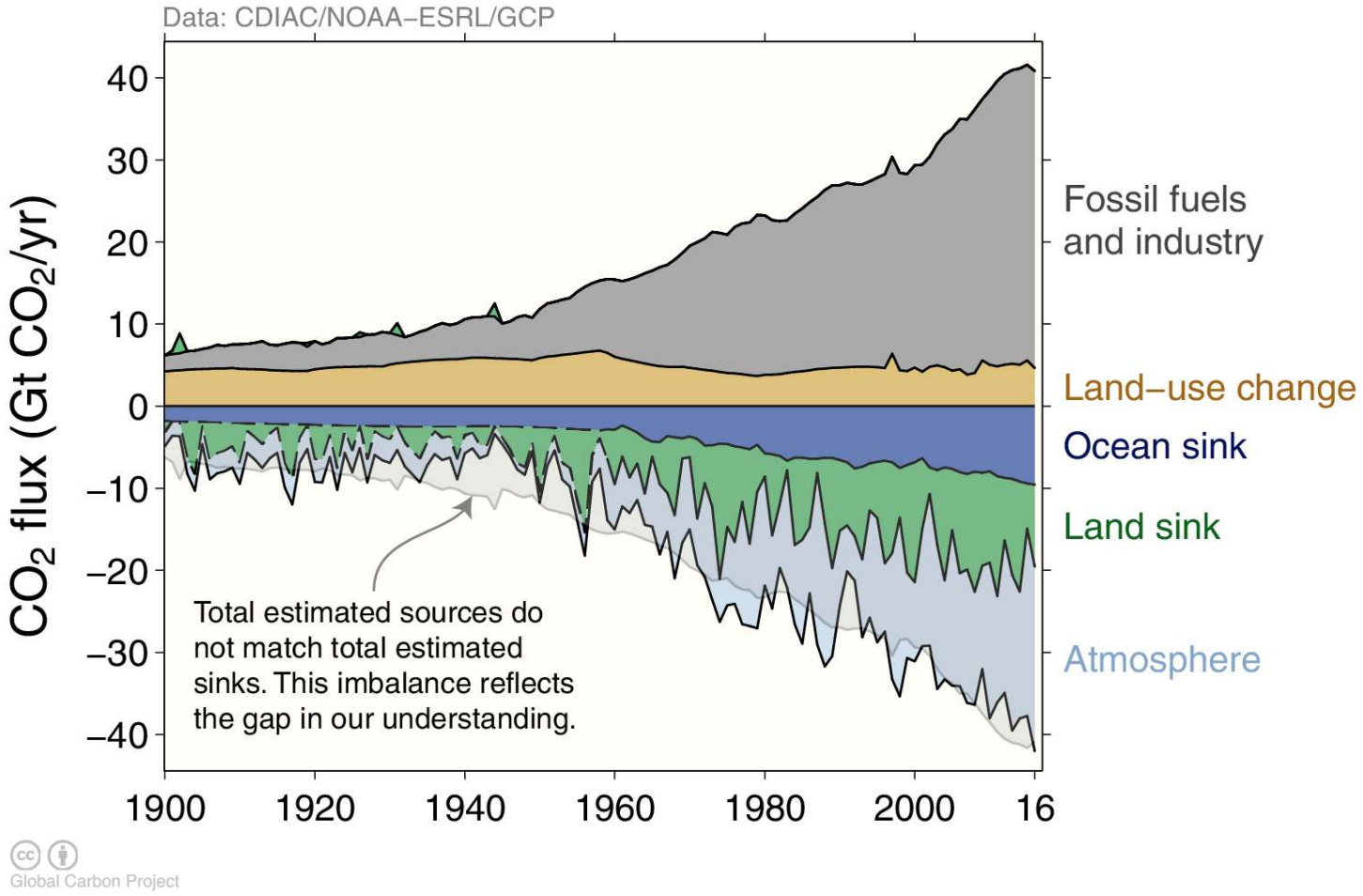
Budget Imbalance: 6%

(the difference between estimated sources & sinks) 2.3 $GtCO_2$/yr

Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Le Quéré et al 2017; Global Carbon Budget 2017

Global carbon budget

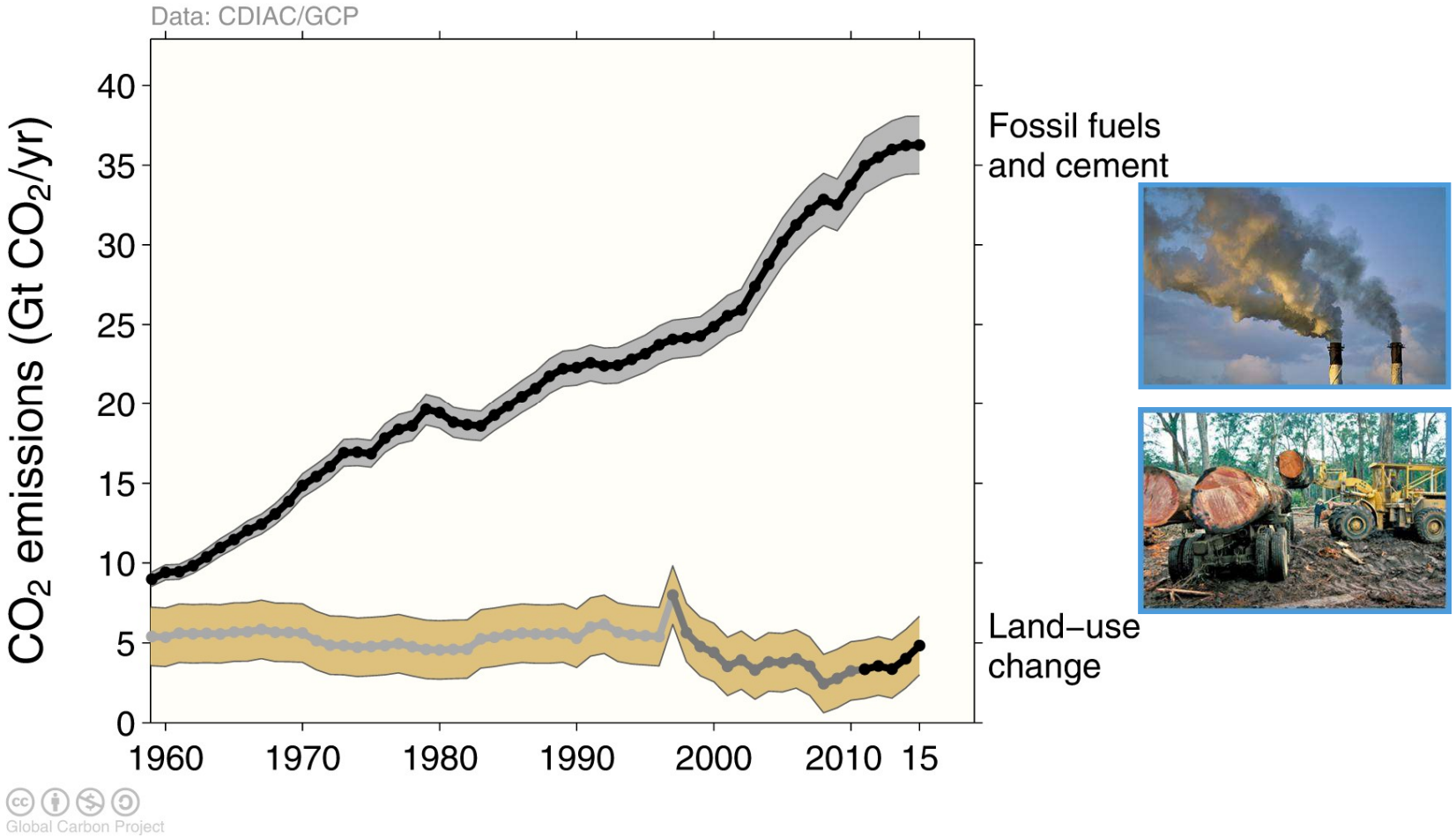
Carbon emissions are partitioned among the atmosphere and carbon sinks on land and in the ocean
The "imbalance" between total emissions and total sinks reflects the gap in our understanding



Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Joos et al 2013; Khatiwala et al. 2013; DeVries 2014; Le Quéré et al 2017; Global Carbon Budget 2017

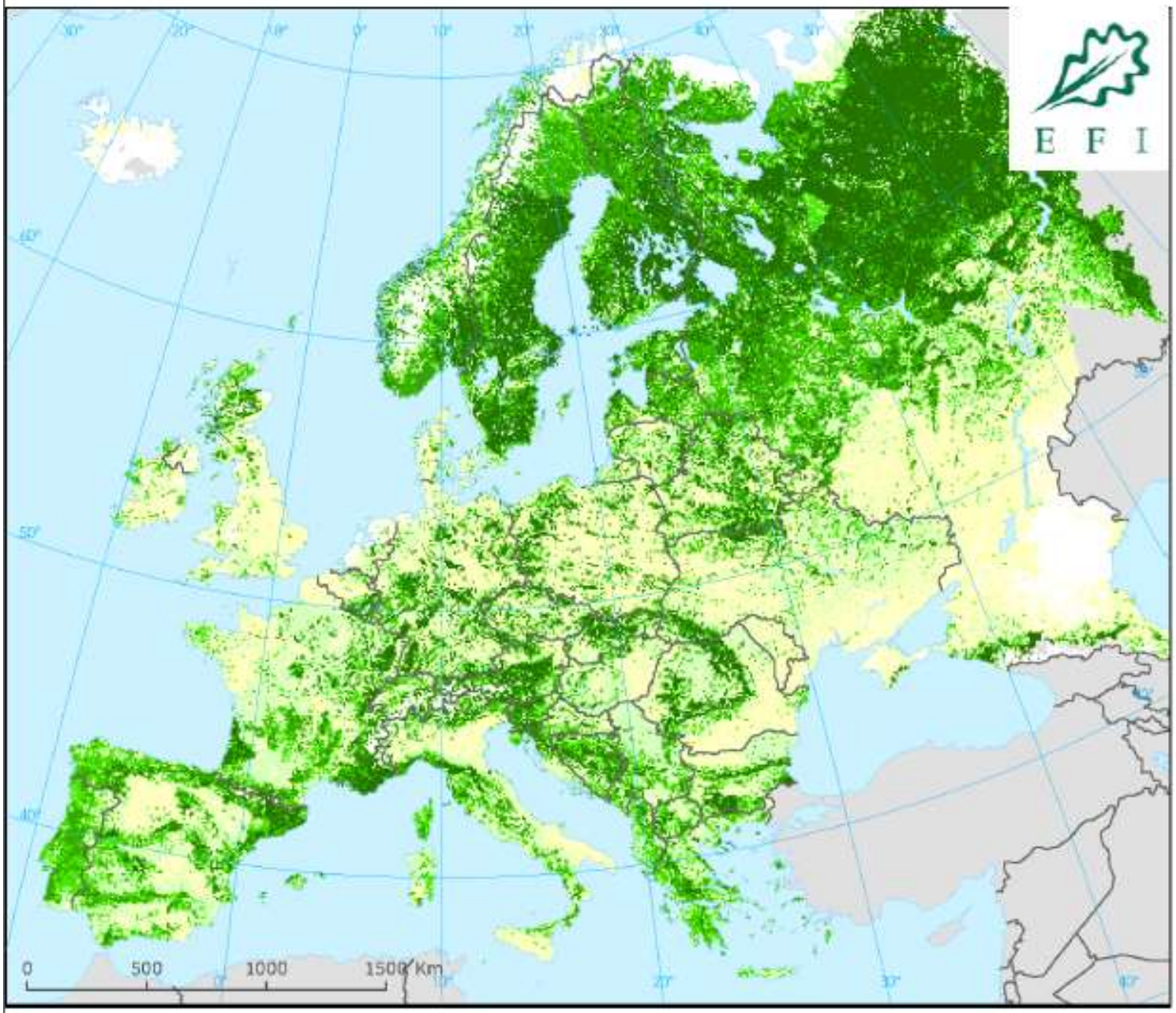
Total global emissions

Total global emissions: 41.9 ± 2.8 $GtCO_2$ in 2015, 49% over 1990
Percentage land-use change: 36% in 1960, 9% averaged 2006-2015



Three different methods have been used to estimate
land-use change emissions, indicated here by different shades of grey

Source: CDIAC; Houghton et al 2012; Giglio et al 2013; Le Quéré et al 2016; Global Carbon Budget 2016



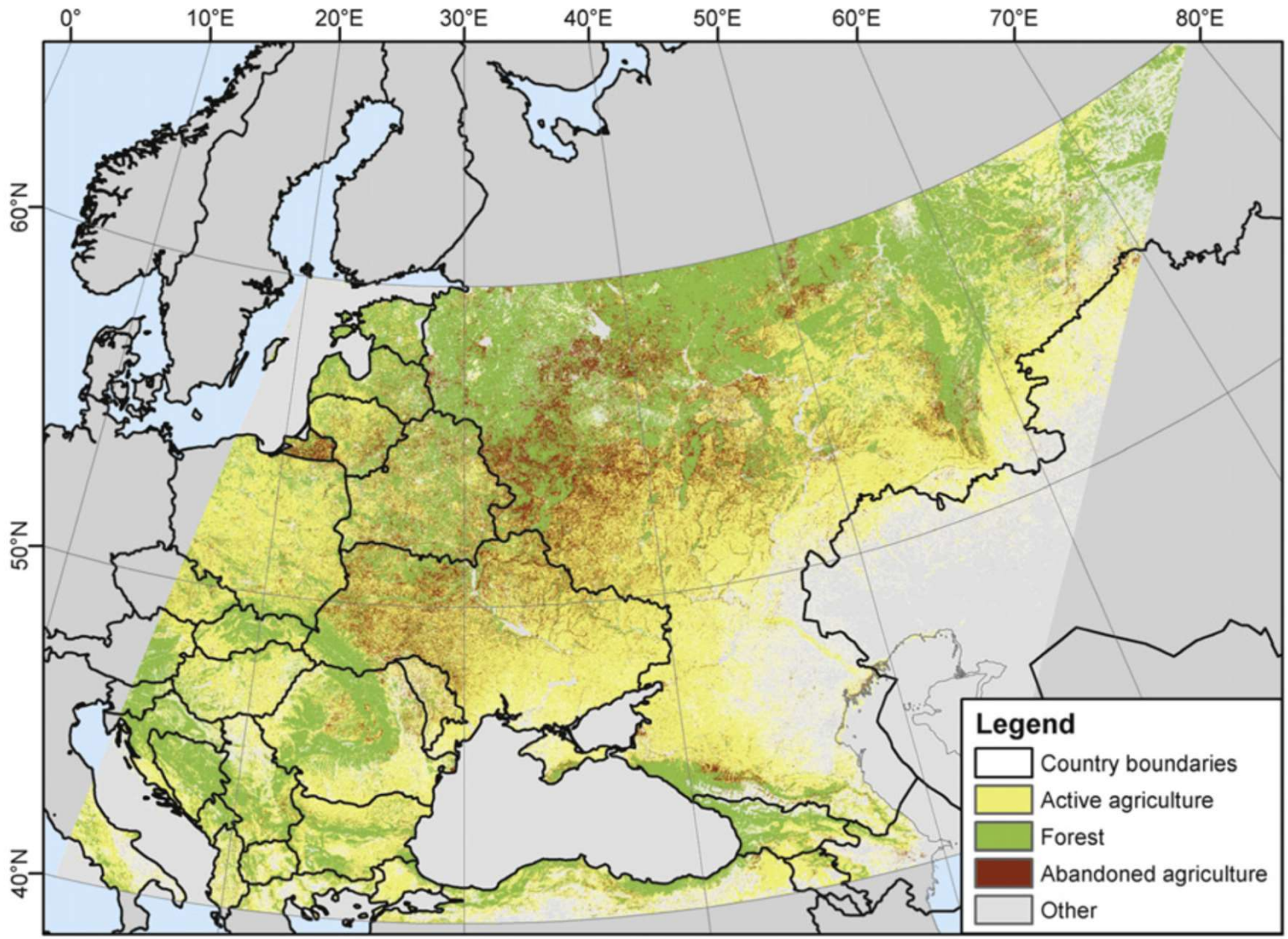
Kempeneers, P., Sedano, F., Seebach, L., Strobl, P., San-Miguel-Ayanz, J. 2011: Data fusion of different spatial resolution remote sensing images applied to forest type mapping, IEEE Transactions on Geoscience and Remote Sensing, in print.

Päivinen, R., Lehikoinen, M., Schuck, A., Häme, T., Väätäinen, S., Kennedy, P., & Folving, S., 2001. Combining Earth Observation Data and Forest Statistics. EFI Research Report 14. European Forest Institute, Joint Research Centre - European Commission. EUR 19911 EN. 101p.

Schuck, A., Van Brusselen, J., Päivinen, R., Häme, T., Kennedy, P. and Folving, S. 2002. Compilation of a calibrated European forest map derived from NOAA-AVHRR data. European Forest Institute. EFI Internal Report 13, 44p. plus Annexes;

Courtesy of European Forest Institute

A postcard from 1902 shows barren surroundings around this church in western Sweden. Today there are trees everywhere. This is a common development in most parts of Sweden during the last 100 years. Less grazing (fewer milk cows and sheep), less use of firewood, better management of forests, etc, are the causes of this development.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60°N
50°N
40°N
Legend
Country boundaries
Active agriculture
Forest
Abandoned agriculture
Other

Marginal lands in Europa – to use for farming, forestry and/or energy?

Infested forest in Colorado

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Challenges for the coming years

- Competition. Low electricity prices and low prices on fossil fuels.
- Low prices in ETS (improving lately)
- Policies in EU may hamper development, e.g. state aid rules, cap on biofuels, and sustainability criteria.
- NGO:s on EU level negative to bioenergy.
- Many of our domestic markets are saturated.
- Import of waste competing with wood fuels.

Thank you!

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