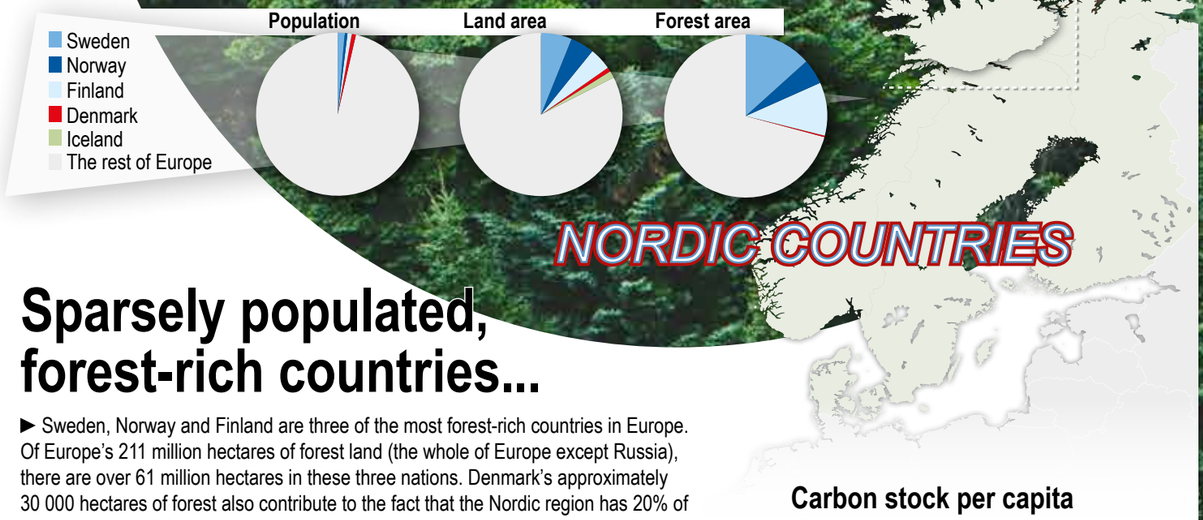


Sparsely populated, forest-rich countries...

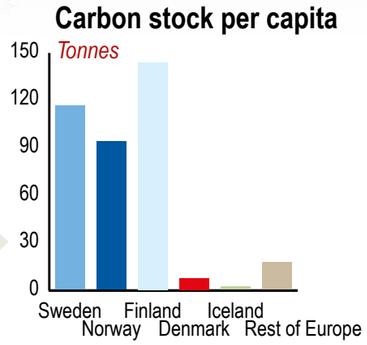
► Sweden, Norway and Finland are three of the most forest-rich countries in Europe. Of Europe's 211 million hectares of forest land (the whole of Europe except Russia), there are over 61 million hectares in these three nations. Denmark's approximately 30 000 hectares of forest also contribute to the fact that the Nordic region has 20% of Europe's wood stock.

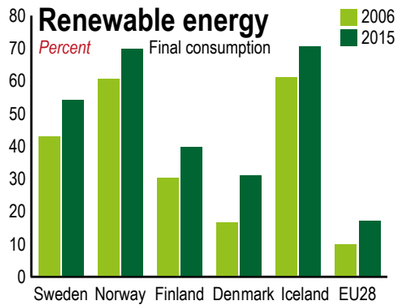
The inhabitants of Sweden, Norway and Finland have access to an average of 3 hectares of forest land per person. Compare this with Germany (0,13 ha), Great Britain (0,05 ha) and France (0,25 ha).

...with a large carbon stock

► The entire Nordic region has an average of 93 tonnes of carbon per inhabitant bound up in the living biomass of the forest. The amount is largest in Sweden, Norway and Finland.

Source: State of Europe's forests 2015, the whole of Europe except Russia.



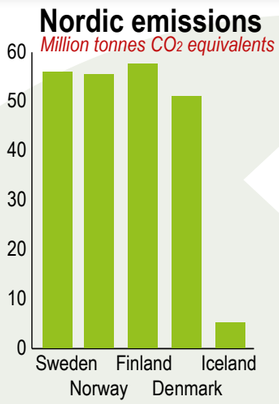


A large share of renewable energy

► Renewable energy comes from renewable sources. Examples are hydropower, wind power, solar energy and bioenergy. In the Nordic countries, conditions vary. Hydroelectric power is an important source of energy in Norway and Sweden, bioenergy plays a major role in Finland and Sweden, Denmark has invested heavily in wind power and Iceland in geothermal power.

The share of renewable energy is significantly higher in the Nordic countries than the EU-average, and it has increased significantly during the 21st century.

Source: Eurostat http://ec.europa.eu/eurostat/web/energy/data/database



Greenhouse gas emissions

► The largest carbon sources in the Nordic countries are transport, energy, industrial use, agriculture and households. Emissions in 2015 amounted to 225 million tonnes of carbon dioxide equivalents.

► Sweden, Finland and Norway released 169 million tonnes in 2015. This is almost equal to the climate benefits of the countries' forests, about 150 million tonnes.

Source: Eurostat, Greenhouse gas emissions, incl. international aviation and indirect CO2, excl. LULUCF.

The brochure "Climate benefit of the Nordic Forests" has been commissioned by Nordic Forest Research (SNS) and the Nordic Council of Ministers. Facts and content: Tomas Lundmark (SLU) och Mats Hannerz (Silvinformation AB). Layout: Katarina Ekegren, SNS. The initiative to produce the brochure was from the NSF Nordic Forest Owners Association. October 2017.
Read more about climate benefits and the calculations on www.nordicforestresearch.org/climatebenefit

Nordiska ministerrådet

The climate benefits

of the Nordic forests

Almost double benefit in 50 years!

Climate benefit 1: Carbon in the forest

► A forest absorbs carbon dioxide from the atmosphere through photosynthesis and releases some of it through respiration. The annual surplus is converted to carbohydrate and used for tree growth. When net growth products are retained in the forest, there is long-term carbon storage and the forest acts as a carbon sink. This annual climate benefit remains as long as the stock increases, but there is an upper limit to how many trees a forest can contain.

One cubic metre of stem wood contains carbon equivalent to approximately 750 kg CO_2. One average forest hectare in the Nordic region, growing at a rate of 5 cubic meters per year, therefore annually stores the equivalent of about 4 tonnes of carbon dioxide in its stems. This corresponds to the emissions from a diesel car that has travelled about 20,000 kilometres.

Climate benefit 2: Substitution

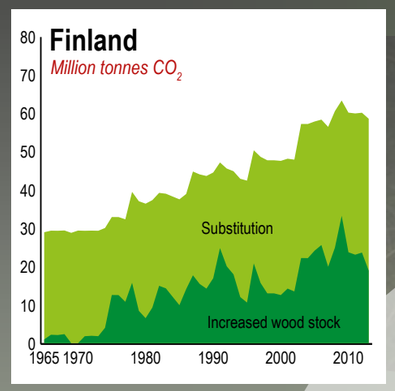
► If the annual net growth of a forest is harvested and used to replace fossil raw materials, climate benefits also arise. Carbon dioxide is first absorbed from the atmosphere and then released back into it, in a cycle in which no new carbon is added. If we use oil, coal or natural gas, or if we manufacture cement, we add new carbon dioxide to the atmosphere.

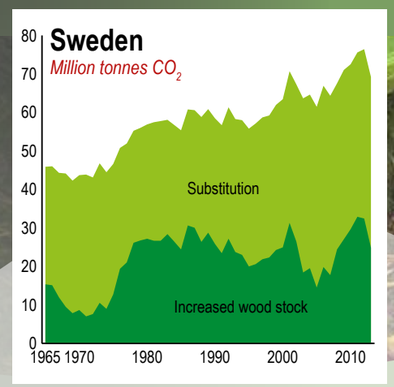
When forest products are used as energy or as an alternative to plastic, steel and concrete, we avoid the release of "new" fossil carbon into the atmosphere. This is known as substitution, similar to displacement of fossil carbon dioxide. In long-lived products, such as wooden houses, we also store the carbon for a long time.

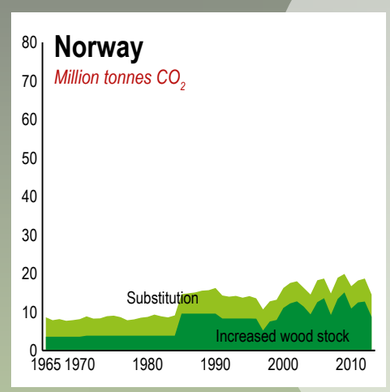
If we harvest and use a cubic metre of stem wood, the substitution effect varies between 500 and 800 kg of carbon dioxide depending on how we use the wood.

Sources: Lundmark, T. et al. 2014. Potential roles of Swedish forestry in the context of climate change mitigation. Forests 5.4: 557-578. ; Braun, M. et al. 2016. A holistic assessment of greenhouse gas dynamics from forests to the effects of wood products use in Austria. Carbon Management 7.5-6: 271-283.

Annual climate benefit of the Nordic forests







► We have extensive **felling and growth data** for the Nordic forests from the national forest inventories. In the figures, we have assumed that each cubic metre of stem wood sequesters 750 kg of carbon dioxide, and stores the same amount if the trees are left in the forest. If the tree is harvested and used, it creates a substitution effect of 500 kg of carbon dioxide.

The sum of the stored and utilized wood represents the total climate benefit. The annual climate benefit increases over time. Over all three countries, it is almost twice as high today as it was fifty years ago, about 150 million tonnes compared with 83 million tonnes in 1965. Forest growth has increased during the period, and so have both substitution and carbon storage in the forests.

In Sweden and Finland, substitution accounts for the bulk of the climate benefit, while Norway's climate advantage mainly consists of an increase in living wood stock.

Double benefit

Manage or preserve?

► Nearly all forests in the Nordic countries have been managed for a long time. A topical question is about the impact of management on climate – is it better to manage the forest or to use it as a carbon store? **In the short term**, it is better for the climate to leave the forest as it is and allow the carbon stock to increase. However, this is only possible up to a certain limit. When the trees age, their net growth decreases. Trees die, the wood degrades, and carbon dioxide is released back into the atmosphere. Old forests capture as much carbon as they emit. A forest without net growth does not add any further climate benefits.

If we stop harvesting the wood, we must ask ourselves what to use instead of paper, wood and biofuel. If it's plastic, oil, coal and cement, the climate will be the loser.

► **In the longer run**, therefore, it is better for the climate if we use and manage the forest. The more the forest grows, the more carbon is captured, and the more wood can be used for substitution. A managed forest landscape has a mosaic of stands with clear cuts releasing carbon, and growing stands capturing carbon. As long as the net growth exceeds the harvest, the carbon stock increases, and this occurs on top of the substitution effect. When old trees with reduced growth are replaced with young trees, net growth increases. Harvesting trees is therefore the most important tool to maintain high growth.

► **The figure below** shows the cumulated climate benefit of two options for using a forest landscape in southern Sweden. — **In the blue option**, harvest is halted and all forest is preserved allowing it to develop freely. — **In the green option**, we continue to manage the forest as we do today by harvesting the net growth.

In the preserved forest, we see an initial increase in stored carbon. We have a climate benefit as long as the wood stock continues to increase. When the forest ages, growth will decrease, and trees die due to storms, root rot and insects. The climate benefit decreases.

The managed forest delivers climate benefits by replacing climate-negative products (substitution) with forest products. In addition, it continues to grow because mature stands are harvested and replaced by new, growing forests. In the longer term, the cumulated climate benefit will be much higher in the managed forest.

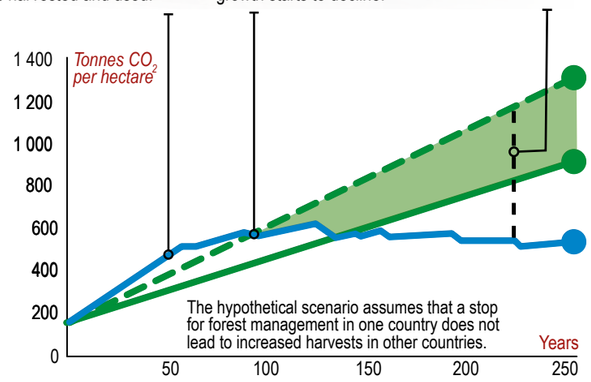
Since climate benefit is determined by growth, the benefit will increase if we are more active in our forest management. Nordic estimates show that growth in individual stands can increase by 30–100% as a result of changing tree species, using genetically improved seedlings or fertiliser application. The more the forest grows, the more it contributes to a fossil-free society. Meanwhile, we have the option to preserve forests for biodiversity, social values and other interests.

The managed forest is the winner in the long run

If a **previously managed forest** is simply preserved, it will initially capture more carbon dioxide than a forest that continues to be managed. Since there are no emissions due to harvest and production, climate benefit will be slightly higher compared to the alternative when the forest is harvested and used.

Sometime around **80 years**, the managed "future forest" surpasses the preserved one since the preserved forest's growth starts to decline.

The difference between the preserved forest's carbon storage and the cumulated climate benefit of the managed forest increases year by year, because the preserved forest's growth declines, whilst the managed forest's growth is stable and high.



Managed forests – future
The raw materials are used as they are today, but also for new products that reduce the need for fossil raw materials.

Managed forests – today
The raw materials are used for wood products, paper and replacement of fossil raw materials, mainly energy.

Preserved forest
After the growth phase, a saturation phase is reached when carbon uptake and release balance each other out. The forest will be a static carbon store.