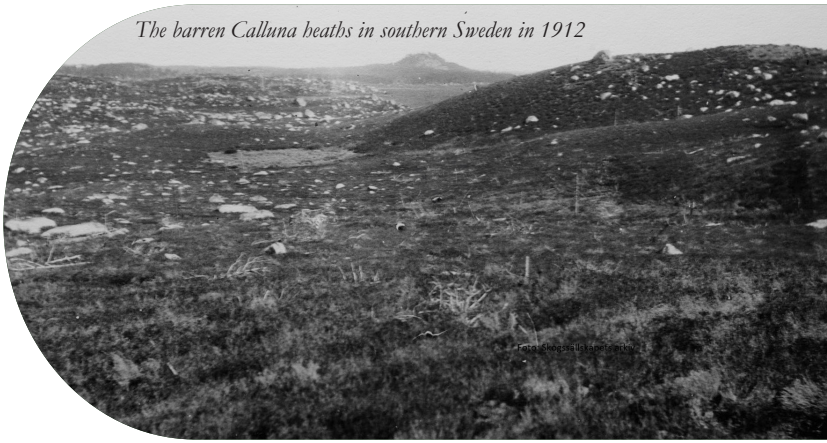
COP30 - **BELÉM BRAZIL**

THE SWEDISH EXAMPLE

THE POWER OF REFORESTATION

skogforsk



The barren Calluna heaths in southern Sweden in 1912

The same area in 2022

1. The Story of the Many Green Plants

NEW BEGINNINGS IN SOUTHERN SWEDEN

FROM BARREN HEATHS TO SUSTAINABLE FOREST MANAGEMENT

In 1850, Sweden was a very poor country. Overpopulation in the southern half of Sweden forced over 1,5 million Swedes to emigrate, which was more than a quarter of the total population. The main reason was lack of food as the state of agriculture was deplorable. To supply firewood, charcoal and building materials forests had been cut down without replanting. This led to former forest land being used for grazing, transforming vast areas from forest to beautiful but barren calluna heaths that provided meagre grazing.

Pictures: The first photo (Source: The Forest Society historical archive) and the second photo (Photographer: Harald Säll) illustrating the results of replanting.

In northern Sweden, forest products developed into a successful export commodity in the second half of the 19th century. This highlighted the need to restore Sweden's forest resources through systematic replanting after felling. It also inspired people in the south of the country to begin planting tree seedlings on the calluna heaths and to protect them from grazing. Especially important was Skogssällskapet, "The Forest Society" founded in 1912, with the purpose of promoting forest management and reforesting the impoverished heathlands of southern Sweden.

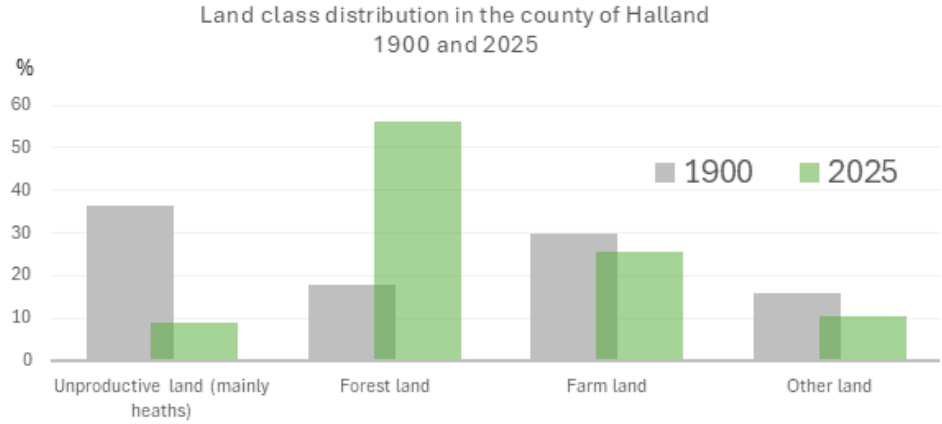
The formal turning point for the Swedish Forestry came with the Forestry Act of 1903, recognized as the world's first modern forestry law. The act's central principle was the mandatory replanting of trees after logging. The concept of a "forest shortage," however, had been noted as early as the 17th century. In 1855, a forestry committee was established to prevent future depletion of forest resources. During this period, awareness was already growing of how important forests were for the country. However, it was not until 1903 that comprehensive legislation was finally enacted.

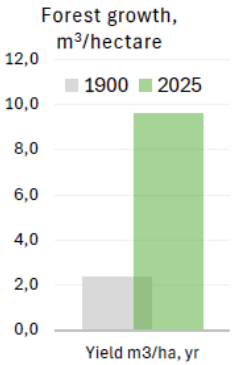
Picture: Photo of school children and women planting trees on a calluna-heath in southern Sweden, 1922.

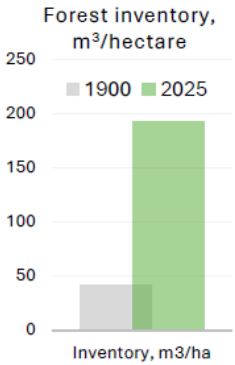
Pictures: SLU Media Bank

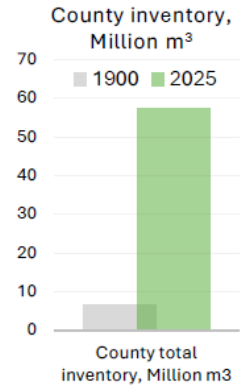
REFORESTATION TRANSFORMED THE ECONOMY

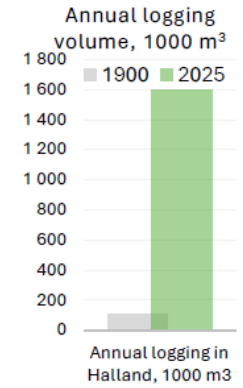
The small plants quickly grew into productive trees that could be used for a wide range of products — not only as fuel, but also for sawn timber, pulp, cardboard, paper, insulation, and various chemicals. These products could easily be exported. Forestry and the forest industry became a backbone of the southern Swedish economy. The graphs below illustrate the remarkable transformation of the forest sector in southern Sweden, using the county of Halland as an example[1,2].





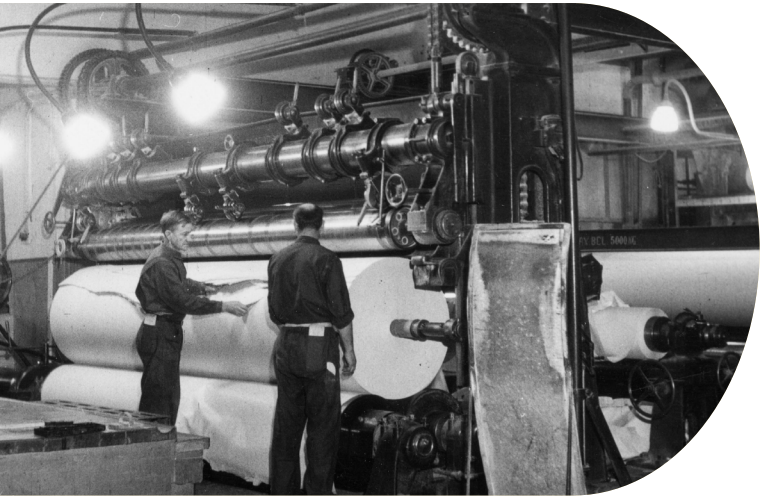






As can be seen in the graphs, reforestation has tripled the area of productive forest land in the county of Halland while the annual yield and standing volume per hectare have been quadrupled. The total forest inventory is eight times higher and annual logging is 16 times higher in 2025 compared to 1900.

The forest sector is now providing an important base for the regional economy, especially in the rural areas of Halland. The inspiring story of the power of many small green plants is now repeating itself around the world — not least in Brazil.



Pictures: SCA's Historical Image Archive

2. Global Reforestation

POTENTIAL AND FACTS

The power of the many green plants transformed the impoverished heaths of southern Sweden into rich forests, providing livelihoods, habitats, ecosystem services, and numerous products with climate benefits. But, how much such land is available for forest regeneration? What is the real potential of reforestation to combat climate change? Scientists have explored this question — though, as usual, their answers vary. Let us review some influential findings.

Growing forests sequester and store large quantities of carbon. Forests therefore play an important role in mitigating climate change, which is mainly driven by the rising levels of carbon dioxide (CO_2) in the atmosphere. Forests that are sustainably managed also produce biomass that can replace fossil feedstocks, the use of which is causing an increase of atmospheric CO_2.

We also know that forests have previously covered much larger areas than they do today. In some cases, the loss of forest canopy cover is inevitable, as forests have been replaced by buildings and necessary infrastructure or by farmland needed for crops and food production. In other cases, the forests have simply been cut down without subsequent replanting. Such areas often degenerate into low productivity pastures. Sometimes substantial amounts of fertile topsoil are lost due to erosion. Reforestation of such areas will mitigate climate change.

Picture: Reforestation Project, Kongo - BCC AB Archive

THE POTENTIAL OF REFORESTATION

In 2019 a study[3] showed that global forest regeneration has a significant potential to reduce atmospheric CO_2-levels. The study examined the globally available land area for practical forest regeneration, aiming to store carbon in standing forests. Data from protected areas were used to establish values for "natural tree cover" in various biomes. By comparing the actual tree covering outside protected areas with the projected capacity for each biome, it was possible to estimate how much forest had been depleted through human activity. Earth's natural forest cover could be 8.7 billion ha but was found to be only 5.5 billion ha. After subtracting cropland, urban areas and other "unavailable" areas, a gross area available for reforestation was estimated at 900 million ha. In descending order, 50 % of these areas are in Russia, USA, Canada, Australia, Brazil and China.

Pictures: Planting spruce seedlings with Pottiputki Tubes - BCC AB Archive

Restoring these areas to the state of existing forests would sequester an additional 205 Gigatons of carbon (GtC) from the atmosphere. This is more than significant considering that the global anthropogenic atmospheric carbon burden is estimated at approximately 300 GtC.

Recent studies[4,5] have taken a more skeptical view on the potential of reforestation. The reasons are mainly practical or policy based:

- Pressure from agriculture and other human development may have been underestimated
- Indiscriminate reforestation can pose a risk of declining biodiversity in certain areas
- Conflicting demands by local and indigenous people also deduct from the potential
- Availability of water or the reflective properties of Earth's surface (albedo) may decline

After deducting for these reasons, less than half of the estimate described above, or 389 million hectares, were found to be available for reforestation. So, even the most skeptical estimates identify a significant potential for fighting climate change through

Picture: Forest Nursery in Latvia - BCC AB Archive

global reforestation. But so far, reforestation commitments made by nations have fallen short of even of this reduced potential.

To fully exploit the potential climate benefits of reforestation, it is therefore essential that

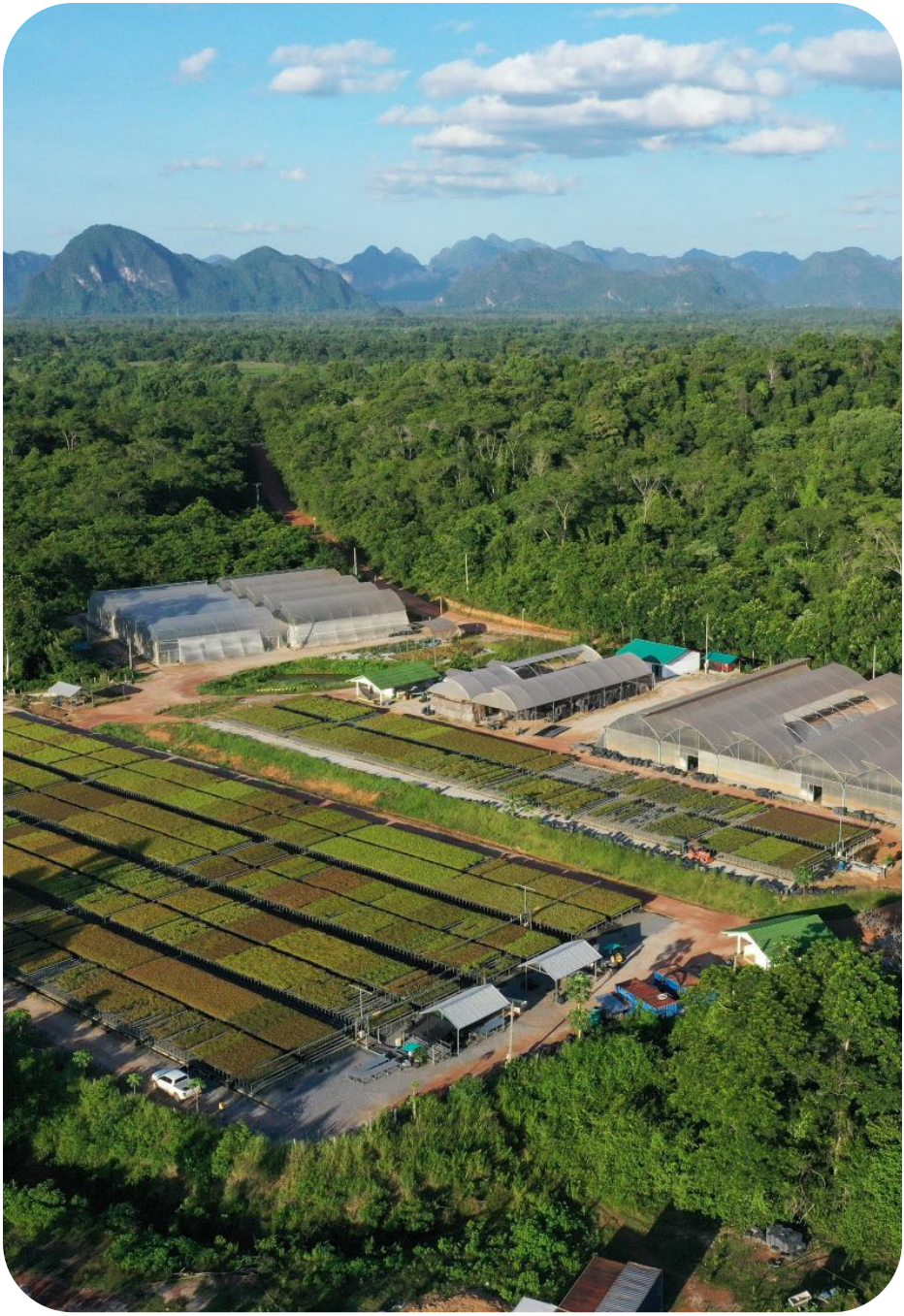
- Nations commit to thoughtful reforestation of all available land
- Produced biomass is not only seen as a store for fossil CO_2 but also as a valuable commodity used to substitute for fossil feedstocks

FOREST REGENERATION – A VITAL PIECE OF THE SOLUTION

After reviewing current studies of reforestation as a strategy to combat climate change it is evident that, although important, storing carbon in forests is not enough, even if all available land is replanted.

This strategy must be complemented with schemes to reduce emissions of fossil carbon dioxide and other greenhouse gases. It is possible to develop green, biomass-based alternatives that allow carbon to recirculate from products back to producers (green plants). This would strengthen the role of forests and, by providing a direct economic return from the efforts of reforestation, it would also boost momentum and create local acceptance.

Picture: Mangrove Rehabilitaion Project, Papua New Guinea - BCC AB Archive



Picture: Forest Nursery in Laos - BCC AB Archive

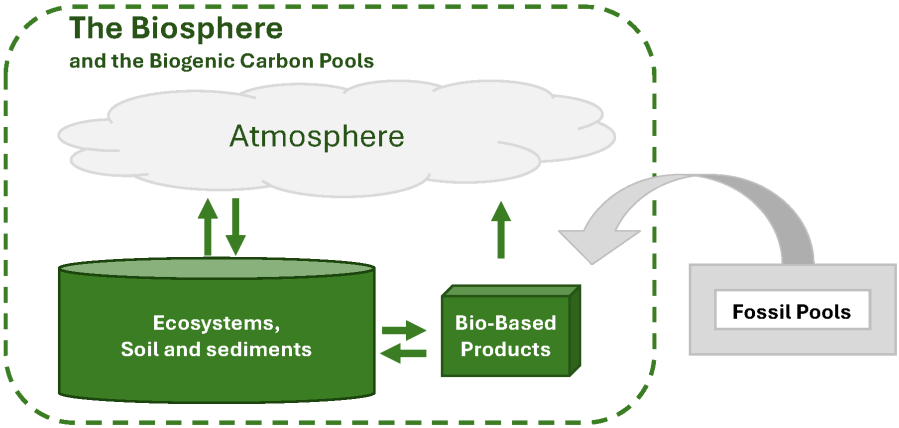
3. Climate benefits of forests

CARBON AND CLIMATE

Fundamentally, the climate benefits of forests and forest products are about carbon management. Carbon is a key element of life on Earth and circulates continuously within the biosphere — the realm of living organisms. Within this system, carbon exists in three main pools:

1. In the atmosphere, primarily as carbon dioxide (CO_2), the dominant greenhouse gas
2. In living organisms, and as organic carbon in litter, soil, and sediments
3. In bio-based products, where carbon is stored after harvest

Carbon moves constantly between these pools. When the amount of carbon decreases in one, it increases by the same amount in another — the total amount of carbon within these three pools remains essentially constant.



However, when carbon is released from sources outside the biosphere, the balance is disrupted. For example, burning fossil fuels mobilizes carbon that has been locked away for millions of years, increasing CO_2 concentrations in the atmosphere and driving climate change, without reducing the carbon stored in the other two pools.

MANAGING FORESTS TO COUNTER CLIMATE CHANGE

By dry weight, more than 50 % of woody biomass consists of carbon, assimilated from atmospheric CO_2 through photosynthesis. Forests can store vast amounts of carbon because trees are both large and long-lived. By planting and cultivating forests, the ecosystem carbon pool increases, thereby reducing the concentration of CO_2 in the atmosphere. Implemented on a global scale, this strategy could significantly slow both the pace and magnitude of climate change.

However, as forests mature, they eventually reach a climax stage, where the uptake of carbon through growth is balanced by carbon released through tree mortality and decomposition. At this stage, forests become carbon-neutral — maintaining their stored carbon but no longer contributing to the reduction of atmospheric CO_2. In contrast, continued reliance on fossil carbon sources adds new carbon to the biosphere, further accelerating climate change.

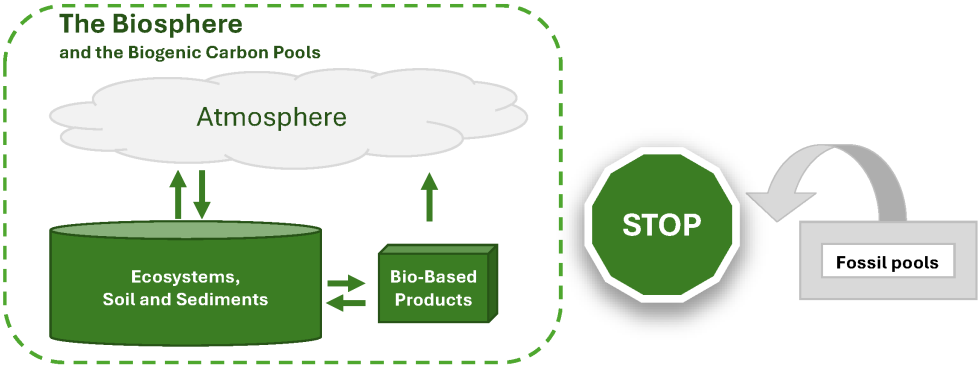
A LONG-TERM CLIMATE SOLUTION

Forest biomass can be used in most applications that currently rely on fossil feedstocks. When forests are managed sustainably — ensuring that harvest and growth remain in long-term balance — they can continue to provide significant climate benefits through both forestry and forest-based industries. This approach offers three major advantages:

1. **Sustained carbon uptake:** Forests are harvested before reaching their climax stage. Once replanted, new trees continue to absorb CO_2 from the atmosphere.

2. **Expanded carbon storage:** The pool of carbon stored in bio-based products increases, keeping carbon out of the atmosphere for extended periods.

3. **Reduced fossil emissions:** Greater use of renewable, bio-based feedstocks limits the extraction and release of fossil carbon, thereby lowering greenhouse gas emissions.



Using sustainably produced biomass for fossil feedstock provides an opportunity to reduce the inflow of fossil carbon to the atmosphere.

4. Maximizing the climate benefits of forest products

Increasing carbon stocks in both standing forests and forest products redistributes carbon within the biosphere, thereby lowering atmospheric carbon dioxide levels. Sustainably managed forests and forest-based industries play a vital role in enabling this redistribution. Recognizing this potential, efforts to increase the standing volume of the world's forests and to expand the stock of long-lived wood products are widely promoted. The underlying strategy is to capture as much carbon as possible from fossil emissions and store it in trees and durable products.

However, the climate benefits of forest products extend beyond carbon storage. Equally important is their role in replacing more fossil-intensive materials. By providing bio-based alternatives, forest products reduce dependence on fossil inputs and thus help curb the emissions responsible for the current high levels of atmospheric carbon dioxide.

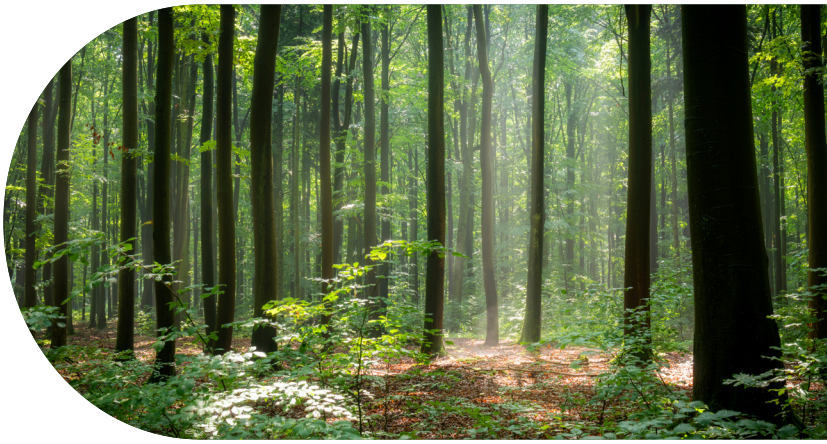
Therefore, assessing the climate impact of the forest sector requires more than measuring the net carbon stock in ecosystems and products. It is also essential to account for the avoided emissions resulting from reduced fossil carbon use — a contribution referred to as the substitution effect.

Pictures: BCC Holding Area Irrigation Boom in Indonesia - BCC AB Archive

THE ELUSIVE SUBSTITUTION EFFECT

The substitution effect describes the extent to which fossil carbon emissions are avoided by using bio-based materials instead of fossil-based ones. Its magnitude depends on the substitution factor of the bio-based product. A substitution factor of 1 indicates that each carbon atom contained in the forest product prevents the emission of one fossil carbon atom. As long as the substitution factor is greater than zero, the bio-based product contributes to reducing fossil carbon emissions.

The substitution factor for a specific product can be determined through Life Cycle Assessment (LCA). This factor varies significantly among different forest products and evolves over time as production technologies for both bio-based and fossil-based materials develop. The substitution factor for forest-based biofuels has been found to be 0.8[6], and as high as 2.8[7] for cellulose-based textiles. For construction wood, the factor typically ranges from 1.3 to 1.6, while forest-based chemicals, paper, and cardboard show values between 1.0 and 1.5. Comprehensive literature reviews suggest an average substitution factor across all product categories of 0.6[8] to 1.2[9].



BOOSTING SUBSTITUTION THROUGH RECYCLING

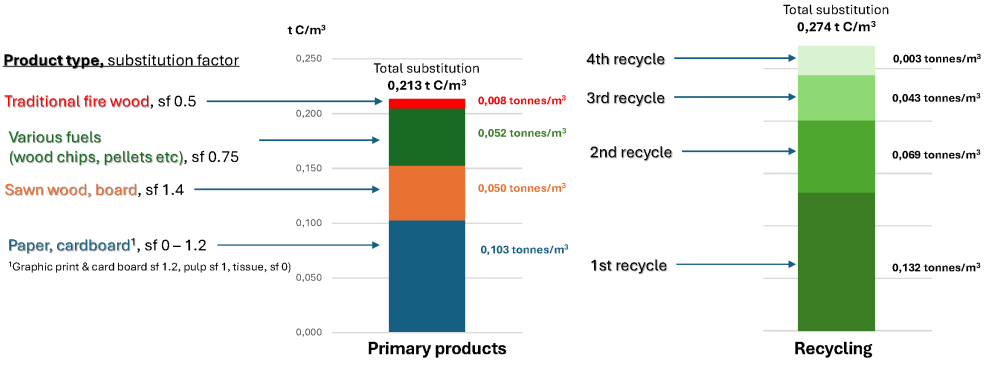
After reaching the end of their useful life, forest products can be used for energy generation through combustion. However, from both a climate and an environmental perspective, it is preferable to recycle the biomass contained in discarded products and use it as raw material for new ones.

A meta-study examining the climate impact of forest products in Sweden[10] was based on official statistics on wood use across different product categories within the Swedish forest industry, combined with reported recycling rates of primary products. These data were integrated with the substitution factors discussed in the previous section to calculate an average substitution effect per cubic metre of wood used in Sweden.

The figure below illustrates the resulting aggregated substitution factor per cubic metre of wood processed by the Swedish forest industry in 2020. The first-generation, or primary, products achieved a combined substitution effect equivalent to a reduction of 0.213 tonnes of fossil carbon emissions. Firewood and wood-based fuels — such as wood chips, pellets, and pulping liquors — contained nearly half the carbon of all primary products but contributed only 28 percent of the total substitution effect.

Cascading use of biomass — through recycling primary products after their service life — substantially enhanced the substitution effect. After four recycling cycles, the substitution effect had more than doubled, avoiding an additional 0.274 tonnes of fossil carbon emissions. Notably, only 22 percent of this increase resulted from the recycling of solid wood products, while recycled paper products accounted for 78 percent. Almost half of the total substitution benefit from recycling was achieved already after the first cycle.

These findings highlight the importance of developing and utilizing bio-based alternatives to replace fossil-intensive materials. They also demonstrate that efficient systems for the collection and recycling of bio-based products provide a viable and highly significant contribution to the overall climate benefits of forest products.



Primary products from 1m³ harvested wood decreases fossil carbon emissions by 0,213 tonnes (right graph) and current Swedish recycling regimes (including final energy conversion) increase the substitution effect by another 0,274 tonnes (left graph).

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