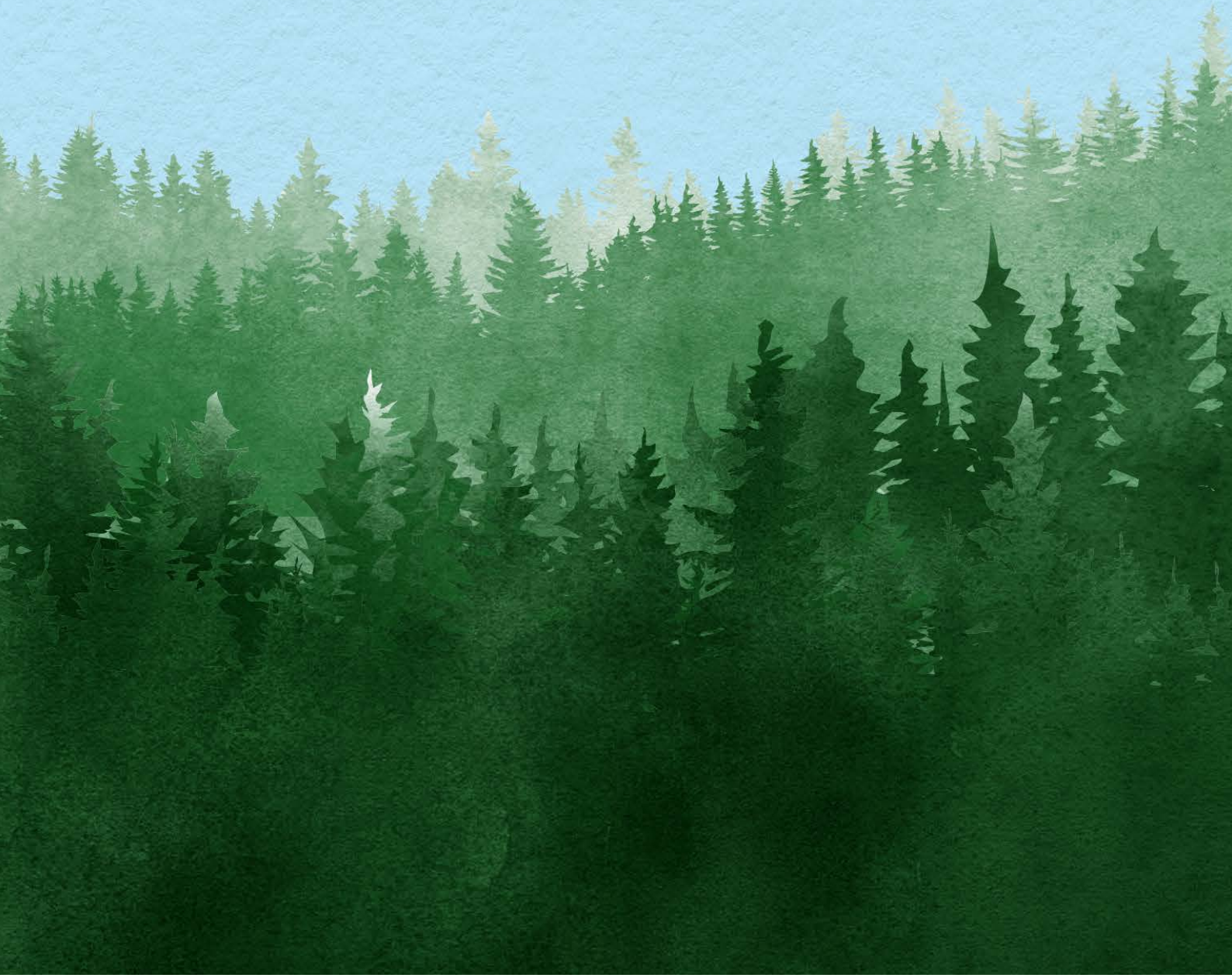
Report: Contribution of the Swedish forestry sector to global climate efforts.



Swedish Forest Industries

Contents

Executive Summary

This report analyses the role in global climate change of the Swedish forestry sector in 2017. The overall effect is taken as the sum of net carbon sink in the forest, fossil emissions in the value chain, and the reduction of fossil emissions by substitution which arise when forest products replace fossil-based alternatives such as cement, steel, plastic and fossil fuel combustion.

Some 500 Swedish industrial plants; pulp/paper mills, sawmills and combined heating and power plants refine about 70 million cubic metres of wood annually into wood products, fibre-based products and renewable energy, thus reducing fossil use through substitution by 42 million tonnes of carbon dioxide equivalents per year ($MtCO_2e/yr$). Moreover, carbon storage in the forest is continuously being built up, primarily as the volume of growing trees increases, corresponding to a net carbon sink of 55 $MtCO_2e/yr$. The forestry sector's own fossil emissions are 4 $MtCO_2e/yr$, which means that the total and positive contribution to reducing climate change of the Swedish forestry sector is approximately 93 $MtCO_2e/yr$. This is considerably higher than Sweden's reported total emissions of 53 $MtCO_2e/yr$.

The forestry sector combines profitability, sustainability and climate benefits. Long-term investments under stable political conditions have doubled the growth and timber volumes in the forest over the past 100 years, while at the same time the forestry sector has grown considerably. One key circumstance is that strong markets for forest products and private sector actors have been crucial in doubling the forest carbon sink, while also reducing fossil use on a large scale.

Intergovernmental climate change arrangements such as the Paris Agreement and reporting formats specified by the Intergovernmental Panel on Climate Change (IPCC) do not emphasize the totality of the forestry sector effect. Instead forests are often addressed separately as a carbon storage that should be maintained or enhanced as such. This perspective risks complicating the transition to a fossil free society. The forestry sector should instead be addressed as a cross-cutting sector and an integral part of the green, biogenic carbon cycle that does not add further fossil carbon into the atmosphere. As such the forestry sector contributes both in directly reducing CO_2 in the atmosphere as well as in reducing society's dependence on fossil energy.

Dr Peter Holmgren
FutureVistas AB
27 June 2019, Skebobruk

About the Report

This report has been published by initiative of the Swedish Forest Industries Federation (Skogsindustrierna, a trade organisation). The author, Peter Holmgren, is a Sustainable Development Strategist and former Director-General of the Center for International Forestry Research (CIFOR) and has also headed up FAO's global work on climate change.

Contact:
Swedish Forest Industries Federation/Skogsindustrierna:
Carina Håkansson
carina.hakansson@skogsindustrierna.se

Peter Holmgren
peter.holmgren@futurevistas.se

Introduction – Where we are headed

Many people are concerned about global climate change and how it affects our society and natural environment. The climate was one of the most important political concerns ahead of the 2019 European Parliament elections (Ipsos, 2019) and the involvement of civil society as well as the media is stronger than ever before (Vi-skogen, 2019). But despite the political momentum, neither the Paris Climate Agreement (UNFCCC, 2015), Nationally Determined Contributions (UNFCCC, 2019) nor the EU climate strategy (European Commission, 2018b) have yet led to clear reductions of our climate impact. On the contrary, political climate ambitions are often perceived as competing with other societal goals such as economic growth and welfare.

Clearly, solutions to the climate problem will be more successful if they are aligned with other ambitions and goals for sustainable development. This report looks at how the Swedish forestry sector achieves precisely this. A major contribution to climate change mitigation efforts is combined with benefits for the economy, welfare, rural development and the natural environment.

Mankind changes the global climate primarily through a dramatic increase in the use of fossil fuels over the past hundred years. Fossil energy sources such as coal and oil now permeate almost all economic activity. The main contributor to the climate problem is the increased carbon dioxide content in the atmosphere that comes from combustion of fossil fuels for energy. We now emit five tonnes of carbon dioxide per person every year, a total of 40 billion tonnes worldwide (World Bank, 2019). Sweden is, in terms of territorial emissions, at the same emission level per capita as the worldwide average – even though we are one of the richest countries. This is largely because we have a forestry sector that delivers high quantities of renewable products and energy. It should, however, be noted that consumption-based emissions in Sweden are higher, at around 10 tonnes of carbon dioxide equivalents per person.

Dramatically reducing fossil emissions is the very essence of climate change mitigation. We must also actively reduce the amount of carbon dioxide we have already put into the atmosphere. The Special Report on Global Warming of 1.5°C (IPCC, 2018) explains the level of emission reductions required, at what rate, and also how forests and trees must be managed to convert far more carbon dioxide into wood. Considerable transformation is required over the next few decades to achieve the goal of halting global warming at 1.5 degrees Celsius. The forestry sector has a unique opportunity not only to reduce fossil use on a large scale by substituting with renewable products, but also to increase the carbon sink in growing forests and in forest products.

Sweden has a long history of successful forestry. Previous generations saw the value of managing the forests well and inves- ted for the long term. As a result, both growth and the timber volume in the forest are now twice what they were a century ago, which gives us tremendous opportunities as well as a great responsibility to continually manage and develop this resource for future generations (Figure 1). Following an increasing forest asset, logging has also increased within the confines of biological growth and long-term sustainability. This means that the Swedish forestry sector has been able to significantly increase its production and contribution to economic growth and welfare.

The current political climate is also favourable, with a clear ambition to enhance a biobased economy, to achieve long-term climate goals as expressed both in the Swedish government 'January Agreement' (Anon., 2019) as well as the EU climate strategy for 2050 (European Commission 2018b). The Swedish forestry sector has also developed a roadmap for fossil free competitiveness, within the framework of the government-led initiative Fossil Free Sweden (Skogsindustrierna, 2018).

So we are headed towards a sustainable, fossil free welfare society. The forest and the forestry sector have a major role to play in this journey. This report describes the forestry sector's contribution to the climate change efforts, quantifies the positive effect the sector already delivers, and outlines how economic success can be combined with fossil free welfare. This is an important story about the country of Sweden in the context of prevailing climate policy. It is also a story that provides inspiration as to how we can leave a better world for our children and grandchildren – in all countries.

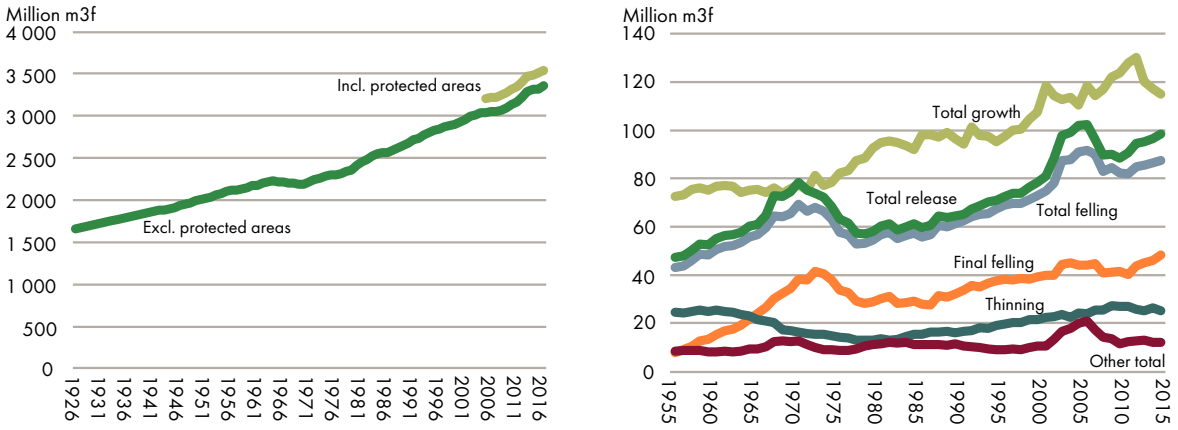


Figure 1. Left: The timber volume in Swedish forests has doubled over the past 100 years. Right: Timber growth has also increased dramatically. Wood removals are consistently lower than the growth. Source: SLU (2018)

Contribution of the Swedish forestry sector to global climate efforts

The forest and the atmosphere are engaged in a green, circular flow of carbon. Trees and vegetation use photosynthesis to turn carbon dioxide into wood and other biomass. This means that carbon is sequestered and stored, first in living trees, then in dead wood and eventually in the soil. Sooner or later almost all of the carbon returns to the atmosphere, either slowly through biological processes or more quickly through fires. In either case, the carbon is oxidised into carbon dioxide, which is then again absorbed by growing trees.

Managing forests and marketing forest products implies that we build on and enhance this green carbon cycle. We harvest trees, and for some period of time the circular carbon remains in the forest products, such as wooden houses, paper products and textiles. Eventually the carbon in the products is returned to the atmosphere – often after we have also made use of the inherent renewable energy in efficient combined heat and power (CHP) plants. The carbon is then sequestered in the growing forest again. This means that forest products are a part of the green carbon cycle, adding no further fossil carbon to the atmosphere. They are naturally climate neutral (Figure 2).

Globally, the green carbon cycle has been estimated to turn over about 220 gigatonnes of CO_2 per year in net primary production on land, most of which in the forest (Haberl et al., 2007), i.e. roughly six times as much as our current fossil emissions. Only 1% of this flux is used as raw materials for the forest industry (FAO, 2019). This means that there is significant unexploited potential for fossil free products that can reduce our climate impact further. Concerning forests, the main focus in the climate negotiation process has been on deforestation problems in tropical regions. Roughly 0.2% of the global forest area is converted every year, primarily into agricultural land, and this causes major climate emissions. Simultaneously though, other areas are afforested or increasing the forest biomass. The IPCC reports that the net storage of carbon in the world's land system is actually increasing slightly, equating to about 6 gigatonnes of CO_2 a year (IPCC, 2014).

Even so, this is only the beginning of the story about the forest sector's contributions to solving the climate problem. Longterm investments and financial returns yield two major positive effects: increased growth in the forest, and a sizeable reduction in fossil emissions through substitution.

.

Figure 2. The circular biogenic carbon cycle lays the foundation for climate-smart products from the Swedish forest.

Increased growth in the forest

Sweden's forests are currently growing at around 120 million cubic metres of stem volume per year, i.e. approximately 12 m^3 per capita. This has not always been the case. In the early 20th century, large areas of the forest were degraded following many years of unsustainable logging and slash and burn agriculture. The forest industry found it increasingly difficult to source wood. Thanks to long-term political commitments and equally long-term investments over the past century, the situation has changed dramatically. Reforestation and forest management have progressively improved over the years. Both growth and volume in the growing forests have doubled. Felling has consistently been lower than growth, but the forest industry has still experienced an increasing supply of wood. The driver behind this development has been economic growth and welfare, founded on long-term commitments and agreements between forest owners, government authorities, and trade and industry. As a result, Sweden today is a world-leading forest nation.

So what does this mean for the climate? Both the United Nations Framework Convention on Climate Change (United Nations, 1992) and its Paris Agreement (UNFCCC, 2015) include the fundamental agreement to "*conserve and enhance sinks and reservoirs of greenhouse gases*", and this also applies specifically to forests. This is exactly what has happened in Sweden over the past hundred years. The carbon sink, i.e. the growth and thereby the absorption of carbon, has doubled. Similarly the reservoir, i.e. the volume of carbon in the forest, has also doubled. Current growth in the forest sequesters carbon equivalent to more than three times Sweden's total climate emissions (Björheden, 2019). Discounting emissions from felling and biodegradation, the net change is still strongly positive – in fact about the same size as Sweden's fossil emissions (Naturvårdsverket, 2017). Long-term forecasts indicate continued positive development – given that active, sustainable forestry continues to develop (Skogsindustrierna, 2015).

It is therefore evident that a large part of the solution to the climate problem lies in growing forests that reduce carbon and build up carbon stocks. Growth can also be significantly increased by investing in forest management, including felling and removals, an area in which Sweden is a role model.

It is also important to consider, though, that the net sink in the forest cannot continue for all future time. Over the very long term growth and felling/losses will be in balance, as it will be unfeasible either economically or biologically to further increase the standing volume. We can of course continue to raise the storage of carbon in the forests' long-lasting products

such as wooden houses, but this too has its limitations. What this means is that we cannot count on the forest, as such, to continue being an effective buffer for fossil emissions in the future. Fossil emissions must categorically be reduced if the climate goals are to be achieved. The next section is about the forest industry's role in this area

Reducing fossil emissions through substitution

As shown above, the forestry sector makes a huge contribution to climate change mitigation through the growing forest. Thanks to the forest growth, Sweden already has close to a net zero balance in climate emissions. Even so, this approach cannot solve the climate problem. Both in Sweden and globally we must also, and above all, reduce fossil emissions. This can be done principally in three ways, which can of course also be combined:

1. Decreasing demand – we reduce our consumption of fossil based products/energy.
2. Efficiency gains – we use less fossil energy per produced unit.
3. Substitution – we replace fossil-based products/energy with fossil free alternatives.

Arguments are often heard in the climate debate for the first of the above points, and we certainly do need to think about the huge amount of products and energy that are consumed. As stated earlier, climate ambitions could however come into conflict with other societal interests, such as when the government wants to reduce air travel for climate reasons while also investing in an expansion of air traffic at Stockholm Arlanda airport (Zachrisson Winberg, 2019). This report will look no further into the option of decreasing demand.

The forestry sector has long sought efficiency gains in its operations, which has led to a dramatic fall in the use of fossil energy in the value chains; today the industrial processes are 95% fossil free (Skogsindustrierna, 2019a). To some extent this is also the result of substitution, since the industry has become better at exploiting residual products in industrial processes, turning them into bioenergy and replacing fossil energy use. The key driver is, again, economic. Cutting costs and enhancing material use also deliver climate co-benefits. The forest sector's own fossil emissions are included in the model below.

The biggest impact for fossil reduction, however, takes place when forest products replace others that have a high burden on the global climate through fossil emissions. This happens for instance when wood products replace concrete and steel, paper packaging replaces fossil based plastic, and biobased energy is used instead of oil and coal. This substitution has long attracted attention in the international climate process. The IPCC's first assessment report (IPCC, 1990) recommends using wood based products and bioenergy in order to reduce fossil emissions. The Special Report on Global Warming of 1.5°C (IPCC, 2018) too highlights substitution through bio-based products. The role of forests for substitution is not, however, mentioned in the Paris Agreement. Moreover, the comprehensive national reports on climate impact, known as Greenhouse Gas or GHG Inventories (Naturvårdsverket, 2017) do not specify substitution effects, since they are not part of the IPCC's reporting methodology. These reports include the forest only as a reservoir (carbon pool), and the information is limited to the changes in this reservoir. While the overall total of GHG inventories are complete and over time implicitly include substitution effects, the reporting approach makes these effects invisible.

Nevertheless, the substitution effect is real. It has a prominent role in the forestry sector's roadmap for fossil free competitiveness (Skogsindustrierna, 2018). In recent years the substitution effect by forest products has been examined in more detail and has also been quantified (Holmgren and Kolar, 2019; Leskinen et al., 2018; Lundmark et al., 2014; Sathre and O'Connor, 2010). This means that we can now use calculated substitution effects as a contributing factor in analysing possible actions for a fossil free society.

Materials and methods

The climate impact of the Swedish forest sector has been calculated based on the model presented by Svenska Cellulosa AB (SCA) in its 2018 annual report, which indicated a positive climate effect of 8 $MtCO_2e$ for 2018. The model is based on existing scientific results and is defined by Holmgren and Kolar (2019). It has also been further discussed and verified in

a round-table meeting with experts from academic research and the private sector (SCA, 2019). The model expresses the overall climate effect of the forestry sector by summing up three parameters:

1. Net carbon sink in the forest (normally a positive climate effect).
2. Fossil emissions in the sector's value chains (a negative climate effect).
3. Reduction of fossil emissions through forest products substituting products with a high negative climate impact (a positive climate effect).

The analysis has been based on data for forestry sector operations across the whole of Sweden. For forest carbon dynamics, data from the National Forest Inventory (SLU, 2018) has been used, which provides reliable data on forest-related changes down to county level, along with Sweden's official reporting to the UNFCCC (Naturvårdsverket, 2017). For calculating fossil emissions and substitution effects, a database has been created with production data from 2017, for 489 industry units located in 215 of the 290 municipalities in Sweden. This includes production at 54 pulp and paper mills, 103 sawmills with an annual production of over 10,000 cubic metres, and the supply of forest raw materials to 332 CHP plants. Data has been based on the Swedish Forest Industries Federation (2019b) and Swedenergy (2019). Additional key metrics for timber use and raw material flows have been obtained from the SDC information hub (2018) and Pöyry (2016). Summary data from the database is shown in Table 1.

Table 1. Summary data from industrial units and their production used in the analysis. Basic data from the Swedish Forest Industries Federation (2019b) and Swedenergy (2019).

Number of sites	489	units
of which pulp/paper	54	units
of which sawmills	103	units
of which CPH plants	332	units
Material use		
Forest raw materials	71	million m^3sub*
Recycled fibre	3.5	million m^3sub
Fillers & coating	1.35	million tonnes
CO_2 emissions in production		
Biogenic	35	million tonnes CO_2
Fossil	0.66	million tonnes CO_2
Marketed products (selected)		
Wood products (incl. units that produce <10,000 m^3/yr)	18.3	million m^3sw* *
Fibre products excl. fillers & coatings	12.6	million tonnes
Electricity	9.5	TWh
Heat	24	TWh

*million cubic metres solid volume under bark

** million cubic metres of sawn wood products

Results

Calculation of the overall climate effect follows the method described in (Holmgren and Kolar, 2019). As for an individual forest industry company, the aggregated climate impact of the entire Swedish forestry sector was calculated using the database created for that purpose.

For the net carbon sink in the forest, the officially reported level has been used (Naturvårdsverket, 2017). This is based on the internationally agreed method for reporting LULUCF (*Land Use, Land-Use Change and Forestry*) (IPCC, 2006) and may be regarded as well established and accepted. In it, Table 6.2.a on page 344 states a net sequestration of 48.2 $MtCO_2e$

on forest land, plus 6.7 $MtCO_2e$ net sequestration in Harvested Wood Products (HWP) for the year 2015. It should be noted that 'forest land' in this context also includes land that is excluded from wood production for various reasons, and it is arguable whether all of this land should be included in a calculation of the forestry sector's climate effect. This is, however, the officially reported carbon sink for '*forestry*'. It is also open to discussion whether carbon sequestration in the products should be counted here, or instead be added to the effect of the products as such. In the internationally agreed method for climate reporting, however, the two are reported together. For clarity and comparability with the official climate reporting, this report therefore presents the climate effect of carbon sink in the forest as 48.2 + 6.7 = 54.9 $MtCO_2e/yr$.

Fossil emissions in the forest sector's value chains were calculated at 3.6 MtCO2e/yr. Of this, roughly 20% emanates from the industrial processes. Transportation of wood, including logging, as well as transportation of products together account for approximately 50% of the emissions. The remaining 30% is emissions related to external production of input materials for the industry.

Fossil reduction through substitution has been calculated for three main categories of products: wood products, pulp/paper and energy. Deliveries from the industrial units was 18.3 million cubic metres of sawn wood products, 12.6 million tonnes of pulp/paper products (excluding fillers and coatings) and 34 TWh of energy (the vast majority from CHP plants) for the year 2017. The substitution effect of these, calculated using the same conversion figures as (Holmgren and Kolar, 2019) was 42.1 $MtCO_2e/yr$ (Table 2).

Table 2. Summary of fossil reduction through substitution for products from Swedish forest industry, and energy production with forest raw materials.

Delivered products	Quantity (2017)	Fossil reduction through substitution
Wood products	18.3 million m^3 sawn	25.2 million tonnes CO_2e
Pulp/paper	12.6 million tonnes	12.0 million tonnes CO_2e
Energy	34 TWh	4.9 million tonnes CO_2e
TOTAL		**42.1 million tonnes CO_2e**

Summing up the above three factors (54.9 – 3.6 + 42.1) gives a total positive climate impact of Sweden's forest sector of 93 $MtCO_2e/yr$ (Figure 3).

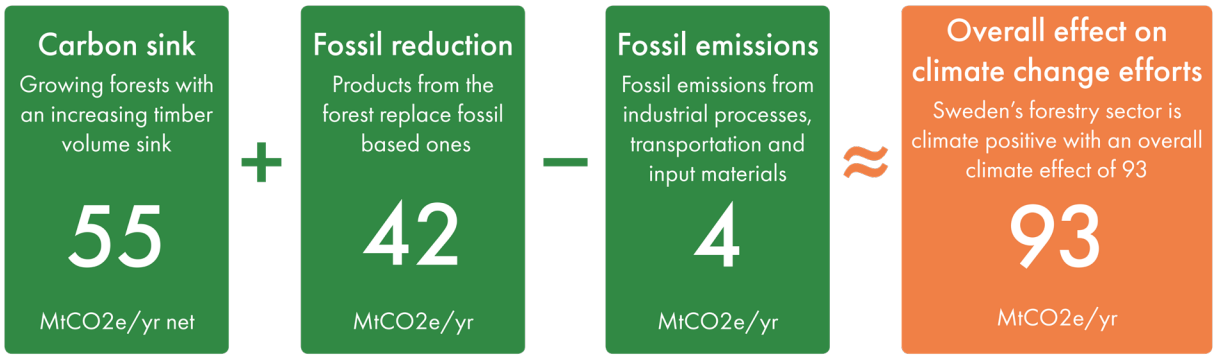


Figure 3. A simplified view of the calculations for forest sector climate impact for the year 2017. The total impact of 93 $MtCO_2e/yr$ is considerably higher than Sweden's reported territorial emissions, which were 53 $MtCO_2e/yr$ in 2016 excluding LULUCF (Naturvårdsverket, 2018a). The positive climate impact is also almost as great as the negative impact of estimated emissions from all Swedish consumption, which is 100 $MtCO_2e/yr$ (Naturvårdsverket, 2018b).

Discussion

The model structure, particularly the component on fossil reduction through substitution

The aim of the model is to provide an overview of complex interactions between forest, industry and climate (Holmgren and Kolar, 2019). This, by necessity, leads to simplifications. An assessment of the SCA report (SCA, 2019) observed that the benefits of a simplified presentation (communicative, focus on results) clearly outweigh the drawbacks (some uncertainty surrounding the concept of substitution, no account taken of variations between more niche products). The assessment urged a stronger focus on the role of forest management in creating opportunities for substitution. Another observation was that the concept of substitution itself requires further clarification and development, since it has not been included in the formal climate reports.

The model aggregates three major parameters which, while they do have the same unit of measurement (CO_2e/yr), in reality represent different types of effect for the climate change efforts. One criticism is that fossil reduction through substitution does not actually (immediately) reduce the amount of CO_2 in the atmosphere, since biogenic emissions are generated instead, and these have the same immediate physical effect as fossil emissions. This is correct. Nevertheless, there is a different reason for including the substitution effect: we must reduce our fossil dependency over time, and parameters that show progress in this area serve an important purpose in climate policy. The fact that forest products are part of a green carbon cycle that adds no fossil carbon to the atmosphere is pivotal in this context, and this has also been identified as a particularly important concept to consider in climate-related decision-making (SCA, 2019). It should also be noted (as above) that a profitable forestry sector provides positive feedback that generates additional climate benefits over time, which is yet another positive effect. The model therefore sums up three different climate effects which, individually, are important expressions of how the climate efforts are supported by the forestry sector. The unit of measurement is the same, which makes the summation and the total impact relevant for climate policies, but the total does not describe a physical carbon flow, nor is that the purpose.

As stated in (Holmgren and Kolar, 2019), the factors for estimating substitution are conservative, since knowledge regarding these effects is still being developed (Leskinen et al., 2018). For fibre products, substitution has been assumed to be the same as for energy extraction only. It is reasonable to assume that substitution is higher for many fibre products, such as packaging materials which replace plastic. Similarly, the substitution figure for energy has been set lower than conversion rates in today's highly efficient combined heating and power plants. Moreover, no estimated substitution figure for fossil based or fossil demanding textiles has been included.

A further question regarding the substitution effect is what happens over time as society potentially becomes less fossil dependent. Further research is needed to look more closely at this. The relevant question then becomes what products, with what level of fossil impact, would be on the market if the forest product in question did not exist.

Significance of the results

The calculated positive overall climate effect of the forestry sector is 93 $MtCO_2e$ for 2017. By way of comparison, Sweden's total reported territorial emissions were 53 $MtCO_2e$ in 2016 excluding LULUCF (Naturvårdsverket, 2018a), which includes the 4 million tonnes caused by the forestry sector, included in the present model. In addition to the formal reporting, Sweden's annual emissions including international travel has been estimated at 63 $MtCO_2e$, and emissions from all Swedish consumption at approximately 100 $MtCO_2e$ (Naturvårdsverket, 2018b). We already had an idea of the magnitude of the forest's contribution to climate change mitigation, and this is included as the first factor in the model above. When the effect of fossil reduction through substitution is also included, we can see that the forestry sector is of far greater significance to managing the global climate.

When making comparisons with geographies that have similar conditions economically, biologically and in terms of forest ownership structure, but where no equally successful forest sector has emerged, the conclusion becomes even clearer. For instance, forest growth per area unit in the far-reaching forests of New York State is about half that of Sweden. Moreover, only around one-third of this lower growth is harvested for a forest industry that also does not have the same degree of

integration as the Swedish forestry sector (Widmann et al., 2015). At the same time the modestly increasing timber volume provides a climate change credit under the logic of climate reporting. It appears, therefore, that the potential for long-term development of the forestry sector, with accompanying higher growth and harvest rate, is high in other parts of the world. This presupposes that long-term conditions for investment are in place, and that the limited traditional view of climate benefits from storing carbon in the forest evolves.

Another comparison can be made with the Swedish government's Klimatklivet initiative, a relatively large climate programme (16% of the national environmental budget) in which the Swedish EPA (2019) deems that the climate impact of SEK 4.7 billion of tax-sourced funding will be 1.5 $MtCO_2e/yr$ over 16 years, primarily in the form of substitution effects. This impact estimate has been questioned (WSP, 2017), but even so the annual level is about one week's climate impact from the forest sector.

The scale of the forest sector's contribution to climate change mitigation can also be juxtaposed with the Swedish steel industry's vision to eliminate its fossil emissions of approximately 6 $MtCO_2e/yr$ by the year 2050, conditioned on major investments, innovations and guarantees from society (Jernkontoret, 2018). This eventual future fossil reduction would then equate to around 6% of the forest sector's positive climate impact as it stands already today.

The forest sector and climate agreements

As mentioned previously, official climate reporting does not specify fossil reduction through substitution from forest products. Changes in the forest carbon pool are reported according to the agreed methods (IPCC, 2006), while substitution effects are only implicit in reports of other sectors. The focus is on physical carbon flows, which make cross-sectoral substitution effects invisible. Climate reporting thereby separates the forest from the forest industry. Consequently, no climate-related incentives are provided so as to enhance the biogenic cycle through better management leading to higher growth and harvesting, or to secure efficient value chains from the forest via industry. The Paris Agreement follows the IPCC's logic and allocates an explicit role for the forest only as a carbon reservoir, i.e. a carbon storage that should be kept intact or increase (UNFCCC, 2015). Furthermore, '*forestry*' is addressed as part of the problem in the IPCC's latest *assessment report*. It states that forestry and other land use account for 11% of global emissions. A common yet erroneous conclusion in the negotiation process, since the focus is on the stock of carbon in the forest, is then that forestry should be restricted since the build-up of the stock, and therefore the climate benefits, are expected to be greatest if the forest is left alone.

Regulations in the EU surrounding LULUCF (European Commission, 2018a) also focus on the carbon stock changes in the forest based on IPCC methods. Since the substitution effect is not made explicit in the agreement, negative incentives can be created whereby it becomes less costly to not manage and exploit the forest, since all felling results in a reported emission. This curtails both the forest sector and the overall potential of achieving the climate goals.

The IPCC's Special Report on Global Warming of 1.5°C (IPCC, 2018) does contain recommendations on both increasing forest growth and fossil reduction through substitution, but this has no onward impact on prevailing climate agreements or reporting. This is a serious limitation, not only for the forest industry per se but also for our ability to turn the climate change tide generally. (Note that a commentary on the recent *Climate Change and Land* report has been added to this English version, after the Conclusions section)

Other points for discussion

Primarily through the IPCC's 1.5°C report, a timeframe has been introduced for how quickly the increase of CO_2 in the atmosphere must be arrested. This time scale has not been agreed but is the result of scientific analysis. The Paris Agreement mentions no specific emission reductions or timeframe but has left this responsibility to the individual nations. Arguments about the time pressure have also influenced the debate about forest and climate. The reasoning is that the forest should be used to its maximum in the short term as a buffer for fossil emissions by dismantling forestry sector activities. It has surprisingly strong support in parts of both the political and the academic debate (KSLA, 2018), particularly associated with traditional nature conservation. There is a clear link to above mentioned limitations in climate reporting that emphasize the

role of forests as a carbon storage. The total climate effect of the forest sector, its synergies with financial returns and very long-term perspectives, should therefore be highlighted so as to ensure a balanced discussion.

The remaining fossil emissions in the forestry sector are significant (7% of Sweden's total emissions), and should decrease in line with general goals for fossil reduction. The challenge for fossil free transport, in particular, should be taken seriously, since the forestry sector is highly transport intensive (Skogsindustrierna, 2018).

On a final note, Sweden has a uniquely good ability to analyse the climate impact of the forestry sector – over time and in terms of future potential. With long-term commitments and cooperation in national forest statistics and timber measurement (Skogsbrukets Datacentral, 2018; SLU, 2018) precise data are available, which provide stability both in terms of results and policy formulation. Very few countries enjoy such good basic statistical conditions.

Conclusions

1. The forestry sector already makes a strong contribution to climate change mitigation and is a natural cornerstone of a fossil free welfare society. The climate effect of the forestry sector today are far greater than Sweden's total fossil emissions.

2. The forestry sector combines climate benefits with long-term operations that are profitable and sustainable. Products and energy from the forest are part of the green biogenic carbon cycle, and add no fossil carbon to the atmosphere.

3. The Paris Agreement and the agreed official reporting methods on climate impact are insufficient, since the forest is primarily regarded as a carbon reservoir, which ignores positive feedback on carbon sinks from the forestry sector's value chains, as well as substantial fossil reduction through substitution.

4. If society is serious about climate neutrality, forest policy needs to be clearly formulated and take a long-term approach, just as it has done for the past 100 years, to enable huge contributions to a fossil free welfare society. The political and commercial spheres must then take a holistic approach to sustainable development, with goals that include conservation of biodiversity as well as robust local communities.

IPCC Special Report on Climate Change and Land

The current report was originally published in Swedish in June 2019. This English version was issued after the IPCC Special Report on *Climate Change and Land* was released in August 2019, including several important analyses related to forests and forestry. The following notes makes reference to statements in this new IPCC report:

1. In top messages, forestry continues to be considered part of the problem. Forestry is defined as areas where trees are removed and causing emissions, whereas growth in managed forests is considered a "natural response". As a result, the net gains of sustainable forestry are not made visible (e.g., Table SPM1);
2. Methods and numbers used in GHG modelling conform with earlier IPCC assessments and guidelines. The discussion in the current report therefore remains valid as to the invisibility of cross-sectoral climate effects, the consequent emphasis of the role of forests as a sink and reservoir of carbon, and potential obstacles for holistic analyses of policy options for the forestry sector as a whole;
3. The substitution effect of forest products has a higher level of recognition than in earlier IPCC reports (e.g. in sections 2.6.1.2 and 4.8.4). However, the analyses appear to have a skeptical tone and include notions of risks and "carbon debt" without strong science backing. Estimates of substitution effects are conservative compared to findings in this report (e.g. in section 6.3.1.1.2). Most of the scenarios exclude substitution effects, quoting lack of evidence. As a result, substitution of material and energy with forest products remains a low-profile topic in this IPCC report;
4. The IPCC special report on *Climate Change and Land* focuses mainly on climate effects of the global food system, including land use change through deforestation as well as value chains with dietary choices. It acknowledges potential benefits of the forestry sector and its value chains, albeit with a lower profile and potential.

References

Anon., 2019. Januariöverenskommelsen. https://www.januarioverenskommelsen.se/ (accessed 6.13.19).

Björheden, R., 2019. Det svenska skogsbrukets klimatpåverkan. https://www.skogforsk.se/cd_49b4c9/contentassets/4b4b423402784d658204a7784723637b/det-svenska-skogsbrukets-klimatpaverkan.pdf (accessed 6.14.19).

Energiföretagen, 2019. Tillförd energi - Energiföretagen Sverige. https://www.energiforetagen.se/statistik/fjarrvarmestatistik/tillford-energi/ (accessed 6.15.19).

European Commission, 2018a. Land use and forestry regulation for 2021-2030. Clim. Action - Eur. Comm. https://ec.europa.eu/clima/policies/forests/lulucf_en (accessed 6.19.19).

European Commission, 2018b. A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0773&from=EN (accessed 10.10.19).

FAO, 2019. FAOSTAT. http://www.fao.org/faostat/en/#data (accessed 6.17.19).

Haberl, H., Erb, K.H., Krausmann, F., Gaube, V., Bondeau, A., Plutzar, C., Gingrich, S., Lucht, W., Fischer-Kowalski, M., 2007. Quantifying and mapping the human appropriation of net primary production in earth's terrestrial ecosystems. Proc. Natl. Acad. Sci. U. S. A. 104, 12942–12947. https://doi.org/10.1073/pnas.0704243104

Holmgren, P., Kolar, K., 2019. Reporting the overall climate impact of a forestry corporation - the case of SCA. https://mb.cision.com/Main/600/2752801/999695.pdf

IPCC, 2018. Global warming of 1.5°C. http://www.ipcc.ch/report/sr15/ (accessed 4.16.19).

IPCC, 2014. Climate Change 2014 Synthesis Report. http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf

IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use. https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html (accessed 4.17.19).

IPCC, 1990. Assessment Report 1: The IPCC Response Strategies [WWW Document]. URL https://www.ipcc.ch/report/ar1/wg3/ (accessed 6.14.19).

Ipsos, 2019. 2019 European Parliament Elections Study of Potential Voters https://europeanclimate.org/wp-content/uploads/2019/04/European-Parliament-Study_Media_EU.pdf (accessed 6.13.19).

Jernkontoret, 2018. Klimatfärdplan: för en fossilfri och konkurrenskraftig stålindustri i Sverige. http://fossilfritt-sverige.se/wp-content/uploads/2018/04/ffs_stalindustrin.pdf

KSLA, 2018. Forests and the climate – manage for maximum wood production or leave the forest as a carbon sink? http://www.ksla.se/aktivitet/forests-and-the-climate/ (accessed 11.22.18).

Leskinen, P., Cardellini, G., González-García, S., Hurmekoski, E., Sathre, R., Seppälä, J., Smyth, C., Stern, T., Verkerk, P.J., 2018. Substitution effects of wood-based products in climate change mitigation. https://www.efi.int/sites/default/files/files/publication-bank/2018/efi_fstp_7_2018.pdf

Lundmark, T., Bergh, J., Hofer, P., Lundström, A., Nordin, A., Poudel, B.C., Sathre, R., Taverna, R., Werner, F., 2014. Potential Roles of Swedish Forestry in the Context of Climate Change Mitigation. Forests 5, 557–578. https://doi.org/10.3390/f5040557

Naturvårdsverket, 2019. Resultat för Klimatklivet. Naturvårdsverket. http://www.naturvardsverket.se/Stod-i-miljoarbetet/Bidrag/Klimatklivet/Resultat-for-Klimatklivet/ (accessed 6.17.19).

Naturvårdsverket, 2018a. National Inventory Report 2018. https://www.naturvardsverket.se/upload/miljoarbete-i-samhallet/internationellt-miljoarbete/miljokonventioner/FN/national-inventory-report-2018.pdf (accessed 6.16.19).

Naturvårdsverket, 2018b. Fördjupad analys av svensk klimatstatistik 2018. https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6848-6.pdf?pid=23767 (accessed 6.16.19).

Naturvårdsverket, 2017. National Inventory Report Sweden 2017 - Greenhouse Gas Emission Inventories 1990-2015 https://www.naturvardsverket.se/upload/sa-mar-miljon/statistik-a-till-o/vaxthusgaser/2016/data-metoder/nir-se-submission-2017.pdf (accessed 11.9.18).

Pöyry, 2016. Bioenergi från skog och skogsindustri. https://www.skogsindustrierna.se/siteassets/dokument/rapporter/bioenergi-fran-skog-och-skogsindustri.pdf

Sathre, R., O'Connor, J., 2010. Meta-analysis of greenhouse gas displacement factors of wood product substitution. Environ. Sci. Policy 13, 104–114. https://doi.org/10.1016/j.envsci.2009.12.005

SCA, 2019. Climate benefits from forests, forestry and forest industry – how can we clarify, calculate and communicate them? Report from a roundtable discussion. https://www.sca.com/globalassets/sca/hallbarhet/klimatnytta/roundtable-discussion-on-climate-benefits-from-forests-forestry-and-forest-industry-march-2019.pdf

Skogsbrukets Datacentral, 2018. Skogsindustrins virkesförbrukning samt produktion av skogsprodukter 2013-2017.

Skogsindustrierna, 2019a. Statistik om el och energi. https://www.skogsindustrierna.se/skogsindustrin/branschstatistik/el-och-energi/ (accessed 6.17.19).

Skogsindustrierna, 2019b. Miljödatabas. https://miljodatabas.skogsindustrierna.org/simdb/Web/main/reportselect.aspx?l1=report&l1=report (accessed 6.15.19).

Skogsindustrierna, 2018. Färdplan för fossilfri konkurrenskraft - Skogsnäringen. http://fossilfritt-sverige.se/wp-content/uploads/2018/04/ffs_skogsnaringen.pdf (accessed 6.13.19).

Skogsstyrelsen, 2015. Skogliga konsekvensanalyser 2015 – SKA 15 (No. 10), Rapport. https://www.skogsstyrelsen.se/statistik/statistik-efter-amne/skogliga-konsekvensanalyser/

SLU, 2018. Skogsdata 2018 - Aktuella uppgifter om de svenska skogarna från Riksskogstaxeringen. https://www.slu.se/globalassets/ew/org/centrb/rt/dokument/skogsdata/skogsdata_2018_webb.pdf (accessed 11.20.18).

UNFCCC, 2019. Nationally Determined Contributions (NDCs). https://unfccc.int/process/the-paris-agreement/nationally-determined-contributions/ndc-registry (accessed 4.17.19).

UNFCCC, 2015. Paris Agreement. https://unfccc.int/sites/default/files/english_paris_agreement.pdf (accessed 6.13.19).

United Nations, 1992. United Nations Framework Convention on Climate Change. https://unfccc.int/resource/docs/convkp/conveng.pdf (accessed 6.14.19).

Vi-skogen, 2019. Varmare klimat - iskall nyhet? https://viskogen.se/app/uploads/2019/05/vi-skogen-rapport-2019-print.pdf (accessed 6.13.19).

Widmann, R.H., Crawford, S., Kurtz, C.M., Nelson, M.D., Miles, P.D., Morin, R.S., Riemann, R., 2015. New York Forests, 2012 (No. NRS-RB-98). U.S. Department of Agriculture, Forest Service, Northern Research Station, Newtown Square, PA. https://doi.org/10.2737/NRS-RB-98

World Bank, 2019. CO2 emissions (metric tons per capita) | Data. https://data.worldbank.org/indicator/EN.ATM.CO2E.PC (accessed 6.13.19).

WSP, 2017. Klimatklivet - En utvärdering av styrmedlets effekter. https://naturvardsverket.se/upload/nyheter-och-press/nyheter2017/wsp-rapport-utvardering-av-klimatklivets-effekter-17-03-01.pdf

Zachrisson Winberg, J., 2019. Regeringens dubbla budskap: Flygandet måste minska – men låter det öka. https://www.svt.se/nyheter/inrikes/regeringens-dubbla-budskap-vi-maste-minska-flygandet-men-later-det-oka (accessed 6.14.19).

Swedish Forest Industries