Advancing the development of a 3S forestry framework for the Forestry Economy Coalition

Consultancy Report

Client Name: Climate KIC

Date: 20th December 2019

Efeca Project Number P130
Advancing the development of a 3S forestry framework for the Forestry Economy Coalition

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Date: 20th Date: 20th December 2019

Efeca Project Number: P130

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Executive Summary

In June 2019, EIT Climate–KIC (CKIC), The Nature Conservancy (TNC) and the World Resources Institute (WRI) initiated the Forest Economy Coalition (FEC). The aim of the FEC is to deliver on the climate mitigation potential of forests and the broader forest economy by mobilising a cross-sector coalition of leaders and key stakeholders. The name ‘Forest Economy Coalition’ was chosen by the group to reflect the need for a holistic approach to climate change mitigation.

To deliver a meaningful impact, there is a need to engage the entire supply chain, rather than solely forest based industries. A holistic perspective is required to support decision-making and action in order to optimise the balance between the 3S (sink, storage and substitution) of forests and wood products for climate benefit. It is from this principle that the aim to establish the 3S Framework was established.

The 3S framework will be designed to utilise sink, storage and substitution to support users of wood products to effectively utilise the forest climate mitigation potential.

Efeca was tasked with facilitating a dialogue between the initial FEC partner organisations, to support the development of a shared 3S approach. In this report we have called this group FEC WG to signify a working group of the FEC as this organisation is still in its infancy. A workshop in Geneva on 19th November 2019 was facilitated in order to provide a common understanding on the perspectives and future expectations of a 3S Framework amongst the founding partners of the Forest Economy Coalition (FEC WG). The outputs of the workshop are integrated throughout this report along with current thinking on the relevant issues and models.

This report combines inputs from the FEC WG dialogue with analysis of current research and a review of current decision-making tools, to feed into the development of a strategy or proposal to support the next phase in the 3S frameworks development.

While companies are increasingly interested in estimating and making claims about GHG impacts, and there are many models available to support decision making, the assumptions and principles behind these models are not always clear. Furthermore, there are conflicting ideas of what the baseline should be when considering carbon savings and climate mitigation. While some experts use ‘untouched’ forests i.e. unmanaged, wild areas as the baseline, others choose to use the existing landscape in its current state. While these different perspectives all bring valid arguments to the debate, the ‘silos’ nature of research and the interests of stakeholders makes it difficult for these perspectives to influence action. A potential benefit of the 3S Framework will be to bring these valid perspectives together. Transparency has been highlighted as a key action for industry and the need for pre-competitive sharing of solutions, such as supporting the agreement of common methodologies has been identified by the WGBC and others, and the 3S Framework could help address these challenges.

Within each of the 3S’s that make up the framework there are challenges. In terms of the sink, younger, faster-growing forests may have a higher rate of carbon uptake from the atmosphere, but it is the older, longer-rotation forests and protected old-growth forests that exhibit the highest carbon stocks. As well as growth, forest degradation also needs to be considered to effectively measure carbon stock changes.
While often treated the same in carbon accounting, there is a difference between biogenic carbon emissions (stored in plants, animals, organic matter) and fossil carbon emissions. Biogenic carbon is cyclical (removed and emitted) whereas fossil fuels are linear. However, although they are different, biogenic carbon should still be accounted for in assessments in order to give the most accurate picture.

The WBSCD has identified the need for data to demonstrate industry's impacts on forest carbon stocks and this could be provided through the 3S Framework. Wood harvested for high-value, long-lived products such as construction wood tend to be both longer-lived than lower-value uses such as pulp or chipboard and these products could be prioritized when developing the 3S Framework.

There are also a wide range of carbon efficient wood, non-wood and hybrid products being developed in the market and the framework will need to ensure that it keeps up with these innovations. Robust data on building material substitution is needed that can be adopted and/or developed by other studies and that can be linked to land use change, forest management practices, and/or of carbon stored in buildings.

The forestry sector typically supports a value chain approach to catalysing change and investment, whereas other groups (civil society, multi-stakeholder initiatives etc) have recently begun to explore alternatives such as landscape or jurisdictional approaches. To ensure maximum effectiveness, the 3S Framework should be dynamic and work at a range of scales to suit the users need. Ideally the 3S Framework would also include a measuring or recalibration element e.g. projecting GHG flux over time in an area to support risk management when using the platform as a planning tool.

Each of these 3S's have a vital role to play in reducing the amount of carbon in the atmosphere and mitigating climate change. One of the largest debates is between sink and substitution, leaving trees in the forest or using timber to replace carbon in downstream value chains. While there is no one size fits all solution, the proposed framework aims to support users in making the decision that provides the most impact for their situation.

In the next ‘development’ phase of the 3S Framework, the FEC WG will create a short proposal accompanied by a funding strategy and begin stakeholder consultation with the view to launching the platform in 2021.
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>CKIC</td>
<td>EIT Climate-KIC</td>
</tr>
<tr>
<td>EASAC</td>
<td>European Academies Science Advisory Council</td>
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<tr>
<td>FEC</td>
<td>Forest Economy Coalition</td>
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<tr>
<td>FEC WG</td>
<td>Forest Economy Coalition Working Group (participants at the November 2019 workshop in Geneva)</td>
</tr>
<tr>
<td>TNC</td>
<td>The Nature Conservancy</td>
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<td>WRI</td>
<td>World Resources Institute</td>
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1 Introduction

In June 2019, EIT Climate–KIC (CKIC), The Nature Conservancy (TNC) and the World Resources Institute (WRI) initiated the Forest Economy Coalition (FEC). The aim of the FEC is to deliver on the climate mitigation potential of forests and the broader forest economy by mobilising a cross-sector coalition of leaders and key stakeholders.

An underlying belief was that a holistic perspective was needed to support decision-making and action to optimise the balance between the 3S (sink, storage and substitution) potential of forests and wood products for climate benefit.

The initial scope of this work is European but there is a recognition that this must also consider boundaries, impacts and linkages to the wider world.

The main dichotomy is between sink and storage/substitution (trees are harvested and substitute carbon in downstream value chains). The aim to maximise the benefits of a system, which means the parts are related and effect one another, rather than trying to achieve a zero-sum equation. For example, more frequent harvest can, under some circumstances, increase resilience. It can also keep trees growing rapidly, maximizing their sequestration function (old forests may contain a lot of carbon, but if they are growing slowly then they are sequestering little if any carbon).

Efeca was tasked with facilitating a dialogue between the initial FEC partner organisations, to support the development of a shared 3S approach. In this report we have called this group FEC WG to signify a working group of the FEC as this organisation is still in its infancy. To support the development of the FEC, Efeca was to draft potential components of the framework, combining inputs from the FEC WG dialogue with analysis of current research and a review of current decision-making tools.

A workshop in Geneva on 19th November 2019 was facilitated in order to provide a common understanding on the current perspectives and future expectations of a 3S Framework amongst the founding partners of the Forest Economy Coalition (FEC WG). The outputs of the workshop are integrated throughout this report along with current thinking on the relevant issues and models.

It is envisaged that there will be 3 main areas of work for the Forest Economy Coalition, comprising of Science, Dialogue and action. The focus of this report is the 3S Framework, which falls into the ‘Science’ element.

The purpose of this report is to enable the FEC WG to develop an outline of the 3S Framework as well as to feed into the development of a strategy or proposal that will include 3 aspects (research, dialogue and initiatives) to support the search for funding next year.
2 Approach

This rapid assignment was conducted by a team of Efeca consultants in November and December 2019. Several remote meetings were held with the FEC WG including group and individual discussions in additional to project management update discussions. A face-to-face workshop was facilitated by Efeca on 19th November (see Annex I for agenda and participants).

There are three main sections in this report. The first section (Section 3) analyzes the principal perspectives on the 3S debate and 3S Framework components that were pinpointed in the 3S Framework workshop. The analysis includes identifying the potential components of a 3S Framework. The factors identified throughout the report emanate from WRI, TNC, C-KIC and the existing literature is used to outline the most relevant current (wider) thinking. This analysis will allow the FEC WG to consider the optimal combinations of the sink, storage and substitution functions of forests and wood products.

Section 4 of this report considers relevant models and how they compare with regards to principles and assumptions. An accompanying excel worksheet provides a comparison between relevant models. This provides background information to support the development of a potential 3S Framework end product.

Finally, section 5 sets out the expectations and shared vision for the 3S Framework by CKIC, TNC and WRI, and includes relevant outcomes from stakeholder 3S Framework scoping workshop.

The literature used in this study was reviewed by the workshop participants to ensure that the most relevant documents and research articles were consulted by the Efeca consultants and is listed in a bibliography in Annex II.
3 3S Framework Perspectives and Components

This section considers the different components of the 3S Framework from current literature with FEC WG perspectives as outlined in Annex IV. The components detailed under sink, storage and substitution are based on the factors which the FEC WG anticipated in the November workshop would need to be measured in the 3S Framework. These factors were then explored in further detail, drawing on findings from the literature.

At the end of each section, the implications for the 3S Framework are summarised, indicating where further research needs, risk or opportunities have been identified, to support FEC WG in developing the framework.

The different components throughout this section are informed by individual discussions with the FEC WG and the outputs from the November workshop and 2019.

3.1 Assumptions and Principles

3.1.1 Transparency of Assumptions

While many companies are increasingly interested in estimating and making claims about GHG impacts, the lack of an agreed framework has meant that companies have either created their own methodologies or have taken no action at all to avoid any claims of ‘green washing’. When companies create their own methodologies there are challenges, for example companies mostly focus on the positive impacts they are having, though in reality both positive and negative impacts should be considered to create a strong climate change strategy.1

Although there are many models available to support decision making, the assumptions and principles behind these models are not always clear. The availability of methodologies to support models vary, and within these assumptions can focus on pricing and the mathematical structure of the tool as opposed to providing transparency on the scenario-based assumptions. Transparency in modelling is crucial as how impacts are allocated in different scenarios can have important effects on the results, so it is essential these are communicated in a transparent manner. The WBCSD forest solutions group note this is particularly relevant for methodologies focusing on the effects of a product (within a value chain approach).2 For more information on models, please see section 4.2. where assumptions and transparency are discussed in more detail.

The 3S Framework could help address these challenges by helping users make carbon emissions (and mitigation) more visible both in business to business communication and to consumers. Transparency has been highlighted as a key action for the construction industry and the need for pre-competitive sharing of solutions, such as supporting agreement of common methodologies has been identified by the WGBC in their recent (2019) report.3 This suggests

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1 http://ghgprotocol.org/estimating-and-reporting-avoided-emissions
3 World Green Building Council (2019) Bringing Embodied Carbon Upfront
there is a willingness to support greater transparency by thought leaders in the sector who could drive support for the 3S Framework.

### 3.1.2 Where is the Baseline?

A baseline scenario is a projection of the changes to carbon in a specified area, in the absence of any interference, for example a carbon sequestration project. It is the reference scenario from which the impact of any action can be measured.\(^4\)

The creation of REDD+ has resulted in a range of data requirements for understanding (tropical) forest regions and a renewed interest in the effectiveness of forest policy interventions. Across the research domain, there are conflicting ideas\(^5\) of what the baseline should be when considering carbon savings and climate mitigation. While some experts use ‘untouched’ forests i.e. unmanaged, wild areas as the baseline, others choose to use the existing landscape in its current state. This includes areas of actively managed forests and degraded forest.

An alternative to this conflicting idea is a choice between an attributional vs consequential approach, and this is used when assessing products (relevant for the storage and substitution elements of the framework). In an attributional approach, emissions over a products lifecycle are compared to those of the reference (baseline) product. A consequential approach refers to how emissions will change because of the assessed product. This can present its own challenges, for example identifying what the ‘reference’ product should be and attempting to account for externalities such as policy changes, particularly over products with a long lifespan.\(^6\) In construction, the baseline is typically a building which has been constructed in a ‘business as usual’ way, against which future buildings carbon reductions and storage can be compared.\(^7\)

**Debate on reducing fossil fuel emissions to zero against protecting and restoring forests:**

UN climate negotiators regularly suggest that planting trees or reducing deforestation is equal to reducing emissions from burning fossil fuels. Fern has argued\(^8\) that this is incorrect and that until this viewpoint is completely refuted, schemes such as REDD, the Clean Development Mechanism or LULUCF have the potential to do more harm than good. Fern also point out although coal can be kept ‘in the hole’ and oil ‘in the soil’, there is no guarantee that carbon will remain in trees particularly given the risks from forest fires, insect outbreaks, decay, logging, land use changes and the decline of forest ecosystems as a result of climate change. Moreover, forest removals are temporary as trees die but carbon released by fossil fuels will last centuries.

In terms of the 3S Framework, it will be necessary to consider whether reforestation or more avoided deforestation should be part of the baseline or if there can be a combination of the two.

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\(^4\) [https://www.woodlandcarboncode.org.uk/standard-and-guidance/3-carbon-sequestration/3-1-carbon-baseline](https://www.woodlandcarboncode.org.uk/standard-and-guidance/3-carbon-sequestration/3-1-carbon-baseline)

\(^5\) WRI. 2019. Estimating and reporting the comparative emissions impacts of products

\(^6\) WRI. 2019. Estimating and reporting the comparative emissions impacts of products


\(^8\) [https://www.fern.org/news-resources/what-are-carbon-sinks-332/](https://www.fern.org/news-resources/what-are-carbon-sinks-332/)
The EU has advised\(^9\) that large amounts of afforestation should be carried out on unforested land to increase the amount of wood available for bioenergy and to develop carbon capture and storage. Despite afforestation leading to Europe's total tree-cover increasing slightly over the past 15 years, 75 per cent of the forest habitats are in a bad conservation state\(^10\).

An opposing view from the science community is that it would be the riskiest option for sustainable land management\(^11\). Recent academic studies\(^12\) suggest that natural forests are better for both the climate and biodiversity. Consequently, afforestation would provide significantly less benefit than leaving forests to naturally regenerate. Moreover, land put aside for natural forests to return can store 40 times more carbon than plantations and six times more than agroforestry.

The EASAC has emphasised the need to reverse current trends towards deforestation and soil degradation, while also increasing land carbon sinks suggesting a combination of both approaches, protecting natural forests while increasing the amount of forest land. Afforestation, reforestation and other natural climate solutions remain the least costly and most easily deployable way to remove carbon emissions from the atmosphere. However, it is recognised that this is in competition with food production and delivery of ecosystem services. In addition, there is currently no comprehensive assessment model to support greater understanding of these implications.\(^{13}\)

These different perspectives all bring valid arguments to the debate, but the silo nature of research and the interests of stakeholders makes it difficult for these perspectives to influence action. A potential benefit of the 3S Framework could be to bring these valid perspectives together, and support users in optimising the different forest functions in order to maximise the benefits of wood and forests on our climate. It is important to recognise that these discussions do not necessarily need to be ‘resolved’ before the launch of the 3S Framework, as the platform could be used to explore the debate. For example, policy makers could conduct scenario analysis on the impacts of converting forest land to non-forestry uses or the impact of gaining forest land from non-forestry use. Given the requirement that the Framework needs to be holistic, taking a ‘consequential’ approach would seem most appropriate, though perhaps not necessarily over a products lifespan alone. For instance, this could be applied to a specific landscape or a construction project.

3.1.3 The local and specific context is critical to address the complexity of the 3S

According to the IPCC:

> "Climate change creates additional stresses on land, exacerbating existing risks to livelihoods, biodiversity, human and ecosystem health, infrastructure, and food systems. Increasing impacts on


\(^{10}\)Fern (2019) EU Forests of hope: How community restoration and management of forests can help meet climate goals


\(^{12}\)Fern (2019) EU Forests of hope: How community restoration and management of forests can help meet climate goals

\(^{13}\)EASAC (2019) Forest bioenergy, carbon capture and storage, and carbon dioxide removal: an update
land are projected under all future GHG emission scenarios. Some regions will face higher risks, while some regions will face risks previously not anticipated. Cascading risks with impacts on multiple systems and sectors also vary across regions."\textsuperscript{14}

Climate change could be considered the strongest risk and most likely to create differences across varying locations. It is estimated that 7% of the European Union’s population lives in a flood prone area, compared to 9% who live in areas with an average of 4 months a year without rainfall. It is for this reason that the European Commission is supportive of ecosystem-based approaches, reflecting the different needs of each area and supporting climate resilience. This is likely to be an important consideration when looking for potential users or supporters of the framework.\textsuperscript{15}

In 2018, the European Environment Agency (EEA) published a report assessing European countries vulnerability and risks of climate-related hazards. The report included a summary of the various assessment approaches, and these could be categorised as ‘common’ challenges such as integrating qualitative and quantitative data and thematic areas such as biodiversity.\textsuperscript{16} According to Roe et al (2019) “effectively reducing deforestation and scaling up restoration depends on understanding local dynamics at the forest frontier and coordinated action among private and public actors”.\textsuperscript{17} Roe’s report goes on to explore how each global region can mitigate climate change differently, giving examples of South America which would increase the forest ‘sink’, food waste reduction for the USA and for the EU and China the reduced consumption of commodities linked to deforestation including timber.

It is inaccurate to claim that working on a local level alone will achieve significant impact, but researchers agree that there should be a greater understanding of the local context on the part of governments, policy makers and potential donors. There should also be a greater understanding between different sectors who use forests for a variety of services such as tourism together with the range of trade, business and civil society interests as this will support increased, sustainable market access.\textsuperscript{18}

The 3S Framework could build on this thinking, allowing a user to identify the key thematic or geographical areas most relevant to them. There is also the implication that surrounding the 3S framework could be a mechanism to connect with other users which could support the development of long-term partnerships building smaller scale changes into larger, long lasting impacts at scale.

\subsection*{3.1.4 How holistic should the framework be?}

The name ‘Forest Economy Coalition’ was chosen by the group to reflect the need for a holistic approach to climate change mitigation. To deliver a meaningful impact, it is necessary to engage the entire supply chain, not just forest based industries. This ensures that the whole lifecycle of

\textsuperscript{14} https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/
\textsuperscript{17} Roe et al. (2019) Contribution of the Land Sector to a 1.5°C World. Nature Climate Change 9: 817–828
the product is considered for example ‘cascading’ use of products once the timber has been harvested and a product created. During the workshop, the FEC WG has discussed whether the term ‘forest economy’ was sufficiently inclusive for the wide range of views of the 3S Framework audience, but so far, an alternative name has not been found.

There are social costs associated with climate change, such as increased healthcare costs and emergency funding requirements following natural disasters, and low-income countries are likely to be more vulnerable. While the 3S Framework is unlikely to focus on social considerations, it may be the future FEC could consider how to support low-income countries to utilise the tool in recognition of this additional challenge.

**Safeguards:** Where there is uncertainty in the framework, the FEC WG suggested the inclusion of ‘safeguards’. These would be additional to the framework and aim to provide reassurance to the user and across supply chains. For example, if the user has selected a forest area that is recognised as being at risk of poor implementation of forest law, the framework could suggest working with a sustainable forest certification, such as FSC or PEFC. These not only provide assurance of legality but also sustainability and can support additional benefits such as recreation.

**Achieving Uptake:** When considering how best to achieve uptake, it is important to explore the way that industry works. The forestry sector typically supports a value chain approach to catalysing change and investment, whereas other groups (civil society, multi-stakeholder initiatives etc) have recently begun to explore alternatives such as landscape or jurisdictional approaches. Rather than focus on the value chain these set specific geographic boundaries and focus on creating change within the identified area, across stakeholders and often across multiple commodities or focus areas. While there are positives and negatives associated with both approaches, a value chain approach still brings together multiple stakeholders but has the added benefit of decoupling risk from any potential investments and can achieve multiple positive impacts at once. To be successful there needs to be increased levels of transparency, to allow stakeholders to share their experiences and learn from success stories to support the development of strong business cases which will create long-term buy in.

A recent study by Duchelle et al (2018) found that many REDD+ projects included smallholders and communities with activities including awareness raising and capacity building, but there was less focus on larger drivers of deforestation. The greatest barriers to uptake were found to be lack of information and complex enrolment logistics, and uptake improved where there were clear returns and a desire to engage in a collaborative effort.

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19 Nyambuu (2020) Climate change and the transition to a low carbon economy – Carbon targets and the carbon budget. Economic modelling 84:367-376
https://www.sciencedirect.com/science/article/pii/S0264999318305765#bib69


**Leakage:** Leakage refers to changes in emissions outside of the focus area, accounting system or project which are caused because of changes made inside the area, system or project. It is particularly important to understand leakage in REDD+ projects as it can affect the integrity of any emission reduction or removal claims made. Leakage is treated differently at a jurisdictional approach vs a project-based approach, and in general the smaller the scale the higher the expectation of awareness and accountability (as it is deemed to be a greater risk). For example, international agreements and commitments such as the Kyoto Protocol do not consider leakage. Voluntary carbon standards are perhaps the most detailed, with some identifying a ‘leakage belt’ that surrounds the project area where accounting and monitoring are expected.²²

Figure 1 below sets out types and geographical scale of leakage as well as suggesting quantification tools. It may be possible to partner with an existing standard such as the Verified Carbon Standard (see section 3.2.3 carbon trading and standards below) which already undertakes monitoring and modelling within their system.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
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<tbody>
<tr>
<td>1) Leakage type</td>
<td>Leakage can be distinguished by the nature of the processes that motivate displacement:</td>
</tr>
<tr>
<td></td>
<td>• <em>Primary leakage</em> (or ‘activity shifting’): direct displacement of activities from one area to another. E.g.: local communities using forest for subsistence, or logging/agribusiness companies.</td>
</tr>
<tr>
<td></td>
<td>• <em>Secondary leakage</em> (or ‘market effects’): when forest conservation in one place indirectly creates incentives to deforest in other places. E.g.: Reduction in supply of commercial products (e.g., timber) causes price increase that makes logging more attractive to others.</td>
</tr>
<tr>
<td>2) Geographical</td>
<td>Leakage processes can occur on different geographical scales: The process can be <em>local</em>: e.g., when subsistence activities such as small-scale agriculture are affected, or it can be a further reaching: e.g., when the production of market commodities is affected on <em>national or international level</em>. International leakage describes displacement from one country to another; e.g., when a country introduces emission reduction policies and companies relocate to countries without those restrictions.</td>
</tr>
<tr>
<td>leakage scale</td>
<td></td>
</tr>
<tr>
<td>3) Quantification tool</td>
<td>Quantification of leakage effects can vary greatly in the type and quality of data required and the accuracy of estimates. Primary leakage often uses direct measurements in the field, e.g., remote sensing or ground measurements, interviews and household surveys. As secondary leakage cannot be measured directly, tools used for quantification are often economic models or default discount factors.</td>
</tr>
</tbody>
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Figure 1: Different characteristics of leakage (source: Focali, 2012)²³

### 3.1.5 Implications for the 3S Framework (Assumptions and Principles)

- It is essential to have a clear and transparent methodology for establishing the baseline. This will support users in interpreting the frameworks outputs correctly and allow for

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²² https://theredddesk.org/markets-standards/design-features/leakage-displacements

comparison between the framework and other approaches, to identify similarities and differences.

- Transparency is a core principle for the 3S Framework as future users need to be assured that they can be guided in a neutral manner. This can be achieved through clearly setting out the methodology behind the framework and identifying key organisations and delivery partners.
- It is also important that any existing tools, platforms or frameworks that are referred to are also transparent, to show users how different approaches can give differing results.

- An identified weakness of existing models and approaches is that they are limited in what they are measuring. Those owned by the industrial sector for example focus on substitution benefits primarily, and storage secondarily. The timber industry however is more likely to focus on sequestration and storage in models. Both can be considered “highly misleading” when forest carbon is not also considered.\(^\text{24}\) This suggests that a more holistic approach (capturing all 3S’s) as suggested by the FEC WG would be supported.
  - While some tools are available that capture the 3S’s in theory, they typically ‘prioritise’ one above the others or approach them through the three sustainability pillars (environmental, social and economic implications) as opposed to carbon specifically. Furthermore, the design of the tools could make it challenging for some users to make decisions across the 3S’s, as opposed to a more holistic process.

- The FEC WG has decided to ultimately focus the scope of the framework to the delivery of carbon benefits and maximizing forests role in climate mitigation.
  - It should be noted though that unlike other carbon focused models, by capturing all 3S’s, this framework could still recognise the benefits derived from carbon sinks such as the recreation benefits of forests, even if this is not an ‘active’ focus.
  - The FEC WG should transparently recognise that the value of forests is not just economic, and that there are also social, emotional values to consider. By explaining that climate change was perceived to be the most pressing issue where future FEC members could achieve impact it will ensure stakeholders are reassured they're not at risk of using another ‘siloh’ like the other platforms and models already available.

- As the users of the 3S Framework will be working at a range of scales, with the potential to overlap it is likely that ‘stopping’ leakage is not practical. Therefore, exploring how to account for leakage within the Frameworks methodology and ensuring this is transparent is recommended. The process for ensuring this will be subject to the existing data sets being used to establish the Framework.

3.2 Drivers

3.2.1 Current Situation
The main driver of global climate change is carbon dioxide (CO2) emissions. And the main source of carbon dioxide emissions is burning fossil fuels like coal, gas, and oil. The most recent

\(^{24}\) Sierra Club, Forests, Wood and Climate
IPCC report has set a clear target that greenhouse gas emissions must be reduced to net zero by 2050 in order to limit global warming to 1.5°C. If business as usual were to continue, the report predicted a 3°C rise.  

Heavy industry is responsible for approximately 22% of global CO2 emissions. 42% of that (around 10% of global emissions) comes from combustion to produce large amounts of high-temperature heat for industrial products like cement, steel, and petrochemicals. The nature of these industries means they are challenging to decarbonise, as global commodity markets govern trade and price there is a risk that action could be disadvantageous to a company or nation. This industry is also a challenge compared to other high carbon emitting industries such as transport as it is less visible to consumers, meaning there is less pressure to change. While obstacles remain, action to decarbonise these industries can be seen, for example in November 2019 the UK Government committed to investing £315 million to help energy intensive industries lower carbon emissions it is unlikely a solution will be available in the short term.

### 3.2.2 EU Policies and the 3S Framework

Within the November workshop, the FEC WG agreed it was essential that the 3S Framework should guide and inform EU policy, challenging policy makers if needed using the latest research and innovations. There is potential for the framework to support regional and national reporting on climate mitigation activities in a more comprehensive way, and support decisions to manage forests or utilise storage or substitution methods on the global stage. It also presents an opportunity to explore climate mitigation in a more holistic manner, supporting a move away from current ‘silied’ thinking and allowing users to show impact across a range of areas.

Forest policy within the EU is owned by each individual member state, each with different networks of laws, regulations and ownership rights. In 2013 the EU launched the EU Forest Strategy, and though this aims to integrate forests with climate change mitigation as implementation remains at a member state level there are varying levels of engagement which is a contrast to other climate policies which are implemented at a larger scale, making synergy a challenge. While this challenge exists, there is also a potential benefit in this approach, as across Europe (particularly Western Europe) there is a strong policy-level backing of sustainable forest management, which as well as providing environmental sustainability can also deliver social benefits.

The EU has made quantified commitments. In particular, the 2030 climate and energy framework, adopted by EU leaders in October 2014, sets three key targets for the year 2030:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 27% share for renewable energy

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25 [https://www.ipcc.ch/sr15/](https://www.ipcc.ch/sr15/)
28 EASAC (2017) Multi-functionality and sustainability in the European Union's forests. EASAC policy report 32
• At least 27% improvement in energy efficiency

As part of these requirements, EU member states account for carbon emissions from forests, wetlands and agricultural land in order to demonstrate carbon storage and climate mitigation. This is to ensure accountability from member states, as without reporting there is risk that a country could claim using biomass fuel was carbon neutral when in reality it is more complex. Recently there have been challenges to reporting, with Finland requesting permission to release 10 million tonnes of carbon dioxide in October 2019.

It is important to note that some funding for climate related projects such as the Clean Development Mechanism stress that projects must provide emissions reductions that are additional to what would otherwise have occurred. However, due to lack of guidance it is not always clear when carbon reduction methods should be treated equally or if (due to the specifics of the situation) these methods can be prioritised.

More recent policies that are either in the process of being implemented or are in development appear to focus on embedded carbon. For example, France is piloting the Positive Energy and Carbon Reduction voluntary labelling scheme and plans to regulate embedded carbon by 2020 with good performers eligible for bonuses. Also, in Europe the Netherlands has committed to 50% economic circularity by 2030 and 100% by 2050.

Bioenergy: There is a risk that using large areas of land for tree-planting or growing feedstock for bioenergy will endanger global food security and could trigger further desertification and land degradation. In one model, it was predicted that if current policy goals for bioenergy were achieved it would require a 21% increase in harvesting, and 50% of the harvest would be used for energy. Not only would this reduce the capacity of the forest ‘sink’ but also indicates a rise in pricing and an increase in imports from outside the EU.

3.2.3 Carbon Trading and Standards

There are many carbon standards available on the market that could have the potential to tie into or support the 3S Framework. Below are listed two examples the Verified carbon standard (formally the voluntary carbon standard) and the Plan Vivo standard. We have also provided information on the main carbon reduction alliance and two examples of trading systems. It may be possible for the 3S Framework to engage with and feed into these standards and systems. Equally it may be possible for these to be supporters of the Framework, perhaps providing data or expertise and they could be identified as early targets for stakeholder engagement.

33 Rüter et al. (2016) ClimWood2030: ‘Climate benefits of material substitution by forest biomass and harvested wood products: Perspective 2030’
The **Verified Carbon Standard (VCS)** is the world's most widely used voluntary GHG programme and provides ex-post credits to projects. The standard was designed to validate and verify rigorous and trustworthy voluntary greenhouse gas offsets. In addition, the standard aims to generate permanent carbon credits, keep validation and verification costs low, and ensure basic environmental and social benefits.\(^{34}\) The standard has robust validation and verification systems in place, including the use of modelling to manage risk. For example, the standard uses the GapFire model to project the growth and mortality of individual trees under different fire regimes and determines burn probabilities. There is potential for the FEC WG to align the 3S Framework with the VCS to align monitoring of forests.\(^{35}\)

The **Plan Vivo standard** allows for results-based payments to be made to project participants. Plan Vivo projects follow a ‘whole landscape’ approach; they are normally made up of multiple participants and interventions, depending on the needs and priorities of the communities involved. This means that projects can be made up of a single area or many separate project areas (e.g. many smallholdings) across a landscape and can expand programmatically over time. Plan Vivo Certificates may be either ex-ante or ex-post depending on the project and activity. For both ex-ante and ex-post methodologies, the same requirements apply in terms of long-term monitoring, carbon buffers, independent validation and verification. The Plan Vivo foundation state that Ex-ante crediting, particularly for carbon sequestration (tree-planting) activities, has been shown to be instrumental in getting projects off the ground in poorer countries (therefore increasing uptake).\(^{36}\)

The **International Carbon Reduction and Offset Alliance (ICROA)** is a non-profit industry body for businesses delivering carbon reduction and offset services. ICROA aims to promote best practices in carbon management and offsetting to support voluntary climate mitigation efforts. The alliance provides updates to members on the latest developments within carbon management and the carbon markets to ensure they adhere to the best possible practices in the industry.\(^{37}\) It may be that ICROA could be a potential supporter of the framework who could support the FEC WG during the development phase to ensure any potential linkages are identified and capitalised on.

The **EU Emissions Trading System (EU ETS)** gives each member state an 'allowance' of emissions to be split between installations within each country. These installations can trade their emission allowance amongst themselves, either selling surplus where they have made changes to reduce their emissions or to purchase more allowance if needed. While considered successful the system is not without challenges. When first created, emissions were presumed to be much higher as they were based on projections as opposed to data. As a result of this over-allocation of the allowance the market value dropped and a cumulative surplus remains.\(^{38}\) This reinforces the suggestion that the framework should use actual data as much as possible as

\(^{35}\) https://verra.org/methodology/vm0029-methodology-for-avoided-forest-degradation-through-fire-management-v1-0/  
\(^{36}\) https://www.planvivo.org/faq/#3  
\(^{37}\) https://www.ieta.org/page-18887  
\(^{38}\) https://ec.europa.eu/clima/policies/ets_en#tab-0-2
opposed to projections, particularly if there is potential for the framework to feed into carbon trading systems.

Currently, it is impossible to use credits from carbon sinks within the EU ETS, due to fears this would undermine the EU ETS’s integrity. Projects would be unable to deliver ‘permanent’ emissions reductions, and the temporary and reversible nature of the sink would mean a robust monitoring and reporting system would need to be created which could be confusing to users and costly to implement. Instead, it was felt that proceeds from allowances could be spent to fund ‘sink’ activities. It is however possible to implement ‘substitution’ activities, for example, the UK based Drax power plant reduced emissions by 53% in 2016 compared to 2015 through converting three of its coal unites to biomass. The biomass emissions methodology used by Drax is mandated under EU rules and includes lifecycle emissions from cultivation, harvest, processing and transport of pellets, but critics argue the methodology ignores changes in forest carbon stocks and the indirect effects caused by increased demand for wood products. For example, if biomass demand increases would a forester harvest more frequently (reducing the sink capability of the forest)? There is also differing information on the emissions associated with various sources of biomass e.g. forest residues and sawmill residues and this can also vary depending on source. In short, the EU ETS can be viewed positively for the way it has assigned value to carbon emissions and reductions, and the method of trading carbon could be helpful to the framework when demonstrating the gains and losses associated with trade-offs either over a landscape or within a supply chain. However, it is also an example of how assumptions on the capability of the forest sink, or that all substitution is ‘good’ can cause confusion and push back from stakeholders.

The EU ETS recognises that changes to reduce emissions will be driven by costs. Cost effectiveness can be measured in terms of how much carbon can be saved compared to the value of the forest or the value of the carbon itself. While there is a perception that working in a way to reduce carbon emissions is more costly, there are industry leaders who claim to make progress without any upfront “green premium” as they can show carbon benefits in other ways, for example through selection of materials.

The California Cap and Trade programme was launched in 2013 and is the 4th largest in the world following the EU, Republic of Korea and Chinese province of Guandong. The cap-and-trade rule applies to large electric power plants, large industrial plants, and fuel distributors, which translates to approximately 450 businesses responsible for about 85% of California’s total greenhouse gas emissions who must comply. Businesses are given a free allocation which reduces over time, with other allowances purchased via auction or trade. Allowances are allocated based on output and section-specific emissions benchmark for industry but electivity

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is based on long-term procurement plans and natural gas based on 2011 sales. While it is clear the focus on the 3S Framework will be Europe, it is perhaps worth consulting with other carbon trading programmes to explore methodologies and lesson learning.

In the next phase of stakeholder consultation, the FEC WG may want to consult with carbon standard owners to explore if the framework could be integrated into carbon standards to that a user may benefit from the sale of carbon, thus generating further income opportunities.

3.2.4 Markets

Although there are several papers that explore how consumer choices can lower carbon emissions across several areas of lifestyle such as travel, food and housing it is uncommon for research to connect these different areas together into a single framework. There is also debate as to whether individual consumers should be the focus of tackling climate change, with the suggestion being companies and the public sector should create change on their behalf.

Consumer led change has focused on encouraging alternative products (substitution) and improved energy conservation practice, including through choice of construction material (storage). A study by Verain et al (2015) found that when exploring sustainable consumption, research focused on quantity of sustainable choices as opposed to quality suggesting that both researchers (and as a result consumers) are less likely to look into a range of sustainable choices.

Early adopter companies may be able to capitalise on developing low-carbon products to enter new markets and increase their profits. One example of this is the substitution of wood products in construction. Winchester et al (2019) found that under a carbon cap-and-trade policy, substituting lumber products lowers the carbon price as well as the cost of meeting the carbon cap. Furthermore, the study also indicates that forestry and lumber production would increase, decreasing production from carbon intensive sectors.

Many policy measures have aimed to support the development of the circular economy, however while much of these have focused on the ‘production’ perspective, consumers have a significant role to play in either supporting or harming the wider transition with how they use products. A 2018 study showed that while many consumers were supportive of repairing/purchasing second hand there was a gap in stated values and actual engagement. This was due to two leading factors, the price-cost ratio and differing levels of effort. The study found a consumer was more likely to consider reparability when purchasing larger, expensive items.

44 https://www.c2es.org/content/california-cap-and-trade/
45 Schanes et al. (2016) Low carbon lifestyles: A framework to structure consumption strategies and options to reduce carbon footprints. Journal of Cleaner Production 139:1033-1043
49 http://trinomics.eu/project/the-effects-of-consumer-behaviour-on-the-circular-economy/
The implications for the 3S Framework therefore suggest there could be potential to show economic benefits to encourage uptake of the 3S Framework. Furthermore, it may be necessary to explore how consumers use products in more detail when considering storage, for example if a wood product is replacing another wood product would this impact on the carbon storage attributed to the replacement or should wood products sent to landfill be captured within the 3S Framework? These issues are discussed further in sections 3.5 and 3.6 below.

3.2.5 Technological Innovations

Web based tools

The Forester platform was commissioned by the UK Forestry Commission in 2015. The platform brings together several datasets to support forest owners and managers in their decision making. Based on GIS mapping, the platform also allows users to forecast timber production, monitor forest development and protect habitats, all of which could feed into the ‘sink’ element of the 3S Framework. According to the Head of Forestry Information Systems “We can use GIS to predict the likely consequences of global warming on trees and how much carbon they can sequester... we can then present evidence to central government ministers responsible for decision making”. It should be noted that 80% of the public data used in this platform is spatially related, and this may not be consistent across Europe, however basing the 3S framework on a GIS baseline appears straight forward and cost effective. This baseline can also be built upon, adding additional layers, for example supporting users to demonstrate regulatory compliance. Another benefit identified by users was the ability to communicate quickly, transparently and cost-effectively.

i-Tree\(^5\) is an online platform that hosts a range of tools which support users to quantify the benefits of trees, support forest management and shows potential risks to tree and forest health. The platform is peer-reviewed and supported by USDA Forest Service Research.

The platform also includes a tool which estimates the amount of carbon stored in harvest wood products, i-Tree Harvest\(^5\). Users input details on a specific Stand (which must be US based), and the tool gives estimates of carbon storage in tonnes per hectare for total carbon storage after 100 years and average annual carbon storage. Estimates are given for five different storage categories as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products</td>
<td>End-use products that have not been discarded or otherwise destroyed, such as construction products, containers, and paper products.</td>
</tr>
<tr>
<td>Landfill</td>
<td>Discarded wood and paper products in landfills.</td>
</tr>
<tr>
<td>Stored</td>
<td>The sum of Products and Landfill.</td>
</tr>
</tbody>
</table>

\(^5\) https://resource.esriuk.com/esri-resources/forestry-commission/  
\(^5\) https://www.itreetools.org/  
\(^5\) https://harvest.itreetools.org/
Energy Capture, otherwise known as ‘Energy’ | Combustion of wood products with energy capture as the carbon is emitted to the atmosphere (e.g. production of energy from forest products that could offset energy production from another source – also called Energy).

No Capture otherwise known as Emissions | Carbon in harvested wood emitted to the atmosphere through combustion or decay without energy recapture.

The stand information can be updated over time, so a user can track how the carbon storage changes over the size of the stand, species make up and volume harvested. The tool also provides a 10-year report which shows carbon storage calculations in 10-year increments for each of the five storage categories.

This method of presenting the 3S Framework, as a platform with a collection of tools could be a potential method of presenting the various components that make up the framework in an easy to use manner, though care should be taken to ensure the 3S’s can feed into each other to avoid the silo effect of other existing tools and platforms. This approach would also allow easy ‘future proofing’ of the platform as each section could be partnered with key supporters who ensure the Framework uses the latest data and remains relevant. This would also simplify the implementation of the principle that the Framework should be dynamic and work at a range of scales, as the user could update data inputs themselves based on their specific needs.

**Innovative technology**

As set out by Gasser et al.\(^53\) options for keeping global warming below 2 °C involve capturing carbon there are an increasing number of proposals for ‘negative emissions technologies’ (NETs). While afforestation and reforestation are considered the most feasible options, it is recognised that land availability could be a significant challenge to this method being implemented alone.

The technology which currently appears to hold the most potential is bioenergy with carbon storage (BECCS), which sequesters underground the emissions resulting from the burning of biomass for power. It is appealing due to the ‘double gain’, as the biomass is acting as a substitution for fossil fuels but also as carbon storage. In a 2014 IPCC report nearly all of the scenarios modelled relied on BECCS,\(^54\) though currently the technology has not been proved on a commercially viable scale.

Biochar is charcoal that is produced through pyrolysis (burning biomass while limiting oxygen) and added to soil as opposed to burned as fuel. This is appealing as it needs limited additional land and water and can improve soil fertility as it releases carbon slowly back into the atmosphere over centuries.\(^55\)

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\(^53\) Gasser et al. 2015. Negative emissions physically needed to keep global warming below 2 °C [https://www.nature.com/articles/ncomms8958](https://www.nature.com/articles/ncomms8958)


\(^55\) [https://www.biochar.ac.uk/what_is_biochar.php](https://www.biochar.ac.uk/what_is_biochar.php)
While these innovative technologies are not the norm, it is important that the 3S Framework owner or perhaps the FEC WG as a ‘secretariat’ should stay informed of these innovations, perhaps building a network of technology experts working in this area who can suggest how their projects could be included within the 3S Framework.

3.2.6 3S Framework Implications (Drivers and Influences)

- It will be important when undertaking stakeholder engagement to conduct a specific, in-depth assessment of which EC level policies in place (and those in development) are of interest to users, to ensure that the FEC WG (or specific ‘owner’ of the framework once decided) can respond to questions. This is not to say the framework should be necessarily always be supportive of policy but should communicate clearly where there is alignment and where there is a difference.

- The EU is currently pursuing a renewable energy policy which relies heavily on wood for bioenergy. One view is that governments should focus on approaches that do not increase competition for land, mainly through reducing deforestation and managing existing forests less destructively. The debate on bioenergy together with the competing viewpoints and policy actions highlight the necessity of including differing intervention scenarios in the model.

- The ClimWood report\textsuperscript{56} identifies several policy areas that could be supported by FEC WG as part of their ‘guide and inform’ approach and potentially be considered for inclusion within the 3S Framework:
  - Economic incentives to store carbon in living biomass or reduction of existing incentives for wood production
  - Increase recovery of post-consumer wood e.g. through landfill directive, improving markets and regulating disposal of wood waste
  - Performance based construction standards that are material neutral
  - Public/private investment in R&D for innovation for wood products and wood promotion

- Similarly to the 3S Framework itself, a study attempting to create a framework to support consumers found that climate mitigations proposed by one study were rejected by another, as each measured the ‘trade-offs’ with other non-climate related environmental issues such as land-use change and water use differently.\textsuperscript{57}

- Interventions should tackle both the individual practices of consumers, and the material and social context within which those practices are embedded.\textsuperscript{58}

\textsuperscript{56} Rüter et al. (2016) ClimWood2030: ‘Climate benefits of material substitution by forest biomass and harvested wood products: Perspective 2030’


- The framework could have a role in supporting the creation of products which can either fit into the circular economy e.g. wooden furniture which can be repaired or recycled and support the purchase of the ‘best’ product from a climate perspective when buying new.

- The design of the 3S Framework should consider the user experience and also how resources might be adapted to effectively ‘future proof’ the tool. One way to achieve this may be through providing a hub of smaller tools that users can input their own data into.

- While it is important to maintain awareness of innovative technological developments, the 3S Framework should focus on those which are commercially viable, ensuring the framework provides meaningful, real world change.
  - It may be the new technology owners wish to partner with the 3S Framework in order to show the real-world implications of its uptake and therefore prove its effectiveness. These would likely need to be reviewed on a case by case basis to ensure the technology aligned with the principles of the 3S Framework.

3.3 Dimensions

The four dimensions are shown in Figure 2 include (i) value chains, (ii) territory/landscape, (iii) time and (iv) cross boundary exchanges.

![Figure 2: The 4 Dimensions needed for the 3S Framework](image)

While the workshop was just one day, it was agreed by the group that the 3S Framework should serve a range of users, making it relevant to many different interlinking value chains. It was also important that the framework add value at a range of scales, so that both a high-level user (public sector) and a smaller scale industry user (architect) could benefit from the framework. It was also essential that the framework be dynamic, updating to reflect changes over time and the latest information.
3.3.1 Value chains
Typically, existing models, tools etc will either follow a value chain approach or a landscape or territory focus. A value chain approach to the 3S Framework would involve exploring the production implications of a product, including the production of materials, processing, transport, use and disposal or recycling. Essentially this means that minimising impacts at one stage of the value chain should not cause increased impacts elsewhere, we are not 'shifting the environmental burden'. Typically, value chains are international, and the impacts have an effect on a global level. Therefore, having strong system boundaries are essential. In Life Cycle Assessments, value chains are calculated from 'cradle to grave' or 'cradle to cradle' which includes recycling, reuse or remanufacturing.59

When exploring how the construction industry addresses climate risk within the value chain, a report by the IFC60 found that companies were facing pressure from the financial sector (investors, banks, regulators), contracting authorities and consumers to mitigate climate risk. This suggests that a value chain approach can be more useful in communicating actions to mitigate climate as an individual company, as it focuses on the areas that organisation can influence. This includes integration into the circular economy, therefore potentially considering storage and substation via a cascading approach to the use of wood products.

There is however a risk that not all of the 3S's would be captured by the user. In some cases, a partial approach may be taken, for example 'cradle to gate' for the purposes of business to business communication or as a starting point for a more comprehensive assessment. For example, the IFC report assumes the start of the construction value chain to be the production of materials (processing), potentially missing any considerations that could be made for the 'sink', such as choosing to use timber from certain forests. It also creates a challenge when trying to utilise the approach across a range of landscapes where the value chain may differ.

A value chain approach can help individual companies to make better choices, and to prioritise areas where there is a carbon sink, store or substitution potential, provided a 'cradle to cradle' approach is used. As mentioned in 3.2.4 above, as markets shift, and consumers become more aware of climate change it could support companies capture new markets or avoid future costs and regulations on carbon thereby generating higher profits over time.61

3.3.2 Landscapes
In addition to the value chain approach is a landscape approach (or a jurisdictional if using political lines to identify the space e.g. a municipality). Rather than focusing on a product as in the value chain approach, this explores carbon mitigation geographically, and therefore may be of more use to the public sector such as local or national governments or civil society.

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This approach can account for changes to land use within an identified area including the carbon sink. For example, the increased intensity of conventional agriculture and forestry reduces both biodiversity and forests’ ability to remove carbon.62

When considering the existing landscape, forest degradation needs to be considered to effectively measure carbon stock changes. As this refers to changes in the forest structure as opposed to a change in land use this is challenging to calculate using remote sensing. Current monitoring data sources include “field data (i.e. multi-date national forest inventories and permanent sample plot data, commercial forestry data sets, proxy data from domestic markets) and/or remote sensing data (i.e. direct mapping of canopy and forest structural changes or indirect mapping through modelling approaches)”,63 with the combination of techniques providing the best options. Challenges when trying to accurately estimate the volume of carbon stored in a landscape including ensuring leaf biomass, ground vegetation and litter are accounted, as well as the carbon content of the soil. These are often ignored due to the difficulty in conducting a cost-effective assessment.64 There can also be challenges concerning the data used. For example, some baselines refer to EUROSTAT and FAO-STAT data, and while this is publicly available and therefore transparent, these data sets can be more prone to errors as the data relies on submissions from several countries and there is less resources available to ‘clean’ the data compared to more targeted, paid for data sets.65

A further benefit of the landscape approach is the ability to work at a range of scales. It is possible to work at a micro level (for example a single landowner) and build up these smaller users to a larger region or area. An example of this is the work of IDH who develop production, protection, inclusion (PPI) compacts between public, private and civil society stakeholders to make land more productive in exchange for protection of forests.66 Landscape scale interventions have been embraced across a variety of sectors, for example Integrated Rural Development, Integrated Natural Resource Management, Integrated Watershed Management, and Integrated Floodplain Management being a few examples.67 In a review of their landscape approach to support sustainable soybean production in Brazil and Paraguay, Solidaridad reflected that in order to have impact it was necessary to work at a range of scales, taking “decisions made globally to a local scale” as when restricted to rural properties and certain products there were limited interventions available and therefore large-scale impact was challenging.68

62 Fern (2019) EU Forests of hope: How community restoration and management of forests can help meet climate goals
66 https://www.idhsustainabletrade.com/approach/production-protection/
3.3.3 Time
As discussed above, it was agreed in the FEC WG workshop that the framework should be dynamic and change over time. This is essential not only to capture the latest innovation and thought development but also to recognise the changing role of trees and forests as carbon sinks. Although younger, faster-growing forests may have a higher rate of carbon uptake from the atmosphere, it is the older, longer-rotation forests and protected old-growth forests that exhibit the highest carbon stocks.\(^6^9\)

As the diagram below shows, a tree is at its most effective 'sink' when it is younger and growing, compared to when mature and standing. This means that a 'no harvest' strategy may be successful in the (relative) short term, but not in the longer term as the tree becomes more likely to lose material and die (releasing carbon). If this changing ability to store carbon can be monitored, then forest managers will be able to make a more informed choice of when to harvest and therefore divert wood into a storage or substitution use. Although the example below is using a Douglas-Fir, different species will have different growth rates and so it may be possible for the framework to break this information down into more specific guidance by species.\(^7^0\)

Figure 3: Data from Washington State (USA) using US Forest Service data. Forest carbon growth rates begin to slow before the age of 100 years with little to no growth after 100 years\(^7^1\)

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\(^6^9\) EASAC (2017) Multi-functionality and sustainability in the European Union’s forests. EASAC policy report 32


3.3.4 Cross-boundary exchanges

The FEC WG noted that a rise in pricing and the resulting increase in imports from outside of the EU would then create a question regarding externalities, as while the framework is focused on Europe it is important to consider the wider implications of decisions made by European users.

This concern raised at the November workshop by the FEC WG, can be reinforced by modelling carried out in ClimWood 2030. The modelling includes a scenario where EU and member states achieve policy goals for bioenergy. This scenario predicts that there would be a 21% harvest increase in EU-28 forests, and harvest for energy use increased by 50% resulting in a steep decline in EU forest sink (though the forest still remains a sink, seeing a 10% increase of carbon pool over 30 years). The same scenario assumes the price for harvest wood increases and in 2030 net imports reach about 10% of domestic harvest which would then lead to consideration of external factors such as impacts outside of Europe, availability and pricing.

For context, the ClimWood2030 modelling framework criteria either apply inside the EU28, outside EU28 or have no geographical differentiation, and comprises of data for years 2010-2030. Where possible the model extrapolates (for example end-of-life and cascade use of wood) to 2100.

The importance of these issues is one reason why the cascade uses discussed in section 3.6 are needed in the 3S Framework.

3.4 Sink Components

The carbon sink function is the capacity of the forest to absorb carbon from the atmosphere and sequestrate it in biomass above and below ground.

Scale, landscape, geographical boundaries, age and species are important sink components, and these have been discussed in section 3.3 on dimensions. Reforestation or avoided deforestation is another important component and has been included within the baseline discussion in section 3.1.2.

There is a difference between biogenic carbon emissions (stored in plants, animals, organic matter) and fossil carbon emissions. Biogenic carbon is cyclical (removed and emitted) whereas fossil fuels are linear. However, although they are different, biogenic carbon should still be accounted for in assessments in order to give the most accurate picture.

Lippke, B. et al (2011) suggest that the effect of harvesting and replanting on soil carbon is difficult to generalize, due to variables such as initial soil depth, the intensity of harvest, and post-harvest strategies. The same paper points out that a review of 432 studies assessing responses of soil carbon to harvesting in temperate forests worldwide reported an 8% average reduction in soil carbon stocks after harvesting over all forest and soil types studied. Despite

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72 Rüter et al. (2016) ClimWood2030: ‘Climate benefits of material substitution by forest biomass and harvested wood products: Perspective 2030’
73 Rüter et al. (2016) ClimWood2030: ‘Climate benefits of material substitution by forest biomass and harvested wood products: Perspective 2030’
74 Berndes et al. (2018) Forests and the Climate: Manage for Maximum Wood Production or Leave the Forest as a Carbon Sink?
this reduction, as these losses were primarily in the upper layers, they would not be permanent and would lead to recovery after 50–70 years. The conclusion was that total soil carbon levels would remain stable over the long term where harvest intervals exceed 70 years or under other less intensive harvest regimes.

3.4.1 Forest Management Practices

Maintaining or increasing forest management for wood products can in some cases result in greater overall greenhouse gas mitigation than leaving forests unharvested. Numerous studies have pointed out that the sustainability of forest practice is crucial to achieve GHG mitigation. Active forest management and harvest tend to outperform no harvest where (i) there is rapid forest growth and re-growth, (ii) harvested wood is utilised efficiently, (iii) a high proportion of wood enters long-lived products, (iv) product markets provide an incentive to increase forest area and (v) products have a high degree of substitution for emissions-intensive alternatives. These are in essence the principles of the 3S Framework, suggesting the approach should be to support sustainable forest management.

It can be difficult to compare between rotational and selection forest management if one is better than the other purely in terms of carbon balance. Rotational forest management is common in boreal countries with well-established forest sectors, which will go through a cycle of sequestration, to carbon removal (when harvested) and a slow regeneration which has a rapid net carbon gain in young stands which decreases with age. By contrast, selective forestry uses unevenly aged more complex forests, for example ground and sub-canopy are continuously present. This method of forestry means that carbon is lost from soil etc but also means a more limited harvest. There is a debate on whether there is a risk that carbon sequestration would decrease during the transition period between rotation and selective management.

Roe et al. (2019) provide an insight into two opposing views in the research on the optimal balance between carbon storage in the forests and biomass harvesting to enable the substitution of fossil fuels. This research could also be widened out to consider how forest management fits into the debate on avoided deforestation. One view is that increased production to meet the higher demand for forest products, will lead to major reductions in forest carbon stocks and carbon sink strength, which will then outweigh the GHG savings accrued from product substitution. A related concern relates to a reduction in the number of tree species being used, which could increase vulnerability to climate change. In this viewpoint, the preference is for carbon sequestration and storage in forests over wood production for product substitution.

The alternative view is that forest management should aim for a consistently high wood yield, since the use of wood product substitution is an effective way to reduce GHG emissions. According to this view, a strategy that prioritises carbon sequestration and storage in forests has serious limitations. There is also the concern that capacity for carbon sequestration in forests declines as they become older.

75 TNC forest economy climate change report (2019)
76 Berndes et al. (2018) Forests and the Climate: Manage for Maximum Wood Production or Leave the Forest as a Carbon Sink?
The next few decades are considered by Keith et al (2015)\textsuperscript{78}, to be the most relevant for preventing climate change. This means that short-term increases in forest carbon sequestration could be given preference over reductions in cumulative emissions associated with long-term forest management. This type of policy choice would significantly affect the optimum strategy in forestry.

### 3.4.2 Sink Evolution Triggers

Forests and their role in the carbon cycle are affected by changing climatic conditions. Evolutions in rainfall and temperature can have either damaging or beneficial impacts on forest health and productivity.

Climate change affects site properties such as climate, water supply, and the nutrient supply from soils. There is a close linkage between site conditions and forest development and to highlight that trees cannot outgrow the limits imposed by soil properties and regional climate. Climate change can alter tree species ranges and forest communities to unexpected species mixtures. The speed of change can be as little as a few decades at regional hotspots\textsuperscript{79}. A recent study\textsuperscript{80} investigating climate change impacts on ecosystem functioning found that high-diversity forests are expected to be more resilient to climate change than low-diversity forests.

In relation to the development of the 3S Framework, Jandl, et al. (2019) suggest that there are a range of tools that can assess future site conditions based on externally defined climate scenarios\textsuperscript{81}. These include niche modelling to estimate the future spatial distribution of tree species and the expected habitat change. Niche models use predicted site conditions at different time periods as input parameters and shows the dominant tree species that are most suitable under the respective site conditions. An alternative is to use succession models, where the tree competition and the speed of tree migration are considered.

### 3.4.3 Risks (Force Majeure)

Risks (force majeure) will change over time and sinks are affected by a range of forest management considerations.

According to Roe et al. (2019) there are signs of carbon sink saturation in European forests and there are large uncertainties concerning the impacts of climate and other environmental changes on forest growth rates, decomposition rates, and natural disturbance regimes (fires, droughts, storms, insect infestations). There is also the risk that the sequestered carbon will be inadvertently emitted to the atmosphere once again as a result of storms, insect infestations, and fires.

\textsuperscript{78} Keith et al. (2015) Under What Circumstances Do Wood Products from Native Forests Benefit Climate Change Mitigation? PLoS ONE 10(10): e0139640
\textsuperscript{80} Morin et al. (2018) Long-term response of forest productivity to climate change is mostly driven by change in tree species composition. Sci Rep 8, 5627 doi:10.1038/s41598-018-23763-y
\textsuperscript{81}
Jandl, *et al.* (2019) note that abiotic disturbances such as the size and frequency of wildfires and storm events have been linked to climate change, even though the immediate causal relationships are not yet proven. However, the relationship between climate change and biotic disturbances is clearer because biological processes are temperature controlled, which means that pests and pathogens are expected to change their habitat ranges and are becoming virulent in areas where they have not reached critical population densities earlier. The same researchers assert that there is strong evidence that some recent outbreaks of bark beetles and defoliating insects are related to climate change, and these are having large impacts on ecosystems as well as on communities of forest insects.

A combination of risks in France have been considered by Roux *et al.* (2017) which they investigated. The researchers assessed that there is a likelihood that these risks could be amplified as a result of climate change. The hazards that were selected included storm, fire, bark beetles, insect invasion, etc. or pathogens (drought was already included). Some of the combinations included fires linked to drought, storms followed by bark beetle outbreaks and fires. For these two combinations, the intensity of the hazard was modified by a climate change scenario. However biological invasions were treated individually and were considered independently of the climate option.

Each of the types of crises will have a different impact on the dynamics and the associated sectors, these impacts could also vary according to the management scenario and the severity of climate change. For example, a comparison between a year with high fires and a crisis triggered by a storm but with complications due to bark beetle outbreaks and fires, would have an impact of -15% on the carbon balance which the researchers\textsuperscript{82} assessed would be resolved in about 20 years. Conversely, an ecological crisis would have consequences throughout the period, with the most severe being those affecting all of the oaks and causing the death or weakening of up to 800 Mm\textsuperscript{3} accumulated over 20-30 years (up to -20% on the carbon balance). The same paper notes that current practices of crisis prevention and preparedness in France are insufficient for the risks.

Within the Geneva workshop, the group developed the following worked example that had been developed by C-KIC (figure 4 below). It suggests that the research by Roux *et al.* (2017) could relate more widely to the situation in this part of Europe.

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\textsuperscript{82} Roux *et al.* (2017). Quel rôle pour les forêts et la filière forêt-bois françaises dans l'atténuation du changement climatique? Une étude des freins et leviers forestiers à l'horizon 2050. Rapport d'étude pour le Ministère de l'agriculture et de l'alimentation, INRA et IGN
Worked example: Southern Europe

To demonstrate differing factors within the local context, we refer to Southern Europe. The main impact of climate change in this region is increased risk of forest fires, which remove part of the carbon stored in forests and reduces the forests capacity to work as a ‘sink’. The sink can also be affected by droughts, which are also occurring more frequently, leading to more forest fires and so the cycle continues.

To mitigate these potential impacts, suggestions include:

- Adapting through the use of more drought resistant species;
- Monitoring forest status and risks (particularly early warning for fires) using innovative tools;
- Improved sustainable forest management, through the creation of buffer strips, improved wood harvesting techniques etc.

All of these mitigation measures could protect the forests ability to act as a sink and increase resilience. Also, increased wood harvesting as part of improved management could still produce positive climate impacts if the timber is utilised as a store or as a substitute.

Figure 4: C-KIC Worked example: Southern Europe

All of these risks will influence the strength of the future forest carbon sink as well as forest harvest volumes.

Non carbon specific positives of forests such as natural disaster protection, water and air quality etc are difficult to quantify compared to tourism and other benefits recognised by the market, but SFM principles do recognise this multi-functionality.83

3.4.4 3S Framework Implications (Sink)

- To ensure that sustainable forest management is an integral part of the 3S Framework
- There are questions around risk management and there needs to be a way to capture these ideas as they develop. Ideally the 3S Framework would include a measuring element e.g. projecting GHG flux over time in a specific area.
- As part of the risk management issues, the 3S Framework may need to consider biodiversity safeguards that are needed in relation to the need for a diversity of forest types and management systems across Europe.
- One question to consider is how the framework could be designed to support recalibration, for example showing the impact of disease within the forest. Tellness et al (2017)84 suggest that there is a potential to draw on and expand existing information sources, such as EPDs (see section 4.1.1), but this would need to be explored in more detail to ensure data could be accessed regularly and reliably.

• A shift to selection over rotational forestry could create more favourable conditions for recreation, biodiversity and ecosystem services so the debate on which forest management system has the better carbon sequestration is not the only factor to consider.

• According to Winchester et al (2019), the impacts of forest harvest on carbon emissions from changes in the stock of carbon on harvested land, including vegetation and soils vary widely. On one end of the spectrum, harvesting virgin forest can lead to carbon loss that offsets any benefit of avoided emissions from the substitution of lumber for other building materials, and it may take multiple harvests over decades make up for the original carbon debt. At the other end of the spectrum, increased timber use alongside sustainable forest management result in a good low carbon approach.

• The 3S Framework will need to explicitly define the reference scenario as the current condition of the forest in order to be able to make a comparison.
  o Longevity of stock: Since carbon is transferred through plants, soil, products and waste materials the size and longevity of these biomass pools are the essential elements to determine the contribution to mitigating atmospheric carbon dioxide concentration.
  o That the climate change urgency is such that mitigation activities that will only become effective after 100 years should not be pursued within the 3S Framework.

3.5 Storage Components
The carbon storage function is the capacity of wood-based products (timber, furniture etc) to store carbon for a significant period of time. This function should be strengthened by circular economy principles.

3.5.1 Distribution of carbon going back into the atmosphere (over time)
A number of studies of forest carbon relationships have concluded that a policy of active and responsible forest management is more effective in capturing and storing atmospheric carbon than a policy of hands-off management that precludes periodic harvests and use of wood products. This assessment claims that over the long term, a sustainable forest management strategy that is aimed at maintaining or increasing forest carbon stocks will have the biggest sustained mitigation benefit.

3.5.2 Estimate of stored carbon pool (over time)
The wood product carbon pool in Europe is increasing, but at a fairly modest rate of 10% of the rate of the forest carbon pool. The current use of wood harvested from European forests avoids in the region of 100 million tonnes of fossil carbon emissions through substitution compared to a zero-wood use alternative.

According to Lippke, B. et al (2011), if sustainable forest management is considered at the landscape level then the loss of carbon from harvests in any given year should be at least equal to gains in carbon elsewhere in the forest management area. The same research demonstrates how sustainable forest management across a landscape leads to a stable non-declining forest carbon pool via a stable short-lived product pool after the initial rotations, with increasing long-lived products and substitution pools.

Large amounts of carbon are removed from the atmosphere and stored in forest products for long periods of time. WBSCD\textsuperscript{86} point out that if industry sources wood in ways that allow forest carbon stocks to remain stable, it means that the forest carbon cycle for the forest used by the industry is a net sink for atmospheric carbon due to carbon storage in products rather than simply carbon neutral. The same WBSCD paper has identified the need for data to demonstrate industry’s impacts on forest carbon stocks.

### 3.5.3 Embodied Carbon (wood products)

**Final Use:** The final use of harvested wood determines the duration of carbon storage in products and, the potential benefits obtained through substitution. Wood harvested for high-value, long-lived products such as construction wood tend to be both longer-lived than lower-value uses such as pulp or chipboard, and to act as substitutes for high-emitting alternatives such as concrete and steel. Short-lived products, especially paper products, can make more efficient use of harvested wood, but re-emit carbon rapidly and carry a less clear substitution benefit\textsuperscript{87}. Use of wood and residues for bioenergy or biochar may or may not have greater benefits than leaving them in the forest, depending primarily on the counterfactual fate of biomass, the efficiency of energy conversion and the extent to which they truly displace fossil fuel.

**Increasing use of wood products and SFM:** That expansion of the use of bioenergy and biobased materials should be accompanied by sustainable forest management principles as a safeguard against overharvesting that would result in losses in forest carbon stocks and sink capacity. Berndes et al (2018) assessed that this would endanger GHG emissions savings, in addition to future wood production capacity\textsuperscript{88} but others would argue that increased demand will help drive reforestation.

### 3.5.4 Emissions (Made Products)

**Construction Industry:** Embodied carbon in the construction industry is defined as the carbon emissions attributed to manufacturing and transporting construction materials and the process of construction. According to the Urban Land Institute (2019)\textsuperscript{89}, the carbon-intensive material manufacturing processes and large quantities of fossil fuels used in transportation are the main reasons why embodied carbon can account for as much as half of a building’s total carbon footprint over its lifetime. The Urban Land Institute claims that unless clear actions are taken to

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\textsuperscript{86} World Business Council for Sustainable Development Forest Solutions Group (2019) Forest Sector SDG Roadmap


\textsuperscript{88} Berndes et al. (2018) Forests and the Climate: Manage for Maximum Wood Production or Leave the Forest as a Carbon Sink

\textsuperscript{89} Urban Land Institute (2019) The Business Case for Reducing Embodied Carbon in Real Estate
reduce embodied carbon in buildings, it is unlikely that emissions targets necessary to keep global warming within 2 degrees Celsius will be met.

During redevelopment, structural systems can be composed of up to 80 percent of a building’s embodied carbon\(^\text{90}\), depending on building type, so the most critical factor in a building’s embodied carbon could be dependent upon whether a development uses an existing building or constructs a new one. Large quantities of steel and concrete are typically used in the structure of new buildings, so if an existing infrastructure can be maintained through the redevelopment, projects could significantly decrease embodied carbon.

Currently about 35% of buildings in the EU are 50 years old or older, and 97% of the building stock is not efficient enough to be able comply with future carbon reduction targets\(^\text{91}\). These buildings will require deep, energy efficient renovation, contributing to increased embodied carbon even as operational emissions are reduced.

The table below (table 1) provides a useful summary of the green building certification schemes that include embodied carbon and that could be included in the 3S Framework.

<table>
<thead>
<tr>
<th>Green Building Certification Schemes That Look at Embodied Carbon</th>
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<td>Certification</td>
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| Building Research Establishment Environmental Assessment Method (BREEAM) | Global | Performance of a life cycle assessment (LCA) can provide up to 26 credits, includes recognition for use of environmental product declarations (EPDs).
| Excellence in Design for Greater Efficiencies (EDGE) | Global, emerging markets | Tracks and awards certifications to projects that show reductions in embodied energy.
| Plus Energy and Carbon Reduction (E+C) | France | Includes method to track and report embodied carbon performance.
| Futurbuild | Norway | Includes method to reduce embodied carbon by 50%, with third-party verification.
| Green Star—Green Building Council Australia | Australia | Gives credits for the use of LCA, EPDs, and low carbon materials.
| LBC version 4.0—ILFI | Global | Rewards embodied carbon benchmarking and reduction in the LBC Energy Petal.
| Zero Carbon—E.F.I | Global | Projects must reduce embodied carbon by at least 10% and purchase offsets for the remaining embodied carbon.

Table 1: Green Building Certification Schemes including Embodied Carbon\(^\text{92}\)

The use of wood in construction generally provides a clear substitution benefit, given the high carbon intensity of cement, steel and other building materials. However, emerging textiles, plastics and chemicals from woody feedstocks also hold great promise in reducing fossil emissions. Evidence for the substitution benefits of other short-lived products such as paper and packaging are much more equivocal; in some cases (e.g. graphic paper) there are no obvious alternatives for which wood products can be said to substitute.

**Wood polymer composites** are a subset of natural fibre polymer composites (NFPC), which are steadily increasing in use in product design due to their lightweight, cost-effective, and


\(^{91}\) World Green Building Council (2019) Bringing Embodied Carbon Upfront

potentially biodegradable, depending on choice of polymer, qualities\textsuperscript{93}. Applications so far include the automotive industry (body, door and lining panels and floor trays), construction industry (outdoor decking, cladding, fencing and furniture).

### 3.5.5 3S Framework implications (Storage)

- The WBSCD has identified the need for data to demonstrate industry’s impacts on forest carbon stocks. This could be provided through the 3S Framework
- Wood harvested for high-value, long-lived products such as construction wood tend to be both longer-lived than lower-value uses such as pulp or chipboard. Therefore, could be prioritised over other products such as paper when developing the 3S Framework
- To ensure that the 3S Framework includes considerations on whether developments are using new or existing buildings and how that impacts stored carbon.
- While short-lived products, especially paper products carry a less clear substitution benefit, they can make more efficient use of harvested wood, and if recycled can store carbon longer than the alternative use of similar types of wood cuttings such as biomass

### 3.6 Cascade Uses

Cascading use refers to what happens at the end of product life, and whether there are subsequent uses for which a material might be applied. One output of the FEC WG November workshop was the decision that ‘Cascade Uses’; should be specifically included in the 3S Framework alongside storage and substitution in order to add an end of life element, which also highlights the need to use cradle to grave LCAs.

Multiple sources suggest a cascade approach, construction/long term use wood products can be used as woodfuel at the end of their life. They can also be re-used as long-lived wood products, for example timbers from an old building used to build a new building. Efficient use of harvested wood and residues, as well as recycling and cascading use of products, should be encouraged.

**Positive substitution** within construction and long-term use replacing concrete or steel means that at the end of their (long) life, products can be used with the framework of a cascade approach\textsuperscript{94}.

**Reuse from used materials**: In a circular economy, waste of new materials is minimised, and resources are continually reused. The Urban Land Institute\textsuperscript{95} notes that as materials for buildings become scarcer and more expensive, reusing these materials generates a steady stream of low-carbon materials for new buildings. Designing for reuse can be carried out from the outset by ensuring that the architect selects solutions and materials that generate the least

\textsuperscript{93} Arup, (2019). Rethinking timber buildings: Seven perspectives on the use of timber in building design and construction.

\textsuperscript{94} https://www.easac.eu/fileadmin/PDF_s/reports_statements/Forests/EASAC_Forests_web_complete.pdf

\textsuperscript{95} Urban Land Institute (2019) The Business Case for Reducing Embodied Carbon in Real Estate
amount of waste. A plan should also be made for how the materials can be reused later during reconstruction or demolition work. For timber buildings, disassembly, adaptation and reuse is the ideal disposal option at end-of-life and is likely to become more attractive with the rise of large-section glulam beams and columns and large CLT (cross-laminated timber) floor and wall panels96.

Storage in landfill: The potential for changed decomposition conditions in the future means that there could be a greater risk for greenhouse gas emissions. Keith et al. (2015)97 suggest that the use of wood product waste for bioenergy instead of input to landfills would provide a helpful substitution for fossil fuel energy sources.

Bioenergy: As discussed above, there is a risk that the large amount of wood needed for energy purposes may already be resulting in wood shortages and high wood prices as well as potentially increasing deforestation outside of Europe through increased imports from regions such as southeast USA and South Africa. Several studies appear to agree that one mitigating option98 could be to increase cascade use, through improved wood recovery despite the rise in wood consumption rises.

The assumptions about how renewable energy targets could be achieved are crucial. For example, if solar was given priority or if coppice/perennial energy crops were increased etc then there would be less pressure to use wood for energy from forests. Consequently, lower demands for energy from wood could potentially create more opportunities to develop cascade use and harvested wood product climate benefits99.

3.6.1 3S Framework implications (Cascade Uses)

• The ClimWood report100 provides a useful insight as it concludes that protecting forests, cascade and substitution approaches but coupled with further progress in energy efficiency and renewable energies (perhaps combined with an increase of short rotation coppice) might be the best scenario, providing GHG savings both in 2020-2030 and in the future.

• In terms of end of life/circular economy, it is important to understand the assumptions after the product is used. For example, the average half-life of a house is 40 years, so the question is what happens at year 40? Should the framework consider this as a separate component or part of something else?

• One aspect that is important for the 3S model to encompass is the wide variety of innovative products including hybrids such as glass and wood or steel and wood as well as

100 Rüter et al. (2016) ClimWood2030: ‘Climate benefits of material substitution by forest biomass and harvested wood products: Perspective 2030’
as innovations in products such as the range of new adhesives as well as glulam encasements to stabilise thin-walled steel beam sections.

3.7 Substitution Components

The carbon substitution function results from the capacity of forestry-based products to substitute fossil-based products and avoid the GHG emissions of these products.

3.7.1 Embodied carbon (in alternative materials to wood)

According to Materials Palette, the embodied carbon of buildings is responsible for 11% of global GHG emissions annually with concrete, steel, and aluminium alone producing 20% or more of total global GHG emissions\(^{101}\). Arup (2019) note that although the iron and steel industry have made big strides to improve energy efficiency that they still account for between 6–7% of global CO2 emissions. The level of steel recycling is currently quite low and may be around 35–40% globally but is likely to increase in future.

The Urban Land Institute\(^{102}\) recommends that when considering low-embodied-carbon materials, it is important to keep in mind the “worst offender” materials. These are materials that tend to have high levels of embodied carbon, such as concrete, steel, and insulation. For example, traditional concrete can be substituted by concrete made with high levels of recycled materials. In addition to wood-based products, there are also alternative options for steel and insulation with high levels of recycled material are on the market. Natural materials are another good low-carbon alternative to traditionally manufactured materials.

Multiple sources confirm\(^{103}\) the finding that wood-based construction materials are less carbon intensive than conventional building materials such as concrete and steel\(^{104}\).

3.7.2 Extent of Substitution Products and Comparable Materials

It is anticipated that the 3S Framework will encompass whole product use including avoided material use compared to functional equivalent alternative, rather than confining itself solely to direct substitution. When considering how much carbon and for how long, use is an integral part as this gives the indication of duration. Replacing part of a product with wood should be considered substitution. It is also necessary to consider whether, in the current market, each wooden product has a substitute. Some products may not have a substitute and there is a need to compare against business as usual.

Draft research being carried out by Pierobon et al. (2019) has evaluated the cradle-to-gate environmental impact of a mid-rise, hybrid, cross-laminated timber (CLT) commercial building compared to that of a reinforced concrete building, with similar functional characteristics. The study found that the embodied energy assessment of the hybrid CLT buildings and concrete building were similar. However, the non-renewable energy (fossil-based) use in hybrid CLT building was 8% lower as compared to the concrete building. This

\(^{101}\) https://materialspalette.org/about/
difference was due to carbon storage in the wood components of the buildings. The study points out that recent advancements in the concrete industry have led to significant decreases in environmental impact.

The use of hybrids and composites means that the debate is not solely about individual material since as Arup (2019) states, steel has long been combined with timber to increase timber’s strength and stiffness. Another example is the use of wood cement composites which use cement paste as the matrix and wood fibre as the reinforcing component and have been developed for external cladding and decking uses in the construction industry.

Södra is a forest owners’ association which also operates jointly owned, integrated forest industry processing units. In order to analyse their effect on climate the group used two subsystems105. Members (52,000) accounted for their forest management and timber delivery, while industry processes and marketed products were accounted for on a group level. For some products such as wood chips a revised substitution factor was given, as the product was forwarded on from members and would either be used as biofuel or as board products. This is an approach the 3S Framework could take forward, in order to measure the substitution effect at all stages in a value chain from forest to end consumer. The report stresses the importance of recognising that the substitution effects are initiated in growing forests and passed down, and the benefit of substitution is an estimate of downstream activity.

**New technology:** New biorefining technology could potentially be more positive than bioenergy, but the extent of this may depend on the product as the technology is able to feed into a wide range of products including food, feed, chemicals and materials106.

It has been suggested107 to first make industrial processes as efficient as possible, and then to explore changes in lifestyle/consumption patterns before considering substitution. There is more general agreement of substitution in construction and in biobased plastics, but less so for energy application substitutions.

### 3.7.3 Whole Lifecycle Approach

Embodied carbon typically encompasses both carbon and other greenhouse gases, and should include emissions from all the extraction, transport and manufacturing processes required before products are ready at the factory for delivery to the customer (cradle to gate). It can also cover transport to site (cradle to site), installation impacts (including the impact of dealing with construction waste) (cradle through construction), maintenance such as cleaning, repairs, replacement and refurbishment of products, and the impacts associated with the product’s end of life, such as demolition, recycling and disposal. If all the life cycle stages are cradle to grave, it doesn’t mean that the assessment assumes products are landfilled. If products are normally recycled at end of life, then a cradle to grave assessment would account for this but ensure that

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105 https://www.sodra.com/climateeffect
107 Berndes et al. (2018) Forests and the Climate: Manage for Maximum Wood Production or Leave the Forest as a Carbon Sink?
the benefits of recycling for a material are not double counted for both the use of recycled content and its recycling at end of life\textsuperscript{108}.

A key point is how different people measure and compare materials. Typically, LCA is only assessed for 1 or 2 materials at a time. Alongside this, LCA is commonly manipulated according to research bias. It is also necessary to delve deeper into the source wood material because if only carbon is considered then it is oversimplified. In addition, as Pierobon \textit{et al.} (2019), point out, despite the importance of forest management practices in the overall impact of wood products, they are currently not included in standard LCA. The same researchers\textsuperscript{109} recommend that future work should also focus on the incorporation of the biogenic carbon emissions and sequestration into the LCA using a dynamic approach.

For some product types and end uses (e.g. wood in construction), there is already considerable research quantifying lifecycle emissions across various case studies. Deeper insights could come from making explicit the conditions and assumptions underlying the different conclusions across these studies. At a larger scale, such product-level assessments need to be complemented by region-wide system modelling to articulate coherent future visions for the European forest sector.

More research is needed to understand the life cycle emissions of emerging wood products such as biochemicals and textiles, as well as emerging non-wood alternatives such as low-carbon cement.

\textit{WBSCD}\textsuperscript{110} have concluded that any research assessing the overall impacts on the atmosphere associated with using biomass should ensure that they cover the whole life cycle, including photosynthesis and land use change as well as encompassing gains and losses of carbon from all forest carbon pools. They also advise that as a minimum the supply area for the facility or entity being examined should be included in any assessment.

Forest carbon accounting must be appropriate but a key part of the debate centres around what this means. This links back to the importance of transparency in methods and accuracy and precision in accounting that is discussed in section 3.1.1.

Voluntary green building ratings schemes are likely to continue to have a positive effect. LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Methodology) have recently recognised life-cycle assessment as an important tool, which means that timber’s embodied energy storage can be more accurately quantified. However, it is important to note that LCA methods in the USA do not including sequestration in tools used for the new LEED credits\textsuperscript{111}.

\textsuperscript{108} http://www.greenspec.co.uk/building-design/embodied-energy/
\textsuperscript{110} WBSCD Forest Solutions Group (2015) Recommendations on Biomass Carbon Neutrality
\textsuperscript{111} Arup, (2019). Rethinking timber buildings: Seven perspectives on the use of timber in building design and construction.
3.7.4 Externalities

In terms of externalities, it is necessary to attempt to identify the climate positive actions where possible for example the water use in manufacturing rayon compared to cotton.

Operational emissions are emissions associated with operating a building (or other asset) over time. These may include energy emissions for heating, air conditioning, lighting and other uses, emissions associated with maintenance activities, etc. Embodied carbon, which is the carbon that is released in the manufacturing, production, and transportation of building materials, but calculations of embodied carbon do not typically include consideration of changes in carbon stock in the forest – thus the need for the 3S Framework.

Avoided emissions in industry include GHG Protocol Scope 3 but are now moving towards Scope 4, i.e. to expand sustainable sourcing to measurable impacts in regions and commodity systems. This means that different options need to be available for users to access in the market.

One perspective\textsuperscript{112} is that the use of harvested wood products leads to lower emissions over the whole life cycle than the use of the functionally equivalent alternatives. Keith \textit{et al.} (2015)\textsuperscript{113} recommend that wood products should only be substituted if the alternative products are more fossil fuel intensive to produce. Consequently, both the use of fossil fuel in the production process, such as coal in the case of steel, and as the energy source in their manufacture, should be considered. Production emissions are only one ‘S’ in the proposed framework, so this research indicates an important gap and illustrates the importance of a ‘3S’ approach.

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The diagram below shows which substitutions could replace fossil fuel for industrial heat decarbonisation\textsuperscript{114}

\textsuperscript{112} Rüter et al. (2016) ClimWood2030: ‘Climate benefits of material substitution by forest biomass and harvested wood products: Perspective 2030
\textsuperscript{113} Keith et al. (2015) Under What Circumstances Do Wood Products from Native Forests Benefit Climate Change Mitigation? PLoS ONE 10(10): e0139640
\textsuperscript{114} https://www.icef-forum.org/roadmap/
3.7.5 Evolution of Substitution Over Time

Substitution needs to both evolve over time and be dynamic as if the 3S Framework is static then drivers such as the influence of policy will not be incorporated into the model. Critical to all assessments is the counterfactual or reference scenario: What would have happened in the absence of a management or policy choice? This is especially important to the estimated benefits of forest product substitution. The appropriate counterfactual is not purely a scientific question, but depends on the specific economic, ecological and cultural context, and could vary widely for different forests across Europe.

There is a probability that more consumption of wood leads to more climate impacts so the recommendation is to assess what the 3S ‘wins’ could be which will be more effective than other options.

3.7.6 3S Framework implications (Substitution)

- The importance of including building material substitution in economy-wide analyses that can be adopted and/or developed by other studies was noted by Winchester and Reilly (2019). The same authors pointed out the need for additional research (such as a 3S Framework) to linking an economy-wide model to detailed models of land use change, forest management practices, and/or of carbon stored in buildings.

- The fast-developing innovations of wood, hybrid and non-wood materials and the resulting changes in embodied carbon will need to be accounted for and adapted for in the 3S Framework.
Substitution can be the most important in determining net greenhouse gas reductions owing to the large range of possible outcomes: substitution factors for wood range from -0.6 to +5.1 kilograms of carbon mitigation per kilogram of carbon in the wood product. However, the 3S Framework will need to consider that substitution is highly sensitive to context and assumptions about the type, footprint and amount of displaced materials, as well as the potential for re-use, recycling and cascading use of products.

4 Models, Principles and Assumptions.

4.1 Operational

The operational considerations relate to how the FEC WG will use the 3S Framework. The following points were concluded by the FEC WG in the November workshop.

Note: the 3S Framework could be used to achieve consensus amongst FEC WG participants in order to agree on an action, see modus operandi below:

System Structure

- European in scope but consider boundaries and linkages to the wider world.
- System should be clear and defined. A final framework needs to have simple, transparent assumptions.
- To build in the requirement for combining different timescales. This is important as some S’s are longer-term than others.
- The framework will need to have an adaptive management tool approach,
- To start with the macro level before the micro level.
  - For ease operation, there is the potential to start with simplified conditions. This would allow the framework to start and then be built up.

Measurement

- Requires a robust set of measures which need to be replicable.
- Ensuring “what gets managed gets measured” and a recognition that this may need innovative solutions.
- The baseline will need to be regularly updated to ensure the framework remains up to date. (The question of how to build in this recalibration needs further discussion.)
  - Need to create a ‘combined’ curve so that the output is simple
- It will be important to have a way to recognize data gaps.
Content

- Supports application of safeguards e.g. certified SFM.
  - The greater the uncertainty, the greater the safeguards.
- There should be the scope for a range of products that would include value chain as well as landscape approaches.
- Sensitivity analysis will be needed using the principle that the focus is on the most important variables (working to an 80/20 rule).
- A multifaceted approach that should include conservation as well as allowing for factors such as disease, fire, stand level harvesting etc.
- To include process and transport considerations.

An additional question was to consider whether true sustainability must also account for the crucial protective, recreational and cultural roles of forests in Europe. Roux et al. (2017) note that the argument for policy choices concerning forests and the forest value chain is often unclear. This is because carbon considerations may be among the most important criteria, but that they must be weighed against other considerations such as the degree of vulnerability, resilience and reversibility of the ecosystems.

The 3S Framework may need to consider how to include these non-carbon elements into the model and whether there is a practical means to do this.

4.1.1 Sources of Information

LCA (Lifecycle Assessment) has become a globally accepted method for evaluating and communicating these environmental impacts\(^{116}\). International standards have been developed which aim to ensure consistency and comparability of outcomes. LCA relies on robust raw data and tools, expertise to interpret the results, and transparency in data sources and methodology to ensure the outputs support decision making that minimises negative environmental impacts.

Historically, the cost of conducting LCAs has been very high due to the software and the required expertise. However, this is changing in respect to software costs through and some is now open source. Examples of LCA based tools for construction include: the French tool ELODIE; eToolLCD and The Footprint Calculator from Australia; One Click LCA from Finnish company Bionova: and Tally, a US developed plug-in for the design software Revit and The Embodied Carbon Calculator for Construction (EC3). These tools have been reviewed in a separate spreadsheet and are discussed in section 5.2.

There is a lack of high quality, robust data from LCAs and EPDs, particularly in some regions, which makes it difficult to set benchmarks and targets. This may be compounded by a lack of affordable technical solutions to help plan and implement embodied carbon reduction strategies\(^{117}\). The World Green Building Council suggest that the full range of technological solutions needed to achieve net zero embodied carbon globally is not yet available at scale and shows that there is a gap for the 3S type of framework.

\(^{116}\) World Green Building Council (2019) Bringing Embodied Carbon Upfront
\(^{117}\) World Green Building Council (2019) Bringing Embodied Carbon Upfront
Usability could be crucial to the effectiveness of the 3S Framework. Existing tools and models tend to be very complex and need a high level of expertise to use and interpret. As the World Green Building Council (2019) note, "without the necessary knowledge and tools there is very limited scope to implement carbon reduction strategies successfully, whether for a material or an entire project."

**Environmental Product Declarations (EPD):** The results of LCA for a product or material are increasingly communicated in the form of environmental product declarations (EPDs).

There is a series of European Standards provide a common methodology for providing EPD across Europe in EN 15804 and they link to a common methodology for the assessment of building Life Cycle Assessment (LCA) in EN 15978. EPD schemes in the UK, France, Germany, the Netherlands, Sweden, Norway, Spain, Portugal, Italy and the United States have now adopted the EN 15804 standard and offer compliant EPD. The European schemes are united through the ECO Platform organisation, and there has been a rapid rise in the number of EPD, with over 2000 EPD now available within ECO Platform programmes and mutual recognition schemes in place for several of the members.

Tellnes et al. (2017) provide a useful examination of the data needed on emerging methods for biogenic carbon as well as the data required by the technical standards for EPDs and it points out that there is currently no scientific consensus on which method is the most appropriate for use for an LCA applied in EPD. This paper points out the inconsistencies of data and information required in differing technical standards. Moreover, that none of the standards require sufficient product information declarations or reports that facilitate an LCA-practitioner to apply the emerging research methods dealing with biogenic carbon on GWP in comparative or whole-building assessment.

One recommendation by Tellnes et al. (2017) is that the information on the country or region of origin in combination with the species required by the EU Timber Regulation would enable an estimation of the rotation period. This same format could then be used in the EPD.

**Corporate inventory accounting and comparative assessments:** A recent WRI paper provides a neutral framework for estimating and disclosing the greenhouse gas (GHG) emissions impact of a product (good or service), relative to the situation where that product does not exist. A key recommendation in this paper is that when estimates are used to inform decision-making, they should ideally use 'consequential' methods that measure total, system-wide changes in emissions. The reason given for this is because the available data is often limited. However, the author suggests that alternative ('attributional') methods can be considered as interim measures for applications that can be supported with an interim

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118 http://www.greenspec.co.uk/building-design/embodied-energy/
121 Russell (World Resources Institute) (2019) Estimating and reporting the comparative emissions impacts of products

Efeca 40 3S Forestry Framework
attributional approach. Despite this, the research shows that companies have solely used the attributional approach to estimate comparative impacts. This shows a clear divergence between this research and the situation in the market. One reason for this may be that companies are claimed to be the ‘cherry-picking’ products (or product applications) that have positive impacts.

Out of 5 listed major existing guidelines/standards applicable to avoided emissions, only WRI’s own standard, the Greenhouse Gas Protocol Policy and Action Standard from 2014 uses a consequential methodology. Russell (2019) concludes that the consequential method is used for all public claims on comparative emissions impacts involving market effects. This debate links back to the transparency discussion in section 3.1.1

**National Database**: One LCA and EPD expert[^122] has suggested that over time, national tools and databases should become available and she cites to generate or provide these scenarios should become available. For example, the Netherlands and Germany, have published national databases of LCA data for construction products and include mandatory building level LCA within their Building Regulations (Netherlands) and within DGNB (the equivalent of BREEAM in Germany).

### 4.2 Review of current decision-making 3S support tools

A separate excel spreadsheet was been created to compare and review relevant models and is included in Annex VI. The topics included in this spreadsheet include the model transparency and assumptions. During the FEC WG workshop it was noted that there is a need to surface assumptions in a comparable way to be able to compare models.

The models that have been selected are those that have been developed over time with a view to being used as a basis for a number of studies rather than those that are constructed for use in a single piece of research. The models considered include:

- Athena Impact Estimator for Buildings (IE4B)
- CARBINE
- CO2FIX
- EFISCEN (The European Forest Information Scenario Model)
- Embodied Carbon in Construction Calculator (EC3) tool[^123]
- eToolLCD
- FABio (Forestry and Agriculture Biomass Model)
- G4M (Global Forestry Model) and W
- GLOBIOM (Global Biosphere Management Model),
- One Click LCA
- ToSIA (Tool for Sustainability Impact Assessment)
- United Kingdom’s Environment Agency Carbon Calculator
- Wood Carbon Monitor
- WoodWorks Carbon Calculator

The key messages and inferences from this review are listed below.

[^122]: [http://www.greenspec.co.uk/building-design/embodied-energy/](http://www.greenspec.co.uk/building-design/embodied-energy/)
4.2.1 Transparency in the Models

- In general, the models reviewed had clearly accessible documentation provided by developers that outlined the aims, objectives and methodology of the tool. The exception would be some of the LCA tools (which can be found at the latter end of the spreadsheet) which lack detailed documentation.
- The developers/funders of each model were considered during the review to determine the possibility of bias. Many are EU-funded or developed by independent research institutes, suggesting neutrality. Some of the reviewed LCA tools are products of individual consultancies, and although the tools may not be biased, they may be competing with one another for usage, giving the possibility that they are not completely neutral.
- Although many models have a transparent methodology, the information available for each tool is inconsistent.
  - For example, in some cases, it is possible to infer from the available information whether a particular assumption topic has been considered within the model, but details on what exactly is assumed about that topic are unclear or nonexistent (e.g. ToSIA).
  - In other cases, supporting documents may clearly inform the reader on some assumptions relevant to the 3S framework but be vague on others (e.g. CO2FIX).

To be truly transparent, 3S framework model methodology should feature a clearly defined ‘assumptions’ section that lists the different assumption categories and what the model assumes about them.

4.2.2 Assumptions in the Models

- Most models that were reviewed failed to adequately address the comparison between the circular nature of carbon in forests and its linear nature in fossil fuels.
  - As assumptions about this topic were not clear in most cases, this is an area that could set the 3S framework apart from other models as it is a key factor in the storage and substitution 3S functions.
- Although many of the models consider different forest management strategies, sustainable forest management is not specifically mentioned in any of their documentation.
- None of the reviewed models have the exact function that a 3S framework model would aim to have (that of evaluating the roles of the sink, storage and substitution functions of forests), and therefore none act as a direct competitor to the potential tool.
  - Rather, each model can provide an insight into a different aspect of the 3S framework – for example ToSIA for wood production chains, EFISCEN for forest resources, and CARBINE for wood product substitution – from which a holistic tool could gain inspiration.
  - In light of this, perhaps the ultimate form that a 3S framework tool may take could be a set of interacting models, each with a specific function, much like the use of the GLOBIOM, G4M and WoodCarbonMonitor models together in the ClimWood2030 report.124

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5. Forest Economy Coalition Expectations and Shared Vision of the 3S Framework

5.1 The 3S Framework Goal
The aim of the framework is to allow users to credibly assess the impact of marginal changes in wood products utilization on climate and forest products. The final Framework will support users to optimise the different forest functions in order to maximise the benefits of wood and forests on our climate. Through its holistic design and conceptual innovation, it will also support progress and greater understanding of climate mitigation and the role of forests. This should cover the full holistic potential of the ‘forest economy’ i.e. from sapling to product end of life.

Currently, key stakeholders (see section 5.3) are unable to make informed choices as there are no decision making or planning tools available that support users to explore the impact of their decisions. By combining sink, storage and substitution into a single framework, the latest innovative research and knowledge will become accessible to a broad range of users, enabling action. There is also the opportunity to connect to other efforts, broadening the impact as the framework also aims to resolve ongoing debates in the research across the 3S’s.

It could be argued that the most significant risk to the success of the framework is the reason it is needed. The relationships between sink, storage and substitution are complex and dynamic. Differing underlying assumptions can create vastly different results, and the total impact of a choice to use a given wood product or engage in a certain forest management practice will vary over time depending on a wide range of factors. It is also important to consider the differing needs across the regions within Europe, for example how the framework will approach forest fires, a key issue in the Mediterranean forests of Spain and Portugal. As well as landscapes, different value chains will also need to be included in the framework, such as wood used in textiles. The importance of these products will also differ across geography, for instance timber construction in the Netherlands is more prevalent than in the UK. In order to address all of these important considerations organisations typically focus on a single issue such as fires or deforestation, and while this ‘silo’ approach has led to an in-depth understanding of each issue, the framework approach of bringing this thinking together could support a wider transition to a more holistic approach to climate change mitigation.

5.2 Potential 3S Framework Model
The 3S Framework model will be designed to utilise sink, storage and substitution to support users in their decision making and planning. Building on the research compiled above the following framework design has been developed.

Carbon sinks are natural ecosystems that keep more carbon dioxide than they expel. The process of photosynthesis means that plants (particularly forests) can be carbon sinks, absorbing carbon from the atmosphere and sequestrating it in biomass as they grow. It is estimated that agriculture, forests and other land uses (AFOLU) combined currently sequesters 30% of annual anthropogenic emissions.125

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125 https://www.nature.com/articles/s41558-019-0591-9
Storage refers to when wood is harvested and used to produce products, for example furniture, paper, or buildings. The carbon in this wood can be stored for long periods of time, and this can be extended by utilising circular economy principles and using the wood for multiple purposes, such as recycling furniture into packaging etc. Not only does this store carbon, but the forest where the wood was removed can be given the opportunity to regenerate, eventually ‘sinking’ new carbon. While it is important to consider the entire lifecycle of the product to ensure there is tangible carbon storage benefit, this can be an important component of mitigating climate change.

Finally, substitution is the replacement of other (typically fossil fuel based) materials with wood-based products. The most common example of this is increasing the use of wood in the construction industry as an alternative to concrete and steel. Unlike fossil fuels, the carbon cycle within wood products is cyclical, once the carbon is released, it can be recaptured through forests, whereas fossil fuel use is ‘linear’ and typically releases larger volumes of carbon more quickly.

Each of these 3S’s have a vital role to play in reducing the amount of carbon in the atmosphere and mitigating climate change. One of the largest debates is between sink and substitution, leaving trees in the forest or using timber to replace carbon in downstream value chains. While there is no one size fits all solution, the proposed framework aims to support users in making the decision that provides the most impact for their situation. Figure 5 below was developed by the FEC WG during the Geneva workshop in November and the following diagram (figure 6) shows further adaptations made by the Efeca team.

Figure 5: Initial 3S Framework (Source: FEC WG workshop, 19th Nov. Diagram created by Efeca)
Drivers and assumptions, alongside the current forest carbon sink, shape the scenarios featured in the model. Each scenario can then offer insight into the role that forests can play in mitigating climate change given those drivers and assumptions. The most significant change from the original Framework is the split of the ‘sink’ into two components, the ‘current’ sink (the volume of carbon sequestered by forests now) and the ‘potential’ sink (the additional carbon that could be captured if the identified trees were left standing).

Within each scenario the 3S Framework would project the potential sink function of forests, demonstrating the potential benefit of forests that are standing and/or growing. Scenarios can also show the potential storage and substitution benefits of harvesting the forest. This allows the user to assess best use at that point in time, for the area specified. For example, a young
forest may be best left as a potential sink, but then over time as it ages and matures the scenario will indicate, the increasing benefits of storage and substitution.

Carbon emissions are produced through the processing and transport of forest wood products and released throughout the substitution/storage/cascade use cycle, but ultimately this process, combined with the sink function, should have a positive climate impact when compared to ‘business as usual’ where the 3S framework is not available to users.

The ‘potential sink’, storage and substitution benefits will need to be ‘recalibrated’, reviewed and updated to reflect changes and ensure the Framework is relying on the latest data as the levels of CO₂ in the atmosphere and the current sink changes. For example, the ‘current’ carbon sink may have increased since first using the framework as a result of the intervention scenario chosen. A wider recalibration of the framework itself will also be necessary, providing the opportunity to review the framework’s fitness for purpose and inputs, for example ensuring identified drivers are still relevant and the Framework remains user friendly. As this report focuses on the potential components of the 3S Framework itself this wider recalibration is not included in the diagram.

To summarise, the model diagram illustrates that the climate impact of forests in the 3S Framework consists of a carbon sink function combined with the effective substitution of wood products with a carbon storage function.

5.3 Key stakeholders Main Audiences/User Groups for the 3S Framework

This section provides information on key stakeholders for the 3S Framework. Included in Annex IV is a list of potential FEC WG members, compiled in December 2019.

Several stakeholders have been identified throughout the development of the 3S Framework. These are broken down into more detail below but fall into two main categories. ‘users’ of the framework; these stakeholders are the main audience and who the framework is aimed at, they will directly benefit from its use and will need to be considered in the frameworks creation to ensure usability. The other category of stakeholder is ‘Supporters’, these stakeholders are those who can provide expertise to support the development of the framework, such as scientists and IT specialists. This category also includes those who can assist in the communication and uptake of the framework, ensuring it is successfully adopted and referred to by the environmental community, civil society and the forest industry.

5.3.1 Users

The main users of the framework are varied and work at a range of spatial scales.

At the highest level, policy makers and other decision makers may be able to use the tool to support decision making when considering policy or regulation creation, market interventions or other actions to maximise the climate benefits of the forest economy. This could be on a territory level (for example national forest plans) or at a broader European Commission level, feeding into broader policy actions such as the EU Communication on Stepping up EU Action to Protect and Restore the World’s Forests. On a smaller scale, the framework could also be beneficial for sub national public sector users, for example public agencies or policy makers at a city or regional level.
The framework will also be beneficial for a range of industry users seeking to incorporate an accounting of the full climate impact of materials choices into their decision making. At a forest owner level the framework can act as a planning tool, supporting the user to plan forest uses including when to harvest timber (and how best to use that wood for ultimate carbon benefit) and when to leave forest standing, sequestering carbon and providing additional benefits such as recreational opportunities for the community. Moving down the supply chain, the framework could also be a helpful tool for intermediate and final users such as manufacturers, engineers and architects as the framework would allow them to accurately demonstrate the carbon benefits of using timber in comparison to other materials, as well as compared to leaving the forest standing.

Linked to the work of industry, the framework could also support investors, providing information to inform decision making regarding funding the development of new projects or investment in new companies. A recent report from Ceres showed that climate change and other sustainability issues were the main focus areas of investors across 2018 and 2019. For example, in 2018 over 300 investors representing nearly 33 trillion USD in assets formed an initiative to engage with 161 GHG emission intensive companies on climate risk.\[126\]

A key requirement of the framework for users is that it not only be a decision making and planning tool, but that it also supports successful communication of actions taken to mitigate climate change. This is essential as the benefits of activities such as storage can be challenging to communicate given our emotional connection to forests. To support this work, the FEC WG have identified additional 'dialogue' work streams which will identify the requirements of key stakeholders more precisely.

5.3.2 Supporters

As well as the users who will gain direct benefits from the framework, there are the supporters who through engaging with the frameworks development and encouraging uptake can support climate mitigation.

There will likely be crossover with the users above, for example publicly available data gathered by the public sector could feed into the development of the tool. Several key convening groups will likely need to be engaged with as the framework develops, for example the FAO, IUCN and the Green Building Council.

Developers with technical expertise will also be a key part of the framework’s development, this includes scientific institutions, IT specialists who can develop the tool and technology experts who could provide innovative solutions to improve the data collection and interpretation of the framework in addition to the user experience.

There is also the need to communicate the framework well across the potential user groups and wider industry, to ensure a strong adoption of the framework and a high level of trust. Engaging with civil society and industry associations (key stakeholders) will be important to secure buy-

in, and it will also be key to consider existing campaigns and aligned initiatives to identify supporters and challenges who may present a critical response. A few of these campaigns have been listed below, but a next step for the FEC WG would be to conduct a full stakeholder analysis to plan outreach surrounding the framework.

- Wood for Good
- Build in Wood
- Wood Works
- Think Wood
- PACE (Platform for Accelerating the Circular Economy)\(^{127}\)
- RISE\(^{128}\)
- Wood City 2012 (Sweden) / Nordic Wooden Cities / Woodrise forum (France) / Adivbois / Le Bois C’est Essential

The World Green Business Council recently published their report\(^{129}\) setting out suggested coordinated actions for the building and construction sector to tackle embodied carbon\(^{130}\). Their ambition has been endorsed by over 80 organisations, from the Finnish Ministry of the Environment, several cities including Melbourne, Sidney and Vancouver, many industry representatives, technology experts (Google) and financial institutions such as the European Bank for Reconstruction and Development. The 3S Framework could be a key implementation tool to these organisations agreed ambition, and the European signatories could form the initial starting point for future engagement.

### 5.4 End Product Concept (Elevator pitch)

The 3S Framework is a platform currently being developed by the FEC WG to provide greater understanding and guidance to users on the different forest functions (sink, storage, substitution). The goal is for the 3S Framework to enable users to optimise their use of forests and wood in order to maximise the benefits for our climate. The framework different from other tools as it includes sink, storage and substitution rather than just one or two of the forest functions.

The platform is suitable for a range of users, from Governments and policy makers to industry and end users such as architects and engineers. Currently, competing thinking on the role of forests in climate mitigation make it challenging for users of wood products to effectively utilise the forests climate mitigation potential. The 3S Framework aims to support a common understanding of the forests and wood’s climate functions and provide a way to compute the carbon footprints of each of the 3S’s to present different options, at different spatial and temporal scales. Users will be able to use the 3S Framework both as a planning and/or as a policy tool.

\(^{127}\) [https://pacecircular.org](https://pacecircular.org)

\(^{128}\) [https://www.ri.se/en/what-we-do/our-areas/wood-technology](https://www.ri.se/en/what-we-do/our-areas/wood-technology)


\(^{130}\) It is unclear if these carbon emissions are across the entire lifecycle or if they include the effect on the carbon sink
In the initial phase the 3S Framework will focus on carbon and climate mitigation, however it is recognised that other dimensions of sustainability such as biodiversity could also be added to the platform as it develops.

5.5 **Short-Term actions and Long-Term Vision**

5.5.1 **Long-Term Vision**

The development of the 3S Framework will be a stepped, iterative process, and the approach will vary subject to available funding, interested users and technical expertise available. The Theory of Change (ToC) diagram below aims to set out how the 3S Framework could support the final goal of mitigating climate change by 2050.

Currently, the FEC WG having identified a need is exploring research and reviewing existing tools and approaches in order to agree the key principles behind the 3S Framework. From there, the Framework enters the ’design’ phase (shown in green) which is where the 3S framework is developed with inputs from funding organisations and stakeholders to ensure the Framework is suitable for user needs. In particular it is essential that the FEC WG engage with advocates of the sink and storage/substitution who until the development of the 3S Framework have approached the role of forests in climate mitigation separately. This engagement provides an opportunity to bring these users together in a precompetitive way to support the framework and this innovative, holistic approach. Within this design phase the Framework will be refined, until initial stakeholders are able to demonstrate climate benefits as a result of decision-making influence by the 3S framework. Users will also begin to promote the tool as they see benefits, communicating the tool and its innovative holistic approach. This will support an increase in users and therefore an increase carbon benefit (shown in blue).
5.5.2 Short-Term Actions

It is envisaged that the output of this report will enable the FEC WG to develop the following documents in January 2020:

- An Elevator Pitch and a 10-page summary – to explain the aims of the 3S Framework to potential stakeholders and supporters.
- 6-7-page strategy document
- A short strategy document which will ensure the FEC WG and wider FEC members when appropriate have an aligned way of working and approach to the development of the platform. This will also include agreement of which organisation or group shall ‘own’ the platform, and be responsible for day to day running and upkeep and;
- A funding strategy –to be developed alongside or shortly following stakeholder consultation where additional funding opportunities may become apparent.

To be developed in 2020:

- Identify other relevant initiatives e.g. EC3
- Draft design of a 3S Framework
- full stakeholder mapping exercise categorised by ‘S’ function
Annex I: 3S Framework Scoping Workshop Agenda

**FOREST ECONOMY COALITION**

‘3S framework’ scoping workshop

**AGENDA**

*Date & time:* 19th November 2019 | 10:00 – 16:00

*Meeting called by:* The Nature Conservancy, EIT Climate-KIC and World Resources Institute

*Venue:* WBCSD HQ [Mekong Room] Chemin Eugène-Rigot 2, 1202 Genève, Switzerland

https://goo.gl/maps/nZsXT7R5d1JeK4SG7

*The Concept:*

The Nature Conservancy, EIT Climate-KIC and World Resources Institute propose to develop a ‘3S Framework’ for Forests - holistic and context-sensitive metrics and tools which integrate the three climate functions of forests and forest products into decision making.

*Scoping Workshop:*

The aim of this workshop is to download current thinking regarding the framework into a consensually agreed scope and structure that can then be organised into a workplan that sets the project up for success.

*Key Questions:*

1. What are the underlying assumptions behind the Framework concept and their impact on conclusions/results?
2. What are the main audiences/user-groups for the Framework?
3. What issues/challenges do we hope to solve with the Framework?
4. What are the knowledge gaps that could impede the development of the Framework or render its content to be deficient?
5. What current (decision-making) tools exist in this space?
6. What are the main components of a 3S Framework?
7. How might the Framework best be organised to ensure uptake?

A list of confirmed participants, to-date, is included at the end of the Agenda.

Our Facilitators for the day will be Liz and Rose from Efeca: https://www.efeca.com/our-team
<table>
<thead>
<tr>
<th>Time</th>
<th>Item</th>
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<tbody>
<tr>
<td>10:00</td>
<td>Coffee. Meet &amp; Greet.</td>
<td>All</td>
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<tr>
<td>10:30</td>
<td>Welcome from the partners.</td>
<td>Mark Wishnie, Daniel Zimmer, Rod Taylor</td>
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<td>10:45</td>
<td>Introductions and sharing of views.</td>
<td>Efeca</td>
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<td>What is the goal of the Framework?</td>
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<td>Discuss the principal perspectives relevant to the 3S debate with a focus on the underlying assumptions and their impact on conclusions/results.</td>
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<td>11:15</td>
<td>Exploring a common vision that we can build upon.</td>
<td>Efeca</td>
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<td></td>
<td>Identification of potential components of a 3S framework including optimal combinations of the sink, storage and substitution functions of forests and wood products.</td>
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<td>12:00</td>
<td>Break</td>
<td>All</td>
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<td>12:15</td>
<td>Stakeholder brainstorm</td>
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<td></td>
<td>Identification of key audiences, possible technical partners etc..</td>
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<td>13:00</td>
<td>Lunch</td>
<td>All</td>
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<td>14:00</td>
<td>Common vision cont.:</td>
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<td></td>
<td>Explore knowledge gaps, agree core components and discuss possible end-product e.g. online platform or policy guide?</td>
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<td>14:45</td>
<td>Efeca team to re-group / Break</td>
<td>Efeca / All</td>
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<tr>
<td>15:00</td>
<td>Efeca team to feedback what they have heard and suggest next steps</td>
<td>All</td>
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<td></td>
<td>Next steps</td>
<td>Efeca</td>
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<td>Define a shared action/effort that is worth moving forward with, now.</td>
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<td>Wishlist of quick to mid-term actions / work-streams.</td>
<td>Kerstin Maurus</td>
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<td>16:00</td>
<td>Close</td>
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Participants

1. Daniel Zimmer – Director Sustainable Land Use (European Institute of Innovation & Technology EIT Climate-KIC)
2. Jamie Lawrence – Forest Economy Lead EU (TNC)
3. Kerstin Maurus – Forestry Lead (EIT Climate-KIC)
4. Luis Rocharme – Director (Forest Solutions Group - World Business Council Sustainable Development - WBCSD)
5. Mark Wishnie – Director Global Forestry & Wood Products (The Nature Conservancy TNC)
6. Rod Taylor – Global Forests Director (World Resources Institute)
## Annex II: Bibliography

### Selected Bibliography

The most useful literature accessed for this report are as follows:

<table>
<thead>
<tr>
<th>Title</th>
<th>Topics covered in report</th>
<th>Summary</th>
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</thead>
<tbody>
<tr>
<td>Arup, (2019). Rethinking timber buildings: Seven perspectives on the use of timber in building design and construction.</td>
<td>Embodied carbon in alternative materials to wood</td>
<td>A strategic overview of timber. It considers seven perspectives on the use of timber in building design, exploring where and when it is used, factors influencing its adoption, and how it might evolve. These seven factors reflect timber’s current social, technological, environmental, economic and political context, and provide a broad and holistic review.</td>
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<tr>
<td>Berndes et al. (2018) Forests and the Climate: Manage for Maximum Wood Production or Leave the Forest as a Carbon Sink</td>
<td>Embodied carbon in wood products, Forest management practices, Estimated store of carbon over time, Extent of substitution products and comparable materials</td>
<td>Discusses problem of attributional LCAs assuming linear emissions scale between products, and the need for conservative assumptions when uncertainty is high</td>
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<tr>
<td>Lippke, B. et al (2011) via AHEC briefing note</td>
<td>Estimate of stored carbon pool (over time), Forest carbon growth rates, Dimensions (Time)</td>
<td>Discusses problem of attributional LCAs assuming linear emissions scale between products, and the need for conservative assumptions when uncertainty is high</td>
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<tr>
<td>Referrer</td>
<td>Key Points</td>
<td>Further Information</td>
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<tr>
<td>Russell (World Resources Institute) (2019) Estimating and reporting the</td>
<td>Defines the baseline between products, and the need for conservative assumptions when uncertainty is high.</td>
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<td>comparative emissions impacts of products</td>
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<tr>
<td>Rüter et al. (2016) ClimWood2030: 'Climate benefits of material</td>
<td>Discusses the problem of attributional LCAs assuming linear emissions scale between products, and the need for conservative assumptions when uncertainty is high.</td>
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<tr>
<td>substitution by forest biomass and harvested wood products: Perspective</td>
<td>Cross boundary exchanges Cascade uses EU policy Dimensions (landscapes) Externalities</td>
<td>This study assumes policy options imply large-scale structural changes of the economy, and EU Member States National Renewable Energy Action Plans are assumed to be met. It also makes assumptions on the end of life destiny of wood products (landfill, energy recovery or recycling), and on the cascading use of wood products. Assumptions about the baseline scenario are based on EUROSTAT and FAOSTAT data.</td>
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<tr>
<td>2030</td>
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<tr>
<td>Tellnes et al. (2017) Comparative Assessment for Biogenic Carbon</td>
<td>This source provides a useful examination of the data needed on emerging methods for biogenic carbon as well as the data required by the technical standards for EPDs.</td>
<td>It highlights that there is currently no scientific consensus on which method is the most appropriate for use in an LCA applied in EPD. This paper also points out the inconsistencies of data and information required in differing technical standards.</td>
</tr>
<tr>
<td>Accounting Methods in Carbon Footprint of Products: A Review Study</td>
<td>Data required in technical standards and EPDs</td>
<td></td>
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<td>for Construction Materials Based on Forest Products</td>
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<td></td>
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<tr>
<td>World Business Council for Sustainable Development Forest Solutions</td>
<td>This study assumes policy options imply large-scale structural changes of the economy, and EU Member States National Renewable Energy Action Plans are assumed to be met. It also makes assumptions on the end of life destiny of wood products (landfill, energy recovery or recycling), and on the cascading use of wood products. Assumptions about the baseline scenario are based on EUROSTAT and FAOSTAT data.</td>
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<tr>
<td>Group (2019) Forest Sector SDG Roadmap</td>
<td>Assumptions and principles Insight into carbon storage and substitution</td>
<td></td>
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<tr>
<td>World Green Building Council (2019) Bringing Embodied Carbon Upfront</td>
<td>Tackling embodied carbon in the construction sector</td>
<td>This study assumes policy options imply large-scale structural changes of the economy, and EU Member States National Renewable Energy Action Plans are assumed to be met. It also makes assumptions on the end of life destiny of wood products (landfill, energy recovery or recycling), and on the cascading use of wood products. Assumptions about the baseline scenario are based on EUROSTAT and FAOSTAT data.</td>
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Full Bibliography

- Agostini et al. (European Commission Joint Research Centre) (2013) Carbon Accounting of Forest Bioenergy
- Anderson. Embodied Carbon & EPDs http://www.greenspec.co.uk/building-design/embodied-energy/
- Berndes et al. (2018) Forests and the Climate: Manage for Maximum Wood Production or Leave the Forest as a Carbon Sink?
- Böttcher et al. (2018) Forest Vision Germany
- Cevallos et al. (Institute for Climate Economics) (2019) Relocaliser la filière bois française : une bonne idée pour le climat
- Dhôte et al. (Institut national de la recherche agronomique) (2017) Quel Rôle pour les Forêts et la Filière Forêt-Bois Françaises dans l'Atténuation Changement
- EASAC (2017) Multi-functionality and sustainability in the European Union’s forests. EASAC policy report 32
- Fern (2019) EU Forests of hope: How community restoration and management of forests can help meet climate goals
- Ganguly et al. (2019). The role of Washington’s private forests in mitigating global warming, study presentation.
- Leskinen et al. (2018) Substitution effects of wood-based products in climate change mitigation
- Lewis et al. (2019). Restoring natural forests is the best way to remove atmospheric carbon. Nature 568, 25-28
• Ramani (2019) Running the risk: How corporate boards can oversee Environmental, Social and Governance (ESG) issues
• Russell (World Resources Institute) (2019) Estimating and Reporting the Comparative Emissions Impacts of Products
• Rüter et al. (2016) ClimWood2030: ‘Climate benefits of material substitution by forestbiomass and harvested wood products: Perspective 2030’
• Schanes et al. (2016) Low carbon lifestyles: A framework to structure consumption strategies and options to reduce carbon footprints. Journal of Cleaner Production 139:1033-1043
• Sierra Club, (2019). Forests, wood & climate briefing
• Trionmics (2018) The effects of consumer behavior on the circular economy
• World Green Building Council (2019) Bringing Embodied Carbon Upfront

List of Internet Sources Used for Analysing the Models in the Excel Spreadsheet
http://tosia.efi.int/
https://www.efi.int/knowledge/models/efiscen
https://www.iiasa.ac.at
https://ec.europa.eu/clima/sites/clima/files/strategies/analysis/models/docs/g4m_en.pdf
http://dataservices.efi.int/casfor/downloads/co2fix3_1_description.pdf
https://biomasse.oeko.info/index.php?id=63&L=1
http://www.carbonleadershipforum.org/projects/ec3/
https://calculatelca.com
https://etoolglobal.com
https://www.oneclicklca.com
https://www.woodworks.org
Annex III: Section 4 FEC WG Perspectives

The issues and components detailed in section 4 in this report are considered here from the FEC WG workshop participants perspectives (where relevant/provided). The different components throughout this section are informed by individual discussions with the Steering Committee, outputs from the November workshop and 2019 report written by TNC for CKIC 'The Forest Economy and Climate Change: A Review of Greenhouse Gas Mitigation in Europe’s Forests and Forest Products’.

Assumptions and Principles

Transparency of Assumptions
Assumptions were a key theme that ran throughout the workshop discussion. It was agreed that current models and tools could be more transparent, as often it was challenging to identify when assumptions had been made which would have potential to change the outcome of the tool. This was felt to be the case for the methodologies behind existing resources but also about the funding organisations and owners of the tool.

Where is the Baseline?
In the FEC WG workshop on the 19th November, it was decided to use the current landscape as the baseline, as this would provide greater understanding of the benefits to actions taken in the short term as well as over longer periods of time. However, it was agreed that the baseline should be dynamic, as it is acknowledged that sink and substitution values can change throughout the year.

Dimensions
While the workshop was relatively brief, it was agreed by the group that the 3S framework should serve a range of users, making it relevant to many different interlinking value chains. It was also important that the framework add value at a range of scales, so that both a high-level user (public sector) and a smaller scale industry user (architect) could benefit from the framework. It was also essential that the framework be dynamic, updating to reflect changes over time and the latest information.

How holistic should the framework be?
The name ‘Forest Economy Coalition’ was chosen by the group to reflect the need for a holistic approach to climate change mitigation. To deliver a meaningful impact, it is necessary to engage the entire supply chain, not just forest based industries. This ensures that the whole lifecycle of the product is considered for example ‘cascading’ use of products once the timber has been harvested and a product created. During the workshop, the FEC WG has discussed whether the term ‘forest economy’ was sufficiently inclusive for the wide range of views of the 3S Framework audience, but so far, an alternative name has not been found.

While it is recognized that the value of forests is not just economic, there are also social, emotional values to consider, it was decided to ultimately focus the scope of the framework to the delivery of carbon benefits and maximizing forests role in climate mitigation. This was decided as climate change was perceived to be the most pressing issue where FEC WG members could achieve impact. It should be noted though that unlike other carbon focused models, by
capturing all 3S’s, this framework could still capture benefits derived from carbon sinks such as the recreation benefits of forests. Furthermore, where there is uncertainty the framework will suggest the use safeguards within the supply chain, and these could include certification which also captures additional social benefits.

**Drivers and Influences**

**EC Policies and 3S Framework**

The FEC WG agreed it was essential that the framework should guide and inform EU policy, providing a challenge if needed due to innovations in research. There is potential for the framework to support countries in reporting on their climate mitigation activities in a more comprehensive way, and support decisions to manage forests or utilise storage or substitution methods on the global stage. It also presents an opportunity to explore climate mitigation in a more holistic manner, supporting a move away from current ‘silenced’ thinking and allowing users to show impact across a range of areas.

The FEC WG noted that a rise in pricing and resulting increasing imports from outside of the EU would then create a question regarding externalities, as while the framework is focused on Europe it is important to consider the wider implications of decisions made by European users.

FEC WG have also expressed that policy should also recognise the multiple values associated with forests, and ensure that forests with high biodiversity, cultural significance or protective functions are protected in strategies to reduce emissions from the forest sector.

**Sink Components**

**Scale and Landscape**

It is important to understand that landscape carbon is defined by the dynamic baseline. Differences in scale of the analysis as well as the timescale of interest can impact results. Forest modelling studies often consider a single stand, in which harvest causes a large and abrupt emission (a carbon debt) followed by a gradual regeneration. Yet over a landscape of different-aged stands, emissions and sequestration are more smoothly distributed over time.

**Reforestation or Avoided Deforestation**

A key question in European forest and climate policy is how far policymakers should encourage greater harvest of forests and use of forest products to drive reforestation, increased growth rates and product substitution, and to what degree should they aim for reduced harvest, close-to-nature forestry and conservation of current forest carbon stocks. There is no single answer but TNC assessed there are 3 main drivers and assumptions that most impact the greenhouse gas mitigation outcome in each case.

- Decisions about the scope and scale of the analysis, such as whether and how to account for substitution effects, or whether the analysis focuses on a single forest stand or a larger, more heterogeneous forest landscape.
• The forest system under consideration, including such factors as the climate and growth rate, whether reforestation or deforestation is assumed to occur, the efficiency of harvest and the fate of harvested wood.
• Assumptions about the context and wider system in which the analysis is situated, including, most crucially, the choice of baseline or counterfactual against which the modelled scenarios are compared.

**Geographic boundary – input/outputs**
Forest Economy Coalition Perspectives
It is important to consider the boundaries of the system and trade both outside and inside Europe in relation to the consequences of promoting wood on imports. The FEC WG worked example for Southern Europe provides more insights on the thinking in this area.

**Forest management practices**
On the forest management side, sustainably increasing productivity in currently managed forests can increase carbon sequestration.

Management for wood production typically seeks to maintain forests in a phase of high growth in order to maximise net annual yield. In actively managed forests, silvicultural practices can also improve growth rates and survival of young trees, which in time can further enhance net sequestration rates. FEC WG argue that on average, managed forests may be able to maintain higher sequestration rates (although not carbon stocks) than unmanaged forest. This enhanced sequestration can mean that managed forests can maintain higher annual mitigation rates than unmanaged forest (provided harvested wood is converted efficiently to long-lived products), especially in comparison to older forests in which net growth has slowed.

Similarly, faster-growing forests are able to more quickly re-sequester carbon emitted through intensifying harvest and produce higher volumes of wood per unit of carbon emitted, maximising relative substitution benefits. Intensifying harvest in slow-growing natural forest ecosystems are likely to have more muted net greenhouse gas benefits in the short term.

**Age and species composition**
Forest Economy Coalition Perspectives
There is a wide range of managed and forest systems in Europe and much of it is managed for wood production. Europe is currently in a period of recovery after historic deforestation and over-exploitation. Although carbon stocks in European forests are increasing by more than 110 million tonnes per year, this sink is decreasing as the forests mature and net growth declines.

**Carbon stock (current and projected)**
European forests influence the climate system directly through their impacts on albedo, evapotranspiration and heat transport in the atmosphere. These effects are similar in importance to forests’ impact on the carbon cycle, but the TNC foresee that more work is needed to understand the subtleties of these feedbacks.
Another issue is the percentage of the biomass removed from the forest stand (by harvest or damage) that ultimately ends up in useful products. If only a small fraction of the biomass removed is recovered for products, the emission of carbon per unit of useful wood produced is much greater.

**Storage Components**

**Embodied Carbon (wood products)**
The use of wood in construction generally provides a clear substitution benefit, given the high carbon intensity of cement, steel and other building materials. However, emerging textiles, plastics and chemicals from woody feedstocks also hold great promise in reducing fossil emissions. Evidence for the substitution benefits of other short-lived products such as paper and packaging is much more equivocal; in some cases (e.g. graphic paper) there are no obvious alternatives for which wood products can be said to substitute.

The final use of harvested wood determines the duration of carbon storage in products and, the potential benefits obtained through substitution. Wood harvested for high-value, long-lived products such as construction wood tend to be both longer-lived than lower-value uses such as pulp or chipboard, and to act as substitutes for high-emitting alternatives such as concrete and steel. Short-lived products, especially paper products, can make more efficient use of harvested wood, but re-emit carbon rapidly and carry a less clear substitution benefit. Use of wood and residues for bioenergy or biochar may or may not have greater benefits than leaving them in the forest, depending primarily on the counterfactual fate of biomass, the efficiency of energy conversion and the extent to which they truly displace fossil fuel.

**Substitution Components**

**Comparable Materials**
To consider whether, in the current market, each wooden product has a substitute. Some products may not have a substitute and there is a need to compare against business as usual. Not changing (substitution).

**Scope**
When considering how much carbon and for how long, use is an integral part as this gives the indication of duration. Replacing wood in a product should be considered substitution.

Maintaining or increasing forest management for wood products can in some cases result in greater overall greenhouse gas mitigation than leaving forests unharvested. Active forest management and harvest tend to outperform no harvest where (i) there is rapid forest growth and re-growth, (ii) harvested wood is utilized efficiently, (iii) a high proportion of wood enters long-lived products, (iv) product markets provide an incentive to increase forest area and (v) products have a high degree of substitution for emissions-intensive alternatives.

Substitution can be the most important in determining net greenhouse gas reductions owing to the large range of possible outcomes: substitution factors for wood range from -0.6 to +5.1 kilograms of carbon mitigation per kilogram of carbon in the wood product. However, substitution is highly sensitive to context and assumptions about the type, footprint and amount
of displaced materials, as well as the potential for re-use, recycling and cascading use of products.

**Whole Lifecycle Approach**

If different accounting is used to consider opportunity cost (mature carbons continue to sink carbon) then this is a 6x increase. It would be best to have a broad-brush approach to optimising the sink whether this includes leaving or managing areas.

A key point is how different people measure and compare materials. Typically, LCA is only assessed for 1 or 2 materials at a time. Alongside this, LCA is commonly manipulated according to research bias. It is also necessary to delve deeper into the source wood material because if only carbon is considered then it is oversimplified.

For some product types and end uses (e.g. wood in construction), there is already considerable research quantifying lifecycle emissions across various case studies. Deeper insights could come from making explicit the conditions and assumptions underlying the different conclusions across these studies. At a larger scale, such product-level assessments need to be complemented by region-wide system modelling to articulate coherent future visions for the European forest sector.

More research is needed to understand the life cycle emissions of emerging wood products such as biochemicals and textiles, as well as emerging non-wood alternatives such as low-carbon cement.

WBSCD have concluded that any research assessing the overall impacts on the atmosphere associated with using biomass should ensure that they cover the whole life cycle, including photosynthesis and land use change as well as encompassing gains and losses of carbon from all forest carbon pools. They also advise that as a minimum the supply area for the facility or entity being examined should be included in any assessment.

**Externalities**

Avoided emissions in industry include GHG Protocol Scope 3 but are now moving towards Scope 4, i.e. to expand sustainable sourcing to measurable impacts in regions and commodity systems. This means that different options need to be available for users to access in the market.

**Evolution**

Critical to all assessments is the counterfactual or reference scenario: What would have happened in the absence of a management or policy choice? This is especially important to the estimated benefits of forest product substitution. The appropriate counterfactual is not purely a scientific question, but depends on the specific economic, ecological and cultural context, and could vary widely for different forests across Europe.

Carbon from fossil fuels and forests cannot be treated in the same way. Where forests are circular, fossil fuel production and use is linear so it isn’t appropriate to treat them the same but both should be included in calculations.
There is a probability that more consumption of wood leads to more climate impacts so the recommendation is to assess what the 3S ‘wins’ could be which will be more effective than other options.

**Cascade Uses**

Forest Economy Coalition Perspectives

Cascade Uses is needed in the 3S Framework to add an end of life element in order to connect storage with substitution.

Multiple sources suggest a ‘cascade’ approach, construction/long term use wood products can be used as woodfuel at the end of their life. Where forests are managed, efficient use of harvested wood and residues, as well as recycling and cascading use of products, should be encouraged.

In terms of end of life/circular economy, it is important to understand the assumptions after the product is used. This is the relationship between storage and substitution e.g. the average half-life of house is 40 years, so what happens at year 40? Should the framework consider this as a separate component or part of something else?

There are also debates on optimizing virgin vs recycled content. There is agreement that end of life/pre life needs to be included but how to do this?
Annex IV: FEC WG Participants

The FEC WG
TNC
Climate_KIC
WRI

Other potential participants
Arup
Confederation of Forest Industries (Confor)
EFI
European Forest Institute (EFI)
European Organization of the Sawmill
European Panel Federation
FAO SW4SW
FINSA
ICLEI
IUCN
Poyry / Climate Leadership Coalition
Sonae
Stora Enso
TargetingZero
Taylor Wimpey
UPM
Waugh Thistleton
WBCSD (Forest Solutions Group)
World Economic Forum [WEF]
WWF
Annex V: FEC Mission statement

DRAFT IV

VISION & MISSION STATEMENTS FOR THE FOREST ECONOMY COALITION

Vision statement: “We envision a world where there are more forests than any of us have ever known; where our resources are used within the natural boundaries of our planet. A world in which the places we live and work in, the products we use, are derived from responsibly produced renewable sources that contribute to a low carbon future. A future where our cities are built from renewable materials, providing nurturing environments and serving as growing storehouses of carbon; where a responsible forest sector has built greater and greater social license through rising social and environmental ambition; and policy makers, consumers, and the general public have confidence in the environmental and social benefits of climate-positive forest product utilization.”

Mission Statement: “The Forest Economy Coalition (FEC WG) is a cross-sector platform that advocates for significant expansion of responsibly managed forests by advancing collective understanding of the role of forests as carbon sinks, the function of forest bio-based materials in carbon storage and the use of sustainably-sourced forest products as substitutes for non-renewable, carbon-intensive materials.

Role: As a consortium of stakeholders, the FEC WG will aim to achieve a broad and balanced view of the contribution of the forest economy towards global carbon neutrality as well as develop a sound rationale to define and agree measures, that if implemented, would unleash the full climate mitigation potential of forests and forest products."
Annex VI: Review of models

Please see accompany Excel spreadsheet