



Harnessing the Potential of Productive Forests and Timber Supply Chains for Climate Change Mitigation and Green Growth

Opportunities for Private Sector Engagement

Knowledge Product

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1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

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Abbreviations and Acronyms

AFE	Amhara Forest Enterprise
AFR100	Africa Forest Landscape Restoration Initiative
CAF	Corporacion Andina de Fomento
CIA	Central Intelligence Agency
CIF	Certificado de Incentivo Forestal
CIF	Climate Investment Funds
CIFOR	Center for International Forestry Research
CO ₂	carbon dioxide
CO _{2e}	carbon dioxide equivalent
CONAFOR	Comision Nacional Forestal
COP	Conference of the Parties
CRGE	Climate-Resilient Green Economy
CSA	Central Statistical Agency
DUAT	Direito de Uso e Aproveitamento da Terra
ECOCASA	Green Building Program
EDB	Ethiopian Development Bank
FAO	Food and Agriculture Organization
FARC	Revolutionary Armed Forces of Colombia
FCPF	Forest Carbon Partnership Facility
FIP	Forest Investment Program
FLR	forest landscape restoration
FONAFOR	National Forestry Fund
FREL	Forest Reference Emission Levels
FTE	full-time equivalent
GDP	gross domestic product
GHG	greenhouse gas
GTP	Growth and Transformation Plan
HWP	harvested wood products
IDB	Inter-American Development Bank
IDEAM	Institute of Hydrology, Meteorology and Environmental Studies of Colombia
IIASA	International Institute for Applied System Analysis
IIC	Inter-American Investment Corporation
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
KfW	German Development Bank
m ³	cubic meter
MADR	Ministerio de Agricultura y Desarrollo Rural
MAI	mean annual increment
MASA	Ministry of Agriculture and Food Security
MDB	multilateral development bank

MEFCC	Ministry of Environment, Forest and Climate Change
MITADER	Ministry of Land, Environment, and Food Security
NDC	Nationally Determined Contribution
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OFWE	Oromia Forest Wildlife Enterprise
OSINFOR	Organismo de Supervision de los Recursos Forestales
PETT	Special Land Titling and Cadastre Project
PPP	public-private partnership
PROFOR	Program on Forests
PRONAFOR	National Forest Program
RBF	results-based finance
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RIL	reduced-impact logging
SFC	state forestry company
t	ton
UAF	Unidades Agrícolas Familiares
UNFCCC	United Nations Framework Convention on Climate Change
UPRA	University of Puerto Rico at Arecibo
US\$	U.S. dollar
USAID	U.S. Agency for International Development
WWF	World Wildlife Fund

Executive Summary

This report evaluates opportunities for harnessing the potential for climate mitigation and green growth in the forest sector. The analysis focuses on mitigation benefits related to carbon storage in planted forests, harvested wood products (HWP), and the substitution of materials. This emphasis on the role of forestry in climate mitigation in developing countries fills an analytical gap—until now, the role of the productive forest sector has largely been ignored. In addition, the analysis quantifies the climate change adaptation benefits of investments in the HWP supply chain, such as creating economic opportunities and increasing resilience.

Under current conditions, the supply of HWP is unlikely to keep up with expected demand. Increasing economic and population growth in the study countries will drive greater consumption of HWP. Without making the recommendations suggested in this report, increasing consumption will result in large HWP supply gaps.

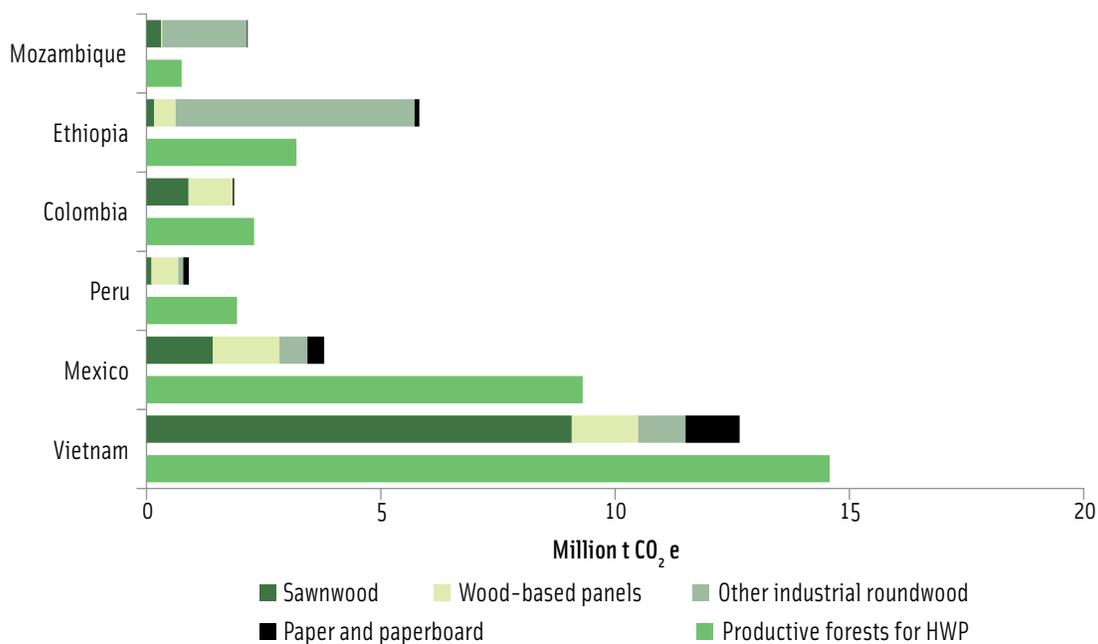
Promoting HWP helps to increase the carbon sequestration potential of the forest sector. HWP store accumulated carbon for the lifespan of the product. Additional climate change mitigation benefits occur if HWP substitute materials that are greenhouse gas (GHG) intensive to produce, such as concrete or metal for construction. HWP production must be done in a sustainable manner, without contributing to deforestation and forest degradation, to ensure environmental integrity.

Where governments seek to attract private sector investments that combine climate and forest sector benefits, investments in long-lived HWP, such as wood-based panels and sawnwood, offer significant opportunities. The production of paper and paperboard offers more limited mitigation potential, because of the short lifespans of these products. There is also potential to reduce emissions from uses of wood for energy, by reducing demand for fuelwood through improved technology and increasing the sustainability of the supply of fuelwood. However, the mitigation potential of improved fuelwood use is not considered in this analysis, because of methodological and data concerns. Furthermore, for investments, the informality of the sector in many developing countries limits the opportunities for private sector engagement.

By increasing the production and consumption of HWP, the six countries analyzed in this report—Colombia, Ethiopia, Mexico, Mozambique, Peru, and Vietnam—can make significant progress toward meeting the objectives formulated in their Nationally Determined Contributions (NDCs). Figure 1 summarizes the climate change mitigation potential of various HWP and associated productive forests in the six countries. In the countries assessed, sawnwood, wood-based panels, and production of other industrial roundwood have the greatest mitigation potential. Vietnam, Mexico, and Ethiopia have the highest potential for carbon sequestration through HWP among the countries assessed.

Shifting the construction sector's use of fossil fuel-based materials, such as brick, concrete, and metals, to HWP is the single most effective means of sequestering carbon via HWP. Given the demographic and economic development of the analyzed countries, demand for construction and other materials is expected to continue to grow. The United Nations Habitat Program estimates that by 2030 about three billion people will need proper housing, requiring the construction of

FIGURE 1 Mitigation Potential of HWP and Associated Productive Forests in the Study Countries



Note: HWP = harvested wood products; t CO₂e = tons of carbon dioxide equivalent.

roughly 100,000 housing units per day from now until 2030. The materials used in this housing can be fossil fuel-based materials or sustainably produced HWP that sequester carbon dioxide for their entire lifespan.

In addition to contributing to countries' NDCs, promoting HWP can positively impact other international land use objectives. There are important synergies between promoting HWP, engaging the private sector in reducing emissions from deforestation and forest degradation (REDD+), and forest landscape restoration (FLR) targets that many countries have committed to under the Bonn Challenge. Increasing the formality of the forest sector can help to reduce deforestation while also supporting HWP production. Increasing the supply of HWP through productive forests would help to meet countries' restoration targets and reduce pressure on natural forests.

Promoting HWP has many additional social and economic benefits, such as gross domestic product (GDP) growth, employment creation, and economies' increased resilience to climate change. HWP production is labor intensive and can be an effective means for countries to promote inclusive economic growth while increasing value added in the forest sector. HWP production is estimated to create between 14,000 full-time jobs in Mozambique and as many as 244,000 jobs in Vietnam. Although the wood-processing industry is contributing the main proportion of the related GDP growth, most of the new jobs are related to forest management, and thus create employment opportunities in rural areas.

Changes in domestic policies and consumer attitudes are needed to increase local consumption of HWP and realize their potential. In many developing countries, wood is not yet

widely used in urban construction; however, in high-income countries, such as Germany and Switzerland, HWP play a significant role in construction—in particular as technology innovations allow for new uses. Actors in construction supply chains are often more accustomed to using brick, concrete, or other non-wood materials. The perception of wood use in construction is also an impediment to HWP growth, as wood construction materials are sometimes perceived as low status or associated with low-income, poor quality housing. However, some of the most advanced economies have the highest per capita use of panel and construction wood. Depending on the country, it can be difficult for construction companies to comply with building standards when using HWP, and to access modern HWP through the supply chain. The report recommends technical assistance and training for architects and construction planners, quotas for the use of wood in construction, and preference for wood use in public tenders to increase the domestic consumption of HWP.

Trends in future HWP demand and market volumes provide the foundation for strong business cases for companies and investors to invest in productive forests and HWP processing industries in the countries studied. The model business cases for each of the six study countries in this report describe country-appropriate investments. Due to expected private sector investment, supporting the use of HWP can contribute to achieving NDC targets and engage the private sector in REDD+ implementation.

Nonetheless, private investment in HWP production is constrained by several factors. Lack of ready-to-invest land without land tenure conflicts, lack of forest management skills, underdeveloped infrastructure, and lack of access to finance with appropriate terms to reflect the nature of forestry investments (front-loaded costs and back-loaded returns) are common across the six countries studied. These issues create uncertainty for private companies and investors that are active in the sector, slowing the growth of HWP production. Countries need to address these issues to create the enabling environment necessary to unlock the environmental, economic, and social benefits of HWP.

National governments should improve the enabling environment for HWP growth. Given the identified barriers, the following actions are recommended:

1. Promote policy reform, and strengthen law enforcement, governance, and incentives.
2. Facilitate private investment by identifying concrete investment opportunities.
3. Support procurement policies that require the use of HWPs in construction.

International development partners can play an important role in reducing nonfinancial barriers to scaling up HWP production. The report recommends that the development community supports the forest sector in the following ways:

1. Offer technical assistance to improve the technical and management capacity of the forest and wood-processing sectors.
2. Improve access to market information through the development of regional dialogues with producers, federations, buyers, processors, green city planners, and financial intermediaries. This will help to reduce uncertainty around investments in productive forests and processing industries.

3. Provide dedicated funds for market and feasibility studies to develop and demonstrate the feasibility of HWP business models. To be “bankable” for private investors, many forest management and processing companies require business development support.

The development finance community can increase forestry enterprises’ access to finance by offering concessional financial products. Among other barriers, lack of access to long-term finance for forestry investments due to perceived credit risk stands out as a critical obstacle to increasing HWP production. To reduce credit risk and crowd-in private investors, the development finance community should provide investment capital to absorb and share risk. The report recommends at least two financial mechanisms that the development community can offer:

1. A revised private sector financing window operating via multilateral development banks (MDBs) should provide equity and guarantee products in addition to debt and grants. The existing financing products tend to be limited to debt and grants, which do not always serve the financing needs of companies in the HWP sector. Equity investments via dedicated forest funds can provide forestry companies with the time needed to start generating profits. In addition, revised private sector windows should streamline their approval processes to fit the needs of private companies. The uncertainty and long approval processes of existing windows reduce their effectiveness.
2. In addition to a revised private sector window working through MDBs, the development finance community should structure funds and guarantee products that enable local banks to establish or modify existing credit products to reflect forest sector investment requirements and reach forestry enterprises. The existing financial intermediaries can reach small- and medium-size companies that MDBs are unable to finance. In addition, working through local financial intermediaries will help to improve the long-term sustainability of HWP investments. However, these intermediaries are often hesitant to lend to the HWP sector because of perceived risks. Credit guarantees for financing companies in targeted sectors can reduce this risk and help intermediaries to build familiarity with the sector.

1. Introduction

The forest sector has tremendous potential for contributing to the protection of the environment and spurring economic development. Through the roles they play in the water and carbon cycles, forests provide vital ecosystem services, including the regulation of climate processes. If managed sustainably, afforestation, reforestation, and management of forest biomass production over time increase carbon sequestration and help to mitigate climate change. Harvested wood products (HWP) extend carbon storage until the end of their lifespan by providing an efficient and low-carbon alternative compared with many other materials, especially concrete, steel, and aluminum.

In addition to the many regulating and provisioning ecosystem services that forests provide, the forest sector contributes significantly to employment and economic development in rural areas. A global survey estimates that more than one-quarter of household income in rural areas in developing countries stems from natural forests and other natural areas (Angelsen et al. 2014). In a changing climate, the jobs created by the forest sector offer countries an opportunity to adapt to climate change and increase the resiliency of their economies.

However, for several reasons, the productive supply chains offered by forests are still underdeveloped. The forest sector in many countries is hampered by the lack of infrastructure and technical forestry knowledge. Poor governance and enforcement allow illegal logging to continue in many tropical countries, undercutting the economic gains of legal forestry operations and local communities. Although illegal logging decreased by nearly a quarter between 2002 and 2009, more than half the timber sourced from the main forest countries in the tropics (such as Brazil, Indonesia, the Democratic Republic of Congo, and Malaysia) is still illegally sourced (Hoare 2015). In addition, the economic benefits provided by forests, such as climate change mitigation, are not included in the economic valuation of forests or the “downstream” supply chains.

To address these challenges, multilateral and bilateral development partners, governments, and the private sector have significantly increased support for the protection, restoration, and sustainable use of forests through various initiatives and programs over the past decade. Many programs are beginning to realize their impact and learning lessons while moving from the project level to the landscape level. However, these promising efforts have not yet managed to “tip the scale” and trigger the aspired transformational change to sustainable land use.

The Bonn Challenge, New York Declaration on Forests of 2014, and Paris Agreement of 2015 have created new momentum to enhance and complement existing efforts. The Intended Nationally Determined Contributions (NDCs) of many countries include the forest sector and lay out ambitious carbon sequestration objectives. The NDCs need to be further defined and translated into specific policies and measures. Many developing countries are already engaged in the process of formulating national plans for mitigation actions, including the implementation of REDD+.¹ The expected ratification of the Paris Agreement will create new momentum for these activities and provide options and financing for countries to collaborate. In addition, the high-level political discourse, which started with the New York Climate Summit of 2014 on developing deforestation-free supply chains, offers a new window of opportunity to include the private sector and leverage limited public finance. Further,

¹ REDD+ stands for reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks (UNFCCC, Decision 1/CP.16, paragraph 70).

voluntary country commitments for forest landscape restoration (FLR) support the operationalization of political objectives for the land use sector and forests, including investment models for the private sector and public-private partnerships.

Multilateral development banks (MDBs) have played an important role in emphasizing the urgency of climate change and the role that forests play in mitigating climate change. The World Bank Group, for example, has developed a Climate Change Action Plan that identifies climate change as a primary threat to achieving the goal of reducing poverty. The World Bank Group's Forest Action Plan highlights the importance of forests and sustainable forestry management in achieving economic development and climate change mitigation goals.

Given these policy milestones and tools, development partners have the opportunity to adopt a more comprehensive approach to promoting sustainable and productive forestry.² The objective of this report is to provide strategic advice for development partners, in particular MDBs, on how to promote and implement activities that can harness the potential for climate mitigation and green growth in the forest sector. This analysis focuses on mitigation benefits related to carbon storage in planted forests, HWP, and the substitution of materials. The emphasis on forestry's role in climate mitigation in developing countries will fill an analytical gap—until now, the role of the productive forest sector has largely been ignored. Further, the analysis quantifies the social benefits of investments in the HWP supply chain, such as creating employment opportunities.

The focus of this study is only on harnessing the potential of planted forests and sustainably managed natural forests, including derived products and supply chains. Fuelwood use is excluded from the analysis for two reasons. First, the use of fuelwood for energy releases sequestered carbon as carbon dioxide emissions, so ultimately whether energetic use is beneficial for mitigation depends on the circumstances, in particular the energy source that fuelwood replaces and if fuelwood is produced sustainably. There is not enough certainty about the energy source that fuelwood would replace to make calculations with confidence. Second, there are limited private sector land use investment options, because of the informality of the sector.³

Section 2 of the report provides a brief outline of the international strategic context for climate change and forestry support. Section 3 describes forest supply chains, their mitigation potential, and the methodologies used in the report. Section 4 assesses the mitigation benefits related to carbon storage and substitution of HWP. Section 4 also identifies policy priorities and strategies for engaging the private sector, by developing potential business and investment cases. Section 5 summarizes the contribution of HWP supply chains to NDCs and FLR. Section 6 concludes the report with strategic recommendations for the World Bank and other actors to support climate change mitigation and green growth through HWP supply chains. Finally, the Annex provides the different country case studies and more information about how calculations were made.

² The report defines productive forests as forests that are managed to optimize the sustainable harvest of forest products. This includes a range of forest types, such as commercial plantations, smallholder woodlots, and sustainably managed natural forests. To make calculations about the productivity of the productive forests analyzed in this analysis, the report makes the assumptions detailed in the annex.

³ More details on this decision are provided in the elaboration of the methodological approach in section 3.2.

2. Strategic Context

2.1. International Incentives for Sustainable Forest Use and Protection

The past decade has seen unprecedented momentum in the forest sector, with governments, the private sector, and civil society actors joining efforts in several ambitious commitments and initiatives:

- The United Nations Sustainable Development Goals of 2015 seek to conserve and restore forests and other ecosystems by 2020 (Goal 15).
- The Bonn Challenge has pledged to restore 150 million hectares of degraded land by 2020. The Bonn Challenge is supported by regional restoration initiatives: Initiative 20x20 commits to restoring 20 million hectares in Latin America and AFR100 pledges a further 100 million hectares to be restored in Africa.
- The New York Declaration on Forests of 2014, a political declaration endorsed by more than 130 governments, companies, civil society, and indigenous peoples' groups, has set an ambitious goal to halt natural forest loss by 2030, and—building on the Bonn Challenge—to restore 350 million hectares by 2030.
- The Tropical Forest Alliance 2020, a global public-private partnership, seeks to reduce tropical deforestation associated with agricultural commodities.
- Regional efforts, such as the European Union's Forest Law Enforcement, Governance, and Trade Action Plans, seek to address the problem of illegal logging.
- Various other efforts are driven by civil society and private actors in the context of sustainable supply chains, such as commodity roundtables and global corporate initiatives.

For many governments, REDD+, the internationally adopted approach to reduce forest sector emissions from forests, is the most important strategy to achieve their mitigation targets. REDD+ also provides an important basis for cooperation between high-income and developing country governments.

Under the recently adopted Paris Agreement, all countries are called upon to define and communicate their contributions to global efforts to mitigate climate change; it is widely acknowledged that such contributions will include forest-related emission reductions and removals. The Paris Agreement provides, for the first time, a universal, albeit nonbinding, framework applicable to *all* countries to increase actions on climate change (see box 1 for details). The agreement anchors the REDD+ mechanism and refers to the United Nations Framework Convention on Climate Change (UNFCCC) mandate for sustainable management, conservation, and enhancement of biological carbon reservoirs.

Considering the mitigation potential in many countries, it is expected that forests will play an important role in global climate action, and that incentives should be provided to countries for reducing emissions (or sequestering carbon) from forests now, as well as beyond 2020. Many countries view reducing carbon emissions from forests as a valuable mitigation strategy—as forest protection is consistent with sustainable development goals. Forests provide goods and services, especially for rural communities.

For these reasons, efforts to define a framework for REDD+ have progressed relatively far compared with other issues treated under the UNFCCC. Since the Bali Action Plan (COP13, 2007)

Box 1: HWP and REDD+

- Builds on voluntary process and progressive ambitions, defined by countries in the context of their Nationally Determined Contributions (NDCs), which need to be specified and translated into concrete activities; the agreement foresees an increase in ambition over time.
- Provides a mechanism for countries to achieve their NDCs jointly and a mechanism for countries to cooperate in achieving NDCs. Countries can meet their NDC targets by transferring “mitigation outcomes” internationally—in the context of emission trading or results-based finance.
- Through the accompanying United Nations Framework Convention on Climate Change decision, establishes a collective climate finance goal of US\$100 billion per year to 2025, and beyond 2025 with US\$100 billion as a floor—to be channeled in part through the Green Climate Fund.
- Provides for public and private entities to support sustainable development projects that generate transferrable emission reductions. Similar to the Clean Development Mechanism, the Mechanism for Sustainable Development is open to private and public sector participation.

first recognized the importance of reducing forest-related emissions, there have been 12 specific Conference of the Parties (COP) decisions related to REDD+. These decisions have covered everything from creating a broad framework for undertaking REDD+ actions (for example, creation of a national strategy, need for a robust forest monitoring system, and guidance on safeguards), to technical guidance for measuring results in the context of receiving results-based finance (RBF). The Parties already agreed at COP16 in 2010 that REDD+ implementation takes place in three phases, starting with technical and institutional capacity building (Phase 1 or “readiness”), followed by policy reform and demonstration activities (Phase 2 or “implementation”), to full implementation and reward for emissions reductions (Phase 3 or RBF). COP21 in 2015 articulated the importance of achieving a balance between sources and removals of greenhouse gases, which implies an important role for afforestation and reforestation.

As such, the Paris Agreement and various ambitious pledges and initiatives set the stage for mitigation opportunities in forestry and timber production. The initial plans adopted by developing countries also indicate that REDD+ and the forest sector will play a role.⁴ To date, several dozen forest countries have initiated large-scale REDD+ programs and are in the process of establishing the systems to access RBF as well as the capacity to address deforestation drivers and promote sustainable forestry.

Recognizing that compliance with REDD+ requirements is still a challenge for many countries, international donors continue to support REDD+ countries through several pilot initiatives: the Readiness Fund of the Forest Carbon Partnership Facility (FCPF) and the United Nations-REDD Program, both focusing on Phase 1 activities; the Forest Investment Program (FIP), primarily funding Phase 2; and the FCPF Carbon Fund and BioCarbon Fund, providing finance for Phase 3. In addition, the bilateral programs of Norway, the United Kingdom, Germany, and other countries also provide finance for implementing REDD+. REDD+ pilot finance is complemented by other sources of climate and environmental finance targeted at the forest sector, including the Global Environment Facility, the Green Climate Fund, and other targeted funding by multilateral banks. Annual disbursements

⁴ The majority of the Intended NDCs (at least 115 of 160 submitted) make specific reference to the sector, mentioning relevant mitigation activities such as afforestation or reforestation, REDD+, sustainable forest management, fire management, or improved cook stoves. One country, Costa Rica, mentions harvested wood products in its NDC.

of Official Development Assistance (ODA) to the sector range between roughly US\$400 million and US\$800 million (2002–14; OECD 2016). ODA is mostly targeted at productive uses and conservation of forests, for example, community forestry, biodiversity conservation, plantations and sustainable logging, and environmental services (Singer 2016). Table 1 provides an overview of different financing instruments relevant to the forest sector.⁵

This allocation of finance indicates that REDD+ support has mainly focused on establishing the systems to access RBF (Phase 1) on the one hand, and commitments for RBF (Phase 3) on the other. Sustainable land use is often constrained by complex political and economic issues, such as the lack of capacity to enforce laws or engage the private sector. Conditional finance can incentivize countries to take action, and strengthens ownership of programs. Several years of pilot experience show that few countries have the budget or financial means for advancing funds to achieve REDD+ benefits that will be awarded by RBF ex post. Moreover, the setup of RBF systems requires considerable time, due to capacity limitations in recipient countries, but also the complexity of donor modalities that still leave important questions unsolved (for example, related to risks).

As a result, there is a clear need for additional investments (Phase 2) and to increase REDD+ support through FIP or other ODA targeted at the forest sector. Recent momentum and pledges offer a window of opportunity for mobilizing additional finance. Taking a comprehensive approach toward sustainable development and green growth, the incentives should target the protection of forests as well as the productive development of the forest sector.

In the context of productive forestry, many programs currently under preparation appear to be limited in scope. Most REDD+ plans are focused on activities in the forest (afforestation, reforestation, and sustainable forest management), and few consider the development of supply chains beyond timber production or plan to account for carbon storage in harvested wood products (HWP). Although HWP accounting faces technical challenges (for example, related to data availability), the issue has not been discussed in the REDD+ context, and it is unclear whether donors are inclined to pay for emissions reductions from this carbon pool.⁶

⁵ Sources: FIP: <https://www.cif.climateinvestmentfunds.org/fund/forest-investment-program>, <http://climatepolicyinitiative.org/wp-content/uploads/2016/06/The-role-of-the-Climate-Investment-Funds-in-meeting-investment-needs.pdf>;
Global Environment Facility: <https://www.thegef.org/gef/SFM>;
FCPF Readiness Fund: <https://www.forestcarbonpartnership.org/about-fcpf-0>, <http://climatepolicyinitiative.org/wp-content/uploads/2016/06/The-role-of-the-Climate-Investment-Funds-in-meeting-investment-needs.pdf>, <http://www.forestcarbonpartnership.org/sites/fcp/files/2014/october/FCPF%20Annual%20Report%202014.pdf>;
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Green Climate Fund: <http://www.greenclimate.fund/contributions/pledge-tracker>, <http://climatepolicyinitiative.org/wp-content/uploads/2016/06/The-role-of-the-Climate-Investment-Funds-in-meeting-investment-needs.pdf>, <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10066.pdf>;
MDB: http://www.worldbank.org/content/dam/Worldbank/document/Climate/Joint%20MDB%20Statement%20Climate_NOV%2028_final.pdf, https://ieg.worldbankgroup.org/Data/reports/chapters/forest_eval2.pdf.

⁶ For example, the Methodological Framework of the FCPF Carbon Fund does not explicitly foresee or exclude HWP accounting. In its Program Document submitted to the FCPF Carbon Fund, the Democratic Republic of Congo proposes to account for HWP as a carbon pool, justifying its inclusion as conservative and following the Verified Carbon Standard's Jurisdictional and Nested REDD+ Framework.

Table 1: Multilateral Sources of Finance for Forestry

Instrument	Objective	Type of finance	Funds under management	Special windows
Forest Investment Program	Supports developing countries' programmatic investments in forest mitigation and REDD+ readiness efforts to access RBF	Input-based grants, loans, guarantees, or equity	Committed US\$771 million, of which US\$291 million was approved for implementation	Dedicated grant mechanism for indigenous peoples and local communities; dedicated private sector window
Global Environment Facility	Addresses global environmental issues and sustainable development objectives; serves as a funding mechanism for Rio and other conventions	Input-based grants or loans	Provided US\$14.5 billion in grants since 1992	Small grants program and private sector window
FCPF Readiness Fund	Supports countries in REDD+ preparation by providing financial and technical assistance to access RBF	Input-based grants	Committed US\$365 million and disbursed US\$79.6 million	N/A
FCPF Carbon Fund and BioCarbon Fund	Pilots REDD+ finance for jurisdictional programs	RBF conditional upon emissions reductions from forest ecosystems	Committed US\$692 million	N/A
BioCarbon Fund Initiative for Sustainable Forest Landscapes	Pilots REDD+ finance for jurisdictional programs taking a broader landscape approach	RBF conditional upon emissions reductions from REDD+ and the land sector	Committed US\$355 million and approved US\$170 million	N/A
Green Climate Fund	Will support developing countries in mitigation and adaptation actions	Flexible depending on fiduciary standards and abilities of implementing agencies	No information available	Private sector facility
Multilateral development banks	Provide support to development of the national forest sector in borrowing member countries	Grants, loans, guarantees, and investments via private sector branches	No detailed information available; the World Bank Group is the largest donor, and has committed approx. US\$2.8 billion since 2002; a similar amount in private sector financing is provided through the International Finance Corporation	N/A

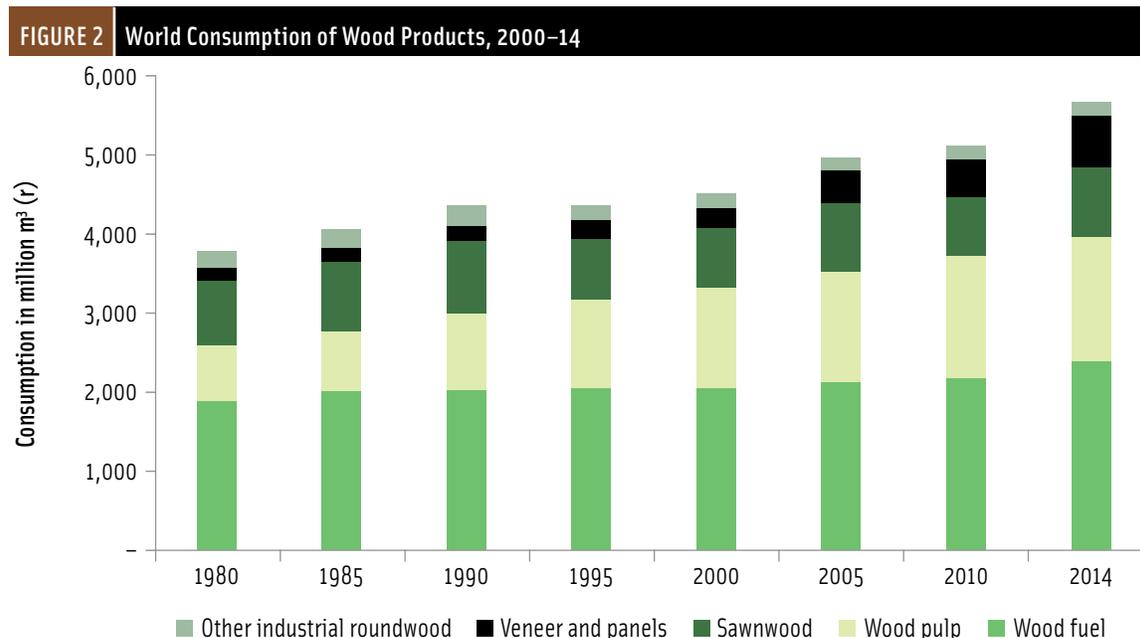
Note: FCPF = Forest Carbon Partnership Facility; N/A = not applicable; RBF = results-based finance; REDD+ = reducing emissions from deforestation and forest degradation.

2.2. International Market Developments and Investment Opportunities for the Private Sector

Recent trends indicate that the global market for wood products has recovered from the impacts of the financial crisis. Production for all major commodities is growing at a current rate of 1 to 5 percent, while exports are growing at a rate of 3 percent (2013–14), reaching US\$255 billion. Growth is particularly high in Asia Pacific and Latin America and the Caribbean (FAO 2015). Demand and consumption of wood products increased approximately 20 percent for all products from 2000 to 2014 (see figure 2), and is projected to increase by 210 percent by 2030, from 2010 levels (WWF and IIASA 2012).

Markets for wood products are strongly influenced by economic and development trends. Consumption broadly follows a U-shaped Kuznets curve: in poor communities, there is high demand for wood, as it is one of the few locally available and affordable raw materials. With rising income and market access, consumers tend to prefer materials such as concrete, steel, and metal. As a national economy continues to grow and affluence increases, consumers often return to high-quality wood products.

The growing international market for wood products points to attractive investment opportunities. During the past decade, the forest sector has seen a fast-growing inflow of international private investments. The majority of the funds are invested in high-income countries (such as the United States and Canada), but this trend has started to shift in recent years (Singer 2016). Large-scale private



Note: The Food and Agriculture Organization defines wood products as follows. Veneer: thin sheets of wood of uniform thickness, not exceeding 6 millimeters, rotary cut (peeled), sliced, or sawn. This includes wood used for the manufacture of laminated construction material, furniture, veneer containers, and so forth. Sawnwood: wood that has been produced from domestic and imported roundwood, by sawing lengthwise or by a profile chipping process that exceeds 6 millimeters in thickness. This includes planks, beams, joists, boards, rafters, scantlings, laths, boxboards, "lumber," and so forth, in the following forms: unplanned, planned, end-jointed, and so forth. This excludes sleepers, wooden flooring, moldings (sawnwood continuously shaped along any of its edges or faces, like tongued, grooved, rebated, V-jointed, beaded, molded, rounded, or the like), and sawnwood produced by re-sawing previously sawn pieces. Wood pulp: fibrous material prepared from pulpwood, wood chips, particles, or residues by mechanical and/or chemical processes for further manufacture into paper, paperboard, fiberboard, or other cellulose products. This is an aggregate comprising mechanical wood pulp, semi-chemical wood pulp, chemical wood pulp, and dissolving wood pulp. Industrial roundwood: wood in the rough other than sawlogs, veneer logs, and/or pulpwood. This includes roundwood that will be used for poles, pilings, posts, fencing, pitprops, tanning, distillation, match blocks, and so forth.

investments in forest plantations in developing countries are estimated at US\$1,763 million in 2011. The bulk of investments went to industrial pulpwood production and a few countries, including Brazil, Uruguay, and China (Castrén et al. 2014). It was estimated that between 2008 and 2010, foreign direct investment for wood and wood processing was more than US\$2.5 billion for developing countries (roughly one-third for China) and US\$1 billion for transition economies in Eastern Europe and the Russian Federation (Singer 2016).

There is widespread consensus about the need to scale up private investments in developing countries, but there are considerable barriers that impair such investments, including the following:

- Land tenure insecurity and complicated land use regulations make it difficult for project developers to identify appropriate areas for productive forests. In some countries, technically suitable land is owned by the state, while in others it is controlled through community management entities. Some countries are in the process of redefining land use regulations and regulatory agencies, which creates uncertainty for investors.
- Infrastructure is often underdeveloped, increasing the costs of accessing national and international markets.
- Technical forestry management skills are often low and limit the private sector's ability to depend on local experts. Existing plantations seldom have high productivity.
- Access to finance with suitable terms for forestry investments is extremely limited. Some requirements for financing—such as collateral requirements—are prohibitively onerous. Companies are forced to self-finance investments, limiting the growth of the HWP sector.
- Information about market conditions and investment opportunities often is not publicly available, making it difficult for companies to make investment decisions.
- In some countries, the HWP sector is undeveloped throughout the supply chain, creating uncertainty for private sector actors that rely on other parts of the supply chain. Uncertainty around accessing raw material may make it difficult for sawmills to expand processing capacity, for example.
- Many barriers are not specific to HWP production. Internal violent conflict and pervasive corruption are two examples that increase the cost of doing business.

Of the various forestry subsectors, *wood-based panels and sawnwood* offer the greatest potential for private sector investment and climate change mitigation. Closely tied to global economic development, both products benefit from the recent recovery of the construction and furniture sectors. In both cases, products find end users in international and national markets, and are thus less affected by negative economic developments in key importing countries (such as China or the United States). HWP store carbon for much longer time periods and therefore have the greatest mitigation capacity.

Pulp and paper markets are highly competitive, concentrated in countries with paper production capacity, and require high levels of upstream and downstream integration. Processing usually requires large investments (on the order of several billion dollars) and is profitable in locations with low-cost access to water, energy, and high-quality land. The large market volume, low correlation with negative economic trends, and potential to substitute packaging materials based on mineral oil offer certain opportunities.

Investing in *fuelwood* operations is often the least attractive, because of informality, lack of aggregation, and consumers' low purchasing power. Incentives through climate policies in regulated markets (such as the European Union Renewable Energy Directive) have spurred investments in wood pellets for export to overseas markets, such as the United States.

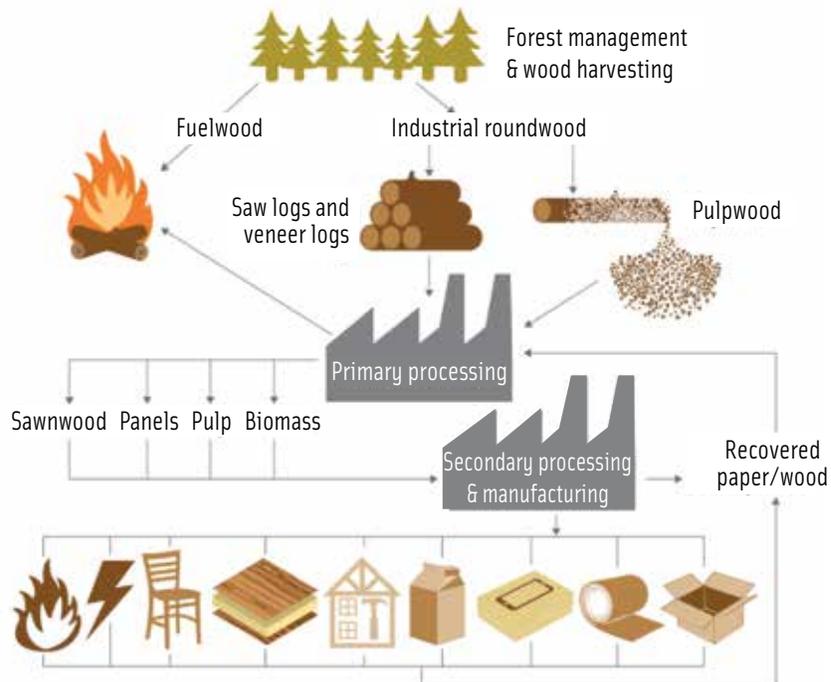
3. Approach for the Country Analysis and Business Cases

3.1. Forest Supply Chains and Mitigation Potential

The manufacture of forest products involves many steps along complex supply chains that make direct and indirect contributions to climate change mitigation and the green economy. The steps include establishment, management, harvesting, processing, distribution, consumption, and disposal or recovery of products. Harvested wood from forests or plantations is first converted to primary products, such as sawnwood, panels, pulp, or biomass, and then further processed into secondary and final products to be used for a variety of purposes, such as construction, furniture, and energy (see figure 3).

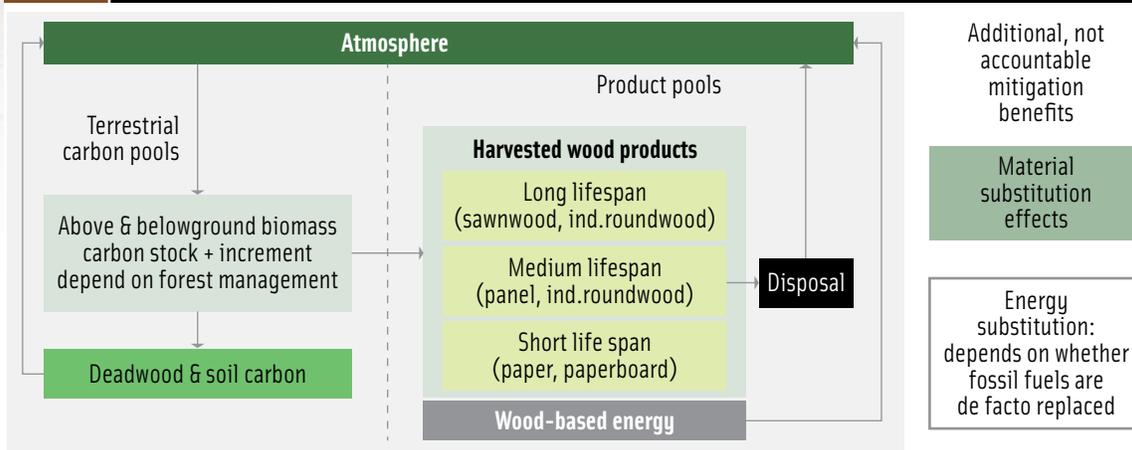
Productive forest supply chains can contribute to mitigation through several processes. There are potential mitigation gains from more efficient use of fuelwood (for example, through sustainably produced charcoal and biochar). However, generally a “cascade use” of wood (use as harvested wood products (HWP), followed by recycling into other products, and finally energy use) optimizes the mitigation contribution. When trees are harvested as HWP, wood biomass continues to store its accumulated carbon for the lifespan of the product. This is known as an extended boundary system, as opposed to the closed carbon cycle that takes place in an entirely unused forest. Depending on the lifecycle of the wood product (its use, recycling, disposal, and durability), carbon storage can range from immediate release (fuelwood) to release centuries later (construction). Other processes, such as

FIGURE 3 Overview of the Forest Supply Chain



Source: WWF and IIASA 2012.

FIGURE 4 Forest Carbon Cycle with Extended System Boundary



Source: Adapted from Pistorius 2007.

energy use during manufacturing and transport of wood products, or methane emissions from decay in anaerobic landfills, also lead to lifecycle emissions. At the end of the product lifecycle, recycling can prolong carbon storage and provide material for secondary products, especially cardboard and paper. When the product material is disposed of and decomposed, carbon is released back into the atmosphere or into the soil, as represented by the black arrows in figure 4. This study focuses on the red, underlined sections in the figure.

Additional mitigation contributions are achievable if forestry activities provide economic alternatives and help address the drivers of deforestation and forest degradation. Better practices, such as reduced-impact logging, can directly reduce emissions from degradation and protect soil carbon pools. However, it is important to consider that some processes in the forestry supply chain, especially transport and processing, can lead to significant greenhouse gas (GHG) emissions, potentially offsetting benefits from carbon storage or substitution.

In contrast to the direct mitigation effects of the carbon stored or conserved in forests, quantification of the indirect mitigation effects is more challenging. Wood products can be substitutes for other materials, such as concrete or metal for construction or fossil fuel energy sources that would otherwise lead to higher GHG emissions. Material substitution effects are highly plausible and have high potential for mitigation; for example, substituting wood for materials that are highly energy intensive to produce, such as concrete, aluminum, and steel, could provide mitigation benefits. While the production of one square meter of a wood-based outer wall leads to the emission of 7.8 kilograms of carbon dioxide equivalent (CO₂e), producing one square meter of a concrete-based wall emits 117 kilograms of CO₂e, which is 15 times more (Albrecht et al. 2008).⁷

Another important use of HWP is for energy, or fuelwood. Globally, burning fuelwood represents 2 percent of GHG emissions (Sekar and Siikamaki 2015) and 25 percent of “black carbon” emissions (Bond et al. 2007). Fuelwood is an inefficient source of energy, and becomes even more so when combusted at suboptimal conditions. Moreover, aside from climate change considerations, burning fuelwood is a major public health concern, as indoor air pollution kills between 3.5 million and 4.3 million people per year (Gordon et al. 2014).

⁷ Staff calculations based on the production of a frame structure of 108 square meters.

There are two primary strategies for reducing the GHGs associated with the use of fuelwood for energy. First, by improving fuelwood combustion technologies, fuelwood users can use less wood to generate the same amount of energy. Improved technology for fuelwood consumption can take many forms, from household cookstoves, to charcoal kilns, to industrial biomass plants. Second, the GHG emissions from fuelwood consumption can be reduced by improving the sustainability of the supply of fuelwood. Currently, fuelwood is often harvested from forests and other natural ecosystems, making it a driver of deforestation and forest degradation. Increasing the supply of fuelwood from plantations, woodlots, sustainably managed natural forests, and other productive forests would reduce emissions from the sector.

However, this analysis has not calculated the mitigation potential of improving technologies or the sustainability of supply. Others have estimated the technical mitigation potential of improved cookstoves to be approximately 1 billion tons of CO₂ per year, or 1 to 3 tons of CO₂ per stove. Although increasing the supply of sustainable fuelwood has great potential, this area of mitigation is excluded from analysis because of inadequate availability of data. The use of fuelwood for energy releases sequestered carbon as CO₂ emissions, so ultimately whether energy use is beneficial for mitigation depends on the circumstances, especially the energy source that the fuelwood replaces. There is not enough information about the sources of fuelwood in the six study countries to estimate the mitigation potential with confidence. Therefore, the analysis focuses on the undisputed benefits of wood used as a material.

Figure 5 provides a summary of strategies that can promote mitigation benefits along the supply chain, building on the previous discussion.

Table 2 provides a qualitative assessment of the mitigation potential of HWP, considering different uses. Supply chains for sawnwood and panels offer large mitigation potential, especially for products with long lifetimes and when substituting for materials that have high emissions intensity.

3.2. Methodological Approach

3.2.1 Country Analyses

The country analyses in this section assess the mitigation potential of the forest sector-based supply chains in six countries: Colombia, Ethiopia, Mexico, Mozambique, Peru, and Vietnam, which were selected for several reasons. The countries represent Africa, Latin America, and Southeast Asia, and

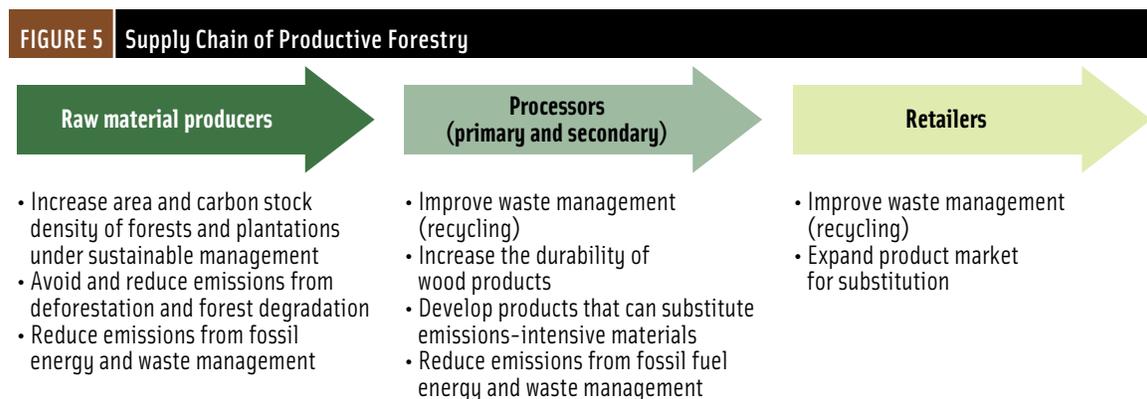


Table 2: Mitigation Potential for Supply Chains

Primary product	Mitigation potential from carbon storage	Mitigation potential from material and energy substitution
Fuelwood	<ul style="list-style-type: none"> Limited due to immediate combustion 	<ul style="list-style-type: none"> Although in the accounting logic calculated with emission factor “0” combustion releases the captured CO₂e, fuelwood takes a longer time to sequester than to emit (so there is asymmetry of sequestration—slow in, fast out) Low, especially if a country’s energy mix is predominately based on renewables (for example, hydropower) High, if fuelwood collection is a significant driver of deforestation and forest degradation
Paper and paperboard	<ul style="list-style-type: none"> Low due to short lifetime 	<ul style="list-style-type: none"> High for substitution of plastic and metal packaging
Sawnwood	<ul style="list-style-type: none"> High due to long lifetime in permanent construction and furniture Low for auxiliary uses (such as casings) or packaging, due to shorter lifetime 	<ul style="list-style-type: none"> High for substitution of concrete, metal, and plastic in construction and furniture
Wood-based panels	<ul style="list-style-type: none"> Medium to high, depending on panel type and end use Lower for other uses (such as casings) or in packaging, due to shorter lifetime 	<ul style="list-style-type: none"> High for substitution of concrete, metal, and plastic in construction and furniture

span diverse ecological zones. In addition to being geographically diverse, their economies and forest sectors are at different levels of development. Furthermore, there is public sector support and private sector interest in the potential of these countries. Last, it is expected that the forest sector in these countries will grow significantly in the years to come.

Demand for HWP was a key variable in assessing the forestry mitigation potential in the six countries. To estimate each country’s potential mitigation effects for forestry-based supply chains, a green growth scenario was developed, which envisions future demand for HWP being met by increasing domestic production (an overview is given in the annex). The term “green growth” is used because the proposed green growth scenario aligns economic growth with environmental benefits by increasing the use of environmentally sustainable investments.

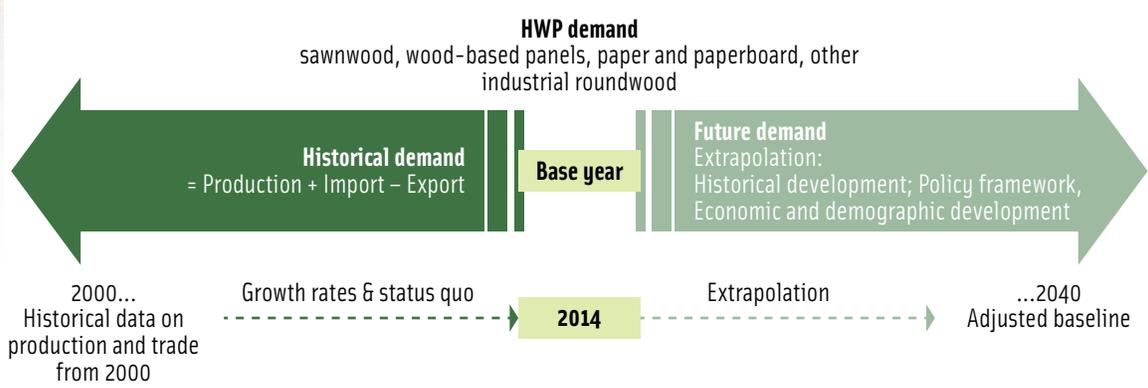
Demand for HWP (including sawnwood, wood-based panels, paper and paperboard, and other industrial roundwood) in 2040 was estimated using a simple modeling approach based on historical patterns, reasonable future policy targets, and World Bank indicators for demographic and economic development (see annex 7.12 for a detailed list of the parameters and model description).

Figure 6 shows the general approach for modeling the future demand for HWP.

The demand for HWP was extrapolated using trend parameters (see annex, table 18), independent of any supply considerations. The basic assumption in the green growth scenario is that countries’ domestic forest sectors would meet increased demand for roundwood by increasing domestic production by 2040. The enhancement of roundwood supply is assumed most likely to be achieved with productive forests.

In each country, specific assumptions were defined for species, mean annual increments, thinnings, and final harvests (see annex, table 19). Forest plantations were categorized into two types: those with

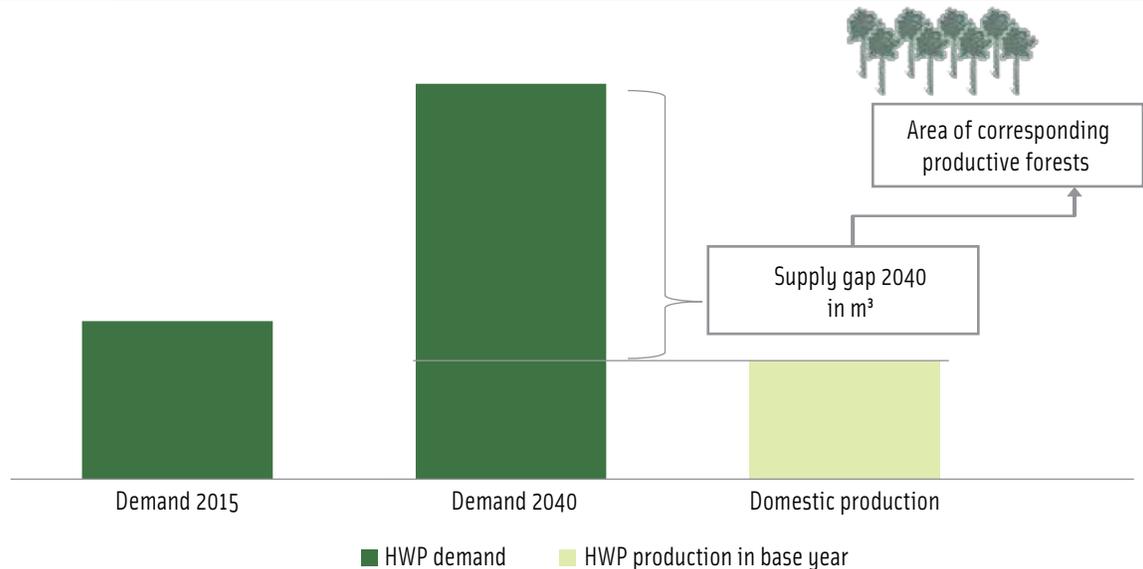
FIGURE 6 Green Growth Modeling Approach



long rotation periods to produce sawlogs, and those with short rotation periods to source paper, panels, and other industrial roundwood. Extraction volumes from productive forests were modeled based on future demand in the green growth scenario. Based on these volume extraction assumptions, a total area of productive forests was estimated to meet this volume (see figure 7). This is a biophysical potential and it is important to note that meeting these area and volume targets would require large changes to countries' forestry and HWP processing policies and the private sector investment environment.

The mitigation potential was then calculated based on the HWP volume consumed and area needed under the green growth scenario. The mitigation effects of HWP and supplementary forest resources were estimated using a stock change approach, generally following guidelines from the Intergovernmental Panel on Climate Change (IPCC), but simplified to suit the focus and structure of the study. Additional mitigation benefits were estimated considering the avoidable emissions in the construction sector, by using HWP to fill the supply gap instead of using other materials, such as

FIGURE 7 Model of Future Wood Supply from Productive Forests



Note: HWP = harvested wood products; m³ = cubic meters.

brick, steel, and concrete.⁸ The substitution effects were calculated with a substitution factor⁹ for wood products in the construction sector, resulting from a meta-analysis of German timber markets. For each ton (t) of carbon in a wood product (about 4 cubic meters), 1.5 t of carbon emissions (5.5 t CO₂) are avoided (Knauf et al. 2015). Data from Germany were used because country- and product-specific data on substitution factors are largely lacking.

The initial step in estimating the HWP contribution in the six countries approximated the carbon stock in HWP for base year 2014, using the average carbon inflow during 2012–16 and default values from the IPCC for first-order decay and product half-lives. The carbon stocks and annual changes in carbon stocks for HWP pools until 2040 were then estimated based on IPCC default values, according to an equation that factors in the yearly inflow and rate of decay for each HWP category. Carbon stock changes were estimated by taking the difference between sequential carbon stocks, all based on IPCC default values (see annex 7.2 for the equations and defaults).

The IPCC default values for paper, wood panels, and sawnwood were complemented by estimated values for other industrial roundwood, which was added as an HWP category.

The mitigation effects from productive forests were calculated as the average change in carbon stock during the total project period, reflecting planting, thinning, harvesting, afforestation, and country-specific growth patterns. The mitigation effects from natural forests and the substitution effects were not considered in the estimations.

IPCC default values were applied to HWP half-lives, carbon storage in HWP, and productive forests, to calculate the GHG mitigation effects. These default values do not reflect the real half-lives of HWP in the study countries (that is, the other industrial roundwood category has a much shorter half-life in Ethiopia than in Colombia) or the carbon storage potential in forests. The latter strongly depends on site-specific growth parameters and applied management practices, which vary significantly, but can only be assessed in detail if the exact location of the forest resource is known.

Only certain HWP supply chains were considered in the country analyses and mitigation potentials. Fuelwood supply chains were excluded, because fuelwood is considered to oxidize within the year of harvest and therefore has no impact on the carbon stock change of HWP.

Data availability for the six study countries varied on actual and future HWP consumption patterns and economic information on value added and employment in the forest supply chain. To obtain comparable data sets for the six countries, production and trade data from the Food and Agriculture Organization (FAO) were used to establish historical HWP consumption trends, recognizing that this information is limited for certain countries and frequently based on estimates. Using FAO data sets can be considered a conservative approach to estimate real consumption figures.

Wherever possible, the data sets and performance indicators were complemented by information from UNIQUE's forestry and plantation databank, available studies, primary data, and policy frameworks (for example, the Ethiopia Forest Sector Review, Mozambique Forest Investment Climate study, Mexico Natural Forest Program, Peru Forest Value Chain study, Colombia Plantation Value Chain study, and Vietnam Forest Carbon Partnership Facility (FCPF) REDD+).¹⁰

⁸ Substitution effects occur when HWP are used to displace products of equal utility but higher emission factors. Following the idea of additionality in carbon markets, carbon credits are not applicable to GHG mitigation activities that would result from status quo behavior.

⁹ Substitution factor = (carbon emissions use of non-wood products—carbon emissions use of wood products) / (carbon content of wood products).

¹⁰ REDD+ stands for reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks.

Economic information on value added and employment in the forestry supply chains was derived, where possible, from national accounts statistics, the FAO, and UNIQUE's database.

The country-specific analysis databases and input values are documented in the annex.

3.2.2 Business Cases

Independent of the economy-wide country cases, example business cases were developed for each country. The business cases demonstrate the potential investments that public and private actors could make to support the sector, and use country-specific data to estimate investment costs, productivity, revenues, and social and environmental benefits. The business cases also consider investment barriers in each country, and how donors can help to overcome these barriers and catalyze private sector investment.

3.2.3 Contribution of HWP to Nationally Determined Contributions and Forest Landscape Restoration

Section 5 compares the mitigation potential of HWP with countries' Nationally Determined Contributions and forest landscape restoration (FLR) commitments. In addition, the report includes in this analysis the potential for reducing emissions by eliminating deforestation and degradation.

The report estimated the potential to reduce emissions from deforestation and degradation from countries' national Forest Reference Emission Levels (FRELs), which are submitted to the United Nations Framework Convention on Climate Change. The FRELs are annual estimates for 2015 or 2016. Because Mozambique has not yet submitted its FREL, the analysis uses an estimated mitigation potential from reducing deforestation from the country's Emissions Reduction Project Idea Note. This estimate only covers the potential of one province and not the entire country, which is why the contribution of reducing emissions from deforestation is much lower for Mozambique.

The analysis also considers the mitigation potential of FLR commitments. To avoid double counting between these commitments and the green growth scenarios, the area needed for productive forests in the green growth scenarios is subtracted from countries' total Bonn Challenge commitments. The analysis assumes that the remainder of the area will be restored mainly for conservation or livelihoods, focusing on subsistence needs. As the Bonn Challenge commitments are cumulative until 2030, these values are annualized by assuming that carbon dioxide sequestration is spread evenly between 2011 and 2030. Vietnam has made national commitments to restore forest cover, but has not committed to the Bonn Challenge.



4. Synthesis of the Country and Business Case Studies

As shown in figure 8, the harvested wood products (HWP) potential of Colombia, Ethiopia, Mexico, Mozambique, Peru, and Vietnam is studied in this analysis. The annex provides details on the country case study analyses.

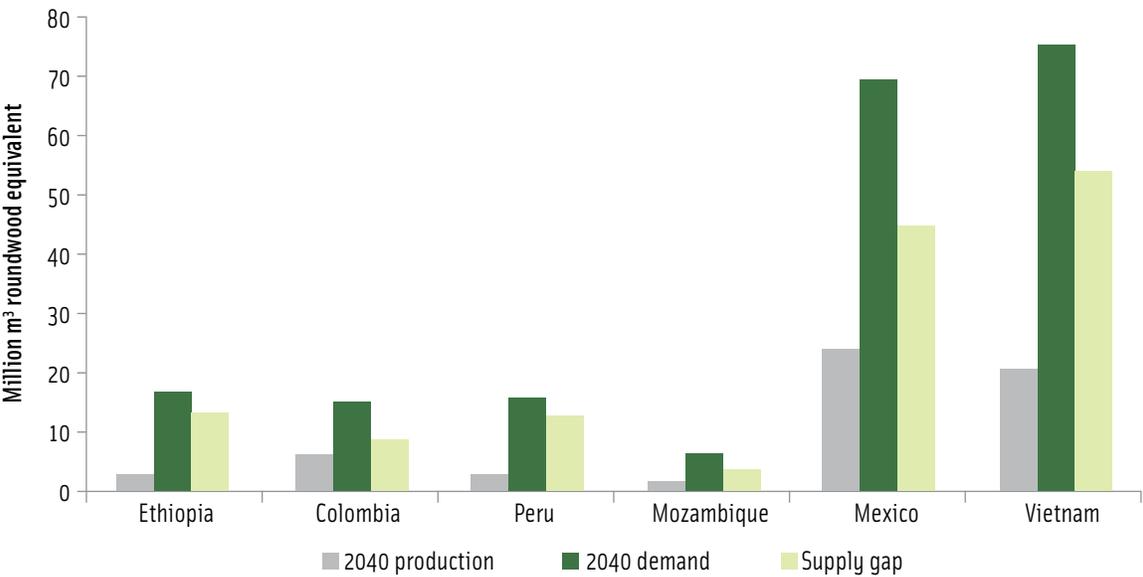
In the six countries, population and economic growth is increasing the demand for HWP, and these trends are projected to continue. However, because of poor land use regulations, underdeveloped forest management skills, immature forestry industries, the investment climate, and other reasons discussed in the country cases in the annex, HWP production is not likely to keep pace under current conditions. As a result, all the countries surveyed in this analysis are projected to have significant supply gaps in the production of HWP (figure 9).

Under the green growth scenario, the analysis assumes that the supply gap is met by increasing domestic production of HWP. Achieving this goal would have significant climate change mitigation benefits (figure 10). Vietnam has the largest mitigation potential, followed by Mexico and Ethiopia. HWP substitution effects provide the greatest mitigation benefit. Additional sources of sequestration potential differ by country; Vietnam, for instance, has the greatest potential to mitigate climate change through sawnwood production, and Ethiopia and Mozambique have much more potential to produce other industrial roundwood. Figure 10 distinguishes between carbon dioxide equivalent (CO₂e) stored in HWP, CO₂e sequestered in the corresponding area of productive forests, and CO₂e of avoidable emissions from substitution effects.

FIGURE 8 Countries Studied



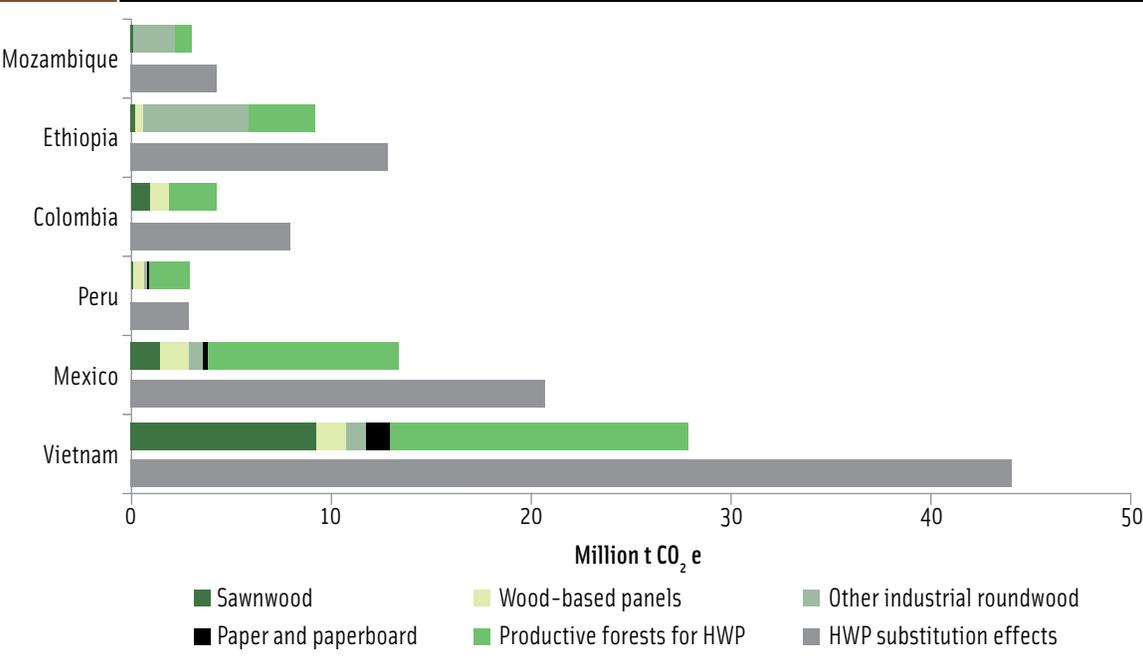
FIGURE 9 Projected HWP Supply Gap in 2040 under Current Conditions



Note: HWP = harvested wood products; m³ = cubic meters.

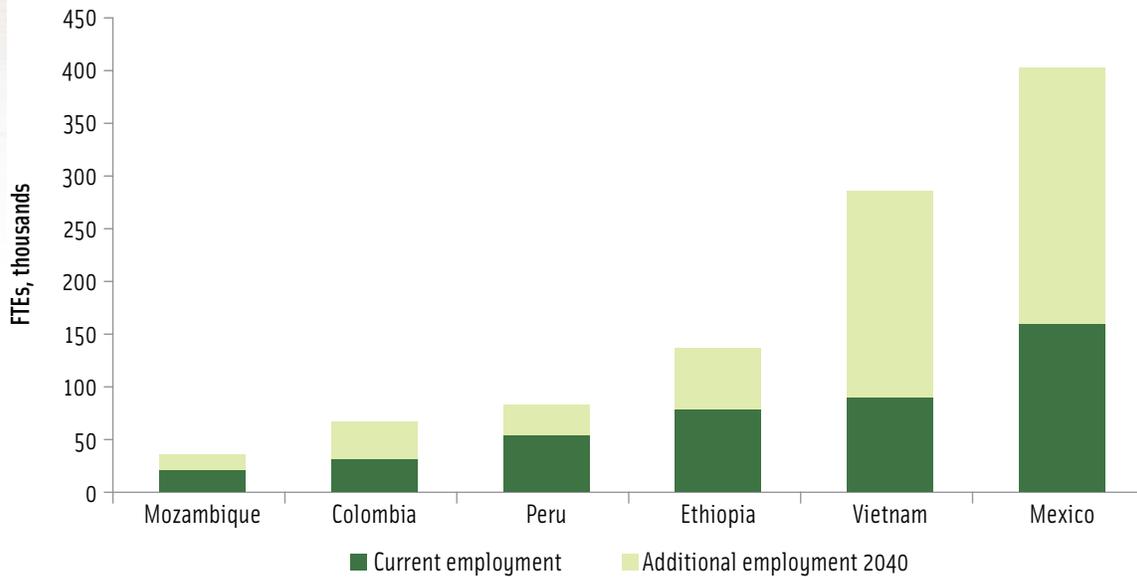
Although plantations for pulp and paper play an important role in some countries' mitigation benefits from HWP support, these figures should be considered carefully. In many countries, land prices, site conditions, and infrastructure create conditions that make it difficult for the pulp and paper industry to be profitable. Mexico, for instance, is unlikely to be able to establish profitably the necessary area for short-rotation plantations to support such growth in the pulp and paper sector.

FIGURE 10 Potential Mitigation Benefits of Green Growth in 2040



Note: HWP = harvested wood products; t CO₂e = tons of carbon dioxide equivalent.

FIGURE 11 Employment Benefits of the Green Growth Scenario

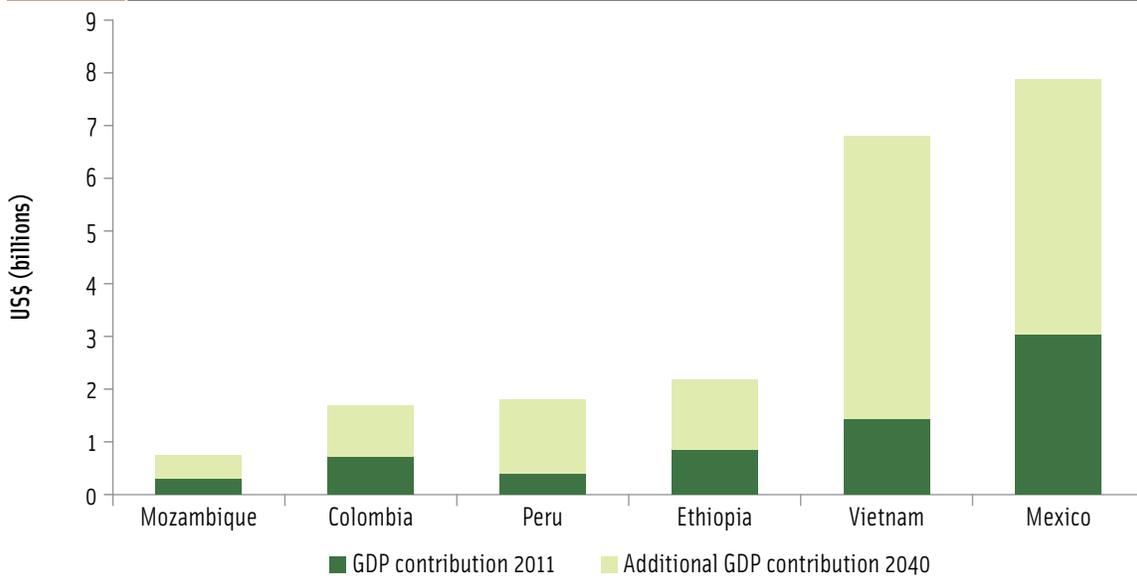


Note: FTE = full-time equivalent.

Moreover, the effects of recycling techniques and availability of alternative fiber (for example, from agriculture) make it difficult to quantify this subsector. In addition, the mitigation potentials generated from paper products are marginal compared with other HWP. Thus, the potentials in this report represent biophysical potentials.

Beyond the potential to address climate change, investing in HWP can help countries to bolster their economies and adapt to climate change. Figures 11 and 12 show the estimated increase in

FIGURE 12 GDP Benefits of the Green Growth Scenario



Note: GDP = gross domestic product.

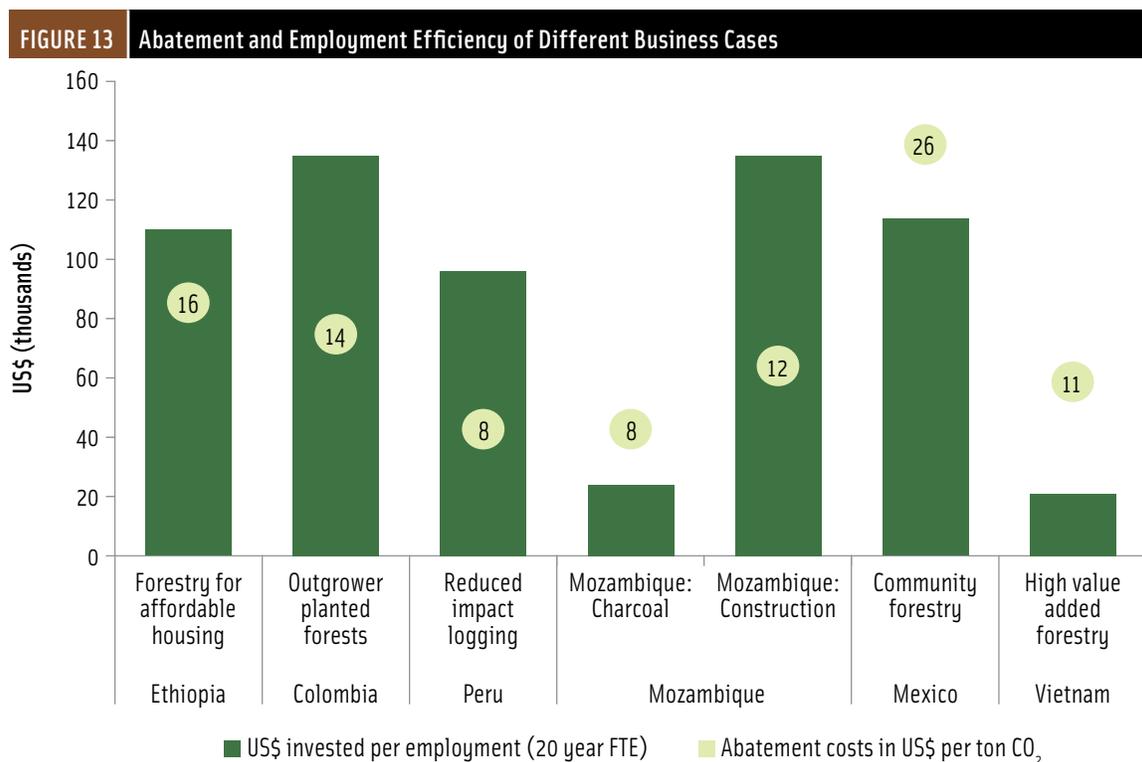
employment and the contribution of the forest sector to gross domestic product (GDP) under the green growth scenario discussed in the country studies.

All the countries show significant potential to boost economic growth through supporting the forest sector. Vietnam and Mexico would experience the greatest increases in forestry GDP and employment from forestry. Although Mozambique has the smallest absolute gain in forestry GDP, the relative growth of GDP would be significant when taking into account the current national GDP.

In addition to the countrywide estimates, the report also considers business cases for each country that detail a specific investment in the HWP sector and barriers that the project might face, which are described in the annex. Figure 13 provides indicative estimates of the efficiency of those investments in terms of jobs created and tons of CO₂e mitigated.

The business cases provide some insight into the investment context in the case study countries. For example, reduced-impact logging in Peru is known to have low abatement costs and low investment costs per job created, which reflects the low current efficiency of timber extraction in the country, and the potential to improve productivity substantially through building forestry capacity and enforcing local regulations. In Mozambique, charcoal production and HWP for construction have similar investment costs per job created, and charcoal production has a much lower abatement cost. Community forestry in Mexico has the highest abatement cost of any business case, which is reflective of the substantial upfront costs required to identify and establish productive forests.

The business cases also consider barriers to investment across countries, including lack of access to finance for investments in productive forests, insecure land tenure and complicated land use regulations, poorly developed infrastructure, insufficient technical forestry capacity, and bottlenecks in HWP supply chains from a generally underdeveloped sector.



Note: CO₂ = carbon dioxide; FTE = full-time equivalent.

5. Contribution of HWP Supply Chains to Nationally Determined Contributions and Forest Landscape Restoration

5.1. Forest-Based Contributions in Nationally Determined Contributions

The Paris Agreement of 2015 saw all countries commit to reducing their greenhouse gas (GHG) emissions, and many Nationally Determined Contributions (NDCs) assign a significant role to the land use sectors. This section discusses the potential of the forest sector to contribute to achieving the NDC targets.

Mitigation benefits related to harvested wood products (HWP) in the green growth scenario represent one of several important strategies to reduce emissions from land use change. Compared with other land use mitigation measures, HWP production offers an attractive opportunity to involve the private sector and catalyze investment in land use. As demonstrated in the country and business cases, there is significant potential for the private sector to invest across HWP supply chains in the study countries. Relatively small amounts of public sector finance (compared with the scale of the targets and required investment volumes) can be used to stimulate large private sector investment, while also enabling countries to take steps toward achieving their NDC objectives.

Apart from promoting HWP, two other important strategies for mitigating climate change in the land use sector are REDD+ and forest landscape restoration (FLR).¹¹ Reducing deforestation and forest degradation is an important strategy for many countries to reduce emissions from forestry and agriculture. Among many other objectives, one aim of FLR is to sequester GHG emissions through the restoration of degraded lands. In the Bonn Challenge, many countries made commitments to restore degraded land, including Ethiopia, Colombia, Peru, Mozambique, and Mexico. Although Vietnam has national plans to restore degraded lands, the country has not made commitments under the Bonn Challenge.

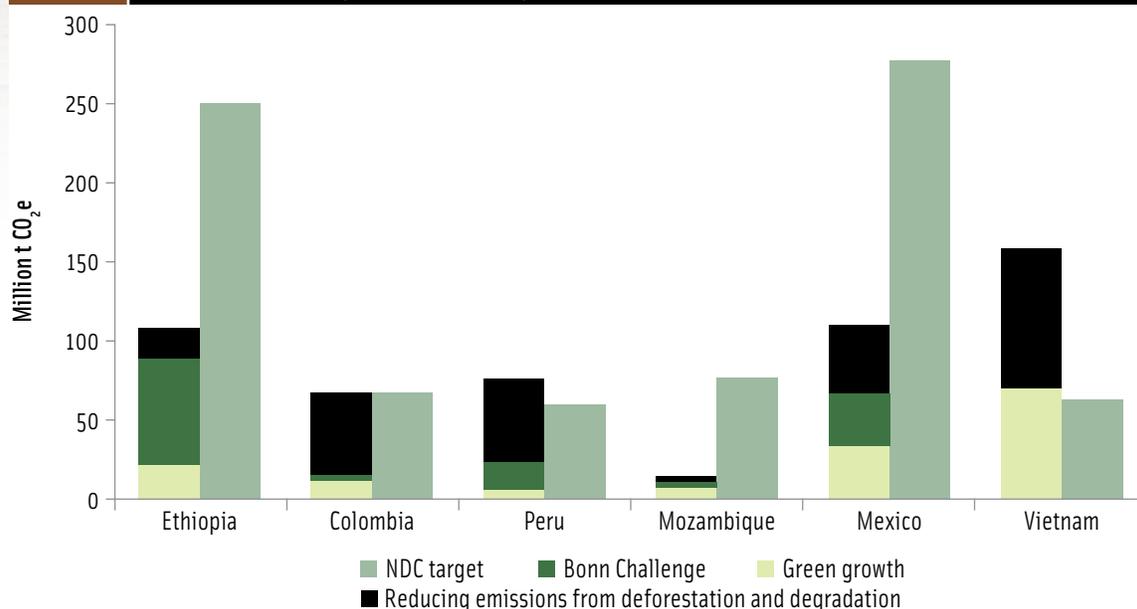
Figure 14 compares countries' NDC commitments with the mitigation potential of HWP, reducing emissions from deforestation and degradation, and meeting the Bonn Challenge. The mitigation potential of reducing emissions from deforestation and forest degradation is represented by countries' current emissions from land use change. The mitigation potential of Bonn Challenge commitments is adjusted so as not to double count with productive forests for HWP.

In the case of Ethiopia, restoration of degraded lands under the Bonn Challenge makes the largest contribution. Ethiopia's commitment under the Bonn Challenge is so large that even after significant expansion of productive forests for HWP, the country will have to restore more than 14 million hectares for other uses. Ethiopia can meet 43 percent of its NDC goal through land use changes.

The emissions reduction profiles of Colombia and Peru are similar in that addressing deforestation is the most important strategy for achieving the climate goals stated in their NDCs. In Colombia and

¹¹ REDD+ stands for reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks.

FIGURE 14 Potential of the Green Growth Scenario, Reducing Emissions from Deforestation and Forest Degradation, and the Bonn Challenge to Meet NDC Targets



Note: NDC = Nationally Determined Contribution; t CO₂e = tons of carbon dioxide equivalent.

Peru, respectively, 52 million and 53 million tons of GHG emissions will be avoided by eliminating deforestation. Colombia and Peru can reach 101 and 127 percent, respectively, of their NDC commitments.

Mozambique has the largest gap between the mitigation potential from land use change strategies and its NDC commitment; only 19 percent of its commitment can be achieved through supporting HWP, reducing emissions from deforestation and degradation, and the Bonn Challenge. The potential to reduce emissions through tackling deforestation can likely play a larger role than represented here, since the countrywide statistics are not available and the potential used in this analysis only covers one province.

Mexico has the largest NDC commitment of the study countries, at 275 million tons of carbon dioxide equivalent (t CO₂e) avoided in 2030. Reducing emissions from deforestation and degradation contributes to this, with the potential to reduce emissions by 44 million t CO₂e. Mexico can meet 40 percent of its NDC objective by improving land use.

Vietnam has the largest contributions from the green growth scenario and reducing emissions from deforestation, which contribute 70.4 million and 88 million t CO₂e, respectively. Reaching these goals would allow Vietnam to meet 251 percent of its NDC target. Vietnam has not made commitments to the Bonn Challenge. However, the country's Forest Development Strategy 2006–20 outlines plans to increase forest cover from 42 to 47 percent.

5.2. Increasing the Mitigation Potential of HWP

This section analyzes the HWP consumption that would be required to achieve 50 percent of the NDCs in the study countries. The calculations are based on the simplified assumptions that the additional

Table 3: Additional Wood Use and Area Required to Achieve 50 Percent of NDC Target

Wood use	Ethiopia	Colombia	Peru	Mexico	Mozambique	Vietnam
Wood consumption in 2030 according to the green growth scenario (million m ³ r)	12	13	14	65	5	51
Additional wood use to achieve 50% of NDC target (million m ³ r)	47	14	15	63	14	—
Productive forest area required to sustain wood production for green growth scenario (millions of hectares)	0.8	0.5	0.5	2.6	0.1	3.2
Additional productive forest area required to achieve 50% of NDC target (millions of hectares)	1.9	0.6	0.5	3.2	0.7	—
Total area	2.7	1.1	1	5.8	0.8	3.2

Note: The estimates assume that additional productive forests have a rotation period of seven years. Carbon pools in harvested wood products and avoided emissions are included in the estimates. m³ = cubic meters; NDC = Nationally Determined Contribution; r = roundwood.

wood use will be wood-based panels used to displace materials in the construction sector, and the raw material will be derived from short-rotation plantations (see section 3.2 for the methodology of substitution).

Table 3 illustrates the volume of HWP production needed to achieve 50 percent of countries' NDC commitments.

Vietnam already achieves its NDC target in the green growth scenario, so additional area is not needed. To achieve 50 percent of their NDC commitments through HWP, the other countries would have to establish significant areas: between 800,000 hectares in Mozambique and 5.8 million hectares in Mexico.

The establishment of productive forests for HWP production can also help countries progress toward meeting their Bonn Challenge goals. Table 4 compares the areas required for NDC commitments with the Bonn Challenge commitments.

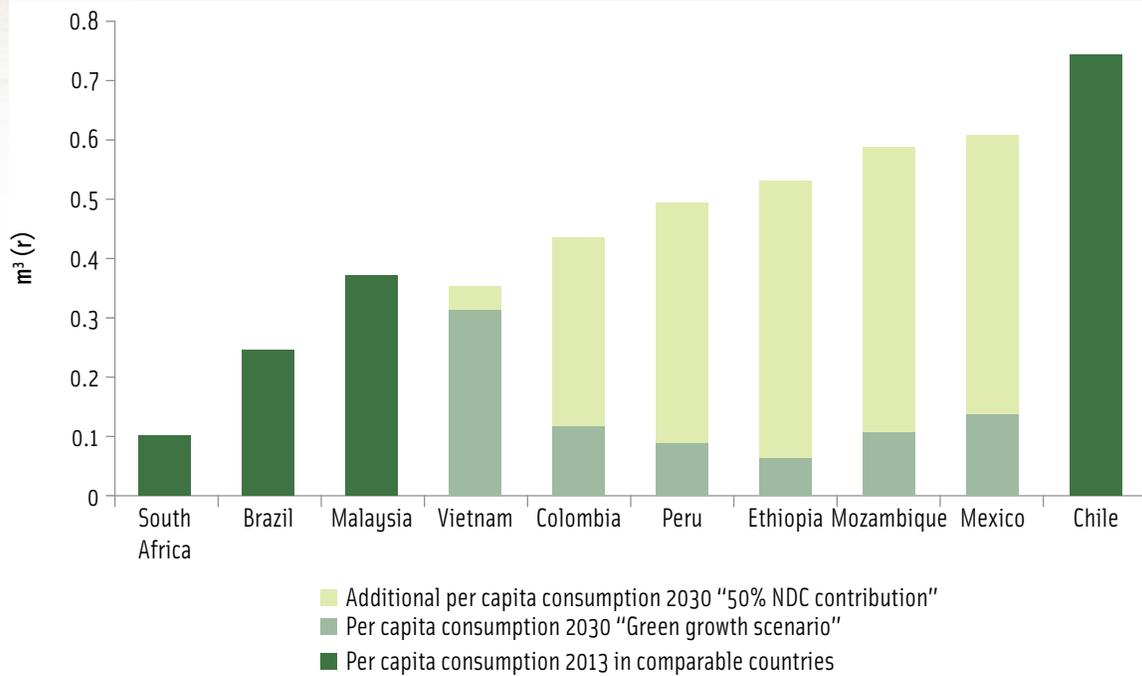
There is a large variety in how productive forest establishment would allow countries to meet their Bonn Challenge commitments. Colombia would exceed its commitment by 20 percent, and Mexico

Table 4: Bonn Challenge Commitments

Area required	Ethiopia	Colombia	Peru	Mexico	Mozambique	Vietnam
Bonn Challenge commitment (million hectares)	15	1	3.2	7.5	1	17 (national commitments)
Area share of Bonn Challenge commitment to achieve 50% NDC contribution of HWP (%)	23	120	31	83	90	20

Note: HWP = harvested wood products; NDC = Nationally Determined Contribution.

FIGURE 15 Actual Per Capita Consumption in Selected Countries Compared with the Per Capita Consumption Required to Achieve 50 Percent NDC Contribution in Study Countries



Note: Values are based on data from the Food and Agriculture Organization's ForestryStat. The calculation considers only sawnwood, wood-based panels, and other industrial roundwood. m³ = cubic meters; NDC = Nationally Determined Contribution; r = roundwood.

and Mozambique would achieve 90 and 83 percent of their commitments, respectively. Productive forest area in Vietnam would contribute the smallest proportion, at 20 percent of the country's commitment. Vietnam has not made a commitment to the Bonn Challenge, but has made national commitments to restoring degraded land.

Absorbing this additional HWP production through domestic demand would require substantial shifts in consumption patterns. Figure 15 compares projected per capita HWP consumption with the consumption needed for HWP to contribute 50 percent of the countries' NDCs.

Consumption in the study countries must reach the levels in upper-middle-income countries, such as Malaysia, or even the levels of high-income countries, like Chile. Especially for low-income countries, such as Ethiopia and Mozambique, such a significant increase is unlikely to be realized by 2030. Per capita consumption in the Latin American countries would need to increase by four to five times, but these changes are feasible given the countries' current income levels.

Perhaps the best strategy for increasing per capita HWP consumption is through the promotion of HWP in construction. The United Nations Habitat Program estimates that, by 2030, about three billion people, or about 40 percent of the world's population, will need proper housing and access to basic infrastructure and services, such as water and sanitation systems. This is an enormous challenge, as it would represent building 96,150 housing units per day from now until 2030 (UN-Habitat 2016).

Sustainable and climate-friendly building materials (wood, earth, bamboo, and natural fibers) play a crucial role in the scenarios to address the future housing demand (UN-Habitat 2016). Key national actors to implement programs to address the housing deficits and urban development must be informed of the technical and environmental potentials of sustainable construction materials. However,

Box 2: Challenges to Expanding the Use of Harvested Wood Products in Construction

- The use of wood in construction is perceived to be vulnerable to fire or less durable. Wood materials are sometimes seen as low status or associated with old-fashioned, low-income, poor quality housing.
- Construction supply chains and actors in those systems are accustomed to using brick, concrete, or other non-wood materials, and are resistant to introducing wood. Material supplier networks often do not provide harvested wood products (HWP).
- Regulations, such as fire safety regulations, may restrict the use of wood.
- Wood materials may be more expensive or unavailable.
- Barriers that constrain the general development of HWP production, such as poor infrastructure (discussed in detail in the country investment environment subsections in section 7), make it more difficult and expensive to access HWP for construction.

wood in urban construction is not yet widely used, because of the lack of technical knowledge and availability of adequate wood-based materials. A World Bank Program on Forests study on Cameroon and the Democratic Republic of Congo found that the lack of demand for legally sourced timber was a barrier to growth for furniture workshops (Cerbu 2016). Box 2 discusses key challenges to the use of wood in Europe and developing countries (Mahapatra and Gustavsson 2009; Falconer 1971). Among other barriers, misconceptions about the fire safety and durability of wood are commonplace in many developing countries, and restrict the use of wood in construction.

One strategy for overcoming these barriers is to require or incentivize the use of HWP in public housing programs. Box 3 discusses other policies and initiatives to increase the use of HWP (Ministry of Foreign Trade and Development 2010).

Although implementing these strategies to increase HWP production is significant and requires substantial investment, the alternatives for achieving the NDCs and Bonn Challenge commitments are even more onerous. Private sector investment in sustainable land use will be critical in transforming land use and increasing the amount of GHGs sequestered in forests and agricultural systems. As the business case studies demonstrate, HWP production has the potential to attract new private investment to the sector if relevant barriers and obstacles are removed at the country level, reducing the need for public investment.

Box 3: Strategies to Increase the Use of Harvested Wood Products in Construction

- Study country-specific attitudes toward the use of harvested wood products (HWP), and educate consumers about the benefits of HWP. Build model wood buildings to reduce the stigma around the use of HWP.
- Educate actors throughout the forestry supply chain, including harvesting, processing, and construction, on how to incorporate HWP into building design.
- “Extend” the forestry supply chain by supporting processing and other value-added activities.
- Reduce losses in harvesting and processing. Where losses are inevitable, waste can be used to produce energy, thereby reducing carbon dioxide emissions from fossil fuel energy sources.
- Identify and address regulations that make the use of HWP more expensive or illegal.



6. Findings and Recommendations

6.1. Key Findings from the Country Analyses

The country studies show significant potential for economic growth, employment generation, greenhouse gas mitigation, and improved resilience to climate change by supporting harvested wood products (HWP) supply chains. The analysis shows significant variation between countries in the status of HWP supply chains, the investment climate, and thus the steps needed to support HWP production.

In Ethiopia, the forest supply chain is not well advanced in technology and final HWP use, with most HWP used for products with a short lifespan, such as fuelwood. Raw material production is dominated by state forest enterprises on the one hand, and many smallholders on the other. The low productivity of the forest plantations managed by these groups presents an opportunity to boost the forest sector. Timber prices are among the highest in Africa; timber demand is rapidly increasing, because of the high growth rate of gross domestic product over the past decade; and site conditions in some regions are attractive for forestry investments. Expansion of production of other industrial roundwood has the greatest ability to mitigate climate change and generate employment opportunities. However, many factors continue to constrain the growth of HWP production, especially the underdeveloped HWP supply chain, insufficient access to finance, and the lack of ready-to-invest land.

Mozambique also has an underdeveloped forest sector, and is constrained by technical forestry capacity. Poor infrastructure is another key limiting factor. If these and other issues are addressed, the country has identified large areas that are suitable for productive forests; production of HWP could be a great boon for this country, which has the highest rural poverty rate among the countries in this study. Another important consideration is the role of charcoal production in Mozambique, which is a primary driver of deforestation and loss of biodiversity.

The forest supply chain in Colombia is more advanced than it is in Ethiopia and Mozambique, with the private sector playing an important role throughout the supply chain, from forest production to final consumption of HWP. Sawntwood and wood-based panels have the greatest opportunity for growth. The major bottlenecks in these supply chains are land tenure uncertainty, poor infrastructure, and access to finance for forestry investments. Colombia's National Planning Department and Ministry of Agriculture and Rural Development (*Departamento Nacional de Planificación* and *Ministerio de Agricultura y Desarrollo Rural*), with support from the Program on Forests and the World Bank, are currently scoping the possibilities to promote the commercial plantation sector.

Given Peru's wealth of natural forests and the inefficiency of current extraction practices in these forests, priority should be given to reducing losses and complying with existing forest policy. Expanding the practice of reduced-impact logging (RIL) in Peru offers the lowest abatement cost of any measure considered in this study. Productive forestry in Peru is constrained by similar issues as those in Colombia, although the lack of technical expertise is a particularly acute problem in Peru. Under current demand projections, Peru has the smallest potential to increase domestic production of HWP among the case study countries. Increasing domestic consumption of HWP is an important strategy to support the forest sector.

The Mexico country and business case studies demonstrate the potential of community forestry to contribute to HWP production and address poverty concerns. Mexico is also notable for the large area of plantation forestry that would be required to meet domestic demand for paper and paperboard. It is

unlikely that plantations for the production of paper and paperboard will achieve the areas estimated in this report, because of the high demand for land in the country. Like Colombia, political violence is a concern for growth of the forest sector in Mexico.

Vietnam likely has the most mature forestry industry of the countries surveyed. Nonetheless, to support HWP production, the country should continue the process of privatization of state-owned forestry companies. Vietnam is also notable for the enormous projected gap between the supply and demand of HWP in 2040, which suggests great potential to expand HWP production through productive forests.

Achieving the economic growth and climate change mitigation potential in HWP supply chains requires an approach that is tailored to each country's needs, prioritizes investments across the HWP supply chain, and promotes private sector investment by improving the enabling environment.

6.2. Links to the Paris Agreement

In the context of the Paris Agreement, countries will be formulating their national plans and contributions to the collective goal set in Article 4.1, “[...] to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.” To meet this ambitious goal, developing and high-income countries will need to make profound changes in their economies. Such changes will be supported by capacity building, technology transfer, and finance, predominantly provided by high-income countries. Well-designed investments in mitigation actions offer development opportunities, but will require political action and access to finance. Such finance can come from private as well as public, including multilateral, sources. The productive forest sector can support the necessary shift from a high- to a low-carbon trajectory.

While the Paris Agreement remains general and operational details remain to be defined, this new international climate framework provides the opportunity to support a comprehensive approach to forest-based mitigation. National policy makers will have to evaluate all economic sectors to assess the full mitigation and economic potential offered by productive supply chains, including forest supply chains.

Based on the targets and actions outlined in these assessments, developing country governments can approach high-income country partners for cooperation and support, and vice versa. Such cooperation may also be supported through the transfer of mitigation outcomes. The cooperating Parties may agree on results-based payments and how to divide emission reductions between them (Article 6.2). Countries may also use the Sustainable Development Mechanism, which is yet to be specified in the post-Paris negotiations. This mechanism foresees the participation of duly authorized private and public sector entities, taking inspiration from the Clean Development Mechanism under the Kyoto Protocol. Depending on the guidance to be adopted by the Conference of the Parties supporting the Paris Agreement, this mechanism may help to support programmatic approaches that channel finance to private entities engaging in forest mitigation activities.

6.3. Facilitating Investments

As discussed in the country investment climate analyses, the development of forest sectors in developing countries faces significant financial and nonfinancial barriers, including the following:

- Land tenure insecurity
- Complicated land use regulation
- Lack of forest management and business development skills
- Underdeveloped infrastructure
- Limited access to finance with suitable terms, such as appropriate grace periods or adequate tenors
- Lack of collateral to match loan requirements
- Limited access to information about markets and investment opportunities, at the producer and investor levels.

Targeted policy support needs to be tailored to address these challenges. The following sections make recommendations for addressing the most common investment barriers. The recommendations to address nonfinancial barriers are geared toward governments and donors, while the recommendations to address financial barriers are to be considered by the donor community.

6.3.1 Addressing Nonfinancial Barriers

To ensure ownership of policy processes, national governments, local communities, private sector actors, and key stakeholders need to take the lead in developing productive forestry. *Governments can take the following measures to promote the sector in the context of their country's Nationally Determined Contributions (NDCs) and REDD+ programs:*¹²

1. Promote policy reform, and strengthen law enforcement, governance, and incentives:
 - a. Conduct national assessments to determine the forest sector's contribution to green growth, the mitigation potential of different forest uses and HWP, and the opportunities and constraints that impair the sector's formalization, development, and investment climate.
 - b. Initiate policy dialogue and formulate a forest sector strategy, while ensuring consultation with key stakeholders, high-level policy engagement, and alignment with policy objectives, to develop and formalize the forest sector.
 - c. Formulate policy reforms to strengthen or develop incentives, such as financial assistance, risk mitigation, and regulatory requirements.
 - d. Strengthen institutions and capacities to account for mitigation benefits from the complete supply chain, including its productive potential.
 - e. Strengthen law enforcement. Although it is not a new problem, without addressing corruption and providing forest agencies with additional capacities and equipment that enable law enforcement, a stable investment climate cannot develop. Brazil has made remarkable progress in slowing deforestation largely because of the country's more stringent enforcement of the law.
 - f. Encourage knowledge sharing. Lack of technical forestry knowledge and business management skills were identified as barriers to the growth of the HWP sector in many of the countries studied. Governments should promote the sharing of best practices between companies and investors operating in the forest sector.

¹² REDD+ stands for reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks.

2. Identify concrete investment opportunities. Facilitate private investment by identifying concrete investment opportunities and providing advice and technical and administrative assistance to investors:
 - a. Facilitate private sector dialogue and explore potential public-private partnerships.
 - b. Open funding windows in national funds and rural finance institutions that support forest investments.
 - c. Establish institutions for support, such as forest investment agencies.
 - d. Determine resource needs for preparation, technical assistance, and investments, and develop financial plans for international support and the government's budget.
3. Support green procurement policies and learn from countries with green procurement policies.¹³ Procurement of wood could give preference to local, certified timber to the extent this complies with trade regulations. Governments, as part of their NDCs and bioenergy strategies, could also move toward timber as the preferred resource for buildings and other purposes. The dual effect of increasing carbon stored in HWP and substituting high-emission building materials, such as cement, could have a strong mitigation impact while promoting the local forest sector.

In almost all the investment cases considered in this analysis, commercial investors must cooperate with local communities and smallholder landowners. It is therefore essential that investment barriers are addressed through a combination of policy measures and tailored financial products that improve cooperation with these groups. Measures need to be coordinated with REDD+ and existing multilateral development bank (MDB) finance to avoid duplication and counterproductive efforts. *Development partners should take the following measures to support developing countries in the context of NDCs and REDD+ programs:*

1. *Technical assistance.* Development partners can make grants available for efforts specifically targeted at increasing technical and management capacity in the forest sector around various activities, including RIL, landscape restoration, productive forest establishment, and certified sustainable forest management. Training should be delivered for forestry extension services. Alternatively, private actors, including nongovernmental organizations, could be tasked with delivering training, including through South-South cooperation.
2. *Improved access to market information.* Development partners can finance activities related to improving the information flow between supply chain actors to reduce uncertainty around productive forest and processing capacities. This could be achieved through strategic collaboration with the stakeholders mentioned in this report, and may include the development of regional dialogues with producers, federations, buyers, processors, and financial intermediaries, to develop relationships and explore business opportunities.
3. *Project development.* One of the main challenges in deploying project finance is the lack of bankable projects. The provision of market information could be complemented by dedicated funds for market and feasibility studies, to develop and demonstrate the viability of particular business models. This information would address the challenges in identifying and developing land use and forest sector investments.

¹³ For examples and best practices, see http://www.oecd.org/gov/ethics/Going_Green_Best_Practices_for_Sustainable_Procurement.pdf.

6.3.2 Addressing Financial Barriers

The barriers discussed here apply to all forestry companies, but have a greater impact on small and medium enterprises. Donor finance in general—and climate finance in particular—can address financial barriers by tailoring instruments to match the investment profiles of businesses throughout supply chains. The Forest Investment Program (FIP), with its access to the full range of financial instruments, can work with its MDB partners to design financial products that are best suited to address investment risks in the forest sector.

Based on the analysis of this report, two overarching investment strategies are recommended:

- Enable medium-size forest enterprises to access equity and loan finance at favorable/viable terms through MDBs.
- De-risk forest sector investments through structured funds, and guarantee products that enable local banks to establish or modify existing credit lines to reflect forest sector investment requirements, such as maturity, interest rate, and collateral requirements.

6.3.2.1 *Revised Private Sector Window for Small- and Medium-Size Forestry Companies*

An FIP private sector window, reformed according to the lessons learned to date, has the potential to increase access to finance, especially for small- and medium-size companies, to build a strong forest sector. To ensure the effectiveness of such a financing window or other donor-supported financing facilities, two design elements are particularly relevant, namely, the range of financial instruments available and the mechanisms put in place for delivery and administration of financing:

1. The FIP's approved disbursements to date have been limited to grants and loans, and equity investments and guarantee structures have been unused. To cater to a more diverse range of investments, the report recommends expanding the range of financial instruments available to the FIP and its partner MDBs. Such instruments could include insurance products, equity investments, or results-based payments. These instruments could lower the cost of capital and reduce risk, to catalyze investment. The establishment of new productive forests that are characterized by long payback periods would benefit from equity investments. Such capital could be catalytic and allow debt to be raised from other development finance institutions or domestic development banks. As projects are also hindered by insufficient collateral—sometimes related to insecure land tenure—the private sector window should provide enhanced flexibility around collateral requirements. This recommendation would be relevant to the business cases developed for Peru, Mexico, and Mozambique.

Debt and equity finance through the private sector window could be complemented with a results-based finance (RBF) instrument. RBF finance could be disbursed against emission reduction proxies (for example, planted area or zero deforestation commodity sourcing) or implementation milestones. Some of the RBF could be structured as advance payments that could be used as equity by the project developer. A percentage of the estimated RBF volume to be disbursed to a company could be advanced as equity finance. When results are delivered, the equity share could be surrendered, resulting in an effective payment for results achieved. Such a structure would

help break the vicious cycle of results not being delivered (and hence not providing a basis for payment) because of the lack of the initial finance required for investment in better management, and accelerate the deployment of RBF while maintaining insurance against nonperformance. However, instead of reverse engineering RBF to make it like existing finance products, providing more public equity, mezzanine finance, and junior loans¹⁴ that are ready to absorb risk can also help to disburse existing RBF and leverage private investments.

2. The delivery and administration process of the private sector window could be streamlined and decentralized. A key barrier to private sector engagement to date has been a perceived incompatibility between fixed deadlines for proposal submission, stringent investment criteria, and long approval processes compared with the ad hoc nature of private sector investment opportunities. A streamlined process could be achieved by:
 - Establishing pre-approved funding windows guided by investment criteria within the private sector branches of MDBs
 - Promoting MDB cooperation with the public sector in host countries, to establish private investment windows in national forest funds, rather than managing funds at the central FIP level.

Both delivery options would benefit from MDB cooperation with an agile administrator that is familiar with the conditions of the country or region that it serves, able to offer streamlined assessment of proposals, and enhances the alignment of investments with local development priorities.

The development of national forest funds has enjoyed popularity in countries such as Brazil, Chile, Costa Rica, Guyana, Indonesia, Mexico, and Peru, among others (Conway et al. 2013). Given their local administration (with a possibility of allowing donor involvement in investment decisions) and alignment with national development priorities, national forest funds would seem to be a natural fit to deploy FIP funds.

6.3.2.2 *First-Loss Guarantee Mechanism to Improve Local Lending Conditions*

The high risk associated with providing credit to small- and medium-size companies (limited creditworthiness, high default risk, and lack of collateral) is typically reflected in loan terms such as high interest rates, excessive collateral demands, and other measures that make the project unprofitable. As a result, the loan products on offer are insufficiently adapted to the realities of forest sector investments, unattractive to producers, and hence inhibit the flow of capital. To reduce the risk exposure of local banks and allow for adjustment of loan terms to reflect the needs of forestry and land use investments, the FIP, together with its partner MDBs, might explore the development of a guarantee mechanism that will take first losses resulting from repayment delays or credit default. In the case of Peru, a credit guarantee could enable a local bank to provide more favorable loan terms.

Guarantee mechanisms have played an important role in leveraging private capital, especially in the renewable energy sector and the Climate Investment Funds (CIF). The Clean Technology Fund (CTF) and Scaling Up Renewable Energy Program (SREP) should be examined to evaluate transferability to the forest sector.

Regional MDBs could offer guarantee products to local banks that could be linked to certified climate benefits. Jointly with local banks, an MDB would develop lending conditions that suit the

¹⁴ Junior loans are loans that are subordinated to senior loans and receive repayment after senior loans are repaid.

needs of the local forest sector, including the interest rate and maturity of the loan. The increased risk of the portfolio would be covered by a first-loss guarantee by the MDB and potentially the FIP. The fee for the guarantee could be partly or fully paid with emission reductions, adding a results-based component to the product.

While the private sector window would be targeted mainly at medium-size companies, the first-loss guarantees issued to local banks would help extend credit to smaller enterprises, thereby encouraging growth from the bottom up.

6.3.3 Summary

Table 5 provides a summary of the recommendations.

Table 5: Summary of Recommendations			
Instrument	Target audience	Core design features	Value proposition
Targeted policy support	<ul style="list-style-type: none"> Local forest service Companies 	Grant-based support to finance strategic interventions around capacity building, enforcement, sustainable building materials, and access to markets (information)	Medium- to long-term improvement of framework conditions that enhance the bankability and competitiveness of the forest sector
Revised private sector window	Medium-size enterprises in host countries	<ul style="list-style-type: none"> Debt, equity, and RBF advance products Administered through an MDB 	Enhanced and accelerated access to a wider range of targeted products for medium-size enterprises
Guarantee mechanism	Local banks, with the ultimate objective of improving loan terms for SMEs	<ul style="list-style-type: none"> First-loss guarantee through MDBs to reduce local bank risk exposure Enable loan term adjustment to reflect forest sector needs 	Improved loan terms and access for SMEs to improve bottom-up sector development

Note: MDB = multilateral development bank; RBF = results-based finance; SMEs = small and medium enterprises.



7. Annex

7.1. Country Case Studies

7.1.1 Ethiopia

7.1.1.1 Country Background and Climate Change and Forestry Commitments

Ethiopia, home to 86 million people, is the second most populated country in Africa. As one of the fastest-growing economies globally, the country aims to achieve middle-income status by 2025.

The forest sector plays a key role in achieving Ethiopia's commitment to limit future total emissions to 145 million tons of carbon dioxide equivalent (t CO₂e) per year by 2030. Deforestation and forest degradation alone accounted for 37 percent (55 million t CO₂e) of the nation's greenhouse gas (GHG) emissions in 2010 (CRGE 2011), and roughly half (130 million t CO₂e) of the total intended reduction of 255 million t CO₂e is expected to result from forest sector interventions. The country has prioritized a pledge to restore 15 million hectares of degraded and deforested lands by 2025, in addition to a pledge to afforest or reforest 7 million hectares, as stated in the national Climate Resilient Green Economy (CRGE) strategy.

Ethiopia's Nationally Determined Contribution (NDC) aims to achieve zero net emissions by 2030, compared with the 2010 baseline. The Government of Ethiopia has made an international commitment to implement REDD+, using a strategy that emphasizes resilient green growth in rural Ethiopia.¹⁵ This green growth strategy integrates productive forest landscapes, healthy forests, and the productivity of land near forests to achieve three objectives: (i) reduced GHG emissions through avoided deforestation and forest degradation and carbon sequestration through tree planting; (ii) reduced vulnerability of rural populations and the rural economy to exogenous shocks from climate risks, disasters, drought, flood, and disease; and (iii) reduced levels of stress on biodiversity, water, and soil resources.

Ethiopia's commitment to forestry is also reflected in its second five-year Growth and Transformation Plan (GTP II, 2015–20), which is a comprehensive national strategy for public investments and legal and institutional reforms to create an enabling environment for private sector and community engagement. The Ministry of Environment, Forest, and Climate Change's GTP II actions include, among others, creating an enabling environment for the private sector, enhancing the establishment of community-based organizations to allow active community participation in the sustainable management and conservation of forests, and providing economic and ecological benefits to communities that are vulnerable to climate change, especially women and youth.

The analysis carried out for this report demonstrates that only a small fraction of the area planned for reforestation in Ethiopia is needed for sustainable forest and wood industries. Most of the reforested or afforested area is meant to contribute to erosion control in watersheds and other protective services, through area enclosure and assisted natural regeneration.

The country study for Ethiopia focuses on enhanced timber production and domestic consumption of wood products for permanent uses (such as construction). Ethiopia has a rapidly increasing timber

¹⁵ REDD+ stands for reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks.

supply gap, and the country's timber prices are among the highest in Africa, despite the potential to produce timber domestically. The study assesses the mitigation potential of harvested wood products (HWP) based on projected demand in 2040, and the green growth scenario assumes that demand will exclusively be met by national production.

7.1.1.2 Green Growth Scenario for HWP Production

Estimates of future HWP consumption were derived from a historical analysis of wood consumption, population, and gross domestic product (GDP) growth. Furthermore, policy assumptions based on the Ethiopia Forest Sector Review (2015) were quantified to develop a green growth scenario for consumption of HWP until 2040.

Three key policies will affect the future consumption of HWP:

1. The Climate-Resistant Green Economy green growth strategy aims to reestablish the commercial forest sector and introduce energy-efficient technologies in industries and buildings.¹⁶
2. National housing programs will be a main driver of wood demand for structural timber and auxiliary uses, such as casing or scaffolding. There will be an indirect, positive impact on wood consumption for furniture.¹⁷
3. Rural electrification, which is part of the general CRGE strategy, will result in increased consumption of utility poles.¹⁸

The analysis projects that demand for HWP (sawnwood, wood-based panels, paper and paperboard, and other industrial roundwood) will grow from 4.1 million cubic meters (m³) in 2013 to 16.7 million m³ in 2040. The supply of HWP is estimated by considering anticipated growth of state forest enterprises, the Oromia Forest and Wildlife Enterprise (OFWE), and the Amhara Forest Enterprise (AFE), as well as the growth of private woodlots. Increasing demand will result in a projected industrial roundwood supply gap of 13.3 million m³ by 2040.¹⁹

The future supply gap could be addressed by establishing an additional 750,000 hectares of professionally managed productive forests (400,000 hectares long rotation to supply sawnwood plus

¹⁶ Ethiopia's CRGE strategy (2011) follows a sectoral approach and has so far identified and prioritized more than 60 initiatives, which could help the country achieve its development goals while limiting GHG emissions. The green economy plan is based on four pillars: (i) improving crop and livestock production practices for higher food security and farmer income while reducing emissions; (ii) protecting and reestablishing forests for their economic and ecosystem services, including as carbon stocks; (iii) expanding electricity generation from renewable sources of energy for domestic and regional markets; and (iv) leapfrogging to modern and energy-efficient technologies in transport, industrial sectors, and buildings.

¹⁷ The Integrated Housing Development Program, 2006/7–2009/10 had initially set an ambitious goal of constructing 396,000 housing units, but was only able to deliver 142,802 due to a lack of adequate financing from the National Bank of Ethiopia. Housing is a key focus within the GTP/ECR-3G2P context, with several new subprograms and financing mechanisms established. Since the GTP started, a total of 96,233 housing units and 1,720 housing blocks have been constructed. Among others, one severe threat to achieving the ambitious Ethiopian tasks in housing development is the lack of construction materials, especially timber. In addition, the massive construction plans result in GHG emissions (if nonrenewable materials are used) that pose a threat to achievement of the Ethiopian NDC submission.

¹⁸ With a strong focus on renewable energy, the Ethiopian government is planning to proceed rapidly with providing grid access to +50 percent of the rural and 100 percent of the urban population by 2025 (IFC Lighting Report, 2010). This will have an influence on fuelwood consumption, but also the use of industrial roundwood is expected to increase significantly to provide electricity poles all over the country.

¹⁹ Since Ethiopia imports 100 percent of its paper and paperboard products, no roundwood gap was calculated for this HWP group.

50 percent of other industrial roundwood due to the demand for poles in intermediate dimensions, and 350,000 hectares to supply pulp for paper, wood-based panels, and 50 percent of other industrial roundwood). Although the Government of Ethiopia has set objectives for increasing plantations for pulp and paper production in GTP I, conditions in the country will make it difficult for the industry to develop quickly.

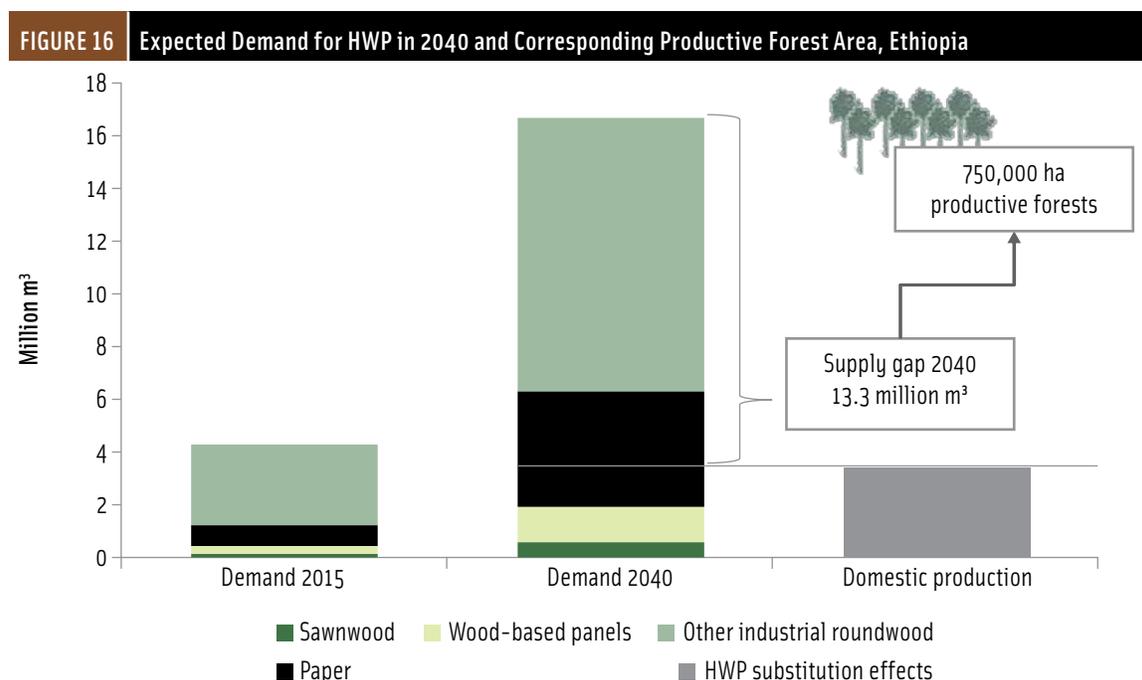
Figure 16 shows the development of demand for HWP and the required development of productive forest area to fill the expected gap in roundwood supply for HWP in the green growth scenario.

In figure 17, the mitigation potentials are presented in detail. Aside from substitution effects, the category "other industrial roundwood" represents the largest share of the total potential. In Ethiopia, this HWP classification refers to utility poles, small poles for rural housing, and urban construction uses, such as scaffolding and the underpinning of concrete encasings. Sawnwood and wood-based panels will gain in importance as the sector modernizes.

The mitigation potential of HWP carbon pools accounts for 5.8 million t CO₂e, and the associated productive forests account for an additional 3.2 million t CO₂e of mitigation potential. Under the assumption that the HWP filling the supply gap in 2040 also substitute and hence avoid the use of other materials in the construction sector, the total mitigation potential of HWP in Ethiopia is 21.6 million t CO₂e.

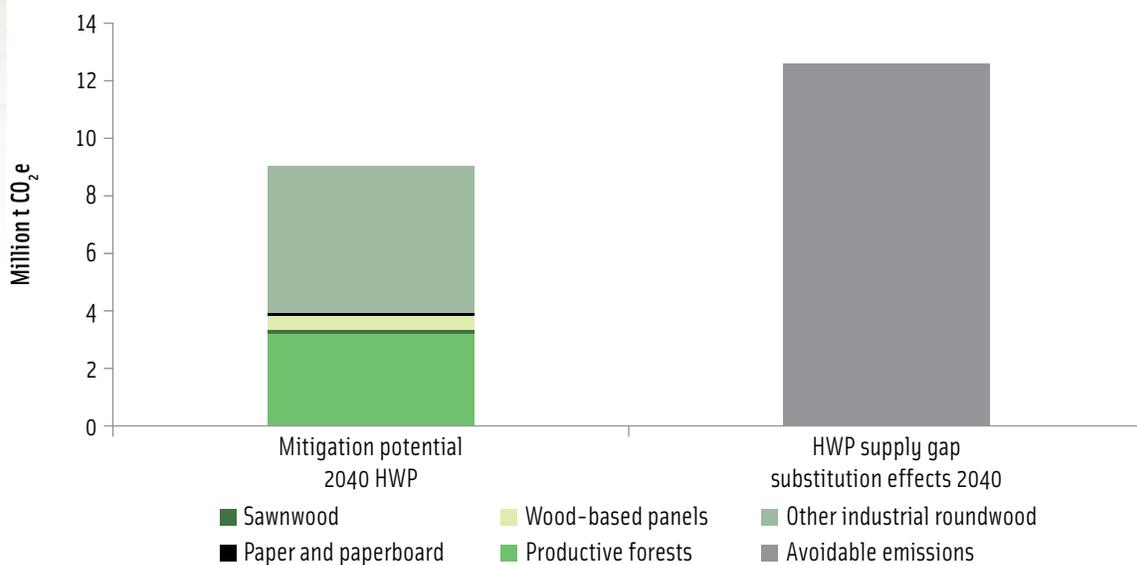
7.1.1.3 Socioeconomic Impacts

The forest sector in Ethiopia has strong potential to generate employment. The green growth scenario would create about 58,000 additional full-time equivalent (FTE) jobs, and if these investments are realized, the forestry and primary wood-processing sector could increase its contribution to national GDP by 153 percent in 2040, compared with the baseline year (figure 18).



Note: ha = hectares; HWP = harvested wood products; m³ = cubic meters.

FIGURE 17 Mitigation Potentials for HWP and Productive Forests, Ethiopia

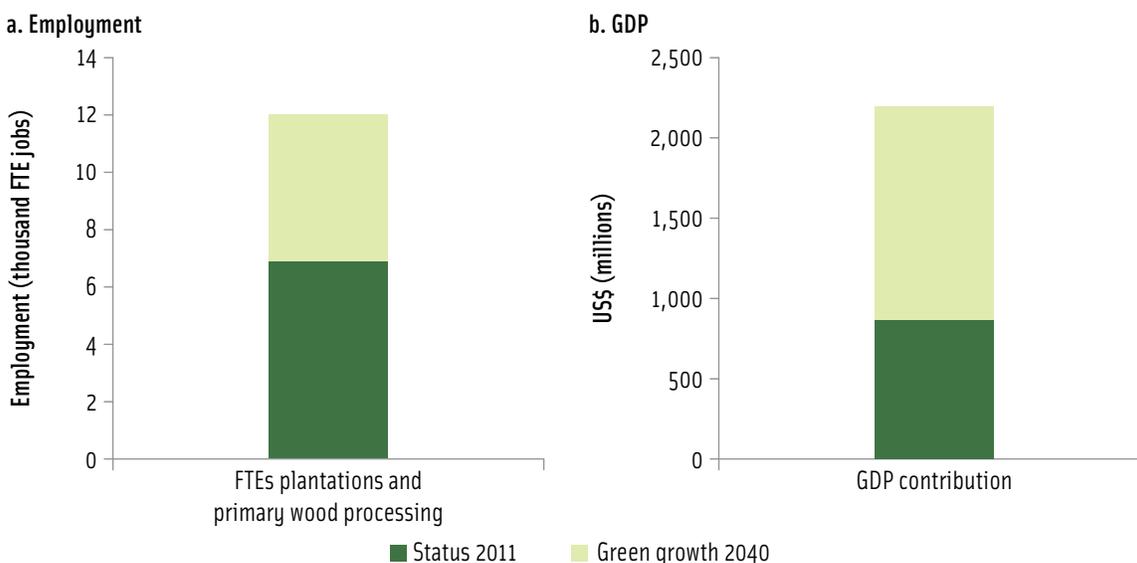


Note: HWP = harvested wood products; ind. = industrial; t CO₂e = tons of carbon dioxide equivalent.

7.1.1.4 Investment Environment

Ethiopia’s forest sector contributed 3.8 percent to the national GDP in 2012–13 (MOFED 2015). Across the supply chain, the sector is characterized by inefficient resource use and small companies. As of 2013, planted forests cover 910,000 hectares in production, approximately 85 percent of which are small, privately owned woodlots. Publicly owned plantations play a minor role, with 157,000 hectares in production

FIGURE 18 Employment and GDP Impacts of the Green Growth Scenario, Ethiopia



Sources: UNIQUE, based on FAO 2014; staff calculations.

Note: FTE jobs in 2013 and the baseline scenario for 2040 do not include paper. The contribution to GDP in 2040 is calculated in 2015 market prices. FTE = full-time equivalent; GDP = gross domestic product.

in 2013 (UNIQUE 2015c). In the processing of wood products, an estimated 92 percent of companies operating in the sector have fewer than 10 employees, and only 30 percent of those companies are formally registered. In total, 31,000 people work in the processing of furniture products (UNIQUE 2015c).

Ethiopia is one of the fastest-growing economies in the world, and offers many investment opportunities. However, primarily because of land tenure, availability of financing, and technical forestry capacity, the country has an enabling environment that presents many challenges to investors and companies across the HWP value chain. There is little private sector investment planned in the forest sector. Ethiopia was ranked 146 of 189 countries for ease of doing business (World Bank Group 2016). Private sector action in HWP faces several barriers, including the following:

- Land for forestry investments is not available for investors. Land tenure uncertainty in some regions makes it more difficult to identify areas for productive forests. Only in the Oromia region have forest boundaries for planted forests been established and tenure conflicts resolved. Land certification is ongoing, but currently primarily focused on agricultural land, not forest land. Partnering with existing state forest enterprises and small landowners through grower schemes may offer the best way for investors to overcome these challenges.
- Access to finance is a significant challenge for forestry investments. The Ethiopian Development Bank provides credit for HWP value chain investments. Commercial banks do not provide credit with long enough tenor to finance productive forest investments. The Government of Ethiopia provides few financial incentives to encourage forestry. Foreign private financial institutions are not permitted to operate in Ethiopia. The majority of production occurs on smallholder woodlots, and these actors have difficulty accessing finance (UNIQUE 2015c).
- Current policies make it expensive or even impossible for investors to repatriate profits. There has been some progress in this area, but investors are still reluctant to invest as a result.
- The small size of most forestry enterprises makes it difficult for foreign investors that have large minimum investment amounts to engage with the sector.
- Ethiopia's commercial forestry industry remains underdeveloped, according to a 2015 Forest Sector Review (UNIQUE 2015c). The high timber prices in Ethiopia reduce the profitability of investments in the processing industry. Importing timber is also expensive, because of bottlenecks in certain parts of the supply chains. The lack of access to reliable raw materials presents a challenge for processing companies, which sometimes must source raw material from remote areas at a high cost. Quality seedling production is also inadequate, which makes productive forest establishment more expensive. Because the sector is undeveloped, forestry and processing expertise is also limited.
- Ethiopia was ranked 103 of 168 countries on Transparency International's Corruption Perceptions Index in 2015.
- Poor infrastructure and transportation logistics in some regions increase commercialization costs.

Recognizing these barriers, the forest sector is a priority for Ethiopia, and the country is instituting several reforms to improve enabling conditions, including the following:

- The Ministry of Environment, Forest, and Climate Change (MEFCC) was established in 2013. Prior to this, forestry management was managed by the Ministry of Agriculture. Although MEFCC is still developing, having a ministry dedicated to forestry should help to improve forest policies and technical knowledge of forestry management. MEFCC prepared a national REDD+ strategy, which includes consideration of how to attract private sector investments.

- The Government of Ethiopia is emphasizing the importance of forestry in its economic development plans, including its CRGE strategy. The government seeks to increase the role of foreign investors in achieving growth of the forest sector.
- Openness to foreign investment funding is reflected in the interest of private equity funds, such as the Arbaro Fund, Global Environment Fund, Schulze Global Investment, and Ascent Rift Valley Fund, making investments in the forest sector.
- To meet broader economic development objectives, the government is rapidly implementing road and railway infrastructure investments.

Table 6 outlines private sector investment options and recommendations to improve the enabling environment.

Investment option	Private sector business case	Interventions to improve the enabling environment
Investments in commercial productive forests	Large- and small-scale investments are possible; given the small size of many existing producers, outgrower or other aggregation schemes should be considered	<ul style="list-style-type: none"> • Improve the availability of land without land tenure conflict in cooperation with the Ethiopian Investment Authority • Enable public-private partnerships between state forest enterprises and commercial plantation investors, to rehabilitate degraded plantation sites • Facilitate the development of financing mechanisms and credit lines through the Ethiopian Development Bank^a • Invest in MEFCC's capacity to execute forestry management plans; improve execution of existing laws • Clarify land most appropriate for productive forests
Investments in modern state-of-the-art wood-processing industries	Sawmills including kiln drying facilities, panel plants, molding and finger joint processing, and pole treatment plants	<ul style="list-style-type: none"> • Improve access to capital and credits • Provide technical assistance to local entrepreneurs • Enable joint ventures of local entrepreneurs with companies from countries with advanced industrial forest sectors (such as Germany, China, and South Africa^b)
Investments in the construction sector	Construction companies offering wood-based, low-cost housing systems	<ul style="list-style-type: none"> • Provide technical assistance and training to architects and planners • Establish quotas for the use of wood in public construction • Commitment of public tenderers to the procurement of legal and sustainable wood products • Establish a preference for wood in public tenders

Note: MEFCC = Ministry of Environment, Forest, and Climate Change.

^a The Ethiopian Development Bank does not provide loans for forestry only. At least part of the loan has to be used for wood processing, in line with the industrialization policy.

^b At least part of the Ethiopian Development Bank loans have to be used for wood processing, in line with the industrialization policy, which foresees the introduction of modern and innovative technologies.

7.1.1.5 Model Business Case: Oromia Wood Construction Cluster

The Ethiopian model business case is based on the planned efforts to construct decent, sustainable, and affordable housing for the growing middle class. In line with Ethiopia's CRGE strategy for green growth, the model business case illustrates the potential impact of a significant increase in wood consumption

in the construction sector by replacing nonrenewable materials, such as cement, steel, and bricks. In 2040, there will be a projected need for around 500,000 rural and urban housing units (new construction and modernization).²⁰ Assuming that rural construction will be carried out according to modern wood design layouts instead of traditional construction,²¹ brick construction, and cement²² would result in consumption of around 3 m³ of structural timber products for the walls and roof per housing unit, or a total of 2.6 million m³ (Weimar and Jochem 2013). The additional area of productive forest that would be needed to provide the sustainable raw material source would amount to 180,000 hectares. *Eucalyptus grandis* will be established for poles and construction timber, not *E. camaldulensis*, which is currently planted using 100-year-old genetic material. *Cypress lusitanica* will be planted for sawnwood.

The analysis assumes that production of the required raw material will be realized in a public-private partnership (PPP) model, where OFWE and AFE are the public partners, and that commercial investors will rely on outgrower schemes in cooperation with local smallholders. Private partners could include international institutional investors, international forestry funds, forest enterprises, and dedicated forest service providers. Land can be provided by the state forest enterprises, or allocated by the National Forest Sector Development Program, which is currently under development by the MEFCC. Potential project sites include areas in Oromia and Amhara, where state forest enterprises exist. Additional regions with substantial forest area include Gambella, Southern Nations, and Benishangul-Gumuz, where local governments are establishing suitable public entities to partner with private investors.

The total area of 180,000 hectares must be divided into four to six forest industry investment clusters, each covering an average of 30,000 to 50,000 hectares within an industry-sourcing radius of around 50 square kilometers. Each forest cluster can consist of newly established productive forests and/or restored underperforming plantations.

It is realistic that, of the total 180,000 hectares, 60,000 hectares of short-rotation woodlots for poles will be established by smallholder farmers on community land.²³ Industry partners will provide quality seedlings and technical assistance. The industry partners will not only provide inputs and technical assistance, but also guarantee the offtake of a defined quantity of roundwood at the future market price. OFWE has already established partnerships with outgrowers, such as in the Wollega branch. The remaining 120,000 hectares will be managed under a joint venture or concessional agreement between local partners and the investors. In the case of establishment of new productive forest, the location of land has to be granted and organized by the regional governments of Oromia and Amhara, and must be negotiated with the affected communities. The estimated total amount of capital required to establish these productive forests is US\$948 million.

²⁰ This projection is based on data from the National Population and Housing Census 2007 (Central Statistical Agency (CSA), 2010) and projected population growth rates by CSA.

²¹ Frequently, traditional construction systems also use wood as a structural element, but because of the high rates of non-sustainable sourcing of wood in rural areas in Ethiopia (while wood availability is diminishing), replacement with timber from commercial plantations or community woodlots is the proposed pathway for the mitigation scenario.

²² In recent years, several development agencies, including the German Development Agency, have identified low-cost housing as a key intervention area to address Ethiopia's housing deficit. However, in the face of the severe shortage of construction timber, the systems that are promoted are based on traditional and conventional materials (bricks, hollow blocks, and metal).

²³ In Ethiopia, there are more than 700,000 hectares of small-scale woodlots (UNIQUE Ethiopia Forest Sector Review 2015), which have been established by farmers and communities on sites with usually less than 5 hectares. The farmers established the woodlots mainly independently from government support, since market demand for electricity poles in Ethiopia and Sudan has turned out to be an economically attractive alternative for land, which has been highly degraded and is not suitable for agricultural production anymore. This underlines the high motivation and capability of the private sector engaging in plantation activities. In the model case, assuming an average area of 5 hectares per plot, land under smallholder management will benefit around 12,000 farmers, farmer associations, and communities.

Private partners are also expected to invest in wood-processing plants, of which 12 sawmills and three wood panel plants are required. Industry investments will be realized gradually; the panel plants will become operational around seven years after they are established; and the sawmills will be fully effective after 15 years. The estimated cost of these industry investments is US\$570 million.

Potential investment benefits include the following:

- Land under the management of investors will create employment for 13,000 persons in FTE jobs (directly employed by the plantation company or equivalent to the labor input of farmers in smallholder management schemes), and the employment impact of processing industries will be 1,200 FTE jobs.
- The annual gross value added (the value of the economic contribution) of all operations is expected to total US\$254 million. The future gross value added equals 0.4 percent of national GDP in 2015.²⁴
- HWP produced under this investment would sequester an estimated 1.2 million t CO₂e in 2040. If HWP substitute energy-intensive materials as expected, this would reduce emissions by an additional 4.4 million t CO₂e in 2040 (both figures are annual).

Support in the form of ready-to-invest land (as proposed in this case through a PPP with state forest enterprises) and help to overcome financial investment barriers have to be provided by the Government of Ethiopia. The Chamber of Commerce and MEFCC are currently preparing a Public Private Dialogue, with support from the World Bank and International Finance Cooperation (IFC), to define the support required. It is worth recognizing the crucial role that international investors and service providers play in building capacity and introducing international industry best practices in joint ventures.

The long payback period of the investment creates another hurdle for potential investors. Greenfield productive forests will not start generating significant revenues from poles for four to seven years, and 14 to 16 years for eucalyptus sawlogs, although pruning and thinning activities will create modest income in the early years. Such a long delay in repayment, among the other risks mentioned, would normally dissuade debt investors from investing; a structure that shares risk between different parties is necessary to catalyze private sector investment. In addition, the financing necessary to plant 180,000 hectares will require significant investment. It is likely that planting and maintenance of the entire area may be distributed among several projects under the following structure:

- The productive forestry companies (private partners in a PPP) may provide equity. Equity investments that would absorb any losses and do not expect returns early in the project are essential for the successful implementation of the suggested PPPs, because they will allow debt to be invested. Raising equity finance is a major challenge for medium and large companies investing in productive forests in developing countries.
- Per the recommendations in section 6.3, concessional equity finance provided by multilateral development banks (MDBs) can help to overcome this barrier, by providing concessional equity finance, possibly in cooperation with the IFC and the private sector windows of other MDBs. In the medium or long term, the Green Climate Fund may play this important role in providing upfront capital that catalyzes the participation of other investors.
- The public partners (OFWE and AFE) may contribute land (that is, existing plantation sites that are currently not planted), staff, and resources for extension work to improve the quality and performance of smallholder woodlots.

²⁴ Ethiopia's GDP in 2015 was US\$61,537 million.

- The Ethiopian Development Bank (EDB) and development finance institutions could provide debt finance for the remaining capital needs. The EDB offers loans for integrated forest production and wood-processing investments at an interest rate of 8.5 percent with tenor of 14-16 years.

Investments for the industrial processing facilities are unlikely to require the same risk mitigation support as the productive forest investments. Industry investments could be supported under the following structure:

- Private investors could provide equity.
- Ethiopian commercial banks could provide loans at an interest rate of about 16 percent, with a tenor of one to two years for working capital needs or short-term investment needs. If a guarantee facility, as recommended in section 6.3 were available, these banks may be able to extend the tenor of their loans.
- The EDB could provide a portion of the capital needed as debt.
- Private sector branches of MDBs could consider direct loans to private investors, but this would only be available for large investments.

Table 7 highlights the main features of the Oromia and Amhara model business case.

Table 7: Oromia and Amhara Model Business Case, Ethiopia	
Key feature	Details
Market	500,000 social housing units in modern wood design Market to be promoted by Ethiopian public procurement
Business model(s)	PPP of OFWE and AFE with large-scale productive forest investors Smallholder outgrowers business model
Roundwood volume	2.6 million m ³ annually
Productive forest area	120,000 hectares of large-scale productive forests 60,000 hectares of smallholder productive forests
Industry facilities	12 sawmills (50,000 m ³ output each) 3 panel plants (300,000 m ³ output each)
Investments	US\$900 million in productive forests US\$540 million in industries
Employment	12,600 FTE jobs in productive forests 1,200 FTE jobs in industries
Gross value added (GDP contribution excl. taxes)	US\$254 million annually
GDP contribution based on 2015	0.4%
CO ₂ mitigation potential	Mitigation: 1.2 million t CO ₂ e in HWP (annual figure, 2040) Substitution of non-wood materials: 4.4 million t CO ₂ e (annual figure, 2040)
Investment return ratios	US\$1 invested for US\$3 annual GDP contribution (over 20-year period) US\$110,000 invested for 1 FTE job (employed for 20 years) US\$16 invested for 1 t CO ₂ e substitution (over 20 years)

Note: AFE = Amhara Forest Enterprise; FTE = full-time equivalent; GDP = gross domestic product; HWP = harvested wood products; OFWE = Oromia Forest and Wildlife Enterprise; m³ = cubic meters; PPP = public-private partnership; t CO₂e = tons of carbon dioxide equivalent.

7.1.2 Colombia

7.1.2.1 Country Background and Climate Change and Forestry Commitments

Colombia is an upper-middle-income economy with a population of 48 million, making it the third most populated country in Latin America. Over the past decade, Colombia has experienced an economic boom, partially related to an ongoing peace process that has improved the investment environment.

In 2010, the country emitted an estimated 224 million t CO₂e, of which, according to the Forest Reference Level 2013–18, about 52 million t CO₂e are emitted annually from deforestation (IDEAM 2015). Colombia has committed to reduce its GHG emissions by 20 percent with respect to the projected business as usual scenario by 2030 (IDEAM 2015). Subject to the provision of international support, Colombia could increase its commitment to 30 percent. The land use sector is included in the economywide target. Carbon emissions and removals from forest plantations and permanent crops are included, but removals from natural forests are excluded. Colombia has pledged a conditional 1 million hectares of restoration by 2020 as part of the Bonn Challenge and 20*20 Initiative.

Colombia's National Planning Department and Ministry of Agriculture and Rural Development (MADR, *Departamento Nacional de Planificación* and *Ministerio de Agricultura y Desarrollo Rural*), with support from the World Bank/Program on Forests (PROFOR), is currently scoping out the possibilities to promote the commercial plantation sector. Ongoing technical studies have identified several bottlenecks rooted in land tenure policies and infrastructure deficits. However, the private sector in Colombia shows great interest in investing in and expanding forestry supply chain activities. Several large private actors have started planning and implementing the expansion of their production capacities. Still, the private sector has expressed concerns that forest sector development will be limited if land tenure and infrastructure problems are not resolved in the near future.

Although policies addressing the supply side of the forest supply chains are currently under reform, demand-side issues have yet to be placed on the political agenda. Initiatives to promote the use of HWP by Colombian industries and private households are not in place (except for the voluntary commitment of several public and private actors to promote the use of legally sourced timber, "*Pacto para la madera legal*"). Thus, there is no formal framework in place to promote the substitution of non-wood materials in other sectors. However, Colombia is currently boosting its housing program, and has made significant public investments in public building and infrastructure through the "*MINVIVIENDA*" program, boosting wood consumption.

7.1.2.2 Green Growth Scenario for HWP Production

Colombia's wood balance in 2015 shows a total consumption of 25.5 million m³, of which 57 percent is fuelwood, 32 percent paper, 7 percent sawnwood, and 4 percent wood-based panels. Of the total volume, roughly 3.9 million m³ of domestically produced industrial roundwood (of which 2.9 million m³ originates from productive forests) was used for sawnwood, panel, and pulp and paper production; a total of 4 million m³ of HWP was imported.

National data indicate that the current plantation area is around 600,000 hectares, which should be sufficient to cover national wood demand in the future. However, most of these resources are dispersed, not well managed, and produce far below international benchmarks. Only 300,000 hectares can be considered a reliable source for domestic market supply, according to a forthcoming World Bank PROFOR report. In general, production costs are not competitive, and domestic industries can

hardly compete against imports and low-cost non-wood materials. Furthermore, the construction sector, which accounts for more than 50 percent of non-fuelwood wood consumption, is increasingly turning toward non-wood construction materials. This is due to the lack of technically appropriate construction timber and the urgent need for fast and “easy” construction.

A historical 10-year analysis of wood consumption, population growth, and industrial sector GDP resulted in the correlation factors that were used for the projection of HWP consumption until 2040.²⁵

Four policies are expected to affect future HWP consumption:

1. The green growth strategy for Colombia, in which the Government of Colombia has identified green growth as critical to maintaining development in the years to come, and has made it a priority to implement inclusive and environmentally sustainable growth principles in the country's development planning (*Departamento Nacional de Planificación* 2014)
2. The National Plan for Commercial Reforestation (2011 and revised in 2015), which has been elaborated by MADR and aims at significantly increasing the area of commercial plantations in Colombia²⁶
3. The national planning study for commercial plantations, which identified more than 7 million hectares with high potential for establishing plantations (UPRA 2015)
4. National housing programs,²⁷ which will be a main driver of wood demand for structural timber and auxiliary uses (casing, scaffolding, and so forth).

The projection of demand patterns in 2040 suggests that 15.2 million m³ of roundwood will be demanded, compared with 6.5 million m³ from national production in 2014. This increase results in a roundwood gap of 8.7 million m³.²⁸ Since more than 70 percent of domestic timber supply for pulp, sawnwood, and panels is covered by productive forests, the scenario considers productive forests as the only resource base for future production (World Bank PROFOR). The area of productive forest that is required to close the anticipated roundwood gap amounts to approximately 480,000 hectares of professionally managed productive forests.²⁹

Figure 19 illustrates the development of demand for HWP and the required development of productive forest area to fill the expected gap in roundwood supply for HWP in the green growth scenario.

The estimated mitigation potential in the green growth scenario is 2.3 million t CO₂e from productive forests, and 1.9 million t CO₂e from HWP in 2040 (figure 20). If HWP substitute fossil fuel-based products as expected, the mitigation potential increases by an additional 7.8 million t CO₂e.

²⁵ Up to 50 percent of the paper products consumed in Colombia are produced of recycled and non-wood fiber. Thus, the figures for paper production must be considered carefully, and the anticipated roundwood supply might be significantly lower, as in the base scenario.

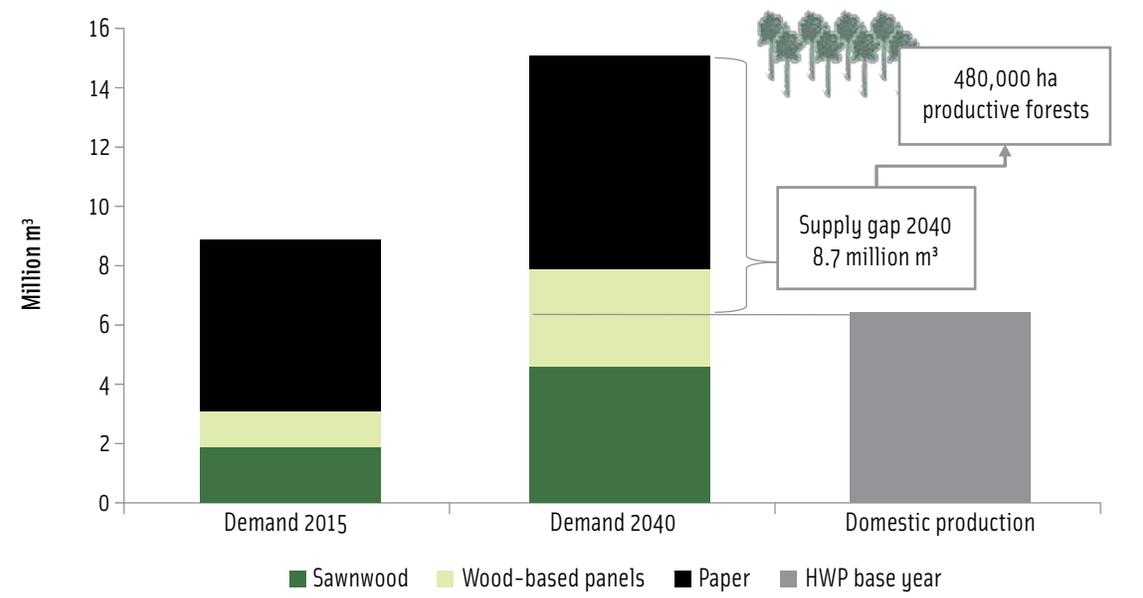
²⁶ Recent and ongoing studies (UNIQUE, prepared for World Bank PROFOR) have identified that from the currently stated 600,000 hectares of commercial plantations, only about 50 percent are productive. Thus, the efforts of the national reforestation plan have not yielded its envisaged targets.

²⁷ Colombia's housing deficit has been identified as being more than one million in the coming years; another 2.5 million units need to be rehabilitated (Departamento Nacional de Estadística and Ministerio de Vivienda). There are several ongoing activities and policies, partly co-financed by the Inter-American Development Bank and the Development Bank of Latin America.

²⁸ The calculation of the roundwood gap includes non-wood fiber and recycled paper in paper production. Thus, it has been increased by 3 million m³ (roundwood).

²⁹ In Colombia, major potential has been identified in silvo-pastoral plantation systems that enhance site productivity in extensive cattle production. However, for this study, this opportunity was not assessed due to lack of reliable data and information for this type of production system in Colombia.

FIGURE 19 Expected Demand for HWP in 2040 and Corresponding Productive Forest Area, Colombia

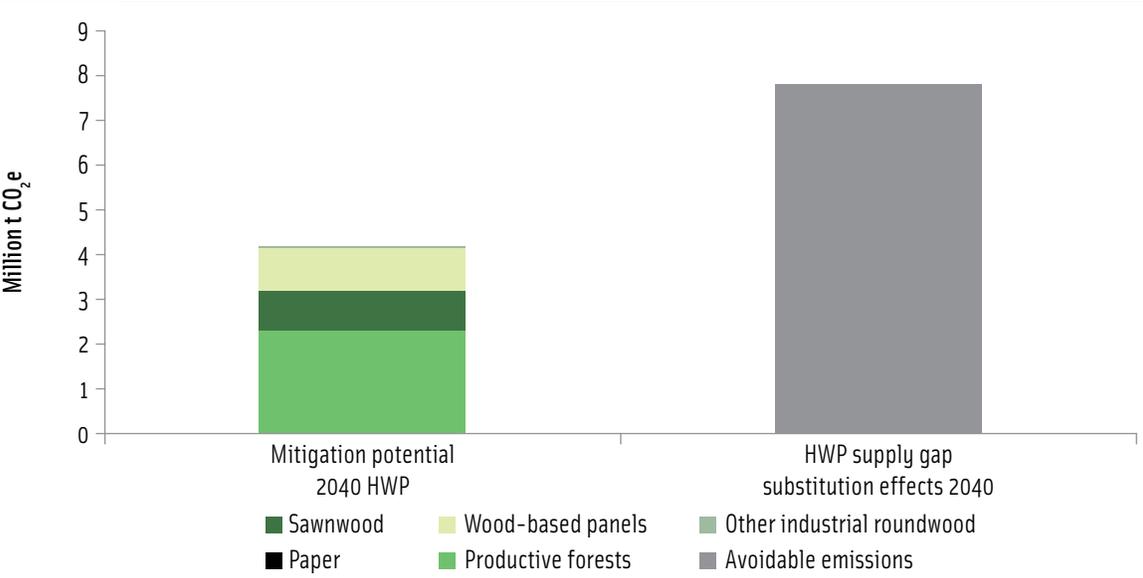


Note: ha = hectares; HWP = harvested wood products; m³ = cubic meters.

7.1.2.3 Socioeconomic Impacts

The establishment of 480,000 hectares of additional plantation area fits into MADR’s plans to revitalize its plantation expansion plan, which aims at a total area of 1 million hectares of productive commercial plantations. These efforts could contribute significantly to an increase in the plantation and primary wood-processing sector’s contribution to national GDP, increasing by 133 percent by 2040. The

FIGURE 20 Mitigation Potentials for HWP and Productive Forests, Colombia



Note: HWP = harvested wood production; ind. = industrial; t CO₂e = tons of carbon dioxide equivalent.

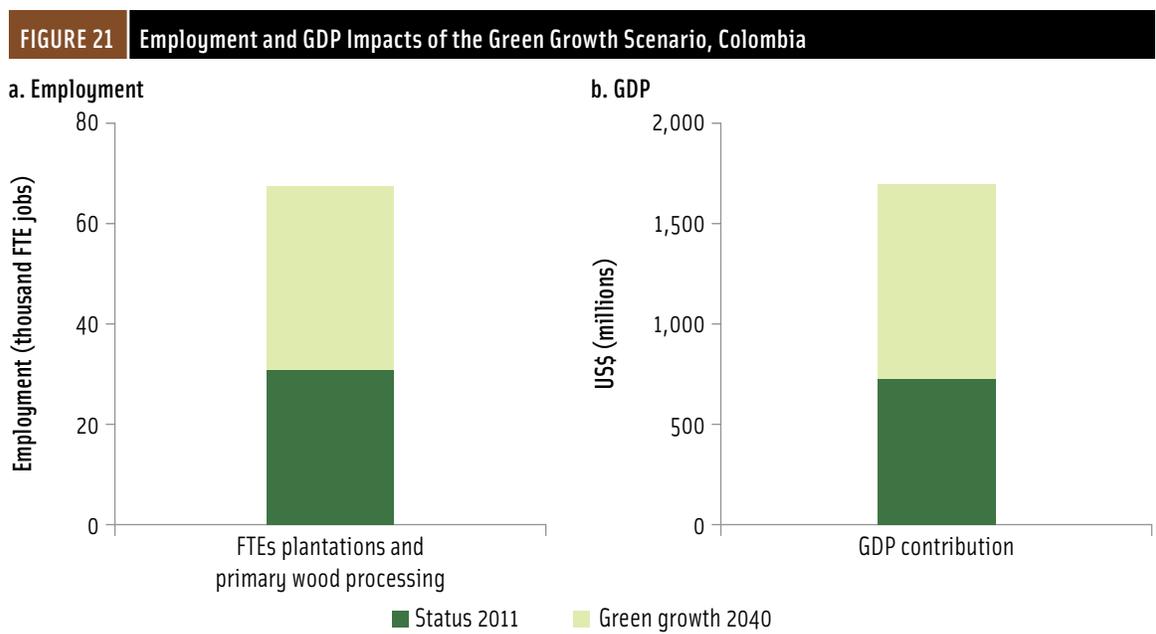
investments would also create 37,000 FTE jobs. Figure 21 details the employment and GDP potential of the green growth scenario.

7.1.2.4 Investment Environment

Colombia's forest sector is relatively small, contributing 0.2 percent of the country's GDP, and creating approximately 90,000 direct and 280,000 indirect jobs. This employment is distributed across the HWP supply chain, including producers of raw wood products, industrial actors who process raw products into goods such as furniture, and companies that commercialize these products. The majority of the actors in the sector are small or medium; approximately 95 percent of producers are considered small, as they have fewer than 500 hectares in production. The processing of furniture and other products is done by 719 formal companies that employ 26,300 people (World Bank Group 2015).

Colombia has an enabling environment that is conducive to private sector growth and has sought to increase foreign direct investment by improving the business climate. The country has transparent legal and regulatory systems, and was ranked 54 of 189 countries by the World Bank's 2016 Ease of Doing Business Report. Net investments in the forest sector increased by US\$160 million between 2009 and 2013. Companies are planning investments in the construction of a panel mill and a pulp mill. Despite these positive trends, there are several barriers to increasing investments across the HWP value chain:

- Internal armed conflict has affected the country since the 1940s, affecting rural areas disproportionately. Conflict between the government, the Revolutionary Armed Forces of Colombia (FARC), and paramilitary groups has lessened in the past decade, and peace talks are ongoing. However, insecurity remains a risk for all businesses, especially those in rural areas.
- Partly because of ongoing internal conflict, land tenure uncertainty is a risk for investments in rural areas, such as those required for HWP productive forests. Lack of legal certainty on land



Sources: UNIQUE, based on FAO (2014) Forest Sector to National Economies, 1990–2011; staff calculations.
 Note: FTE jobs in 2013 and in the green economy scenario do not include paper. The contribution to GDP in 2040 was calculated in 2015 market prices.
 FTE = full-time equivalent; GDP = gross domestic product.

ownership affects landowners' ability to use land as collateral, and therefore their ability to access credit. The government estimates that between 20 and 59.5 percent of land lacks a correct, formal title (USAID 2016). The Government of Colombia has made a concerted effort to issue land titles via MADR, to improve the situation.

- Land ownership is regulated by Law 135 of 1961 (*Unidades Agrícolas Familiares, UAF*), which restricts the amount of land that an individual can own to the land considered necessary for a family to have a decent standard of living. The amount of land that an individual can own under UAF varies by region, but, in many cases, could affect a project developer who is developing large-scale productive forests.
- Infrastructure in some areas of the country is poor and affects the commercialization of HWP. Poor road quality, for example, makes it difficult for actors in the HWP supply chain to bring their products to the market, especially in remote areas where timber resources are most abundant.
- Lack of technical knowledge and support has limited the productivity of existing HWP investments.
- There are insufficient policy incentives for the construction and other industries to use HWP.
- Colombia was ranked 83 of 168 countries in Transparency International's Corruption Perceptions Index.
- The availability of credit, especially for agriculture and forestry in rural areas, remains a barrier to investment. The share of agriculture in the country's credit portfolio (7.3 percent) is lower than that in other countries in the region. Banco Agrario de Colombia is one of the few providers of credit in rural areas. Although there is a National Incentive Program for Forestry Investments (CIF, *Certificado de Incentivo Forestal*), administrative complexity means that it is underutilized.

Colombia is in the process of addressing these barriers and improving the enabling environment through several policy reforms, including the following:

- The National Program for Commercial Reforestation was created in 2011. Among other goals, this program will establish a research and extension agency to increase and disseminate technical forestry skills.
- The Government of Colombia created the National Land Agency in December 2015 to help with the formalization of land ownership; several other initiatives are designed to improve land tenure, including the Land and Rural Development Project with the U.S. Agency for International Development (USAID).
- The Government of Colombia is in the process of identifying and classifying areas with the most potential for planted forest production.
- To address poor infrastructure and reduce transportation costs, Colombia has adopted the National Logistics Plan.
- Peace talks between the Government of Colombia and FARC are ongoing, and risks due to internal conflict have been reduced.

Since the investment-mitigation potential ratio of the pulp and paper sector can be "neglected," compared with other HWP supply chains, the sector is not included in the subsequent recommendations.³⁰

³⁰ Of the total US\$2,280 million, US\$950 million is related to pulp, which accounts only for 0.37 million t CO₂e of mitigation potential.

Table 8: Private Sector Investment Options and Recommendations, Colombia

Investment option	Private sector business case	Key interventions to improve the enabling environment
Investments in commercial productive forests	Large-scale companies should be targeted, but given the small profile of typical Colombian producers, it is critical to work with small producers, through outgrower schemes or financial intermediaries	<ul style="list-style-type: none"> Improving the availability of appropriate land, which is currently limited by the UAF Continuing to formalize land tenure Addressing and resolving the conflict with FARC Revising CIF to match the needs of commercial productive forest investors Improving infrastructure Increasing the financing available for forestry investments Providing technical assistance through the National Program for Commercial Reforestation, to improve productive forest productivity
Investments in modern state-of-the-art wood-processing industries	Sawmills including kiln drying facilities, panel plants, and pole treatment plants	<ul style="list-style-type: none"> Providing technical assistance to small, local entrepreneurs Enabling joint ventures of local entrepreneurs with companies from countries with industrial forest sectors (for example, Chile and Brazil)
Investments in the construction sector	Construction companies offering wood-based, low-cost housing systems	<ul style="list-style-type: none"> Technical assistance and training for architects and planners Quotas for wood in public construction Commitment of public tenderers to legal and sustainable procurement of wood products Preference for wood in public tenders PPPs with the construction sector Coordination with CAF and IDB on financing mechanisms for private households and credit institutes/national banks

Note: CAF = Andes Promotion Corporation (Corporación Andina de Fomento); CIF = National Incentive Program for Forestry Investments (Certificado de Incentivo Forestal); FARC = Revolutionary Armed Forces of Colombia; IDB = Inter-American Development Bank; PPP = public-private partnership; UAF = Family Agricultural Unit (Unidades Agrícolas Familiares).

Table 8 provides an overview of how to attract private sector investments through interventions that improve the private investment environment.

7.1.2.5 Model Business Case: Orinoquia Social Housing Cluster

This business case is supported by the plan to address the Colombian housing deficit of more than one million housing units. In the coming years, another 2.5 million units will need to be rehabilitated. The business case considers the use of sawnwood and wood-based panels, instead of cement and bricks, in housing construction in the projection period until 2040, in alignment with Colombia's green growth strategy.

If 80,000 wood-based housing units were constructed every year, according to European design,³¹ 450,000 m³ of industrial roundwood would be needed annually to provide the raw material for structural panels and sawnwood for wall construction (Weimar and Jochem 2013). The resource base required to produce the raw material that is needed is approximately 20,000 hectares. Eucalyptus and pine would be appropriate tree species for the area.

³¹ Wood consumption on average is 25 m³ of wood-based panels and sawnwood per 1,000 m³ of constructed space. This amount refers to wood as the main structural material in walls.

The Orinoquia region in eastern Colombia offers the most promising options for land availability to produce the required roundwood volume. Given the large volume of wood needed, large-scale productive forest companies and vertically integrated processing industries would be the most likely private sector project sponsors. Interest from large-scale actors seeking to invest in new productive forests in the Orinoquia region has been articulated on several occasions.³²

A significant risk for this business case is uncertainty around land tenure; thus, the investor must carefully assess land tenure rights as part of the due diligence process. Because of the land tenure regulations under the UAF policy, expansion of contiguous, large productive forest areas is difficult (depending on the region, the maximum area per unit is about 1,000 hectares). Thus, productive forest companies must negotiate leases or other land use agreements with many landowners who control small production units. The model business case assumes that 10,000 hectares over several sites will be established by the lead company, and another 10,000 hectares will be established in partnership with various landowners. The establishment and management of these sites will be supervised by the lead company, to ensure quality management and performance. Since the lead company is expected to install the processing capacities, it has a special interest in obtaining quality raw material according to its specifications.

Incentives for the establishment of productive forests are available from CIF, which reduces the costs for establishment and maintenance by 25 to 50 percent.

The wood products required for the social housing program (80,000 units annually) are construction timber and wood-based panels; two sawmills and one panel plant are needed to process the wood. The total capital required for the establishment and operation of productive forests is US\$120 million, and investments in processing facilities amount to US\$95 million.

Potential investment benefits include the following:

- Direct employment for 1,400 persons in FTE jobs from productive forests. The establishment and operation of processing facilities will create 200 FTE jobs.
- The gross value added of all the operations described in the business case in 2040 totals more than US\$48 million (0.02 percent of 2015 GDP).³³
- The annual HWP mitigation potential is 170,000 t CO₂e; the annual substitution potential is approximately 620,000 t CO₂e.

Investment efforts must be accompanied by public programs that clearly establish product specifications for modern wood-based housing projects. The “Mi Casa Ya” program would be a good entry point, where the Government of Colombia is currently providing subsidized loans to low-income Colombians to promote home ownership. Enhanced infrastructure development is also essential, as this is necessary to enable access to consumer markets in the Andean region of the country. The Ministry of Transport has detailed its plans to improve infrastructure throughout the country, in the National Development Plan.

As discussed in section 7.1.2.4, the UAF policy, lack of secure land tenure, poor infrastructure, political conflict, and other factors pose potential hurdles for investors considering this project. The long payback period of the investment may be perceived as another obstacle. The productive forests will not start generating significant revenues from harvest until after seven years for fiber and 18 years

³² Most recently, interest was expressed during stakeholder workshops in ongoing discussions of the World Bank/PROFOR plantation value chain in Colombia (which were to be completed in October 2016).

³³ Colombia’s GDP in 2015 was US\$377,740 million.

for sawlogs, although pruning and thinning activities will create modest income in the early years. These long periods would normally dissuade debt investors from investing; a structure that shares risk between different parties is necessary to catalyze private sector investment. To finance planting and operations of 20,000 hectares at a cost of approximately US\$120 million, the following hypothetical structure is proposed:

- On the land leased from small landowners, the landowner would have to be compensated with a lease payment that is at least as high as the current use of the land. In the Orinoquia region, large areas are used for extensive cattle ranching. This land will be targeted, as the opportunity cost is relatively low. The landowners may provide a portion of the value of the land as equity. However, in most cases, landowners will prefer cash from lease payments and may not invest in longer-term returns. Where land is purchased by the companies, they likely would finance the purchase using own equity.
- Colombia's CIF program could provide up to 50 percent of the establishment and management costs for productive forests. However, the program needs to be revised to make it more attractive for large investors and more accessible for smallholders.
- Local banks, such as Banco Agrario or Bancolombia, may finance the remainder of the investment via loans. However, the tenors available from these sources are shorter than the payback period of the investment. Banco Agrario, for example, offers loans with tenors up to five years. As discussed in section 6.3, a donor-supported guarantee facility is proposed to absorb risk and encourage local banks to expand their financing products for projects such as these.
- Investments for the industrial processing facilities could be financed under the following structure:
- A large, productive forest/wood-processing company could provide a portion of the investment as equity.
- International commercial banks or a development finance institution like the IFC or the Inter-American Investment Corporation (IIC) could provide the remaining capital as loans. Depending on the perceived risk of such an investment, the Forest Investment Program (FIP) or another donor may need to provide a portion of the loan on concessional terms, as recommended in section 6.3.

Table 9 highlights the main features of the model business case.

7.1.3 Peru

7.1.3.1 *Country Background and Climate Change and Forestry Commitments*

Peru is classified as an upper-middle-income country. Since 2009, when the global financial crisis had a significant impact on growth, the economy has built on solid growth fundamentals to continue expansion. Domestic demand has been the main driver of growth, as overall improvement in confidence in the economy has boosted domestic consumption and investment. Peru is the third largest country in South America, with a population of approximately 29 million people.

Ninety-two percent of Peru's forests lie in the Amazon Basin. Estimates of Peru's forest area vary between 65.2 million and 86.4 million hectares (FAO 2005). Of this area, about 24.6 million hectares are dedicated to production forests. Peru has the second largest forest estate in Latin America, and the eighth largest globally.

Peru's timber supply comes primarily from natural forests, which provided 75 percent of the 2 million m³ of industrial roundwood produced in 2014 (excluding fuelwood). The remaining roundwood

Table 9: Orinoquia Social Housing Cluster, Colombia

Key feature	Details
Market	80,000 social housing units in modern wood design Market to be established by Colombian public procurement and infrastructure development in the region
Business model(s)	Large-scale outgrower business model Leverage of productive forest investments through CIF incentives
Roundwood volume	450,000 m ³ annually
Productive forest area	10,000 hectares of large-scale productive forests 10,000 hectares of outgrower productive forests
Industry facilities	2 sawmills (50,000 m ³ output each) 1 panel plant (200,000 m ³ output)
Investments	US\$120 million in productive forests (not considering CIF incentives) US\$95 million in industries
Employment	1,400 FTE jobs in productive forests 200 FTE jobs in industries
Gross value added (GDP contribution excl. taxes)	US\$48 million annually from 2040 (not considering leverage through CIF)
GDP contribution based on 2015	0.02%
CO ₂ mitigation potential	Mitigation: 170,000 t CO ₂ e in HWP (annual figure, 2040) Substitution of non-wood materials: 620,000 t CO ₂ e (annual figure, 2040)
Investment return ratios	US\$1 invested for US\$4 GDP contribution (annually for 20 years) US\$135,000 invested for 1 FTE job (employed for 20 years) US\$14 invested for 1 t CO ₂ e (substitution) (over 20 years)

Note: CIF = National Incentive Program for Forestry Investments (Certificado de Incentivo Forestal); FTE = full-time equivalent; GDP = gross domestic product; HWP = harvested wood products; m³ = cubic meters; t CO₂e = tons of carbon dioxide equivalent.

comes from productive forests. Peru is a net importer of wood products, with a negative trade balance of 1 million m³ for wood products and 550,000 tons of paper products. The roundwood supply shortage is caused by two factors:

1. Insufficient supply from forest concessions. In 2012, about 8 million hectares were given to 609 concessions for timber production. However, few concessions have the financial and operative means to work profitably and sustainably. Almost a third of the timber concessions have been cancelled due to noncompliance with regulations, and many others are under investigation for presumed irregularities in the extracted timber volumes. However, an increasing share of roundwood is harvested under individual licenses, which are difficult to monitor. There is an urgent need for revision of the concession system from an ecological and economic perspective (GGGI 2014).
2. Lack of commercial plantations. Peru plays only a minor role among nearby countries, with around 300,000 hectares planted (of which only 60,000 hectares are commercial plantations of eucalyptus and pine). The lack of available roundwood resources for industrial processing has led to significant increases in imports of sawnwood and wood-based panels by the national construction and furniture industries. Plans to promote plantations have been developed, but may not be implemented in the near term (GGGI 2014).

Peru's NDC unconditionally commits to a 20 percent reduction in GHG emissions compared with the projected business as usual scenario in 2030. This would amount to a reduction of almost 60 million t CO₂e, including land use, land use change, and forestry, in 2030.

7.1.3.2 *Green Growth Scenario for HWP Production*

As Peru's growing import figures indicate, demand for wood products has increased significantly. The main consumption driver is the construction sector, which accounts for more than 50 percent of the 2 million m³ of the primary processed wood products consumed in the country (SNV 2009). The vast majority is sawnwood originating from natural forest concessions.

The following ongoing processes at the policy level affect future HWP consumption and production:

1. The national agenda to promote private investment in forest management, which comprises activities related to the sustainable management of natural forests and the establishment of new plantations, with a target of 2 million hectares.³⁴ The agenda emphasizes market-driven sector growth, where public procurement and green procurement policies aim to induce increasing demand for sustainably produced wood products.
 2. The national plan for green growth, which has not yet been developed in detail, considers the sustainable use of renewable resources as key to achieving emission reduction targets and economic growth (Alliance for Economic Action 2014).
 3. The national agendas promote competitiveness and industrial diversification of national production. The agendas consider forest supply chains in their strategic axes (Government of Peru 2014b).
- The Forestry Division of the Ministry of Agriculture is currently undertaking a program-planning feasibility study, which is explicitly aimed at promoting the forestry supply chains (plantation- and natural forest-based). The program will be co-funded by the German Development Bank (GfW), with an estimated budget of more than US\$30 million in the first tranche. The program will also address investment support to wood-processing industries and promote market-driven stimuli.

In 2040, production of HWP for the domestic market will require 15.6 million m³ of industrial roundwood, compared with around 3 million m³ of production in 2014 (FAOSTAT). The scenario assumes that supply for domestic sawnwood is provided by natural forest concessions, while wood-based panel and paper production will come exclusively from commercial productive forests.

The productive forest area required to provide the raw material for future wood-based panel demand amounts to approximately 420,000 hectares of professionally managed productive forests. To supply the sawnwood demand in 2040 (1 million m³), the area of natural forest concessions would extend to 1 million hectares.³⁵

Figure 22 illustrates the development of demand for HWP and the required development of productive forest area to fill the expected gap in roundwood supply for HWP in the green growth scenario.

³⁴ Peru has pledged this area under the 20x20 Initiative.

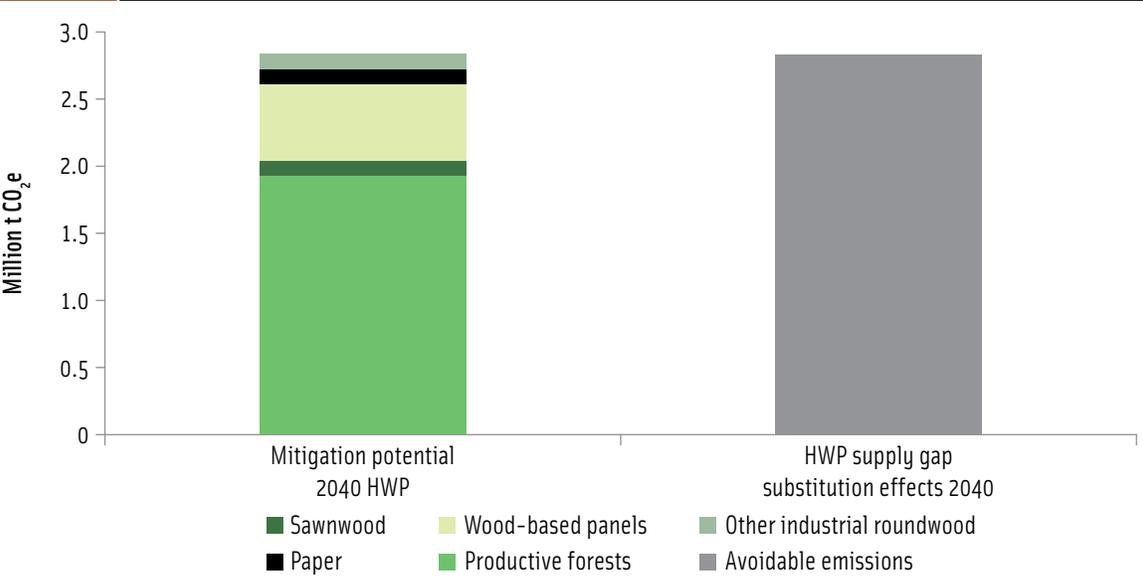
³⁵ According to the Forestry Division's guidelines for concessions, the allowable cut is 20 m³/hectare, with a harvesting cycle of 20 years. Around 4 million hectares of natural forest concessions are under active management in Peru.

FIGURE 22 Expected Demand for HWP in 2040 and the Corresponding Productive Forest Area, Peru



The estimated mitigation potential in the green growth scenario is 1.9 million t CO₂e from short-rotation plantations, and 900,000 t CO₂e from HWP in 2040 (figure 23). Substitution of fossil fuel-based products with HWP would avoid an additional 2.8 million t CO₂e in GHG emissions.

FIGURE 23 Mitigation Potentials for HWP and Productive Forests, Peru



Sources: UNIQUE, based on FAO 2014; staff calculations.
 Note: FTE jobs in 2013 and in the baseline scenario for 2040 do not include paper. The contribution to GDP in 2040 was calculated in 2015 market prices. HWP = harvested wood products; ind. = industrial; t CO₂e = tons of carbon dioxide equivalent.

7.1.3.3 Socioeconomic Impacts

The Peruvian case illustrates the socioeconomic impacts of a combined effort to improve the sustainable management of natural forests and enhance the establishment of productive forests for production in the wood-based panel and pulp and paper industries.

Addressing the growing national market demand through enhanced promotion of the commercial productive forests and primary processing wood industries would result in increasing gross value added by 347 percent in 2040 and the creation of 33,000 FTE jobs, as shown in figure 24. The large contribution to GDP is driven primarily by the increase in panel and pulp production.

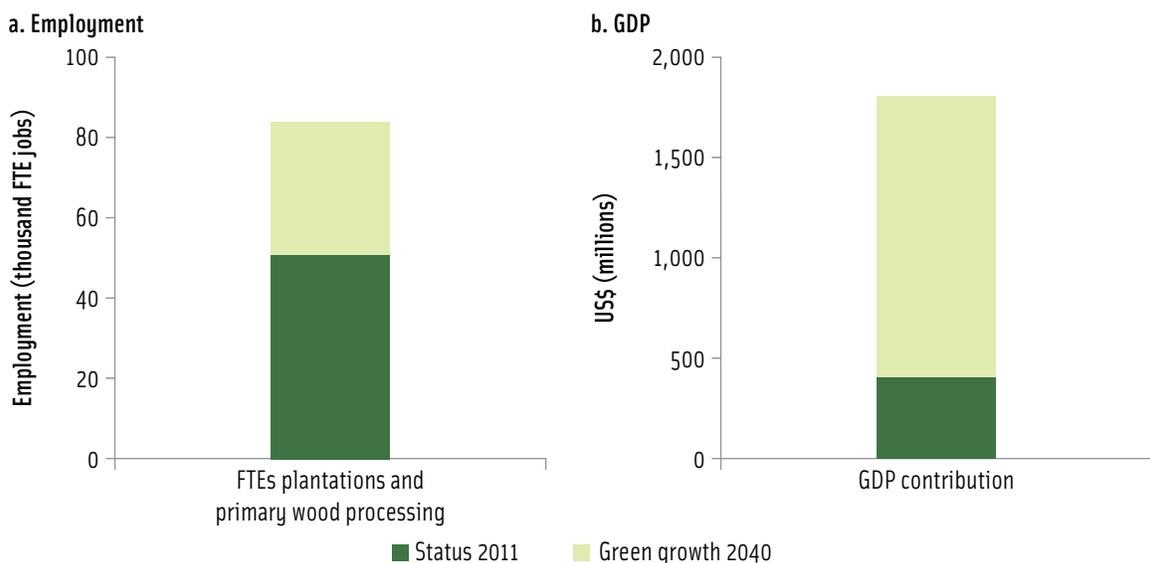
7.1.3.4 Investment Environment

The contribution of Peru's forest sector to GDP has decreased slightly in recent years, from 1.1 percent in 2007, to 0.9 percent in 2013. The forest sector is made up of 23,880 formal companies, only 4 percent of which have more than five employees, comprising a total of 107,000 employees. The furniture subsector is the most important, with approximately 11,000 companies and 50,000 formal employees (UNIQUE 2015b). Approximately three-quarters of Peru's timber production is used for fuelwood (GGGI 2014).

After a slowdown associated with the financial crisis in 2009, Peru's GDP has grown rapidly, with the exception of 2014 when growth was low across Latin America. The Government of Peru has instituted several business-friendly policies, and Peru was ranked 50 of 189 countries for ease of doing business (World Bank Group 2016). Small- and medium-size forestry companies, such as Reforestadora Latinoamerica S.A., are planning expansions. Nonetheless, there are several barriers to HWP growth:

- Infrastructure quality and access to markets is highly variable across the country, with some regions much more accessible than others.
- Due to the low efficiency of harvesting and processing, Peru has high costs of HWP production.

FIGURE 24 Employment and GDP Impacts of the Green Growth Scenario, Peru



Note: FTE = full-time equivalent; GDP = gross domestic product.

- Lack of clarity over land tenure is an obstacle to forestry investments, as only 45 percent of rural land plots are registered under Peru's Special Land Titling and Cadaster Project (PETT in Spanish). Land conflicts are common, and the regulatory framework for resolving conflicts is weak (USAID 2010).
- Access to finance is a limiting factor throughout supply chains in the forest sector. For example, only 25 percent of carpentry companies have a relationship with the financial sector, and only 20 percent of those have access to loans with tenors longer than two years (SNV 2009).
- It is difficult for foreign investors to engage with the informal sector, which poses challenges for regulators. Some companies lack business management skills and a vision for growth of the business.
- Compliance with laws and regulations is uneven across the sector. Nearly one-third of the country's timber concessions have been cancelled because of legal noncompliance, and two-thirds of the existing concessions are under investigation.
- A poorly developed supply chain means that sawnwood is the most commonly exported product and further processing is small. This situation hinders the economic potential of the sector (GGGI 2014).

Several ongoing initiatives and policy reforms should address some of these barriers:

- The Ministry of Agriculture and Irrigation is supporting the National Policy for Forestry and Wild Animals, which, among other objectives, aims to improve technical knowledge around forestry management and strengthen agricultural and forestry supply chains.
- The Finance Alliance for Sustainable Trade is working with the Peruvian forest sector and financial institutions to improve access to finance, and has facilitated approximately US\$13 million in investment to date.
- Peru's PETT project continues to grant land titles to rural lands, and is supported by several external organizations, such as USAID and the Inter-American Development Bank (IDB).
- The Ministry of Development and Social Inclusion works with public agencies and financial institutions to promote financial literacy and inclusion.

Table 10 provides an overview of how private sector investments can be attracted through interventions that improve the enabling environment for private investments.

7.1.3.5 *Model Business Case: Reduced-Impact Logging for Quality Sawnwood Production in Ucayali*

The Ucayali department covers an area of more than 8.7 million hectares, of which about 90 percent is still covered by forests. The forest sector is the most important economic sector, and contributes approximately 70 percent to the regional GDP and accounts for 40 percent of all employment (Haas 2014). Since 2002, a public forest concession system has been in place, where harvesting contracts for permanent production forests can be formally obtained from the forest authorities through a bidding process. According to official data from the regional forest authority, permanent production forests cover an area of approximately 4.8 million hectares (56 percent of the department's territory), of which around 2.8 million hectares are industrial forest concessions and 2 million hectares are native community forests.

Although Peru has a wealth of forestry resources, the current forest concession system is often criticized for being unsustainable due to the lack of efficient monitoring and low productivity. Since 2014, the condition of the country's forest sector and concession regime has been precarious: 77 percent of all harvesting permits in forest concessions and 74 percent in native communities are suspended

Table 10: Private Sector Investment Options and Recommendations, Peru

Investment option	Private sector business case	Interventions to improve the enabling environment
Investments in commercial productive forests	Large- and small-scale investments are possible; given the small size of many existing producers, outgrower or other aggregation schemes should be considered	<ul style="list-style-type: none"> • Continue to support PETT • Develop forestry-specific credit lines to support private sector investments • Increase the formality of the forest sector, throughout the value chain • Enable PPPs between state forest enterprises and commercial plantation investors, to rehabilitate degraded plantation sites • Support technical forestry knowledge through capacity building • Make RIL a precondition for concession operators • Increase access to long-term financing for forestry investments • Strengthen the efforts of OSINFOR to monitor forest concessions
Investments in modern state-of-the-art wood-processing industries	Saw mills including kiln drying facilities, panel plants, and pole treatment plants	<ul style="list-style-type: none"> • Improve access to capital and credits, targeted at investments in efficiency • Provide technical assistance to local entrepreneurs • Enable joint ventures of local entrepreneurs with companies from countries with industrial forest sectors
Investments in the construction sector	Construction companies offering wood-based, low-cost housing systems	<ul style="list-style-type: none"> • Technical assistance and training for architects and planners • Quotas for wood in public construction • Commitment of public tenderers to the procurement of legal and sustainable wood products • Preference for wood in public tenders

Note: OSINFOR = Forest Resources Supervisory Agency (Organismo de Supervisión de los Recursos Forestales); PETT = Special Land Titling and Cadastre Project; PPP = public-private partnership; RIL = reduced-impact logging.

or inactive. Of the concessions, 43 percent are paralyzed due to legal violations; 36 percent are not operational due to financial difficulties; and only 23 percent remain active and operational (Haas 2014).

The model business case especially addresses two main groups of concessionaires: the timber industries and the patrons (*apadrinados*). The timber industries largely control the timber market and provide their concession documents and capital to selected loyal loggers. Patrons rent their concession documents to loggers who work independent of timber companies. The sizes of forest concessions range from 5,000 to 50,000 hectares. Assuming an average size of 15,000 hectares per concession, this business case would involve around 190 concession holders.

The proposed business case focuses on a change in management practice in natural forest concessions, from conventional logging to reduced-impact logging (RIL).³⁶ Through planning and improved harvesting practices, RIL can increase the productivity of forestry operations while minimizing the environmental impact of logging. Specifically, RIL includes the following practices: (i) pre-harvest

³⁶ The business case could further consider the establishment of new sawmill facilities in the region, to produce quality sawnwood and keep value added locally (instead of the common practice of river transport of roundwood to industrial centers), which is competitive in price and quality compared with lumber imports, for example from Chile. Further, mill efficiency is expected to improve significantly, from 40 to 50 percent. This option is not considered in the presented business case, since the new sawmills would replace existing sawmills, and the additional direct CO₂ benefits would be marginal.

inventory of trees to harvest, (ii) pre-harvest planning of roads and skid trails, (iii) pre-harvest cutting of selected vines, (iv) minimization of the environmental impact of roads, (v) use of felling techniques to minimize waste, (vi) ensuring that logs and machinery stay on roads, (vii) minimization of soil disturbance, and (viii) post-harvest assessment (ITTO). Studies from the Brazilian Amazon indicate that RIL improved the performance of the operations and cut costs by more than 10 percent (Holmes et al. 1999). Furthermore, recent studies indicate that Amazon forests logged with RIL techniques may recover their initial carbon stock in seven to 21 years (Rutishauser et al. 2015). However, implementing RIL requires a high level of expertise and significant investments in training and pre-harvest planning.

Investments in the qualifications of forest workers and management staff to apply RIL practices require regular training. Because of the high fluctuation of workers, training should be repeated annually. The investment that is required to implement RIL is estimated at US\$840,000 annually, which adds up to US\$17 million over a 20-year cutting cycle in concessions. Additional pre-harvesting planning and inventory will cost US\$84 million, for a total of US\$101 million.³⁷

An effective forest monitoring system must be established, to monitor compliance with RIL practices and combat the illegal logging activities that currently hamper the market for legal wood products. The government entity in charge is the Peru Forest and Wildlife Oversight Agency (OSINFOR, Organismo de Supervisión de los Recursos Forestales), which still requires external donor support for successful program implementation. USAID has been in close cooperation with OSINFOR over the past year, and may be a partner that can strengthen OSINFOR's capacity in the future.

Potential investment benefits include the following:

- An increase of 2,800 additional permanent employees in concessions,³⁸ primarily because of the greater labor input required by RIL.³⁹ Improved working conditions and salary increases will be indirect positive impacts in the labor sector.
- An increase of roundwood provided from the total concession area of 700,000 m³. On the productivity side, the current harvesting rate is around 10 m³ per hectare,⁴⁰ which is far below the allowed extraction volume of 20 m³ per hectare. Implementation of RIL may increase productivity to 15 m³ per hectare.
- Gross value added will be an estimated US\$95 million annually.
- An annual benefit of 600,000 t CO₂e compared with current forest management practices. The enhanced carbon stock potential was quantified based on the assumption that RIL will be applied on the total area of commercial concessions (2.8 million hectares) required to supply national demand for the sawnwood supply chains in 2040.

Barriers such as lack of land tenure clarity, the informality of the sector, and lack of legal compliance are likely to create significant risks for the project. However, compared with investments to establish new plantations, the returns from Peru's RIL case are expected to be realized sooner.

³⁷ These figures are based on RIL studies by Holmes et al. (1999) and UNIQUE (2016).

³⁸ In natural forest management, a permanent employee is not equivalent to full-time employment, because of the effects of seasonality of activities.

³⁹ It might be useful to discuss whether technological progress will reduce the number of employees in industries, but this effect depends on the configuration of the sawmill, which is highly flexible, that is, in the periphery, such as the log yard and the assortment of sawnwood, where the management can decide between high automatization and manual work.

⁴⁰ Because of the natural availability of marketable timber species, the real annual extraction rate varies significantly between concession sites.

Pre-harvest forest investment could be financed by:

- FIP or other donors (such as KfW) could provide equity or first-loss financing. Concession management companies may also provide equity.
- IIC, IFC, or international commercial banks could provide senior debt with tenors of 7–10 years.
- Short-term financing needs could be provided via Agrobanco, with tenors up to four years. Alternatively, an FIP guarantee could allow a local bank to provide long-term credit and replace an international development bank.

Monitoring concessions and fighting illegal logging are important parts of the business case, and require the active involvement of the public sector to be successful. Table 11 highlights the main features of the model business case.

7.1.4 Mexico

7.1.4.1 Country Background and Climate Change and Forestry Commitments

Mexico has the second largest economy in Latin America, and is classified by the World Bank as an upper-middle-income country. Despite this classification, approximately 53 percent of the country's 120 million people are living below the national poverty line.

Compared with the other countries in this study, land use and land use change represent a relatively small portion of Mexico's GHG emissions. Deforestation and degradation contributed

Table 11: Reduced-Impact Logging, Peru

Key feature	Details
Market	Construction sawnwood in urban centers
Business model(s)	Higher productivity in concessions and efficiency in processing Improving monitoring and law enforcement capacities at the institutional level required
Roundwood volume	Increase by 0.7 million m ³ to 2.1 million m ³ annually
Concession area	2.8 million hectares
Investments	US\$17 million for annual RIL training US\$84 million for pre-harvesting planning and inventory
Employment	An increase of 2,800 FTEs to 8,400 permanent FTEs in concessions
Gross value added (GDP contribution excl. taxes)	US\$95 million annually from 2040
GDP contribution based on 2015 ^a	0.05%
CO ₂ mitigation potential	600,000 t CO ₂ e annually from reduced losses in harvest
Investment return ratios	US\$1 invested for US\$19 annual GDP contribution (over 20-year period) US\$96,500 invested for 1 FTE job (employed for 20 years) US\$8 invested for 1 t CO ₂ benefit (over 20 years)

Note: FTE = full-time equivalent; GDP = gross domestic product; m³ = cubic meters; RIL = reduced-impact logging; t CO₂e = tons of carbon dioxide equivalent.

^a Peru's GDP in 2015 was US\$202,600 million.

to approximately 10 percent of Mexico's 2006 emissions, and agriculture contributed more than 6 percent (Government of Mexico 2011).

Mexico has emerged as a leader in green growth, having launched its Special Climate Change Program in 2009, in which the country announced a goal of reducing GHG emissions by 50 percent of 2000 levels by 2050. In its NDC, Mexico committed to unconditionally reduce its GHG emissions by 25 percent in 2030 compared with the business as usual scenario. Mexico emphasizes black carbon emissions, and has committed to cut black carbon emissions by 51 percent. Among other measures taken to mitigate climate change, the country adopted a carbon tax in 2012 that charges Mex\$10 to Mex\$50 per t CO₂e, depending on the fuel type.

In addition, the Government of Mexico has taken clear steps to implement REDD+. Mexico's General Law on Climate Change, adopted in 2012, includes the establishment of a Climate Change Fund, which will pay for certified emissions reductions, including from REDD+. The country's Emissions Reduction Project Idea Note proposes a community-based landscape approach that will target several low-emissions development activities, including sustainable forest management, rotational grazing, conservation tillage, afforestation, and reforestation. Mexico's REDD+ strategy aims to achieve net-zero emissions from land use change by 2020. The strategy has five components: improving public policies and institutions, increasing access to finance, monitoring and reporting emissions, building capacity, and communicating results and lessons learned.

Mexico is also an FIP country, and its investment plan focuses on increasing access to finance for forestry activities and sustainable forestry management. Through a project administered by the IDB, FIP is supporting a guarantee fund to promote low-carbon forestry.

The Government of Mexico has committed to restore 8.5 million hectares of degraded land by 2020, under the Bonn Challenge and Initiative 20*20. The analysis shows that if one-third of this commitment is dedicated to productive forests, Mexico can meet the expected demand for HWP while making a significant contribution to the NDC. Other land restoration can help to conserve natural forests, providing habitat for biodiversity and protecting watersheds.

The present country study for Mexico focuses on enhanced timber production and domestic consumption of wood products in permanent uses (that is, construction). The study assesses the mitigation potential of HWP based on projected demand in 2040 and assumes the green growth scenario will be met exclusively by national production.

7.1.4.2 Green Growth Scenario for HWP Production

National data indicate a current domestic harvest of 6 million m³ of roundwood on an area of roughly 8.4 million hectares. Mexico's forest resources are nearly sufficient to meet the country's demand, but because the forest sector is underdeveloped, wood-processing industries rely heavily on imports.

Mexico's HWP balance for 2014 shows a total consumption of 40 million m³, of which 70 percent was used for paper and paperboard, 20 percent sawnwood, and 10 percent wood-based panels. Roughly 25 million m³ of HWP were domestically produced. However, because of the limited and declining domestic harvest in recent years, the demand for HWP has been largely dependent on imported raw materials, especially in the paper industry. Since the dependency on imports is strongly related to structural deficits in the forest sector, improvement strategies may result in positive trends for domestic industries.

The following strategies are assumed to influence Mexico's forest sector (CONAFOR 2013):

1. Educating and empowering local communities in technical forestry and business management skills through extension services and training

2. Enhancing forest production through the promotion of commercial species planting, improved financing instruments, improved forest infrastructure, as well as forest management practices
3. Improving control and monitoring systems to reduce illegal or unsustainable harvesting and forest fires
4. Strengthening the coordination of forest-related support for rural communities.

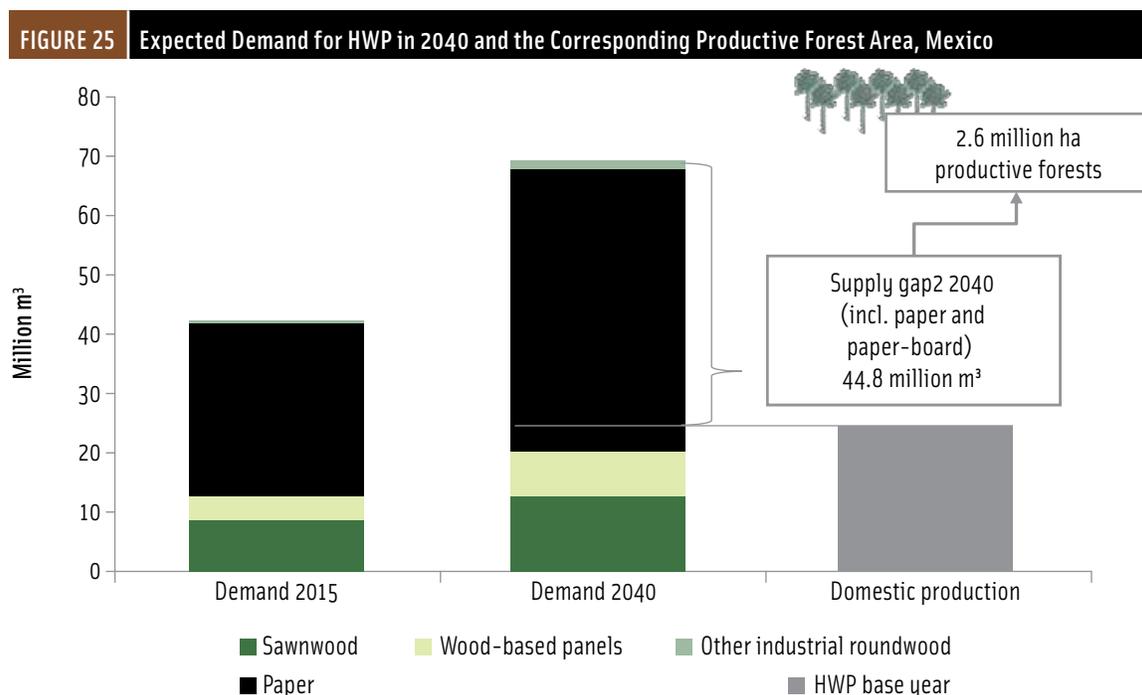
A historical, 10-year analysis of wood consumption, population growth, and industrial sector GDP resulted in the correlation factors that were used for the projection of HWP consumption until 2040.

The projections of future demand result in HWP volumes (sawnwood, wood-based panels, paper and paperboard, and other industrial roundwood) of 70 million m³ in 2040. There is a projected roundwood supply gap of 45 million m³ by 2040.

The future supply gap could be addressed by planting an additional 2.6 million hectares of professionally managed productive forests. The greatest supply gap is in raw products for the paper industry. To supply the paper industry, 1.8 million hectares of short-rotation plantations would be needed. Given the demand for land in the country, this aspect may be difficult to realize. The country would require 750,000 hectares of long-rotation productive forests to produce enough high-quality wood for the sawmilling industry. Figure 25 shows the development of demand for the HWP and productive forest area that is necessary to fill the expected gap in roundwood supply for HWP.

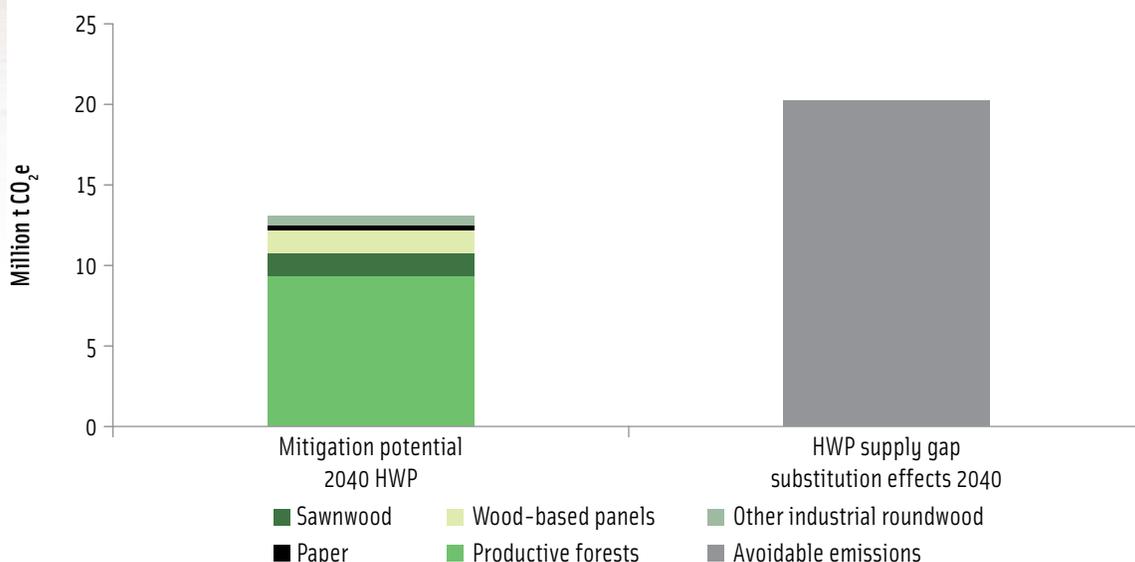
Figure 26 details the mitigation potential of meeting this projected demand. Compared with the large area needed (1.8 million hectares) for the gap in paper production, this component would have a relatively small mitigation impact. Paper products have fast decay rates, limiting their ability to sequester CO₂ over the long term. Nonetheless, if 1.8 million hectares were dedicated to short-rotation plantations, this would make the largest contribution to climate change mitigation.

The mitigation potential of HWP carbon pools is estimated to be 3.8 million t CO₂e, while establishment of productive forests would contribute 9.3 million t CO₂e. Substitution of HWP for fossil



Note: ha = hectares; HWP = harvested wood products; m³ = cubic meters.

FIGURE 26 Mitigation Potentials for HWP and Productive Forests, Mexico



Note: HWP = harvested wood products; ind. = industrial; t CO₂e = tons of carbon dioxide equivalent.

fuel-based products would avoid an additional 20.2 million t CO₂e in GHG emissions. Combined, the forest sector could mitigate 33.3 million t CO₂e in 2040.

7.1.4.3 Socioeconomic Impacts

In addition to this mitigation potential, increasing domestic production would have dramatic social and economic impacts. The establishment of productive forests and the management and operation of additional processing facilities would add an additional 199,000 jobs by 2040. By 2040, gross value added from the forest sector would increase by 159 percent (figure 27).

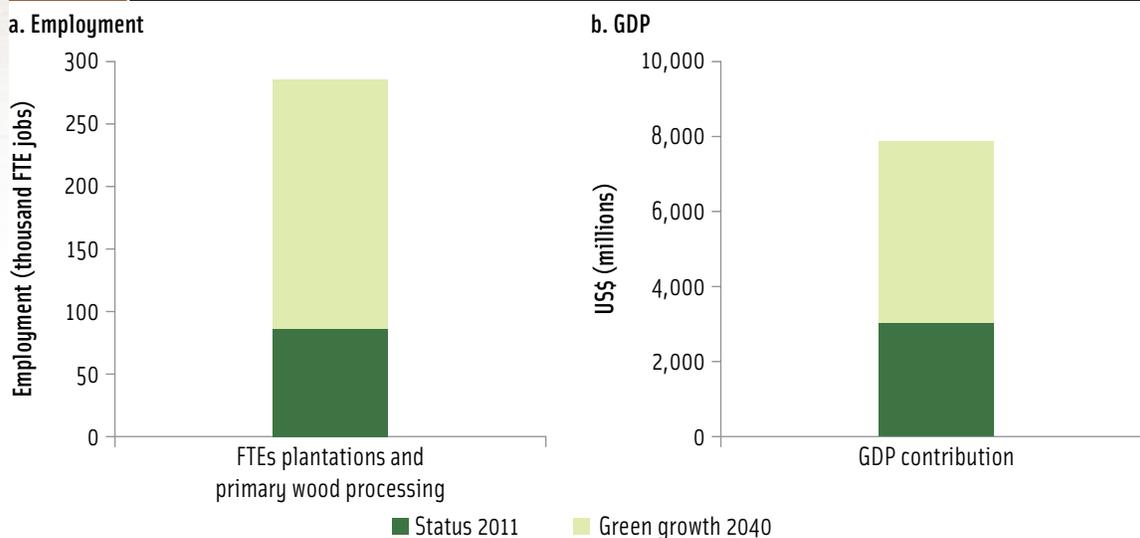
7.1.4.4 Investment Environment

In 2013, Mexico's forest sector produced US\$37.8 billion in output, representing nearly 3 percent of annual GDP. The sector is an important job creator, with nearly 100,000 jobs in silviculture, and another 500,000 in industrial processing (FAO 2015). Most productive forests and industries are small scale (Segura 2000).

Mexico's economy has grown modestly over the past decade, and has been affected by weaknesses in the U.S. economy. Mexico generally has a transparent legal and regulatory framework, and the country was ranked 38 of 189 countries for ease of doing business (World Bank Group 2016). Investment in the forest sector has increased in recent years; for example, the FIP and IDB will support an investment in community forestry. Pine and resin processors, which harvest raw resin from native species plantations, are also planning to expand operations. Growth of HWP supported by the private sector takes place in the following context:

- Violence related to drugs and other organized crime has risen significantly since 2006. The U.S. Embassy in Mexico City advises that security concerns are an issue for companies and investors (U.S. Department of State 2014).

FIGURE 27 Employment and GDP Impacts of the Green Growth Scenario, Mexico



Sources: UNIQUE, based on FAO 2014; staff calculations.

Note: FTE jobs in 2013 and in the baseline scenario for 2040 do not include paper. The contribution to GDP in 2040 was calculated in 2015 market prices. FTE = full-time equivalent; GDP = gross domestic product.

- Land use in Mexico is somewhat complicated by the existence of communally-owned lands (*ejidos*), which control more than half the land area of the country and 80 percent of its forest reserves (Barnes 2014). The purchase of *ejido* land is somewhat restricted for foreign investors; however, the use of land rights may be transferred with a Mexican financial institution as a trustee.
- Mexico was ranked 95 of 168 countries in Transparency International's Corruption Perceptions Index.
- Access to finance for forestry activities is severely limited and represents 0.01 percent of total loans made (Government of Mexico 2011).
- *Ejido* managers in some cases have limited business and financial expertise, which hampers the growth of community-owned forestry companies.

Mexico is improving the enabling environment for forestry investments through the following initiatives:

- The National Forestry Commission (CONAFOR) provides incentives for productive forests. The National Forestry Fund (FONAFOR) is capitalized at Mex\$1.1 billion, and provides financing and guarantees for commercial forestry investments. FONAFOR will guarantee up to 20 percent of a loan provided to companies in the forestry supply chain.
- The National Forest Program (PRONAFOR) rewards landowners for land restoration, through a payment for ecosystem services scheme.
- The Shared Risk Trust, managed by the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food, provides grants and credit guarantees to rural development projects; the grants can be used to support forestry investments.
- Mexico's FIP Investment Plan addresses several private sector forestry barriers, including (i) investing in sustainable forestry management; (ii) creating a dedicated financing line for *ejidos*, provided by Financiera Rural, a public financial institution; and (iii) establishing a technical assistance facility to develop the business management capacity of *ejidos*.

Table 12: Private Sector Investment Options and Recommendations, Mexico

Investment option	Private sector business case	Interventions to improve the enabling environment
Investments in commercial productive forests	Independent operations are possible, but cooperation with <i>ejidos</i> should be prioritized to improve access to land that is appropriate for productive forests	<ul style="list-style-type: none"> • Increase access to long-term financing for forestry investments through existing mechanisms like the National Forestry Fund • Invest in technical forestry management capacity • Build the business management capacity of <i>ejidos</i> that manage productive forests • Continue to address underlying political conflict
Investments in modern state-of-the-art wood-processing industries	Sawmills including kiln drying facilities, panel plants, and pole treatment plants	<ul style="list-style-type: none"> • Improve access to capital and credits • Provide technical assistance to local entrepreneurs • Enable joint ventures of local entrepreneurs with companies from countries with industrial forest sectors
Investments in the construction sector	Construction companies offering wood-based, low-cost housing systems	<ul style="list-style-type: none"> • Technical assistance and training for architects and planners • Quotas for wood in public construction • Commitment of public tenderers to the procurement of legal and sustainable wood products • Preference for wood in public tenders

Table 12 provides an overview of how private sector investments can be attracted through interventions to improve the enabling environment for private investments.

7.1.3.5 Model Business Case: Ejido Community Forestry

A unique land tenure governance system is a defining characteristic of the investment climate in Mexico. Approximately 80 percent of the forested land in the country is under an *ejido* system, where land is state owned but communally managed. Working with *ejidos* allows for maximum economic benefit and transfer of technical knowledge to rural communities. This investment case aligns with Mexico’s green growth agenda as well as the country’s FIP investment plan, which specifically recognizes the need to work with *ejidos*.

This business case proposes to establish commercial pine and eucalyptus timber plantations on 19,000 hectares of *ejido* land. Despite *ejido* participation, identifying sufficient available land will be a challenge for the proposed business case.

A large- or medium-scale plantation company would be an important partner for *ejidos* to benefit from the company’s technical expertise. By leasing their land, *ejiditarios* can maintain long-term control over the land while improving its productivity and creating local employment opportunities. The company will provide quality seedlings and oversee plantation management. In addition to *ejidos* making their land available, the negotiation between the company and the *ejidos* will likely establish an agreement to hire members from the community for plantation establishment and management. An estimated US\$143 million in investment will be needed to establish and maintain the plantations. Two sawmills, at a cost of US\$20 million, will be needed to service the 19,000 hectares. Violent conflict has been an issue in some rural areas in Mexico, and the project will need to invest resources to mitigate this risk as much as possible, by selecting areas that are less prone to violence and possibly hiring guards.

The harvested wood will be transformed into sawlogs to be sold to the domestic construction market. As outlined in the discussion of Mexico's green growth scenario, there is expected to be a significant supply gap in sawlogs and other HWP. The Government of Mexico, in partnership with the Clean Technology Fund and the IDB, is currently supporting a green building program known as ECOCASA. As of June 2015, ECOCASA had financed more than 12,000 energy- and water-efficient housing units. The economic and environmental impacts of the ECOCASA program could be increased by encouraging the use of HWP in construction, which would lead to an increase in the demand for products in the business case.

Potential investment benefits include the following:

- Management of plantations will create an estimated 1,300 FTE jobs, and operation of the panel mills will create another 100 FTE jobs. Most of the jobs will go to community members, but the company will also have to hire external technical experts where necessary.
- This business case would sequester 32,500 t CO₂e in HWP annually. Substitution of energy-intensive, non-wood materials would mitigate an additional 275,000 t CO₂e per year.
- Investments would generate an estimated US\$16 million in gross value added.

The business case will face several barriers, including ongoing political violence and a financial sector that rarely lends to forestry operations. In addition, potential investors and companies will perceive the investment as risky, because of its long payback period and partnership with local *ejidos*. The plantations will not start generating significant revenues from harvest for 10–12 years, although pruning and thinning activities will create modest income in the early years. To reduce investor risk and ensure the project has sufficient capital in the early years, a risk-sharing structure between different parties may be necessary. To finance leasing of land and establishment of 19,000 hectares of plantations at a cost of approximately US\$143 million, the following hypothetical structure is proposed:

- The plantation company could provide a portion of the investment in own equity.
- The project could access credit from the FONAFOR program, which provides credit and guarantees for plantation forestry with tenors of up to 15 years. CONAFOR's credit is limited to US\$1.3 million per project, but by working with different *ejidos*, the loan amount may be increased by counting the investment as more than one project.
- The project could receive payments from Mexico's PRONAFOR program, which incentivizes reforestation.
- A development finance institution or local commercial banks could provide the remainder of the investment costs in loans. The participation of FIP or other concessional financing may be required to reduce the risk for this investor.

Financing of the sawmills is unlikely to be perceived as risky, as the plantation investment could be financed under the following structure:

- The forestry processing company could contribute own equity to the investment.
- Financiera Rural, a public bank, could provide the remainder of the capital as a loan. Depending on the risk profile of the investment, a guarantee from an FIP guarantee facility, as proposed in section 6.3, may be necessary.

Table 13 highlights the main features of the model business case.

Table 13: Ejido Community Forestry, Mexico

Key feature	Details
Market	Domestic construction
Business model(s)	Community and private sector partnership for forest management
Processed wood volume	100,000 m ³ annually of sawwood
Productive forest area	19,000 hectares of productive forests
Industry facilities	2 sawmills
Investments	US\$143 million in productive forests US\$20 million in industries
Employment	1,300 FTE jobs in productive forests 100 FTE jobs in mills
Gross value added (GDP contribution excl. taxes)	US\$16 million annually (equals 0.001% of 2015 GDP)
CO ₂ mitigation potential	Mitigation: 32,500 t CO ₂ e in HWP (annual figure, 2040) Substitution of non-wood materials: 275,000 t CO ₂ e (annual figure, 2040)
Investment return ratios	US\$2 annual GDP contribution per US\$1 invested (over 20-year period) US\$114,000 investment per FTE job US\$26 per t CO ₂ e mitigated substitution (over 20 years)

Note: FTE = full-time equivalent; GDP = gross domestic product; HWP = harvested wood products; m³ = cubic meters; t CO₂e = tons of carbon dioxide equivalent.

7.1.5 Mozambique

7.1.5.1 Country Background and Climate Change and Forestry Commitments

Mozambique has undergone large changes, after a decade-long civil war ended in 1992. Although it was only US\$4 billion in 1993, the national GDP grew to US\$34 billion in 2014 (CIA 2016). The economy continues to grow rapidly, but more than 50 percent of the population remains below the poverty line, and 70 percent live in rural areas.

Deforestation and degradation in the country are primarily driven by large- and small-scale agriculture as well as demand for fuelwood for charcoal production. Commercial logging, mining, infrastructure development, and forest fires are secondary drivers. However, historical land use change and forest cover loss are poorly understood, and more information is needed to implement REDD+ in the country (CIFOR 2012). The rate of deforestation has increased since the early 2000s, and contributed 38.6 million t CO₂e in emissions in 2014 (WRI 2016).

Mozambique has instituted several policies and initiatives to mitigate climate change and support sustainable development; planted forests and HWP play an important role in these policies. The most relevant policies are Decree 30/2012, which defines the terms, conditions, and incentives of planted forests, and Decree 70/2013, which establishes the procedures for approval of REDD+ projects.

Mozambique institutionalized its commitment to sustainable development in 2012 when it released its National Roadmap for the Green Economy. A Green Economy Assessment identified energy, forestry, fisheries, and mining as critical sectors for the green economy. Among other initiatives, the Government of Mozambique has priorities to increase the contribution of the forest sector: improving the enforcement of forestry regulations, and increasing the area of planted forests. The country's

Forest Policy and Strategy 2016–20 aims to reduce deforestation through improving the enforcement of local law and creating sustainable development alternatives for rural populations.

The Government of Mozambique is participating in REDD+, and has identified the following pillars in its National REDD+ Strategy: agriculture, especially reducing slash-and-burn activities; increasing access to efficient energy sources; strengthening the conservation areas system; sustainable forest management; forest plantations; and cross-sectoral activities. Early REDD+ projects are concentrated in the Zambezia province, where a Zambezia Integrated Landscapes Management Program is being developed by the Ministry of Land, Environment and Rural Development (MITADER), the Ministry of Agriculture and Food Security (MASA), and the Ministry of Economy and Finance.

Mozambique is also an FIP country, and planted forests play a prominent role in its investment plan. Module two of the plan is administered by the IFC, and plans to catalyze major investment in plantation forestry to sequester carbon and reduce pressure on natural forests.

The Government of Mozambique committed to restoring 1 million hectares of degraded land under the Bonn Challenge. The analysis shows that HWP demand can be met by 177,000 hectares of planted forests, a small fraction of the total target. Other land restoration can help to conserve natural forests, providing habitat for biodiversity and protecting watersheds.

The present country study for Mozambique focuses on enhanced timber production and domestic consumption of wood products in permanent uses (for example, construction). The study assesses the mitigation potential of HWP based on projected demand in 2040, and assumes that the green growth scenario will be met exclusively by national production.

7.1.5.2 Green Growth Scenario for HWP Production

The primary use of HWP in Mozambique is for fuelwood and conversion to charcoal. The country consumes about 15 million tons of fuelwood per year (Siteo 2008), the third highest amount among countries in Africa. Of the HWP that are not used for charcoal, little is transformed into higher-value wood products. Sawnwood production, for example, was 239,000 m³ in 2013, compared with more than 18 million m³ of roundwood produced.

Because of the country's rapid economic and population growth, demand for HWP is expected to grow significantly. Three key policies will affect future consumption of HWP:

1. Several policies and initiatives, including the country's REDD+ strategy, will promote the use of energy-efficient charcoal production and stoves to reduce the demand for fuelwood.
2. The Government of Mozambique is promoting the use of processed wood products in urban housing units through the *Casas Melhoradas* program.
3. The country's National Roadmap for the Green Economy will increase the area of planted forest, increasing the availability of HWP.

A historical, 10-year analysis of wood consumption, population growth, and industrial sector GDP resulted in the correlation factors that were used for the projection of HWP consumption until 2040. The policy assumptions were quantified to develop a green growth scenario for consumption of HWP until 2040.

This analysis projects that HWP consumption (sawnwood, wood-based panels, paper and paperboard, and other industrial roundwood excluding charcoal) will grow from 2.4 million m³ in 2014 to 6.3 million m³ in 2040. There will be a projected industrial roundwood supply gap of 3.7 million m³ by 2040. This analysis includes the assumption that Mozambique will develop a pulp and paper industry.

The future supply gap could be addressed by planting an additional 177,000 hectares of professionally managed productive forests (37,000 hectares long rotation to supply sawnwood, and 140,000 hectares for paper and paperboard, wood-based panels, and other industrial roundwood). This calculation does not differentiate between increases in large-scale and smallholder productive forests.

Figure 28 shows the development of the demand for HWP, and the required development of productive forest area to fill the expected gap in roundwood supply for HWP in the baseline scenario.

Mitigation potentials are presented in detail in figure 29. The mitigation potential of HWP carbon pools was estimated at 2.1 million t CO₂e, and related productive forests would sequester an additional 750,000 t CO₂e in 2040. Substitution of fossil fuel-based products for HWP would avoid an additional 4.1 million t CO₂e in emissions.

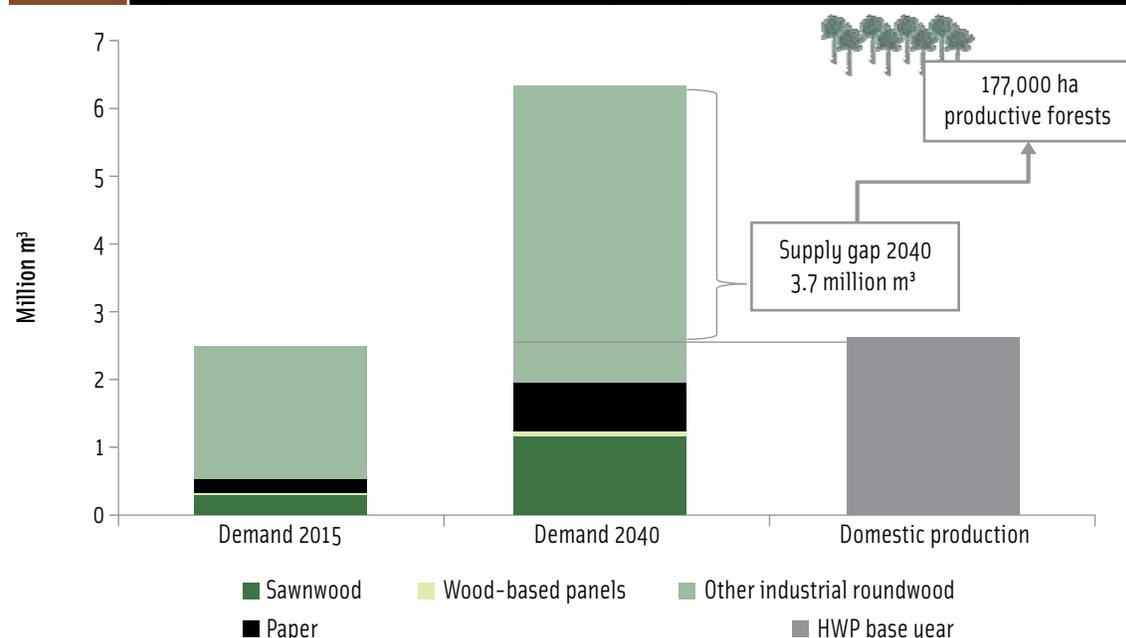
Demand for other industrial roundwood is the highest and therefore has the greatest mitigation potential. This HWP group comprises any kind of roundwood that is not converted to sawnwood, panels, or pulp, such as utility poles, small poles for construction, railway sleepers, and so forth. However, this HWP group is increasingly replaced by elaborated wood products or non-wood products (for example, sawnwood and panels).

7.1.5.3 Socioeconomic Impacts

The country case study highlights the major mitigation pathway for closing the industrial roundwood gap and becoming self-sufficient for HWP consumption, based on increments of commercial plantation areas and investments in wood-processing capacities.

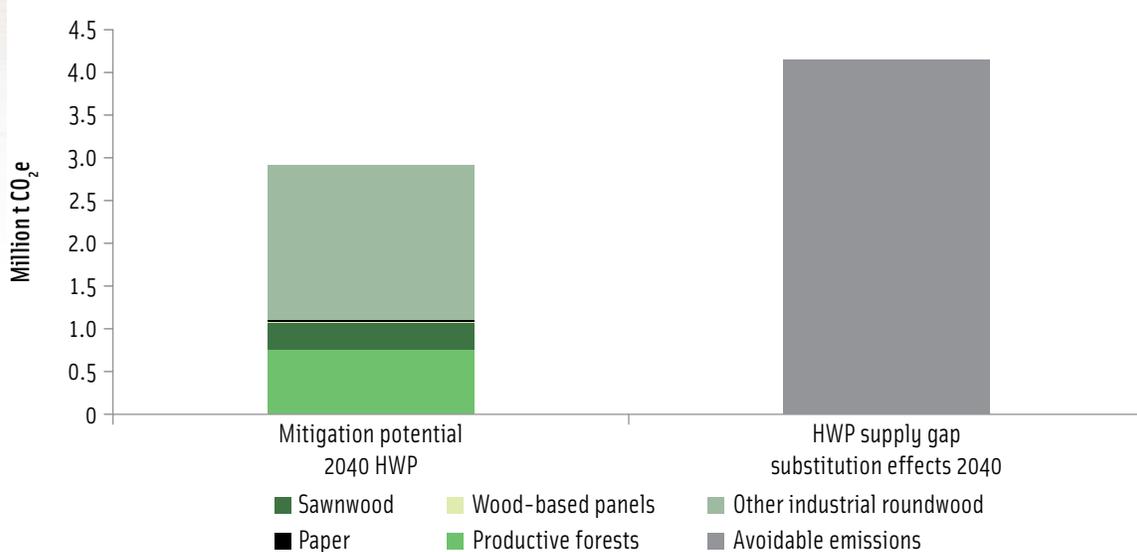
This pathway could create about 14,000 additional FTE jobs (including productive forest smallholders). If these investments are realized, the forestry and primary wood-processing sector could increase its contribution to national GDP by 141 percent in 2040 (figure 30).

FIGURE 28 Expected Demand for HWP in 2040 and the Corresponding Productive Forest Area, Mozambique



Note: ha = hectares; HWP = harvested wood products; ind. = industrial; m³ = cubic meters.

FIGURE 29 Mitigation Potentials for HWP and Productive Forests, Mozambique

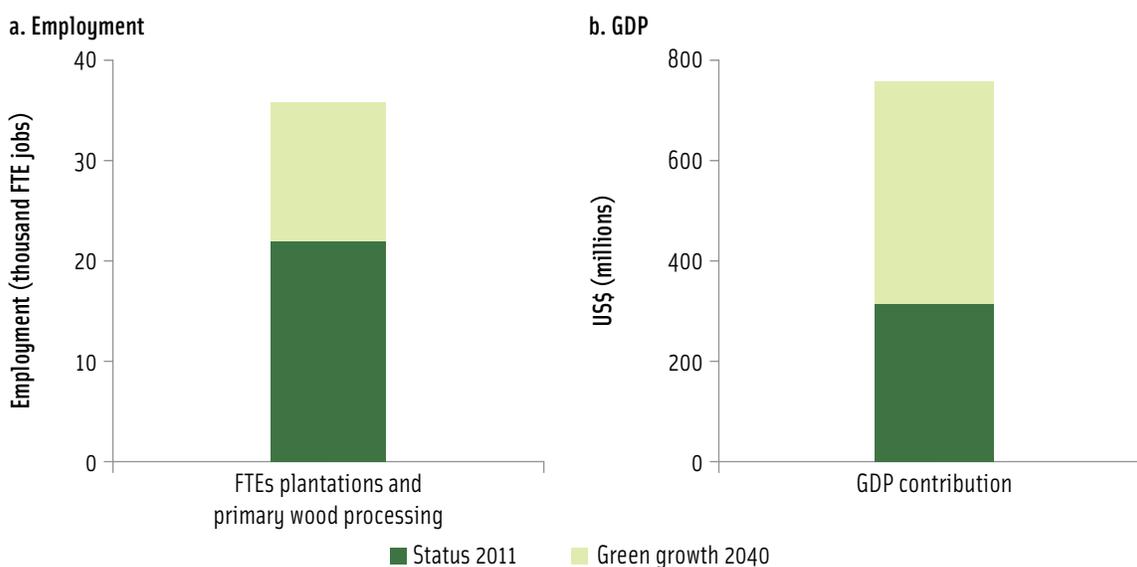


Note: HWP = harvested wood products; ind. = industrial; t CO₂e = tons of carbon dioxide equivalent.

7.1.5.4 Investment Environment

Mozambique’s forest sector is underdeveloped, with only 60,000 hectares of commercial forest plantations in production. However, the country has plans to expand forestry greatly, by planting 1 million hectares by 2030. Few plantations are managed by smallholders in Mozambique. Instead, approximately 10 large companies control the majority of established plantations. The US\$70 million invested in these projects has led to the creation of approximately 3,000 jobs (UNIQUE 2015).

FIGURE 30 Employment and GDP Impacts of the Green Growth Scenario, Mozambique



Sources: UNIQUE, based on FAO 2014; staff calculations.

Note: FTE jobs in 2013 and in the baseline scenario for 2040 do not include paper. The contribution to GDP in 2040 is calculated in 2015 market prices. FTE = full-time equivalent; GDP = gross domestic product.

Mozambique's economy has averaged 7 percent annual GDP growth over the past decade, and is expected to be the second fastest growing economy in the world in the next decade (U.S. Department of State 2015). Portucel Soporcel, the large Portuguese pulp and paper company, has been planning a US\$3 billion investment in eucalyptus plantations. However, the project has been delayed because of the political and economic uncertainties in the country. Mozambique ranks 133 of 189 countries for ease of doing business (World Bank Group 2016), and presents several obstacles to private sector HWP growth, including the following:

- Land administration and land use planning are governed by a variety of ministries and departments. MITADER is responsible for the forest sector, MASA is in charge of "agro-forest plantations," and planted forests are the domain of the National Directorate of Agriculture and Silviculture (UNIQUE 2015). The lack of a clear definition of what constitutes natural forest—and thus what land is available for plantations—also complicates land use planning.
- Investment in productive forests or any land use is complicated because of the complex land tenure governance system. Although land is owned by the state, user rights are granted for 50 years through the Land Rights Use Law (DUAT, *Direito do Uso e Aproveitamento da Terra*) agreements, which allow communities to have secure titles to land. Local communities can then sell or lease DUAT rights to third-party investors for land development. The community consultation process is difficult for investors and communities to navigate, and often results in significant community development responsibilities for investors.
- The technical forestry management skills in the country are low, which limits the productivity of productive forests. Forestry companies often hire specialists from South Africa, Zimbabwe, and Portugal to fill the gap.
- Mozambique was ranked 119 of 177 countries in Transparency International's Corruption Perceptions Index. Extensive corruption has been reported in the management of natural forests for timber production, but has not been reported in the forestry plantation sector (UNIQUE 2015).
- Infrastructure in the country is weak, and the lack of all-season roads is a significant challenge for companies bringing HWP to markets.
- Although access to financial services is improving, Mozambique's financial sector remains underdeveloped; approximately 29 percent of the population accessed formal financial services in 2014 (Finscope 2014). The availability of credit for long-term investments is restricted.
- The high variability of precipitation creates suboptimal growing conditions for plantations. Climate change is expected to exacerbate this difficulty.

Several trends and reforms will help Mozambique to achieve its goal of 1 million hectares planted by 2030:

- In its National Reforestation Strategy, the Government of Mozambique has articulated its plans to achieve 1 million hectares through the promotion of industrial and smallholder forestry (Government of Mozambique 2009).
- The government is conducting a national agro-ecological zoning process, which will classify and map areas suitable for productive forests.
- Responsibility for land tenure and access issues has been passed from MASA to the newly created MITADER.

- MITADER’s rural development program includes a Standing Forest (“Floresta em Pé”) pillar, which, among other reforms, will improve forestry policy and legislation, including adopting a new Forest Act (UT-REDD 2016).
- The Ministry of Education is reforming the education system, which includes a forestry school for training forest operators.
- The Development Corridor Program and the Special Economic Zones Office are two initiatives that aim to promote infrastructure development, especially along the Maputo, Zambezi, Beira, and Nacala corridors.
- Company-community partnerships allow companies to work with communities in Mozambique to increase the social benefits of forestry investments. The private company Green Resources has established outgrower schemes in the country. The New Forestry Company established such a scheme, but recently pulled out of the country (UNIQUE 2016).
- Mozambique has developed a national REDD+ strategy, which will promote productive forests as a means to increase carbon stocks and reduce pressure on natural forests.
- The World Bank is supporting the Government of Mozambique through a technical assistance project to attract private sector investments in the forest sector.

Table 14 provides an overview of how private sector investments can be attracted through interventions that improve the enabling environment for private investments.

7.1.5.5 Model Business Case: Multiple Uses of Planted Forests

Planted forests can help to address several development challenges facing Mozambique as its economy continues to grow, including increasing the supply of sustainable fuelwood and improving the availability of quality housing. The proposed business case demonstrates how a landscape approach to land use planning can have social and environmental benefits. The three interventions at different

Table 14: Private Sector Investment Options and Recommendations, Mozambique

Investment option	Private sector business case	Interventions to improve the enabling environment
Investments in commercial productive forests	Independent operations and cooperation with communities	<ul style="list-style-type: none"> • Clarify land that is appropriate for productive forests • Invest in technical forestry management capacity • Increase access to finance for actors in HWP supply chains • Formalize the charcoal production sector
Investments in modern state-of-the-art wood-processing industries	Sawmills including kiln drying facilities, panel plants (MDP and MDF), and pole treatment plants	<ul style="list-style-type: none"> • Improve access to capital and credits • Provide technical assistance to local entrepreneurs • Enable joint ventures of local entrepreneurs with companies from countries with industrial forest sectors
Investments in the construction sector	Construction companies offering wood-based, low-cost housing systems	<ul style="list-style-type: none"> • Technical assistance and training for architects and planners • Quotas for wood in public construction • Commitment of public tenderers to procurement of legal and sustainable wood products • Preference for wood in public tenders

Note: HWP = harvested wood products; MDF = medium density fiberboard; MDP = medium density particleboard.

points in the forestry and agricultural supply chains are based on the investment plan developed by FIP and the Government of Mozambique (UT-REDD 2016). The interventions include the following:

1. Planting forests
2. Creating high-quality HWP
3. Improving the efficiency of charcoal production.

The proposed business case would plant 64,000 hectares of pine or eucalyptus; pine will be the best option in many areas, because of its resilience to expected climate changes. A DUAT agreement will administer 44,000 hectares, and an outgrower scheme will manage another 20,000 hectares.

Approximately 40,000 of the planted hectares will provide inputs to two mills that process wood into panels. High transportation costs make it difficult for Mozambique's HWP products to compete internationally. Therefore, domestic markets will be targeted in the business case. *Casa Melhoradas* is one example of a Mozambican initiative to promote prefabricated wood-based housing.

The charcoal industry in Mozambique is highly informal and primarily dependent on input from natural forests, often harvested illegally. In the industry's current state, it is unlikely that private sector investors could participate. However, the proposed business case includes charcoal production to demonstrate the economic, social, and environmental potential of the sector, should the supply chain become more formalized. The business case assumes that the remaining 24,000 hectares of planted forest will supply approximately 1,100 high-efficiency charcoal kilns. According to the Mozambican Institute of Agricultural Research, 70 percent of Mozambicans rely on charcoal for energy needs.

The establishment and management of productive forests would require an approximate investment of US\$211 million. The two proposed panel mills amount to US\$300 million, and the charcoal kilns would cost an estimated US\$1 million to install.

Domestic markets would be targeted for purchase agreements for produced panels. Charcoal can be sold locally in urban centers. Quality transportation infrastructure can be a significant barrier in the country. Both revenue assumptions, especially charcoal sales, are dependent on locating sites near quality roads or improving existing roads, which would increase investment costs.

The potential investment benefits include the following:

- Management of productive forests will create an estimated 4,500 FTE jobs; operation of the panel mills will create 400 FTE jobs; and operation of the charcoal kilns will create 1,700 jobs. DUAT negotiations and requirements will help to ensure that jobs remain in communities. The lack of qualified laborers, especially for productive forest management, has led some investors to rely on workers from other countries; the proposed business case seeks to reverse that trend.
- The investments are expected to generate a total of US\$155 million in gross value added.
- For climate change mitigation, substituting unsustainable sources of charcoal would sequester an annual 530,000 t CO₂e. The substitution effects from HWP and productive forest establishment would sequester an additional 1.8 million t CO₂e per year.

The business case is likely to be perceived as a risk, because of the lack of revenue in the early years, complicated community negotiations, poor infrastructure, and lack of technical forestry knowledge. Commercial banks in Mozambique typically charge 22 to 30 percent interest rates, which will further complicate financing of the project. Establishing 64,000 hectares of productive forests would require a US\$211 million investment, which could be financed under the following structure:

- The productive forest company may raise own equity for a portion of the investment. Depending on negotiations between the company and communities, use of community land may be counted as an equity contribution to the project.
- As recommended in detail in section 6.3, FIP or other international donors could play an important role, by absorbing risk related to infrastructure or technical risks through equity or as a first-loss lender.
- Mozambique’s Agricultural Development Fund could provide credit for the remaining investment needs, although interest rates are likely to be expensive.

Financing of two panel mills, at a total cost of US\$300 million, will be challenging, given the scale of the investment. The project could be financed under the following structure:

- A forestry company could provide approximately half the required capital in equity.
- The African Development Bank, IFC, or other development finance institution would be an important provider of credit, given the large amount needed for the investment. Local commercial banks may participate as co-lenders.

Assuming the formality of the sector improves, financing of the charcoal kilns will be relatively less challenging, given the small amount of capital needed per kiln. The kilns can be financed individually with operators’ own equity and credit from local commercial banks. Guarantees provided through an FIP guarantee facility, as described in section 6.3, would help to catalyze these investments.

Table 15 highlights the main features of the model business case.

7.1.6 Vietnam

7.1.6.1 *Country Background and Climate Change and Forestry Commitments*

Vietnam’s economy has been growing consistently since 1986, when it began the transition from a centrally planned economy to one that allows for more private ownership. State-owned enterprises now only account for 40 percent of the country’s GDP, and this number continues to decrease. In the forest sector, Decree 118 of 2015 aims at privatizing the 139 state forestry companies (SFCs). Agriculture’s share of GDP fell from 25 percent in 2000 to 18 percent in 2014, and industry continues to gain in economic importance (CIA 2016). The poverty rate has decreased dramatically, and was estimated at 13.5 percent in 2014.

Deforestation and forest degradation in Vietnam have historically been driven by conversion of natural forest to commercial and subsistence agriculture. Except for a few parts of the country, deforestation has been successfully addressed during the past 20 years, but forest degradation remains a crucial issue. Because of the significant reforestation activities, net forest cover has increased dramatically, from 27 percent in 1990 to 41.5 percent in 2014, primarily because of the expansion of short-rotation plantations (Government of Vietnam 2015).

Vietnam has outlined its commitment to reducing GHG emissions in its National Green Growth Strategy, which has three strategic tasks: (i) reduce GHG emissions intensity (per unit of GDP) by 8-10 percent compared with 2010, by 2020; (ii) promote the development of “green industry and green agriculture”; and (iii) encourage sustainable consumption habits. The Government of Vietnam’s National Action Plan on Green Growth in Vietnam 2014–20 further outlines the country’s strategy to support sustainable green development.

Table 15: Multiple Uses of Planted Forests, Mozambique

Key feature	Details
Market	Domestic charcoal consumers International and domestic wood panel markets
Business model(s)	Targeted large charcoal producers Large-scale productive forests and outgrower schemes
Processed wood volume	666,000 m ³ annually of panel wood 108,000 tons of charcoal
Productive forest area	40,000 ha large-scale productive forests 24,000 ha smallholder productive forests
Industry facilities	1,100 charcoal kilns 2 panel plants (333,000 m ³ output each)
Investments	US\$211 million in productive forests US\$300 million in industries US\$1 million in kilns
Employment	4,500 FTE jobs in productive forests 400 FTE jobs in mills 1,700 FTE jobs in kilns
Gross value added (GDP contribution excl. taxes)	US\$100 million annually from panel mills US\$48 million annually from productive forests US\$7 million annually from kilns
CO ₂ mitigation potential	Charcoal mitigation benefit: 530,000 t CO ₂ e HWP substitution, panels + productive forests carbon stock: 1.8 million t CO ₂ e
Investment return ratios: panel supply chain	US\$135,000 invested for 1 FTE job US\$1 invested for US\$6 GDP contribution (for 20-year lifetime) US\$12 invested per t CO ₂ e mitigated (over 20 years)
Investment return ratios: charcoal supply chain	US\$24,000 invested for 1 FTE job US\$1 invested for US\$6 GDP contribution (for 20-year lifetime) US\$8 invested per t CO ₂ e mitigated

Note: FTE = full-time equivalent; GDP = gross domestic product; ha = hectares; m³ = cubic meters; t CO₂e = tons of carbon dioxide equivalent.

The Government of Vietnam has described specific steps it will take to support the forest sector in its Forest Development Strategy 2006–20, which are broken down into the following categories: (i) policies on forest and forest land management, (ii) finance and credit policies, (iii) encouragement of businesses to participate in the sector, (iv) improvement in the planning and monitoring of forests, (v) solutions for the organization and management of the sector, (vi) support for science and technology, (vii) promotion of human resources, and (viii) solutions for international cooperation. Among dozens of specific policy recommendations, particularly noteworthy for this analysis are recommendations to privatize SFCs, improve land tenure and land use regulation, and support forestry investment through financing incentives.

The Ministries of Agriculture and Rural Development, Natural Resources and the Environment, Planning and Investment, and Finance are responsible for promoting reforestation and afforestation activities, including plantation forestry.

In its NDC, the Government of Vietnam has also made longer-term plans to reduce the absolute amount of emissions. Vietnam will reduce emissions by 8 percent by 2030 compared with the business as usual scenario, and up to 25 percent, depending on international support. This includes reducing the emissions intensity per unit of GDP by 20 percent compared with 2010 levels, and the goal of increasing forest cover by 45 percent. Reaching Vietnam's forest cover targets would imply the restoration of more than 17 million hectares of degraded land.

The country study for Vietnam focuses on enhanced timber production and domestic consumption of wood products in permanent uses, such as construction and furniture. The study assesses the mitigation potential of HWP based on projected demand in 2040, and assumes in the green growth scenario that demand will be met exclusively by national production.

7.1.6.2 *Green Growth Scenario for HWP Production*

Because of the depletion of its natural forests, a logging ban on natural forests, and significant demand by the processing industry for export markets, Vietnam relies heavily on imports of HWP. In roundwood equivalent terms, imports of HWP were 1 million m³ in 2003, and rose to nearly 4 million m³ in 2009. Nearly 60 percent of the timber processed for exports has to be imported. The Vietnam timber and furniture industry contributes more than US\$6 billion annually to GDP, and employs more than 300,000 people. The country is one of the largest exporters of secondary wood products (New Forests 2010). In addition, domestic consumption of HWP is expected to increase if the population and economy continue their high rates of growth (FAO 2009).

Four key trends will affect future consumption of HWP in Vietnam:

1. The decentralization and privatization of forest management, which has historically been dominated by SFCs, is expected to improve productivity and processing efficiency.
2. The National Forest Protection and Development Plan 2011–20 lays out the objective to increase planted forest area by 1.25 million hectares.
3. The Forest Development Strategy 2006–20.
4. Vietnam has experienced significant urbanization—nearly 3 percent growth between 2010 and 2015—and this trend is expected to continue. As the country nears 50 percent of its population living in cities by 2040, an estimated 374,000 housing units will be needed per year to accommodate this growth (Samad et al. 2015).

A historical analysis of wood consumption, population growth, and GDP growth resulted in the correlation factors that were used to project HWP consumption. The impacts of the country's policies were quantified to estimate the gap between demand and supply in 2040.

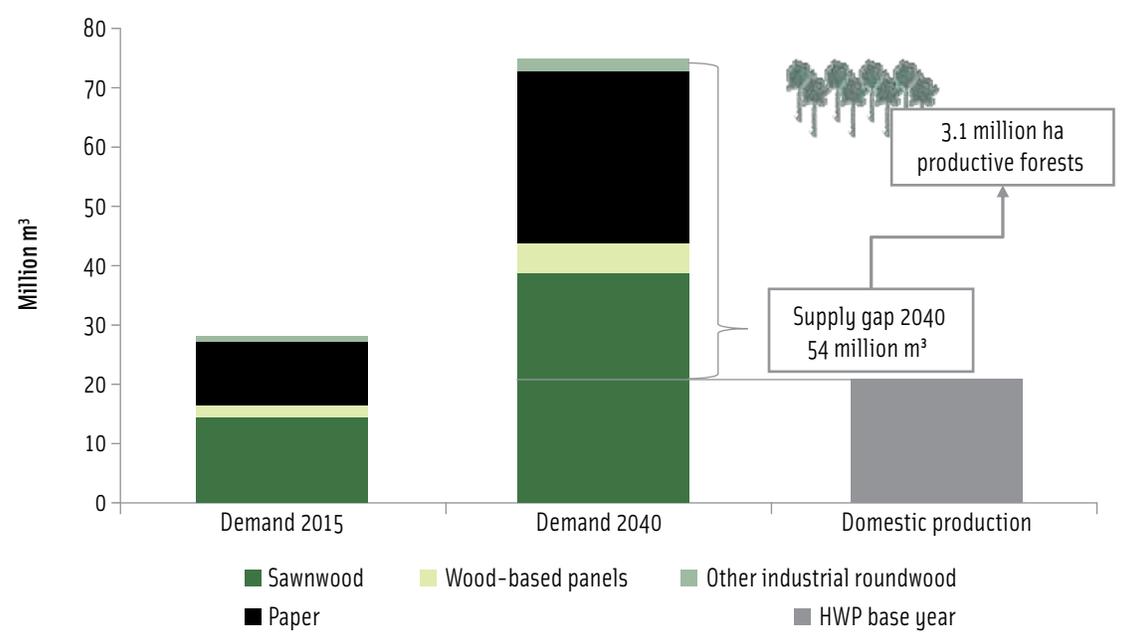
Projections for the demand patterns in 2040 result in demand for HWP (sawnwood, wood-based panels, paper and paperboard, and other industrial roundwood) that is expected to grow from 27 million m³ in 2014 to 75 million m³ by 2040. Based on current production volumes, this would result in a roundwood supply gap of 54 million m³ by 2040.

The future supply gap could be addressed by planting an additional 3.1 million hectares of professionally managed productive forests (1.8 million hectares of long rotation to supply sawnwood, and 1.3 million hectares to supply paper and paperboard, wood-based panels, and other industrial roundwood). This calculation does not differentiate between increases in large-scale and smallholder productive forests.

Figure 31 shows the development of demand for HWP and the required development of productive forest area to fill the expected gap in roundwood supply for HWP in the baseline scenario.

In figure 32, the mitigation potentials are presented in detail. The mitigation potential of HWP carbon pools is estimated at 12.7 million t CO₂e, with sawnwood contributing the greatest proportion. The related increase in productive forests would sequester an additional 14.6 million t CO₂e in 2040. Substitution of fossil fuel-based products with HWP would avoid 43.1 million t CO₂e in GHG emissions.

FIGURE 31 Expected Demand for HWP in 2040 and the Corresponding Productive Forest Area, Vietnam

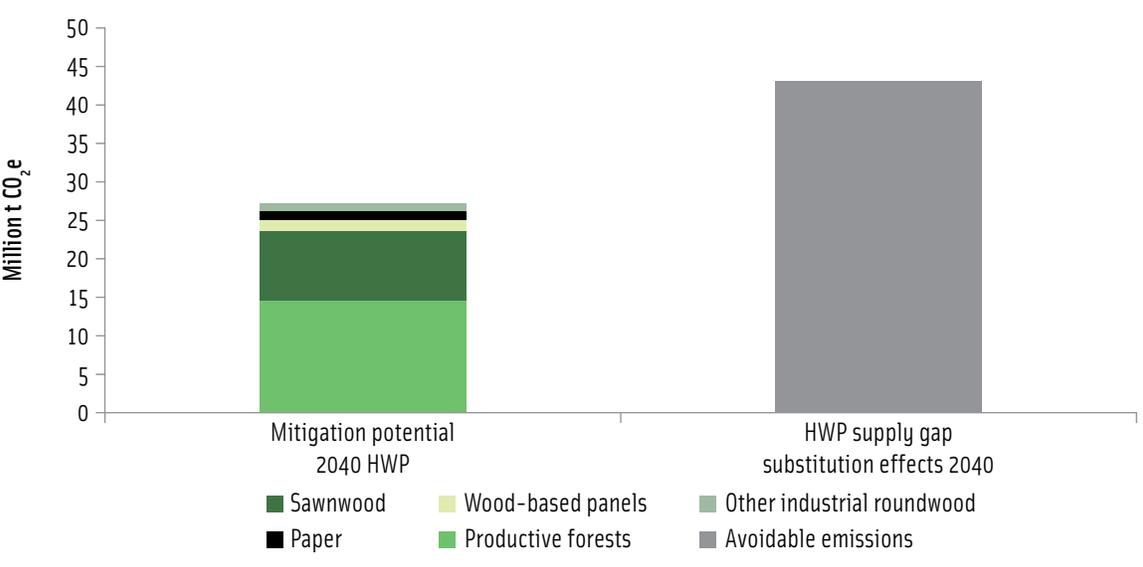


Note: ha = hectares; HWP = harvested wood products; m³ = cubic meters.

7.1.6.3 Socioeconomic Impacts

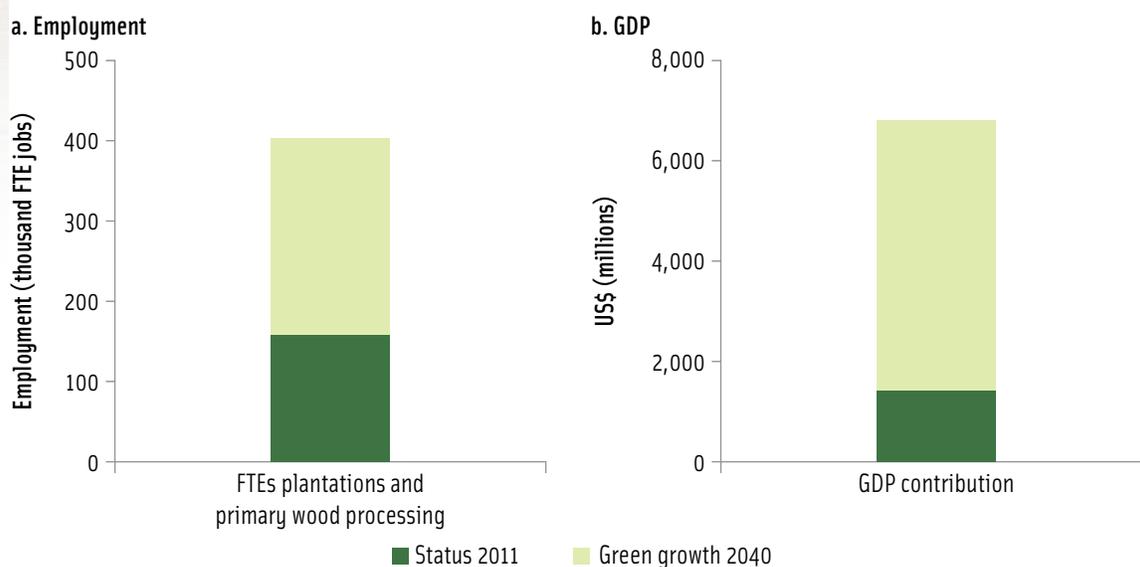
In addition to this mitigation potential, increasing domestic production would have a dramatic socioeconomic impact. The establishment of productive forests and the management and operation of additional processing facilities would add an additional 244,000 jobs by 2040. Investing in the forest sector would also make a significant contribution to the country's economy. By 2040, gross value added from the forest sector would be increased by 373 percent (figure 33).

FIGURE 32 Mitigation Potentials for HWP and Productive Forests, Vietnam



Note: HWP = harvested wood products; ind. = industrial; t CO₂e = tons of carbon dioxide equivalent.

FIGURE 33 Employment and GDP Impacts of the Green Growth Scenario, Vietnam



Sources: UNIQUE, based on FAO 2014; staff calculations.

Note: FTE jobs in 2013 and in the baseline scenario for 2040 do not include paper. The contribution to GDP in 2040 was calculated in 2015 market prices. FTE = full-time equivalent; GDP = gross domestic product.

7.1.6.4 Investment Environment

The forest sector in Vietnam makes a significant contribution to the country's economy. Plantations and the harvest of wood products alone accounted for 1.2 percent of GDP in 2005, and the furniture and timber processing industries contributed another 3.5 percent (FAO 2009). Planted forest area makes up approximately 3.6 million hectares, of 14 million hectares of total forested area in the country. SFCs play an important role and control about 40 percent of land designated as forests (PROFOR 2016). The proportion of production from the private sector continues to rise as the country continues the process of privatization of SFCs.

Vietnam has grown consistently over the past decades; annual GDP growth has fallen below 5 percent only one time since 1988. Investment in the forest sector has risen in recent years; for example, imports of wood-processing machinery tripled between 2009 and 2012. However, Vietnam ranks 90 of 189 countries for ease of doing business (World Bank Group 2016), and presents several barriers specific to HWP investment:

- All land in Vietnam is owned by the state, which has administered land use rights through the so-called red books—similar to usufruct rights⁴¹—for some 94.5 percent of the land in the country (U.S. Department of State 2015). Land use rights may be sold or rented to other individuals, but the transfer of rights is slowed by bureaucratic and administrative hurdles. The process of granting land use rights began in the 1980s, and has led to land-related conflicts, especially when different groups or individuals claim the same land, or when the traditional use of land by ethnic communities conflicts with private use rights (USAID 2013).

⁴¹ Usufruct rights allow one party to use another's property as long as it is not harmed. For example, this could refer to an agreement to extract the products from a plantation over an agreed time period.

- In Vietnam, 151 SFCs are in operation, managed by province-level governments. SFCs demonstrate many weaknesses, including poor forest governance, lack of capital, low profitability, conflicts with communities, and others (Le 2014).
- The ongoing equitization process has so far not resulted in significant private sector investment, because the SFCs and government entities are reluctant to give away their majority shareholder rights. As a result, investors perceive SFCs as a risky investment.
- Forest plantation projects supported by foreign investors must be approved by the National Assembly.
- Vietnam was ranked 112 of 168 countries in Transparency International's Corruption Perceptions Index.
- Liberalization of financial markets has improved access to finance in Vietnam, but remains a barrier for growth in the country, especially for small- and medium-size enterprises. Of the businesses surveyed in the country, 56 percent had not made a credit request from a financial institution within the past 12 months. Businesses ranked access to finance as their fifth most significant obstacle (behind rising business costs, lack of qualified labor, tougher competition, and instability of consumer demand) (Vo et al. 2011).
- Compared with other countries in the region, the business climate in Vietnam presents many challenges, especially in terms of obtaining permission to start a business, dealing with permits, and enforcing contracts, in addition to the issues already mentioned (World Bank Group 2015).

The Government of Vietnam is in the process of addressing these barriers and improving the enabling environment through several measures, including the following:

- If the issues that have been mentioned are addressed, the ongoing process of equitization of state-owned enterprises may create opportunities for the private sector.
- Vietnam's 2006–20 Forestry Development Strategy aims to encourage reforestation through, among other measures, encouraging foreign investment in forest plantations, allocating forest land rights to households and communities, providing technical support for tree planting, and offering loans at preferential terms for tree planting activities (USAID 2013). The strategy allowed the sector to grow by its highest annual rate yet in 2014 and increase overall forest cover. However, many implementation challenges remain, such as continued illegal deforestation in some areas (MARD 2014).
- Resolution 19/NQ-CP/2015, issued in March 2015, aims to improve the business climate by increasing transparency over tax refunds and reducing processing times for clearing imports and exports.
- The Government of Vietnam has instructed the Vietnamese Development Bank to offer credit guarantees for small and medium enterprises, increasing firms' ability to access finance.

Table 16 provides an overview of how private sector investments can be attracted through interventions to improve the enabling environment for private investments.

7.1.6.5 Model Business Case: Adding Value to Plantation Forestry

The proposed business case in Vietnam is comprised of transforming a portion of the approximately 3.5 million hectares of acacia short rotation, used predominantly for low-value chip wood production, toward longer-rotation acacia plantations for sawnwood production and high-value native tree species where appropriate. The business model would be implemented by SFCs and private sector actors investing in SFCs.

Table 16: Private Sector Investment Options and Recommendations, Vietnam

Investment option	Private sector business case	Interventions to improve the enabling environment
Investments in commercial productive forests	Establishment of privately-owned or entrepreneurial forestry companies that make autonomous decisions about their forest businesses	<ul style="list-style-type: none"> • Continue the process of privatization of SFCs • Invest in the technical forestry management capacity of SFCs and other forest owners • Increase access to appropriate finance and lending products for actors in the HWP supply chain • Improve regulations governing private sector forestry companies • Allow furniture companies to offset profits against investments in domestic timber plantations
Investments in modern state-of-the-art wood-processing industries	Saw mills including kiln drying facilities, panel plants (MDP and MDF), and pole treatment plants	<ul style="list-style-type: none"> • Improve access to capital and credits • Provide technical assistance to local entrepreneurs • Enable joint ventures of local entrepreneurs with companies from countries with industrial forest sectors
Investments in the construction sector	Construction companies offering wood-based, low-cost housing systems	<ul style="list-style-type: none"> • Technical assistance and training for architects and planners • Quotas for wood in public construction • Commitment of public tenderers to the procurement of legal and sustainable wood products • Preference for wood in public tenders
Investments in the furniture sector	Furniture companies accessing locally produced roundwood	<ul style="list-style-type: none"> • Strengthen existing markets for HWP • Develop new timber markets

Note: HWP = harvested wood products; MDP = medium density particleboard; MDF = medium density fiberboard; SFC = state forestry company.

The case is aligned with national policy objectives for the sector and contributes significantly to achieving Vietnam’s NDC, which intends to “manage and develop sustainable forest, enhance carbon sequestration and environmental services; conservation of biodiversity associated with livelihood development and income generation for communities and forest-dependent people.” The case assumes the following changes:

- Increased rotation length of 0.5 million hectares of existing short-rotation chip wood-producing acacia plantations to make them suitable for sawnwood production.
- Stepwise introduction of marketable, high-value native tree species (for example, *Hopea odorata*, *Dipterocarpus alatus*, and *Tarrietia*) on 0.1 million hectares of existing short-rotation acacia plantations, to produce high-value timber for the wood-processing industry.

The scenario assumes a transformation period of 10 years. The wood products would diversify into acacia chip wood (currently the primary use), acacia sawnwood, and native species high-value sawnwood, supporting the domestic wood industry and reducing wood import needs. By 2040, 4.5 million m³ of sawlogs (4 million m³ of acacia and 0.5 million m³ of native tree species) would be produced annually.

For the transformation of the existing plantations, a total investment of US\$82 million is required over a period of eight years. In addition, capacity building and Forest Stewardship Council certification costs would require an investment of about US\$20 million for the envisioned area.

For the wood-processing industry, new capacities and modern technology investments would be required. To process the estimated 30 percent increase in roundwood, 13 new sawmills and three new panel mills would be required, with total investments of US\$550 million.

Potential investment benefits include the following:

- Establishment and management of the plantations, leading to about 30,000 additional permanent jobs in the forest production industry, while the wood-processing industry would create about 1,250 new permanent jobs.
- The gross production value of all operations adds up to an average of US\$1.14 billion per year, which is equivalent to 0.43 percent of the GDP.
- In terms of GHG mitigation potential, the transformation models would result in additional annual carbon stock enhancement of about 1.68 million t CO₂e per year. The long-term carbon stock enhancement benefit of 1 hectare of acacia sawnwood production is 67 t CO₂e, amounting to 1.34 million t CO₂e per year over the total area. The transformation to native species high-value timber production will increase per hectare long-term carbon stock by 86 t CO₂e, or 0.34 million t CO₂e per year, for the proposed area.
- The GHG mitigation potential in HWP will add up to 3.2 million t CO₂e in 2040, and the produced wood products will substitute 11.5 million t CO₂e in 2040.

To transform short-rotation plantations to long-rotation and managed plantations, the required investment ranges from US\$2,000 to US\$3,000 per hectare. Investment costs would be paid back within 4–10 years. The investment required for the business case will likely be perceived as risky by private investors because of the continued government control of SFCs and their budgets. To mitigate investor risk, the following structure is proposed:

- The plantation company and private investors may provide own equity.
- Investors with high risk tolerance may be necessary. As discussed in section 6.3, it is recommended that FIP and other donors would make such capital available for plantation investments.
- In the context of the equitization process, a combination of a development finance institution, such as the IFC or the Asian Development Bank, and an international or domestic commercial bank could provide the remainder of the capital through loans. Involving an institution like the IFC could increase private investors' confidence and mitigate risks. A guarantee facility, as proposed in section 6.3, could help to reduce the risk for commercial banks and entice them to invest.
- Provincial authorities should give SFCs the right to retain revenues from acacia harvests, to reinvest in their operations.

The investments in mills will be seen as less risky than plantation investments, but nonetheless will require a structured approach to share risk appropriately for a US\$550 million investment:

- A large forestry company could provide up to 50 percent in equity.
- Given the size and complexity of the investment, the IFC or another institutional investor will be necessary. Commercial banks may participate as co-lenders alongside the IFC.

Table 17 demonstrates the key features of the Vietnam business case.

Table 17: Adding Value to Plantation Forestry, Vietnam

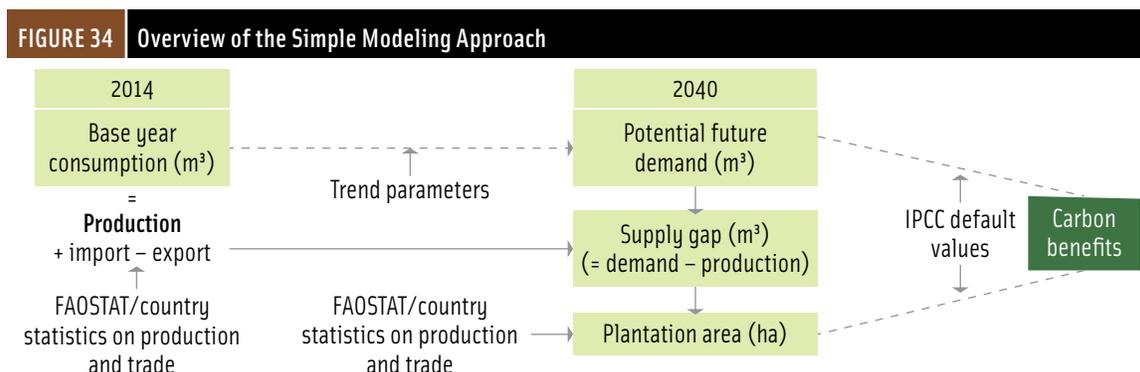
Key feature	Description and business model performance
Market	Diversify acacia chip wood production with acacia sawnwood and high-value timber, and reduce the increasing gap in wood imports to the Vietnamese wood-processing industry.
Business model(s)	Transform short-rotation chip wood acacia production toward long-rotation sawnwood production and high-value native timber production.
Roundwood volume	Acacia sawnwood: 4.0 million m ³ High-value timber: 0.48 million m ³
Productive forest area	0.5 million hectares long-rotation acacia sawnwood production 0.1 million hectares of native species forest production
Industry facilities	13 sawmills (50,000 m ³ output each) 3 panel plants (333,000 m ³ output)
Investments	US\$82 million in productive forests and US\$20 million public investment in technical assistance and Forest Stewardship Council certification US\$550 million in industries
Employment	30,000 FTE jobs in productive forests 1,250 FTE jobs in industries
Gross value added (GDP contribution excl. taxes)	US\$1.14 billion annually
GDP contribution based on 2015	0.43%
CO ₂ mitigation potential	CO ₂ e in productive forests: 1.68 million t CO ₂ e per year 14.7 million t CO ₂ e in HWP and substitution effect in 2040
Investment return ratios	US\$30.6 GDP contribution per US\$1 invested (over 20 years) US\$20,000 invested for 1 FTE job employment generation US\$11 investment needed to mitigate 1 t CO ₂ e (over 20 years)

Note: FTE = full-time equivalent; GDP = gross domestic product; HWP = harvested wood products; t CO₂e = tons of carbon dioxide equivalent.

Green Growth Scenario: Simple Modeling Approach

9.2.1 Overview

Figure 34 presents an overview of the simple modeling approach used in this report.



Note: ha = hectares; IPCC = Intergovernmental Panel on Climate Change; m³ = cubic meters; MAI = mean annual increment.

9.2.2 Model Goal

The simple modeling approach was designed to be a comprehensible tool for estimating future demands for HWP (blue squares in figure 35) at the country level, to link these estimates with opportunities for domestic supply from productive forests, and to assess the potential climate benefits of HWP and productive forests (figure 35).

9.2.3 Extrapolation

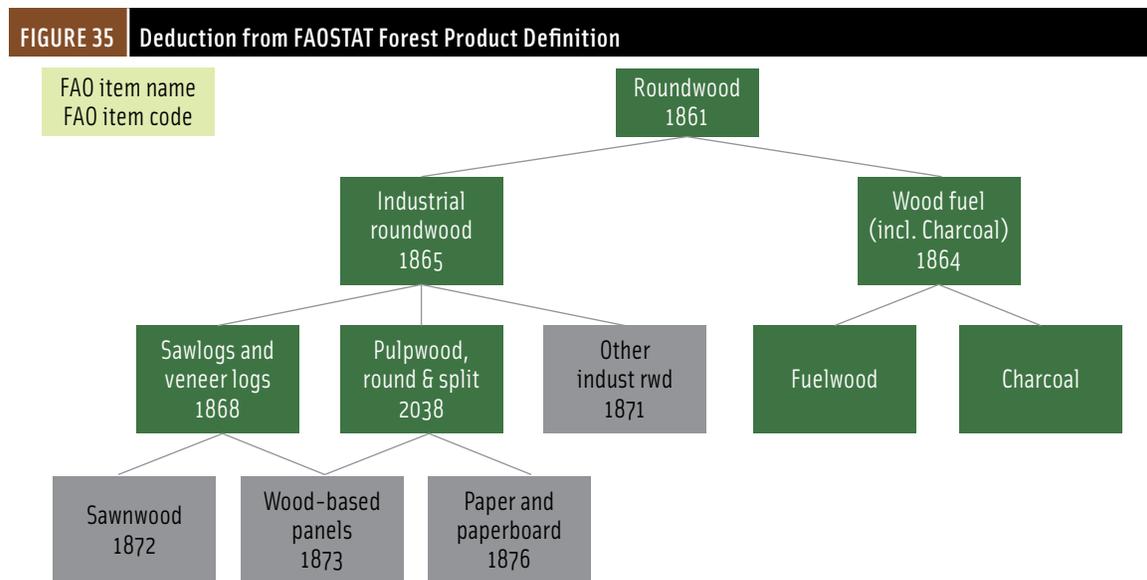
Potential future HWP demands were calculated based on approximated trend parameters and national statistics.

The general approach for trend approximation and HWP demand estimation was an extrapolation of consumption of HWP between 2000 and 2014. The historical trend factors were adjusted due to predicted economic and demographic country developments, as well as expert judgments. Expert judgments considered political, climate, and societal development programs at different levels. (See table 18 for trend parameter descriptions, table 20 for sources, and table 22 for general data in the base year.)

9.2.4 Supply Gap

Values of the estimated future HWP demand in m³ were the input parameters used to identify a future supply gap (see table 22): $supply\ gap_{2040} = dom.\ production\ of\ HWP_{2014} - demand\ of\ HWP_{2040}$.

Net imports of HWP in 2014 were assumed to be the countries' "supply gap." As the potential demand for HWP elevates until 2040, the potential gap elevates accordingly.



Note: FAO = Food and Agriculture Organization.

Table 18: Approximated Trend Parameter Descriptions

	Trend parameters	Sawn wood	Wood based Panels	Paper and Paperboard	Other Industrial Roundwood
Ethiopia	based on trends shown in Ethiopia Forest Sector Report, after 2034 pop. growth rate (World Bank indicator) [%/yr]	8%; post-2034 1.7%	8%; post-2034 1.7%	11%; post-2024 7%; post-2034 1.7%	dynamic 5.1% plus 0.1% per yr; post-2034 1.7%
Colombia	based on trends shown in report on Colombia's forest sector (by UNIQUE, forthcoming), after 2030 pop. growth rate (World Bank indicator) [%/yr]	4.5%; post-2030 0.3%	5%; post-2030 0.3%	1%; post-2030 0.3%	NO CALC IN COLOMBIA
Peru	based on historical trend extrapolation (average growth rate 2000–2014), values corrected with expert judgement and official data, after 2030 population growth rate (World Bank indicator) [%/year]	1.5%; post-2030 0.8%	8%; post-2030 0.8%	8%; post-2030 0.8%	7%; post-2030 0.8%
Mozambique	based on historical trend extrapolation (average growth rate 2000–2014), values corrected with expert judgement and official data, after 2030 population growth rate (World Bank indicator) [%/year]	8%; post-2030 2.4%	6%; post-2030 2.4%	8%; post-2030 2.4%	4%; post-2030 2.4%
Mexico	based on historical trend extrapolation (average growth rate 2000–2014), values corrected with expert judgement and official data, after 2030 population growth rate (World Bank indicator) [%/year]	2%; post-2030 0.6%	4%; post-2030 0.6%	3%; post-2030 0.6%	8%; post-2030 0.6%
Viet Nam	VFDS: rate of forestry production growth (including forest products processing industry and environmental services) will be from 4–5%/yr. Efforts will be made to increase the forestry sector's contribution to the national GDP to 2–3% by 2020.) [%/year]	4%	4%	4%	4%

Note: GDP = gross domestic product; n.a. = not applicable; VFDS = Vietnam Forestry Development Strategy.

9.2.5 Productive Forest Model

Values of the supply gap in 2040 in m³ were the input data for the productive forest model.

The productive forest model is a hectare model, operated by mean annual increment (MAI), final harvest, and optional thinnings. (See Table 19 for country details.)

Table 19: Key Productive Forest Figures

Country	Rotation period	Species	Final cut (years)	MAI (m ³ /year)	Thinning 1 (years)	Thinning 1 (cut in %)	Thinning 2 (years)	Thinning 2 (cut in %)
Ethiopia	Long	Cupressus lusitanica	25	15	7	33	12	50
	Short	Eucalyptus grandis	7	25				
Mozambique	Long	Pinus patula	25	20	8	50	13	55
	Short	E. grandis x E. urophylla	7	25				
Vietnam	Long	Acacia mangium	20	20	3	54	8	50
	Short	Acacia mangium	7	20				
Colombia	Long	Pinus	25	20	8	50	13	55
	Short	Eucalyptus hybrids	7	25				
Peru	Long	Pinus	20	25	6	54	10	50
	Short	Eucalyptus hybrids	7	30				
Mexico	Long	Pinus	25	15	7	33	12	50
	Short	Eucalyptus hybrids	7	20				

Note: m³ = cubic meters; MAI = mean annual increment.

9.2.6 Mitigation Benefits of HWP

Mitigation benefits from the HWP in use and the supply gap in productive forest area were assessed based on carbon stock changes.

- *Stock change approach.* Changes in carbon stock in forests are accounted for in the country in which the wood is grown, referred to as the producing country. Changes in the products pool are accounted for in the country where the products are used, referred to as the consuming country. These stock changes are counted within national boundaries, where and when they occur.

The carbon benefits of HWP related to the stock change in 2040 were estimated using equation 1.

Equation 1: Carbon stocks and annual carbon stock changes in the HWP pool (IPCC 2006; Pingoud and Wagner 2006)

Table 20: IPCC Default Values and Conversion Factors in the Simple Modeling Approach

FAO item code	Item name	Conversion to m ³ (r)	Original unit FAO	HWP half-life	Density (oven dry mass over air dry volume) [Mg/m ³]	C fraction	C conversion factor (per air dry volume) [Mg C/m ³]	Source
1872	Sawnwood	1.87 (COL ^a : 2)	m ³ (s)	35	0.458	0.5	0.229	IPCC
1873	Wood-based panels	1.68 ^b (COL: 1.6)	m ³ (s)	25	0.595	0.454	0.27013	IPCC
1871	Other industrial roundwood	1	m ³ (r)	20	0.56	0.5	0.28	Estimate ^c
1876	Paper and paperboard	3.6 (COL: 3.9)	Tons	2	(Oven dry mass over air dry mass) [Mg/Mg] 0.9		(Per air dry mass) [Mg C/Mg] 0.386	IPCC

Note: FAO = Food and Agriculture Organization; HWP = harvested wood products; IPCC = Intergovernmental Panel on Climate Change; m³ = cubic meters; Mg = Megagram r = roundwood.

^a COL: Colombia; conversion factors for COL were derived from the UNQUE database.

^b No default value for wood-based panels from FAO (the category comprises veneer sheets and plywood (VP), particleboard (PB and OSB) and fiberboard (FB); the conversion factor is an average: (1,87 VP + 1,51 PB + 1,63 OSB + 1,72 FB)⁻⁴.

^c There are no default values for other industrial roundwood from IPCC. The estimates were based on available defaults for other HWP.

$$C(i+1) = e^{-1} * C(i) + \left[\frac{(1 - e^{-k})}{k} \right] * Inflow(i)$$

$$\Delta C(i) = C(i+1) - C(i)$$

where:

i = year

$C(i)$ = carbon stock in the particular HWP category at the beginning of year i , Gigagram (Gg) C

k = decay constant of first-order decay for each HWP category given in units yr⁻¹ ($k = \ln(2)/HL$, where HL is half-life of the HWP pool in years)

$Inflow(i)$ = the inflow to the particular HWP category during year i , Gg C yr⁻¹

$\Delta C(i)$ = carbon stock change of the category during year i , Gg C yr⁻¹

9.2.7 Mitigation Benefits of the Productive Forest Model

The carbon benefits related to the productive forest areas were calculated following Equation 2.

Equation 2 (based on UNFCCC: AR-TOOL14 A/R Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R Clean Development Mechanism project activities Version 04.1):

$$C(i) = CF_j * V_i * D_j * BEF * (1 + R_j)$$

$$\Delta C(i) = C(i+1) - C(i)$$

$$\Delta C_{avg.} = \frac{\sum \Delta C(i)}{PD}$$

where:

CF_j = carbon fraction, default: 0.47

V_i = stem volume per hectare in year i

D_j = wood density, default: 0.51

BEF = biomass extension factor, default: 1.15

R_j = root – shoot ratio for tree species j ($= e^{(-1.085+0.9256*\ln b)/ b}$), where b is the aboveground tree biomass per hectare

$\Delta C_{avg.}$ = average carbon stock change

PD = project duration (25 years)

9.2.8 Sources of Input Data

Table 21: Sources of Input Data for the Simple Modeling Approach

Input data	Sources
Statistics on production and trade of HWP	FAOSTAT (http://faostat3.fao.org/download/F/FO/E) and primary data when available for <ul style="list-style-type: none"> Sawnwood (FAO Item Code 1872) Wood-based panels (FAO Item Code 1873) Paper and paperboard (FAO Item Code 1876) Other industrial roundwood (FAO Item Code 1871)
Approximated trend parameter	Approximations based on <ul style="list-style-type: none"> World Bank indicator SP.POP.TOTL (population) World Bank indicator GDP per capita, PPP (constant 2011 international \$) UNIQUE database Forest- and wood-related country programs and projections (Ethiopia Forest Sector Review, Mozambique Forest Investment Climate study, Mexico Natural Forest Program, Peru Forest Value Chain study, Colombia Plantation Value Chain study, Vietnam FCPF REDD+, and others)
Productive forest key figures (MAI, final harvest, and thinnings)	UNIQUE database
Default values for carbon benefit calculations (half-lives, decay rates, carbon fraction, and density)	IPCC (2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol)
Conversion factors (product unit > unit m ³ roundwood)	FAO-UNECE (ECE/TIM/DP/49)

Note: FAO = Food and Agriculture Organization; FCPF = Forest Carbon Partnership Facility; GDP = gross domestic product; HWP = harvested wood products; IPCC = Intergovernmental Panel on Climate Change; m³ = cubic meters; MAI = mean annual increment; PPP = purchasing power parity; REDD+ = reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks; UNECE = United Nations Economic Commission for Europe.

9.2.9 General Data Overview

Table 22: Data Overview: Base Years, Target Year; m³, ha, CO₂e

Green growth scenario	Ethiopia	Colombia	Peru	Mozambique	Mexico	Vietnam
<i>Base data: Production 2014 [mio m³r]</i>						
Sawnwood	0.03	1.69	1.25	0.72	4.62	11.22
Wood-based panels	0.17	0.56	0.08	0.01	2.07	2.62
Paper and paperboard	0.28	4.21	1.55	0.01	17.48	6.27
Other industrial roundwood	2.92	—	0.11	1.89	0.39	0.79
<i>Production + import – export: Demand 2014 [mio m³r]</i>						
Sawnwood	0.12	1.81	0.81	0.28	8.46	13.98
Wood-based panels	0.28	1.17	0.61	0.03	3.96	1.83
Paper and paperboard	0.81	5.75	3.50	0.18	28.38	10.44
Other industrial roundwood	2.92	—	0.11	1.89	0.39	0.79
<i>Approx. trend extrapolation 2014: Demand 2040 [mio m³r]</i>						
Sawnwood	0.58	4.63	1.09	1.17	12.68	38.76
Wood-based panels	1.34	3.31	2.10	0.08	7.71	5.07
Paper and paperboard	4.38	7.25	12.08	0.71	47.58	28.95
Other industrial roundwood	10.37	—	0.31	4.39	1.41	2.18
<i>Demand 2040 – production 2014: Supply gap [mio m³r]</i>						
Sawnwood	0.55	2.94	-0.16	0.44	8.06	27.54
Wood-based panels	1.17	2.75	2.02	0.08	5.65	2.44
Paper and paperboard	4.10	3.04	10.53	0.70	30.10	22.68
Other industrial roundwood	7.45	—	0.20	2.50	1.02	1.39
<i>Productive forest area 2040 [mio ha]</i>						
Productive forests with <i>short rotation</i> periods (sourcing HWP paper, panels, and other industrial roundwood, except for Ethiopia, where 50% other industrial roundwood would be sourced from productive forests with longer rotation periods)	0.35	0.25	0.42	0.14	1.88	1.36
Productive forests with <i>long rotation</i> periods (sourcing HWP sawnwood; in Ethiopia, also 50% other industrial roundwood)	0.40	0.24	—	0.04	0.75	1.82
<i>Mitigation benefit: HWP carbon stock change 2040 [mio t CO₂e]</i>						
Sawnwood	0.17	0.90	0.11	0.31	1.42	9.08
Wood-based panels	0.45	0.94	0.57	0.02	1.42	1.42
Paper and paperboard	0.10	0.03	0.12	0.02	0.36	1.16
Other industrial roundwood	5.10	—	0.11	1.81	0.60	1.01

(continued on next page)

Table 22: Data Overview: Base Years, Target Year; m³, ha, CO₂e (continued)

Green growth scenario	Ethiopia	Colombia	Peru	Mozambique	Mexico	Vietnam
<i>Mitigation benefit: Productive forest average carbon stock change 2015–40 [mio t CO₂e]</i>						
Short	1.35	0.94	1.93	0.54	5.79	4.19
Long	1.86	1.36		0.22	3.52	10.39
<i>Substitution effects HWP: Supply gap 2040 (solid HWPs) [mio t CO₂e]</i>						
Sum: sawnwood, wood-based panels, other industrial roundwood	12.6	7.8	2.8	4.1	20.2	43.1

Note: ha = hectares; HWP = harvested wood products; m³ = cubic meters; t CO₂e = tons of carbon dioxide equivalent; mio = million.

Default conversion value C to CO₂e: 3.67
Substitution factor m³ to CO₂e: 1.375

7.2. Socioeconomic Impacts of the Green Growth Scenario: Default Values

Table 23: Conversion Factors Used in the Business Cases for Roundwood Equivalent

Conversion factors to 1 m ³ (roundwood equivalent)	
Sawnwood (m ³)	2.0
Panels (m ³)	1.6
Pulp (tons)	3.9

Note: m³ = cubic meters.

Table 24: Gross Value Added Calculation

Gross value added calculation	Sales price	GVA share (%)
High-value sawlogs US\$/m ³	250	60
Coniferous sawlogs US\$/m ³	70–100	60
Fiber log (pulp, panels) US\$/m ³	40–50	60
High-value sawnwood US\$/m ³ air dry	1.200	30
Coniferous sawnwood US\$/m ³ air dry	250–300	25–30
Panel (MDF board) US\$/m ³	300–400	45–50
Pulp (chemical wood pulp) US\$/ton	700	45–50
Charcoal US\$/ton	190	30

Note: GVA = gross value added; m³ = cubic meters; MDF = medium density fiberboard.

Table 25: Employment Impacts

Employment impact industry (1- shift)	FTE (employees)/plant (mill)
Sawmill (simple layout, no kilns)	50
Panel mill (MDF plant)	200
Pulp mill (chemical wood pulp)	300
Charcoal kiln employees/kiln (Mozambique only)	1.5

Note: FTE = full-time equivalent; MDF = medium density fiberboard.

Table 26: Investment Cost Industries

Investment cost industry	Investment (US\$/plant)	Output capacity	Output
Sawmill (simple layout, no kilns)	10,000,000	50,000	m ³ sawnwood
Panel mill (MDF plant)	150,000,000	330,000	m ³ panels
Pulp mill (chemical wood pulp)	250,000,000	250,000	tons pulp
Charcoal kiln (Mozambique only)	900	110	tons charcoal

Note: m³ = cubic meters; MDF = medium density fiberboard.

Table 27: Employment Impact: Timber Production

Sector	FTE (employees)/ha
Productive forests	0.070
Reduced-impact logging (Peru only)	0.003
Rotation extension (Vietnam only)	0.050

Note: FTE = full-time equivalent; ha = hectares.

Table 28: Investment Cost: Timber Production

Investment cost timber production (US\$/ha yr ⁻¹)	Ethiopia	Mozambique	Colombia	Peru	Mexico	Vietnam
Land cost	40	30	120	100	100	50
Establishment cost and maintenance short rotation	1,800	2,000	1,500	1,700	1,700	1,800
Establishment cost and maintenance long rotation	2,300	2,500	2,000	2,200	2,200	2,300
Administration cost	120	130	110	110	110	110
Total long rotation US\$/ha	6,400	6,600	7,900	6,500	7,600	5,600
Total short rotation US\$/ha	3,100	3,300	3,300	3,400	3,400	3,100
Reduced-impact logging (Peru only) US\$/ha yr ⁻¹	N/A	N/A	N/A	40	N/A	N/A
Rotation extension (Vietnam only) US\$/ha	N/A	N/A	N/A	N/A	N/A	1,100

Note: ha = hectares; N/A = not available.

Table 29: Business Case General Data Overview

Product	Ethiopia constr.	Mozambique constr.	Mozambique charcoal	Colombia constr.	Peru RIL	Mexico community	Vietnam rotation ext.
<i>Product volume [1,000 m³ (r)]</i>							
Sawnwood	1,200	—	—	200	—	100	2,250
Panels	1,440	666	—	250	—	—	2,250
Paper	—	—	—	—	—	—	—
Other industrial roundwood	—	—	—	—	—	—	—
Total	2,640	666	—	450	—	100	4,500
<i>CO₂ benefits [1,000 t CO₂e]</i>							
Sawnwood	276	—	—	65	—	33	1,473
Panels	414	414	—	109	—	—	1,760
Paper	—	—	—	—	—	—	—
Other industrial roundwood	—	—	530	—	—	—	—
Product substitution benefits (default: 4 m ³ = 5.5 t CO ₂ e)	4,367	1,375	—	618	—	275	11,543
RIL	—	—	—	—	600	—	—
Rotation extension	—	—	—	—	—	—	42,100
Total	5,578	1,789	535	792	600	308	56,877
<i>Productive forest area required to meet volume (1,000 ha)</i>							
Short rotation	60	40	24	8	—	—	—
Long rotation	120	—	—	12	2,800	19	600
Total	180	40	24	20	2,800	19	600
<i>Industries required (N)</i>							
Saw mills	12	—	—	2	—	2	13
Panel mills	3	2	—	1	—	—	3
Pulp mills	—	—	—	—	—	—	—
Others	—	—	1,100	—	—	—	—
<i>Total investments (mio US\$)</i>							
Investments productive forests (all costs until harvest)	900	132	79	120	101	143	102
Investments in industries	540	300	1	95	—	20	550
Total investments	1,440	432	80	215	101	163	652

(continued on next page)

Table 29: Business Case General Data Overview *(continued)*

Product	Ethiopia constr.	Mozambique constr.	Mozambique charcoal	Colombia constr.	Peru RIL	Mexico community	Vietnam rotation ext.
<i>Employment</i>							
FTEs productive forests	12,600	2,800	1,680	1,400	2,800	1,330	30,000
FTEs industries	1,200	400	1,700	200	—	100	1,250
Total FTEs	13,800	3,200	3,380	1,600	1,050	1,430	31,250
<i>GDP contribution (mio US\$)</i>							
GDP contribution productive forests	103	30	18	16	95	10	340
GDP contribution industries	152	100	7	32	—	7	800
Total GDP contribution	255	130	25	48	95	17	1,140
<i>Total return indicators</i>							
Investment/20 years GDP contribution (US\$)	3	6	6	4	19	2	30.6
Investments per FTE (1000 US\$)	110	135	24	135	97	114	21
Investments per t CO ₂ (US\$)	16	12	8	14	8	26	11
2015 GDP (billion US\$)	62	15	15	292	192	1,144	194
GDP contribution based on 2015	0.41	0.89	0.17	0.02	0.05	0.001	0.58

Note: FTE = full-time equivalent; GDP = gross domestic product; m³ = cubic meters; mio = million; r = roundwood; RIL = reduced-impact logging; tons of carbon dioxide equivalent.



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WORLD BANK GROUP

1818 H Street, NW
Washington, DC 20433
USA
Telephone: +1 202 473 1000
Internet: www.worldbank.org