Technical Background Note for *Why Forests? Why Now?* Chapter 5:

Cheaper, Cooler, Faster: Reducing Tropical Deforestation for a More Cost-Effective Global Response to Climate Change

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Abstract

This technical background note briefly describes how we generated each statistic that appears in Chapter 5 of *Why Forests? Why Now? The Science, Economics, and Politics of Tropical Deforestation and Climate Change* (Frances Seymour and Jonah Busch, Brookings Institution Press, 2016).

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We drew upon three models, described in the following papers:

1. **Open Source Impacts of REDD+ Incentives Spreadsheet (OSIRIS)**. Jonah Busch and Jens Engelmann, 2015. The Future of Forests: Emissions from Tropical Deforestation with and without a Carbon Price, 2016-2050. Working Paper #411, Center for Global Development, Washington, DC.
2. **Global Change Assessment Model (GCAM 4.0)**. Joint Global Change Research Institute, "Global Change Assessment Model", Pacific Northwest National Library and University of Maryland. Kim, S. H., Edmonds, J., Lurz, J., Smith, S. J. & Wise, M. (2006). The ObjECTS Framework for Integrated Assessment: Hybrid Modeling of Transportation, *Energy Journal, Special Issue No. 2*, 63-91. http://wiki.umd.edu/gcam.
3. **SkyShares**. Modeling SkyShares: Technical Background. Alice Lépissier, Owen Barder, and Alex Evans, SkyShares, Center for Global Development, London, United Kingdom. http://www.skyshares.org.

1. "Unless additional countervailing policies for forest conservation are put into place, the world will lose another 2.89 million square kilometers of tropical forest from 2016 to 2050."

Generated using the OSIRIS model described in Busch and Engelmann, 2015.

2. "In the next thirty-five years tropical deforestation will release 169 billion tons of CO_2."

Generated using the OSIRIS model described in Busch and Engelmann, 2015.

3. "If all tropical forest countries put into place between 2016 and 2050 a carbon price of $20 per ton—an arbitrarily chosen point of comparison—about one-quarter of carbon dioxide emissions from deforestation—41 billion tons—would be avoided."

Generated using the OSIRIS model described in Busch and Engelmann, 2015.

4. "A $20-per-ton carbon price would result in a reduction of 0.92 billion tons of emissions from tropical deforestation in 2020."

Generated using the OSIRIS model described in Busch and Engelmann, 2015.

5. "If the full $20 per ton took the form of a payment, the cost to land users of reducing emissions would average out to about $9 per ton…In the case of a higher $50-per-ton carbon payment…77 billion tons would be avoided, with an average cost to land users of $21 per ton and a profit of $29 per ton."

Generated using the OSIRIS model described in Busch and Engelmann, 2015.

6. "A carbon price of $20 per ton…in the European Union would reduce emissions from buildings, energy, industry, and transportation by just 206 million tons. In the United States, it would reduce emissions from the same sectors by 228 million tons."

Marginal abatement cost curves for buildings, electricity, industry, and transportation for 27 countries in the European Union, and the United States, as projected for the year 2020 (GCAM). We excluded potential emission reductions from agriculture because GCAM presented a combined MAC curve for agriculture and forestry that did not split out a MAC curve for agriculture separately.

7. "Put differently, reduced emissions from deforestation would cost less than a quarter of equivalent reductions in the industrial sectors of Europe or the United States."

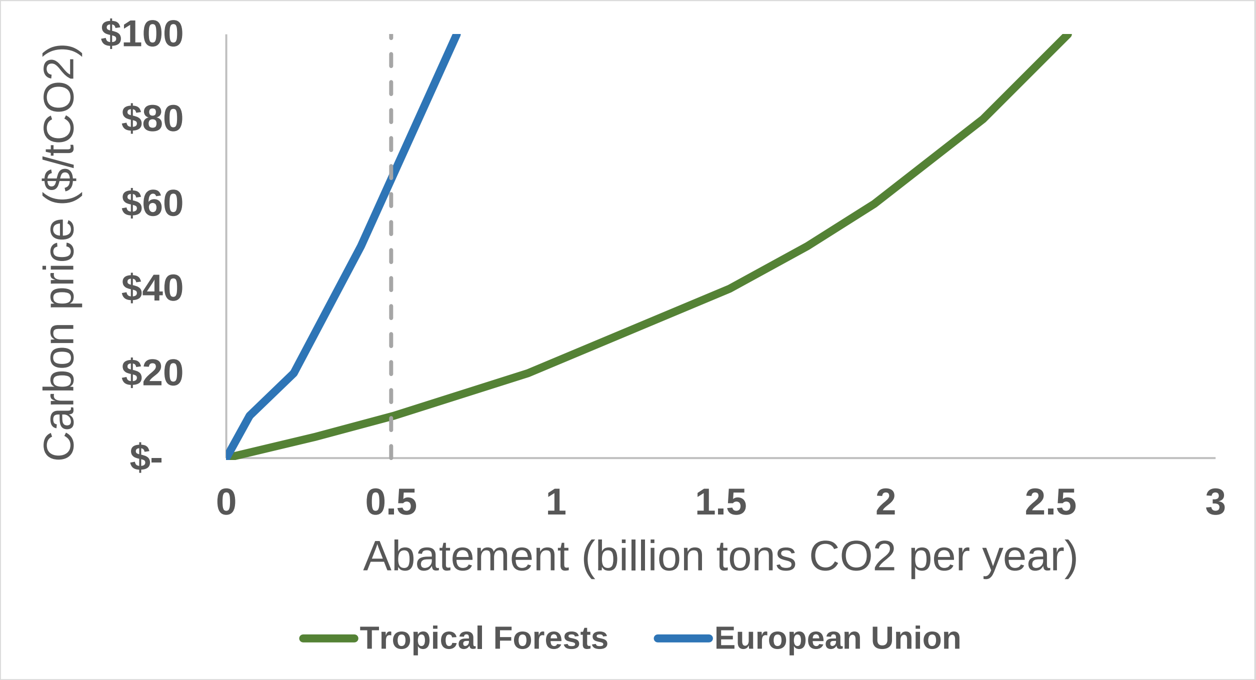
We compared marginal abatement cost curves for reducing tropical deforestation (OSIRIS) with marginal abatement cost curves for buildings, electricity, industry, and transportation for 27 countries in the European Union (GCAM) as projected for the year 2020. The statistic above was evaluated at 500 million tons of carbon dioxide per year, as shown in Figure 1. We excluded potential emission reductions from agriculture because GCAM presented a combined MAC curve for agriculture and forestry that did not split out a MAC curve for agriculture separately.

Comparing MAC curves generated by two different models, as we do, involves two important caveats:

1) **We did not attempt to standardize parameters and assumptions used to generate curves across models**. GCAM and OSIRIS were constructed independently, with each relying on many parameter choices and modeling assumptions (e.g. about future commodity prices, discount rates, and elasticities of demand and supply for commodities). Rather than try to harmonize all parameters and assumptions across the two models, we simply took at face value each model's results of abatement available from a given sector at a given carbon price.

2) **We did not attempt to account for interactions between emission reductions in different sectors**. Potentially, emission reductions in one sector could raise or lower the cost of achieving emission reductions in another sector. For example, increased substitution of biofuel for petroleum in the transportation sector could raise the cost of mitigation in the forest sector; or, slowing the rate of conversion from production forests to agriculture could reduce reliance on cement for construction, lowering the cost of mitigation in the building sector. Rather than attempt to model cross-sectoral interaction effects, we aggregated abatement available at a given carbon price using a simple horizontal summation.

Figure 1



8. "Worldwide, a carbon price of $20 per ton would reduce emissions from buildings, energy, industry, and transportation by 1.9 billion tons"

Marginal abatement cost curves for buildings, electricity, industry, and transportation as projected for the year 2020 (GCAM). We excluded potential emission reductions from agriculture because GCAM presented a combined MAC curve for agriculture and forestry that did not split out a MAC curve for agriculture separately.

9. "Reducing tropical deforestation would represent 33 percent of global, low-cost nonagricultural emission reductions"

We calculated MAC curves for non-agricultural emission reductions using a horizontal summation of MAC curves for reduced deforestation (OSIRIS) and MAC curves for buildings, electricity, industry, and transportation (GCAM).

(0.92 billion tons) / (0.92 billion tons + 1.9 billion tons) = 0.33

See caveats above about comparing MAC curves generated by independently produced models.

10. “Across the developing countries where the GCF is mandated to spend, deforestation constitutes around 15 percent of nonagricultural emissions”

Calculated for 2015, using emissions estimates for tropical deforestation (OSIRIS) and buildings, electricity, industry, and transportation (GCAM). We excluded potential emission reductions from agriculture because GCAM presented a combined MAC curve for agriculture and forestry that did not split out a MAC curve for agriculture separately.

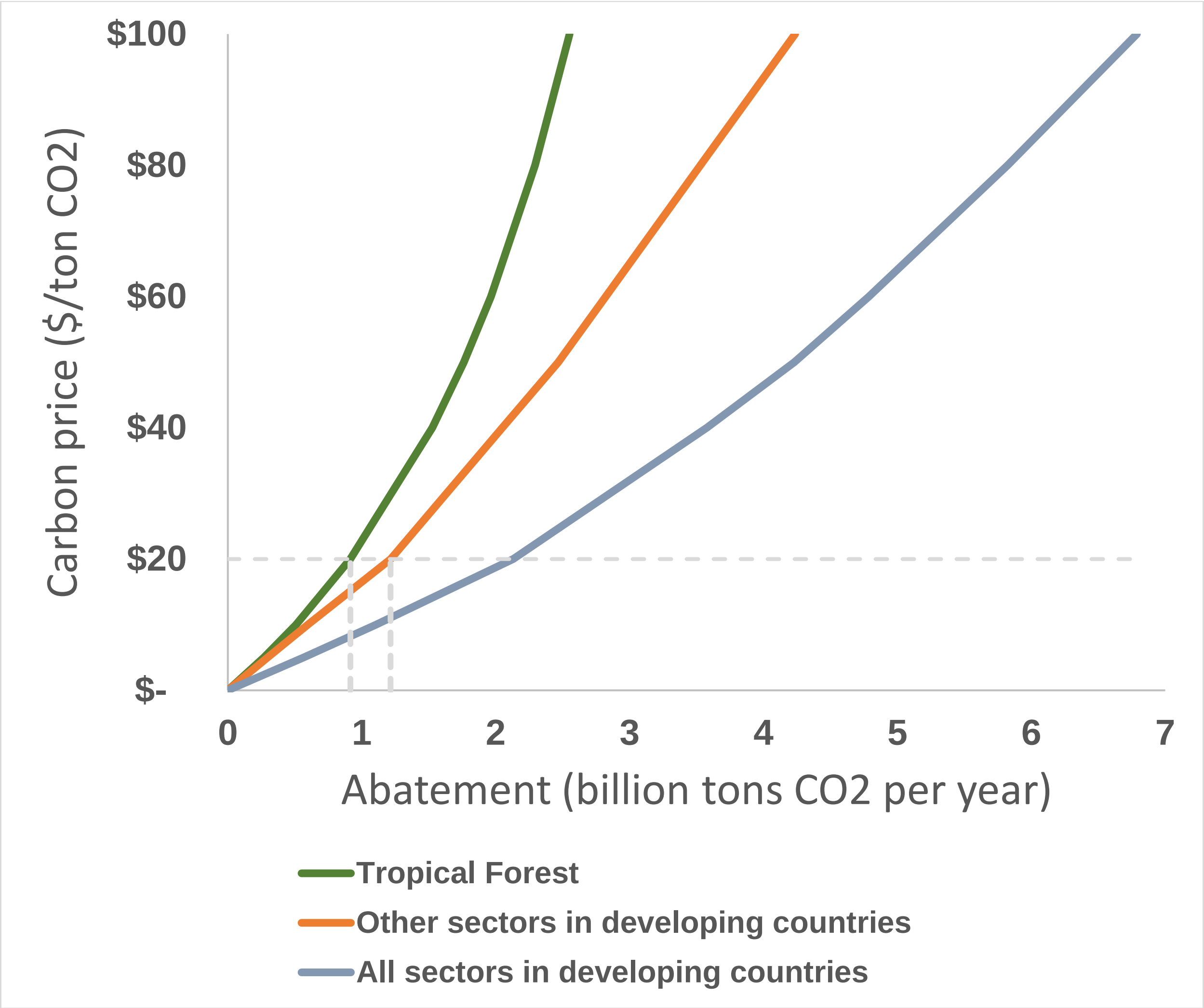
(4.2 billion tons) / (4.2 billion tons + 24.7 billion tons) = 0.15

See caveats above about comparing MAC curves generated by independently produced models.

11. Across the developing countries where the GCF is mandated to spend, “reducing tropical deforestation would constitute 43 percent of low-cost nonagricultural emission—that is, reductions below $20 per ton—reductions in 2020.”

We horizontally summed marginal abatement cost curves for reducing tropical deforestation (OSIRIS) with marginal abatement cost curves for buildings, electricity, industry, and transportation for Non-Annex I countries (GCAM) as projected for the year 2020. The statistic above was evaluated at a carbon price of $20 per ton of carbon dioxide, as shown in Figure 2. We excluded potential emission reductions from agriculture because GCAM presented a combined MAC curve for agriculture and forestry that did not split out a MAC curve for agriculture separately. See caveats above about comparing MAC curves generated by independently produced models.

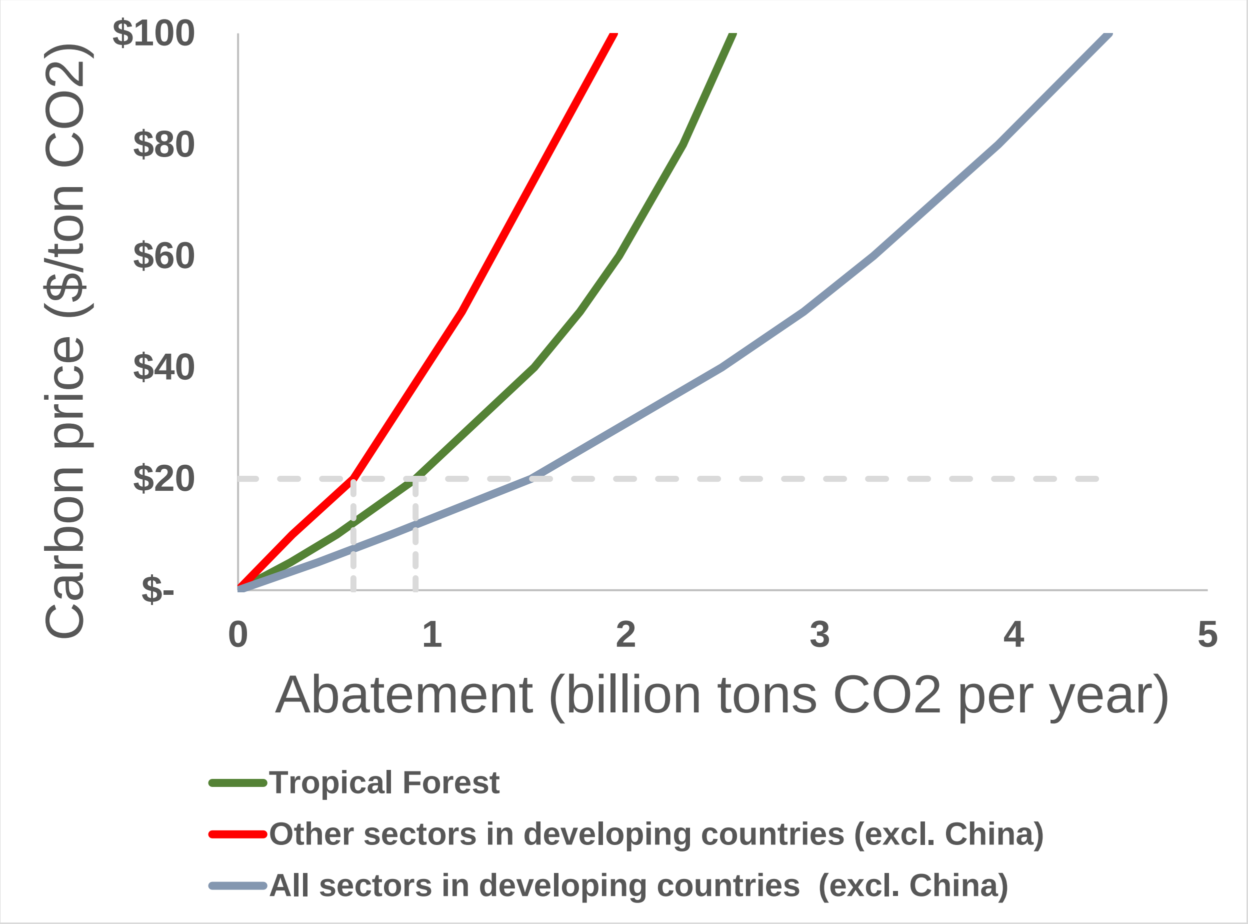
Figure 2



12. "Outside of China, reducing tropical deforestation would constitute 61 percent of low-cost nonagricultural emission reductions in developing countries in 2020.

We horizontally summed marginal abatement cost curves for reducing tropical deforestation (OSIRIS) with marginal abatement cost curves for buildings, electricity, industry, and transportation for Non-Annex I countries (GCAM) as projected for the year 2020. The statistic above was evaluated at a carbon price of $20 per ton of carbon dioxide, as shown in Figure 3. We excluded potential emission reductions from agriculture because GCAM presented a combined MAC curve for agriculture and forestry that did not split out a MAC curve for agriculture separately. See caveats above about comparing MAC curves generated by independently produced models.

Figure 3



13. "Reducing emissions by 140 billion tons of carbon dioxide between 2016 and 2030 would set the world on a pathway to an increase of 2°C."

Calculated using SkyShares. We calculated the global emissions budget consistent with a temperature target of 2 °C. The abatement required was the difference between the emissions budget (shown in red in Figure 4) and the business-as-usual projection (in blue). We used the IPCC's Representative Concentration Pathway 8.5 for our BAU scenario, which is consistent with a mean stabilization of 4.31°C at the end of the century (period 2081-2100), relative to the period 1850-1900[1]. For the calculations in Chapter 5 we considered abatement required during the period 2016-2030 only, which we consider a reasonable time horizon for comparing near- and medium-term policy actions and associated costs.

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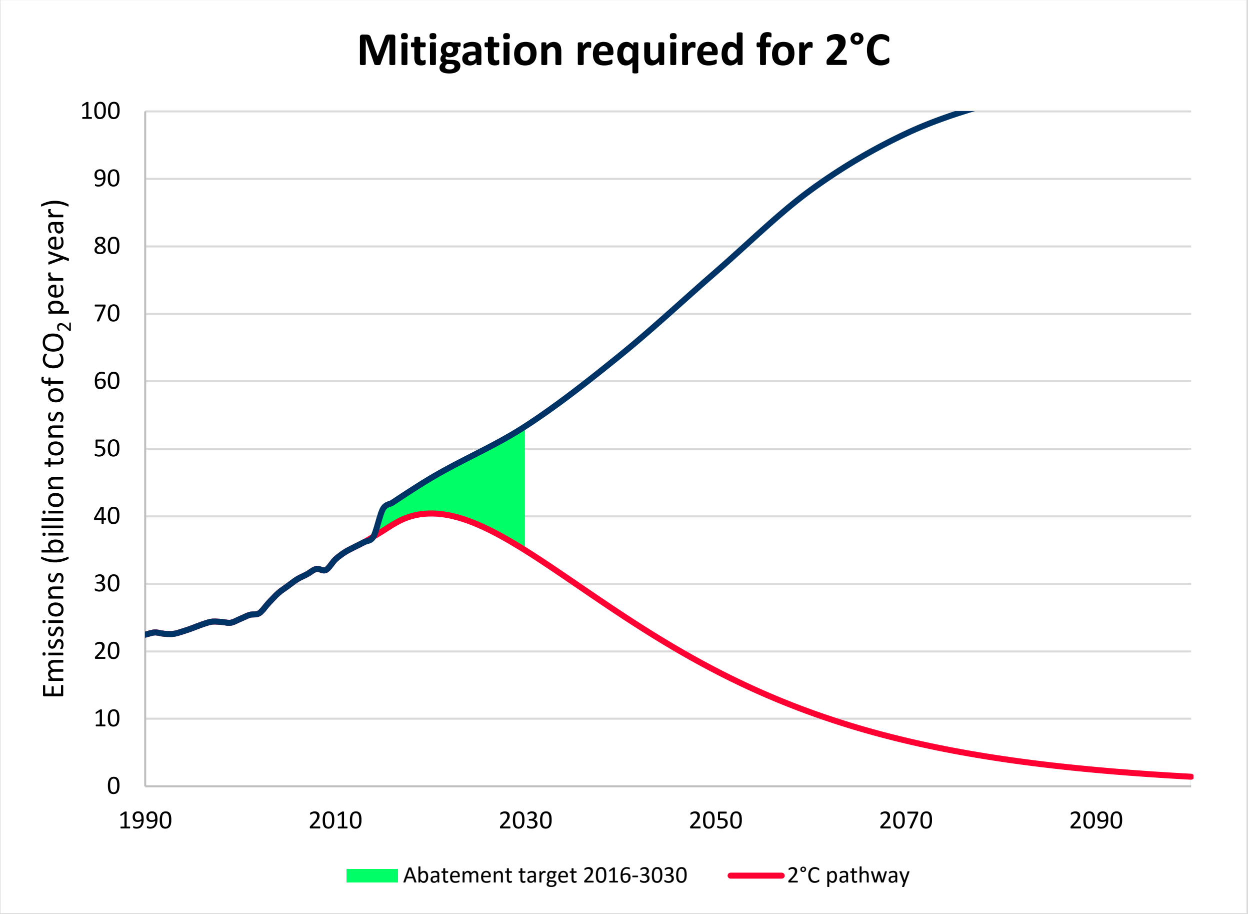
[1] IPCC, AR5, Technical Summary, Table TS1, page 90. Authors' own calculations to re-adjust from the IPCC's new reference period of 1986-2005.

Figure 4

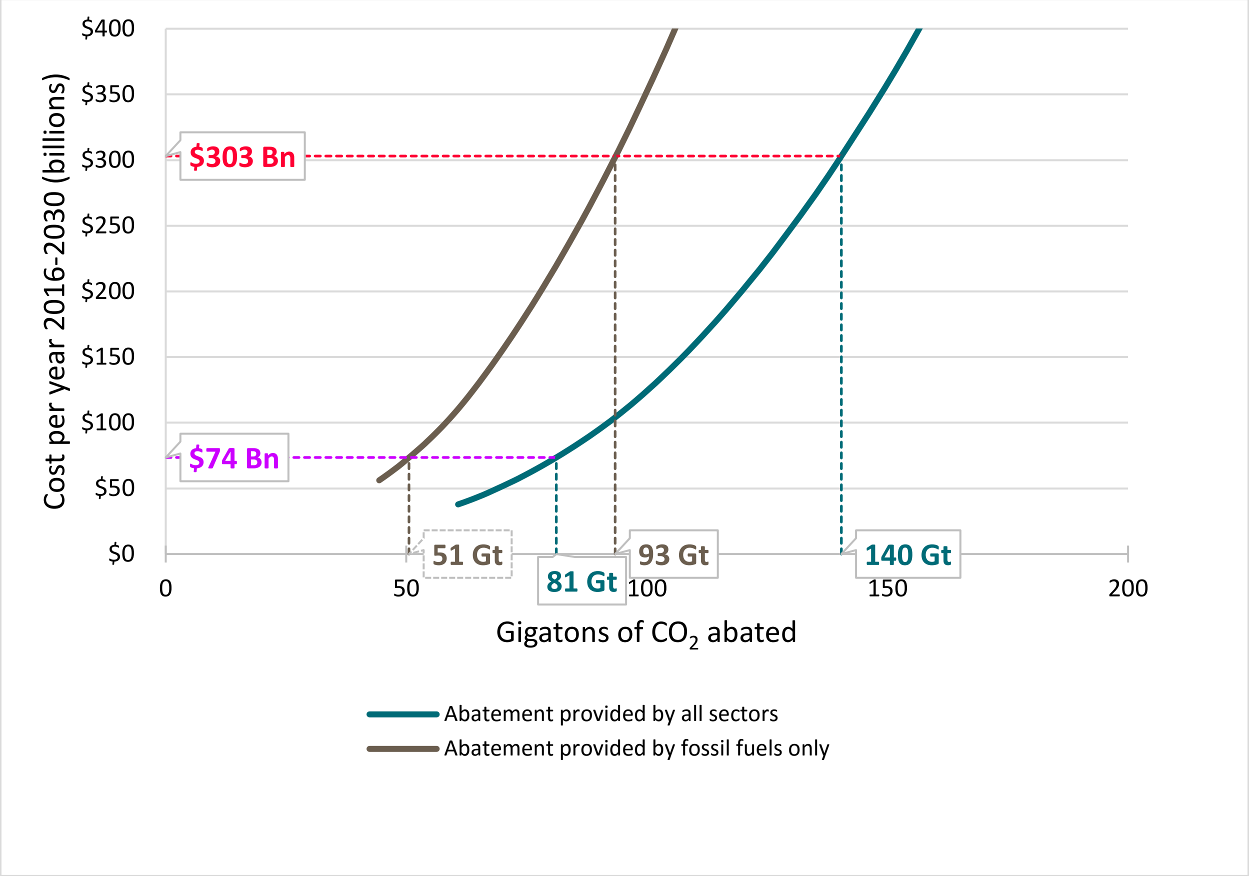


14. "If tropical deforestation were excluded from the climate response, the world could reduce emissions by only 93 billion tons at the same cost from 2016 to 2030."

To compute total mitigation costs, we calculated the area under the marginal abatement cost curve for each year between 2016-2030. We used marginal abatement costs for reduced tropical deforestation from OSIRIS. We used marginal abatement costs for fossil fuels (i.e. the building, energy, industry, and transportation sectors) from GCAM. See caveats above about comparing MAC curves generated by independently produced models.

The average annual total mitigation cost from 2016-2030 required to reduce emissions by 140 Gt CO_2 using abatement opportunities from both fossil fuels and reduced tropical deforestation is $303 billion per year. If abatement opportunities excluded reduced tropical deforestation and included fossil fuels only, then $303 billion a year would achieve only 93 Gt CO_2 of mitigation for the 2016-2030 period, as shown in Figure 5.

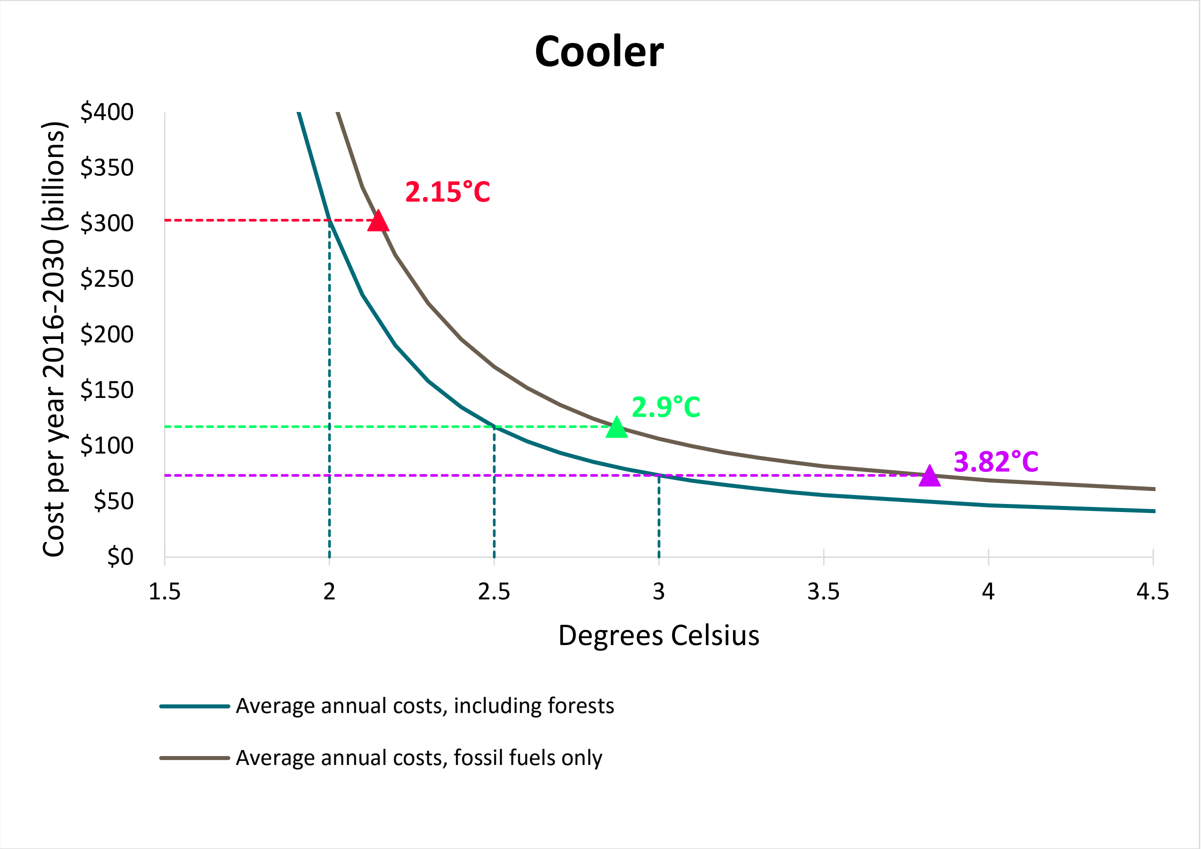
Figure 5



15. "[93 Gt CO_2 of mitigation for the 2016-2030 period] would set the world on a higher temperature-increase pathway of 2.15 °C."

Temperature increase-cost curves shown in Figure 6 calculated using SkyShares. We calculated the global emissions budget consistent with every temperature target. The abatement required was the difference between the emissions budget and the business-as-usual projection. Total mitigation costs were calculated as the area under the combined marginal abatement cost curves for reduced tropical deforestation (OSIRIS) and fossil fuels (GCAM) for each year between 2016-2030, up to the required level of abatement. See caveats above about comparing MAC curves generated by independently produced models.

Figure 6



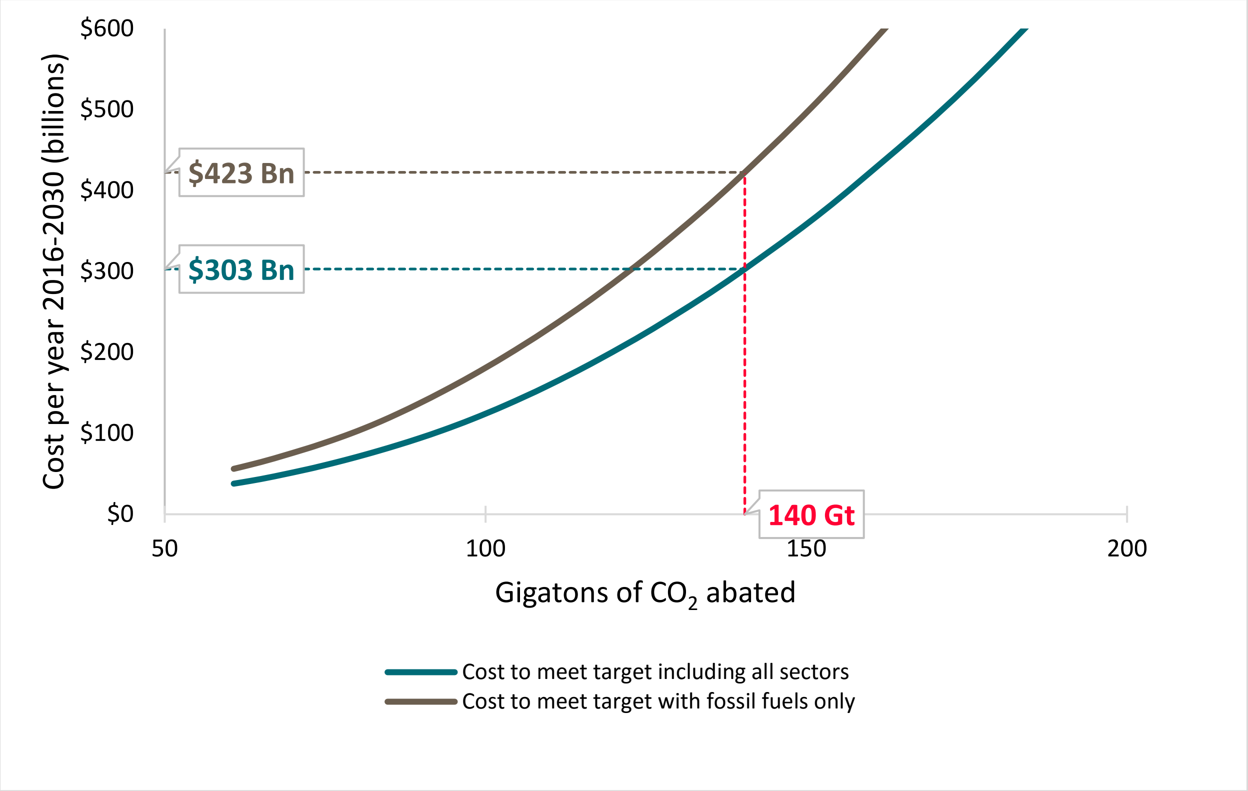
16. "Similarly, including forests in the portfolio of mitigation responses could let the world hit a pathway toward an increase of 3°C rather than 3.82°C, at the same cost from 2016 to 2030"

Temperature-cost curves shown in Figure 6 calculated using SkyShares. We calculated the global emissions budget consistent with every temperature target. The abatement required was the difference between the emissions budget and the business-as-usual projection. Total mitigation costs were calculated as the area under the combined marginal abatement cost curves for reduced tropical deforestation (OSIRIS) and fossil fuels (GCAM) for each year between 2016-2030, up to the required level of abatement. See caveats above about comparing MAC curves generated by independently produced models.

17. "Getting on a pathway to a 2°C target, for example, would cost 28 percent less between 2016 and 2030 if reduced tropical deforestation were included in the global portfolio of climate solutions rather than relegated to the sidelines."

To be on track for 2°C stabilization by the end of the century, emissions would need to be reduced by 140 Gt CO_2 between 2016-2030, as calculated using SkyShares. This would cost 28 percent less if forests are included in the climate response than if they are not, as shown in Figure 7. Total mitigation costs were calculated as the area under the combined marginal abatement cost curves for reduced tropical deforestation (OSIRIS) and fossil fuels (GCAM) for each year between 2016-2030, up to the required level of abatement. See caveats above about comparing MAC curves generated by independently produced models.

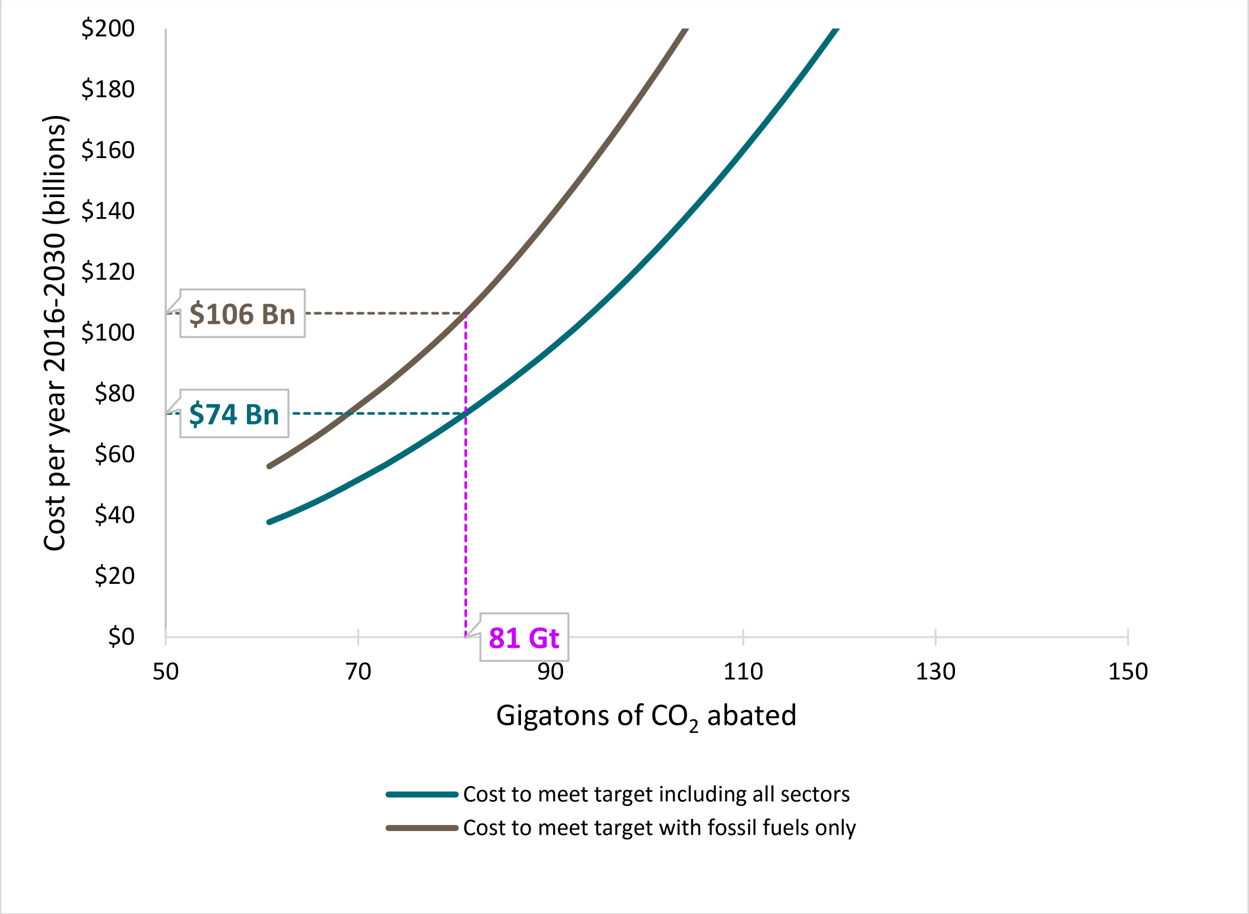
Figure 7



18. "Meeting a 3°C target would be 30 percent cheaper [between 2016 and 2030 if reduced tropical deforestation were included in the global portfolio of climate solutions]."

To be on track for 3°C stabilization by the end of the century, emissions would need to be reduced by 81 Gt CO_2 between 2016-2030, as calculated using SkyShares. This would cost 30 percent less if forests are included in the climate response than if they are not, as shown in Figure 8. Total mitigation costs were calculated as the area under the combined marginal abatement cost curves for reduced tropical deforestation (OSIRIS) and fossil fuels (GCAM) for each year between 2016-2030, up to the required level of abatement. See caveats above about comparing MAC curves generated by independently produced models.

Figure 8



19. "the same amount of emission reductions that could be achieved from tropical forests in the five years from 2016 to 2020 would take sixteen years to achieve in the United States or eighteen years to achieve in Europe, at the same cost."

Calculated at a cost of $20 per ton of carbon dioxide for reduced tropical deforestation (OSIRIS) and fossil fuels (GCAM). See caveats above about comparing MAC curves generated by independently produced models.

20. "If countries started cutting emissions in 2016 to keep global warming below 2°C…a portfolio of climate actions that included reducing tropical deforestation could see global emissions peak by 2020, while an equally costly portfolio that ignored tropical deforestation would not see that happen until 2022."

We used SkyShares to generate different emissions pathways with varying degrees of abatement. In these alternative pathways emissions peak sooner if abatement is larger, and later if abatement is more conservative, as shown in Figure 9. We then estimated how much faster global emissions could peak if reducing tropical deforestation formed part of the climate response (shown in red in Figure 9 and blue in Figure 10), at the same cost as a pathway with fossil fuels only (shown in grey in Figures 9 and 10).

Figure 9

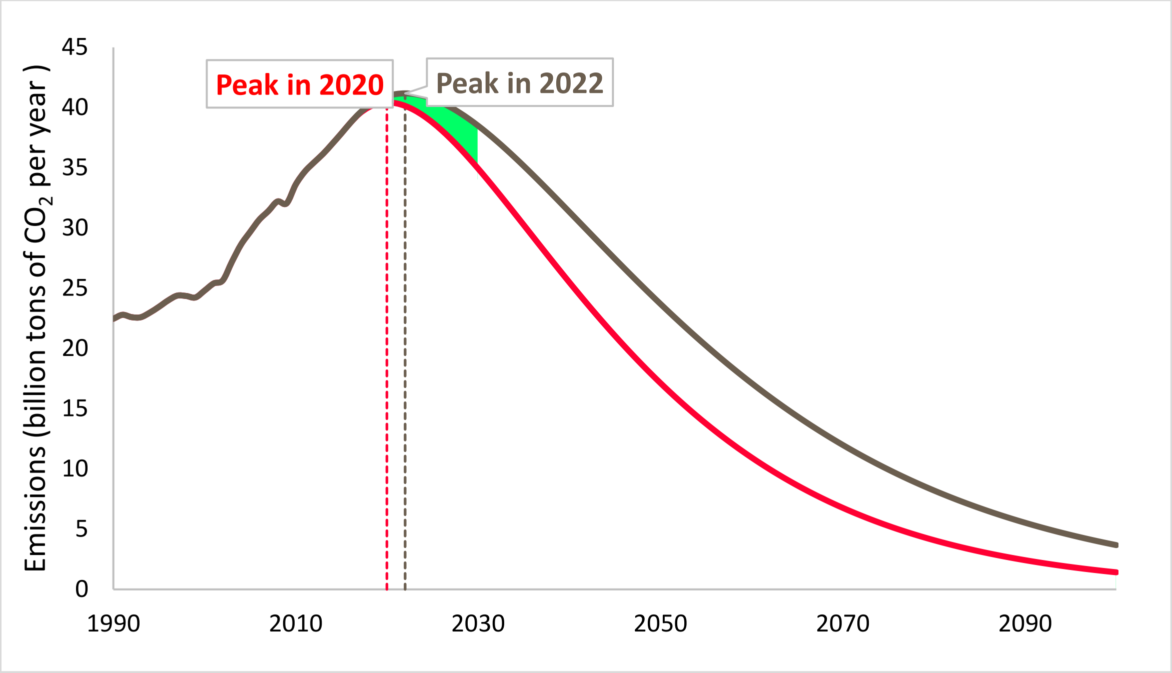
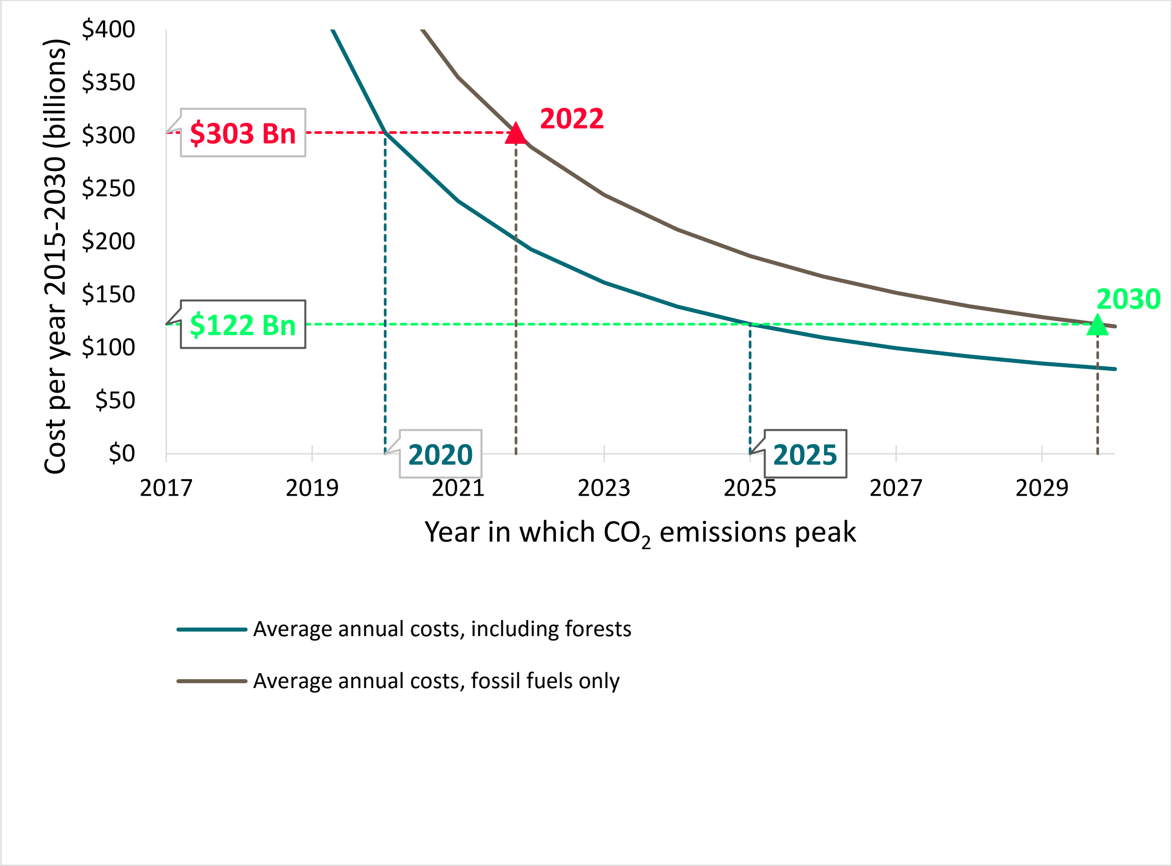


Figure 10



21. "If countries started in 2020 on a pathway toward 2.5°C increase, a portfolio of climate actions that included reduced tropical deforestation could see global emissions peak by 2025 instead of by 2030, at the same cost."

We used SkyShares to estimate how much faster global emissions could peak if reducing tropical deforestation formed part of the climate response (shown in blue in Figure 10 and red in Figure 11), at the same cost as a pathway with fossil fuels only (shown in grey in Figures 10 and 11).

Figure 11