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Navigating climate transition risks

Climate Transition Risk Analyst Brief

Indonesian Palm Oil

AN INITIATIVE OF
CLIMATE ADVISERS TRUST

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What we cover in this Brief:

1. How Indonesian palm oil actors are exposed to climate transition risks and opportunities. **2.** How climate transitions can affect production costs, profitability, capital needs, and growth strategies. **3.** How the financial community and companies can best position themselves for climate transitions, including through a sustainability and smallholder focus.

Climate Transition Risk Analyst Brief
AUGUST 2021

Section I
Key Findings

The Indonesian palm oil industry has experienced unprecedented growth over the past fifty years. But this growth has come at the expense of some of the world's most important carbon sinks -- forests and peatlands -- leaving the industry and its financiers exposed to material risks.

The industry is already in transition due to the COVID-19 pandemic. Now is an opportune moment for palm oil companies to better protect themselves from emerging climate risks particularly as society shifts to a low carbon, climate-aware economy.

This report projects how "climate transitions"—that is, actions by governments, consumers, and the private sector to address the climate crisis—can materially influence Indonesia's palm oil industry.[1] We examine three climate transition pathways -- Historical (baseline), Modest, and Aggressive -- that represent rising levels of global and local ambition to address the climate crisis. Each scenario relies on modeling results presented in a preceding report, "Transition Scenarios in Tropical Agriculture[2]" available at **http://orbitas.finance.**

29%
Higher palm oil prices

52%
higher concession acquisition costs (a proxy for land values)

higher oil palm yields by
9%

$9+ billion
increase in the industry's implied market value (assuming companies respond optimally)

Now is an opportune moment for palm oil companies to better protect themselves from emerging climate risks particularly as society shifts to a low carbon, climate-aware economy.

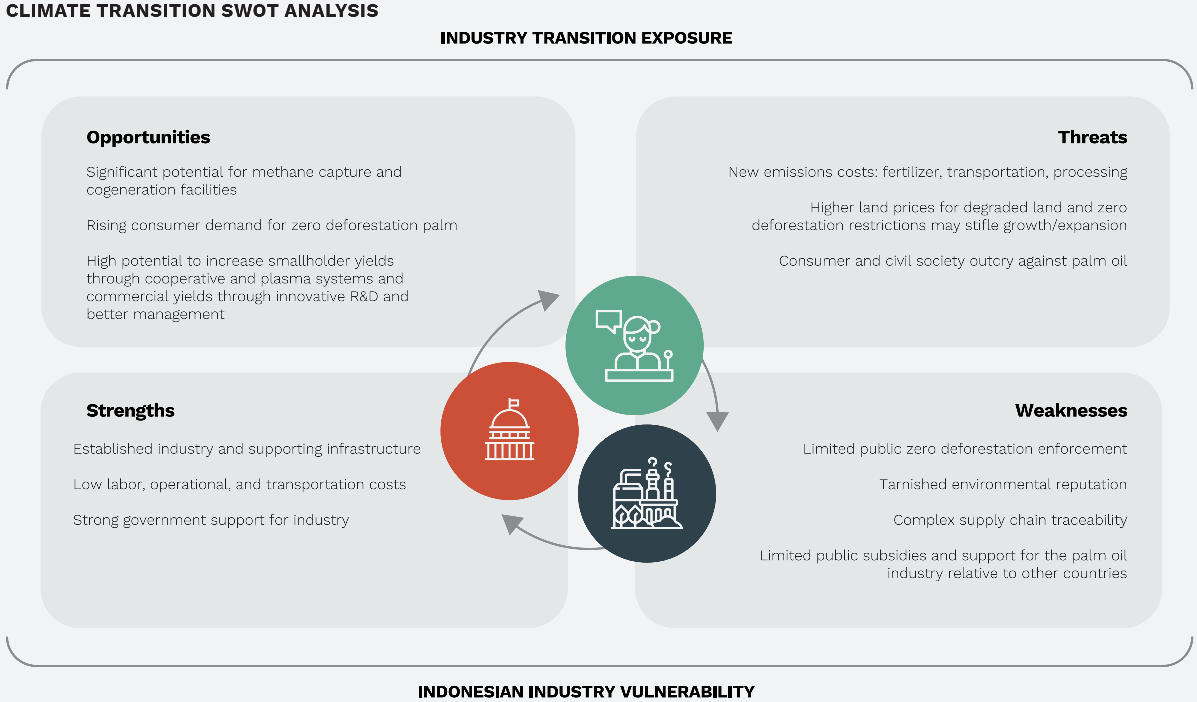
Our economic and financial analysis of climate transition risks for Indonesian palm oil finds:

- The Indonesian palm oil industry is highly exposed to global and local climate transitions given its high export volume, contributions to deforestation, reliance on land, dependence on emissions-intensive fertilizer and diesel fuels, and direct operational emissions.
- Under climate transitions, palm oil demand grows to feed growing populations and greater bioenergy needs. This demand grows faster than production, resulting in real, but likely volatile, price increases as countries adjust their respective climate mitigation, agricultural and land use, and trade policies. Concurrently, land use restrictions create greater land competition, driving up land prices and incentivizing higher productivity.
- By 2040, relative to a Historical scenario that reflects limited climate ambition, following our Aggressive ambition pathway results in:
  - 29% higher palm oil prices;
  - 52% higher concession acquisition costs (a proxy for land values);
  - 9% higher oil palm yields; and
  - A $9+ billion increase in the industry's implied market value (assuming companies respond optimally)
- **Up to 76% -- over 9 million hectares -- of the country's unplanted concessions are at risk of asset stranding under climate transitions.[3] In addition, 15% of currently planted concessions are also at risk of stranding.** Climate transitions boost the industry's implied market value, but operators situated on high carbon stock forests and/or high conservation value lands[4] could see substantial write-off risks from unplanted concessions stranded under "No Deforestation, No Peat, No Exploitation" (NDPE) government and voluntary restrictions. Some of the industry's largest companies face significant legal stranding risks in their asset portfolios, including Korindo and PT Austindo Nusantara Jaya.[5]

Continued
Key Findings

- **A company's vulnerability to projected transitions will be primarily determined by the strength of a company's land use and emissions reduction strategies, access to capital, and operational efficiency.** Our preliminary results find that:
  - **Companies facing the greatest risks under climate transitions tend to be smaller, midstream integrated companies** -- i.e., millers and cultivators -- with low productivity and reliance on expansion into forest/peatlands.
  - **Larger, vertically integrated actors face fewer risks under climate transitions**, but are less able to convert favorable price increases into profits and may still face material write-offs. Examples include Golden Agri-Resources Ltd (Golden Agri), Wilmar International Ltd (Wilmar), and Sime Darby Plantation Bhd (Sime Darby).
- Biogas methane capture and cogeneration facilities provide a clear opportunity to derive higher and more dependable profitability **under all scenarios** and also protect against rising greenhouse gas (GHG) emissions prices under climate transitions.
  - Installing biogas capture and generation facilities in its new mills in 2030 (when GHG prices start to become material) could boost a company's 2020 enterprise value (debt and equity) by 4 times or more.
  - MP Evans, despite being a smaller player, appears well-positioned to further expand its biogas capture and cogeneration assets given its strong financial, sustainability, and yield profiles.
- Smallholders will play a pivotal role in feeding the industry's growing production and helping the private sector adapt to new climate transition norms:
  - Under climate transitions, industrial producers are likely to benefit more from closing their own and independent smallholder yield gaps than expanding through expensive concession acquisition or greenfield development
  - Without adequate enforcement of deforestation restrictions,

Figure 1:
CLIMATE TRANSITION SWOT ANALYSIS



Source: Concordian. Note: This figure does not consider social, labor, and community concerns, which are important threats and weaknesses for the Indonesian palm oil industry and may be exacerbated by climate risks.

Continued
Key Findings

the footprint of independent smallholders could expand into up to 5 million[6] hectares of valuable forest and peatlands at the expense of the industry's global reputation.

Given the industry's material exposure and vulnerability to climate transitions (Figure 1), we recommend that investors with Indonesian palm oil exposure:

- Avoid investments in companies with concessions in high conservation value lands and/or high carbon stock forests, who lack or do not fully implement NDPE policies, and/or whose growth strategies rely on new developments, i.e., geographic expansion.
- Request investees assess and disclose climate transition exposure and vulnerability in line with guidance from Financial Stability Board's (FSB) Task Force on Climate-related Financial Disclosures (TCFD).
- Predicate lending to, and investment in, producers on adopting sustainable practices and sourcing -- including progress toward 100% supply chain traceability -- and meeting minimum yield requirements upon plantation maturity
- Broaden subsidized lending, favorable financing, and technical assistance to small and medium-sized producers adopting sustainable methods.
- Encourage investment in emissions mitigation measures, most notably profitable biogas capture and cogeneration facilities.

A company's vulnerability to projected transitions will be primarily determined by the strength of a company's land use and emissions reduction strategies, access to capital, and operational efficiency.

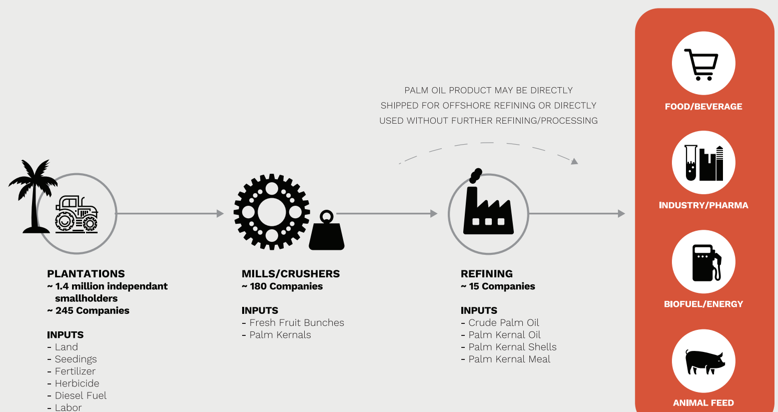
Section II
Palm Oil Climate Transition Risks

KEY TAKEAWAYS

THE INDUSTRY'S CONTRIBUTION TO DEFORESTATION EXPOSES IT TO SEVERAL SOURCES OF CLIMATE TRANSITION RISKS, INCLUDING REPUTATIONAL, POLICY, LEGAL, MARKET, AND TECHNOLOGY RISKS.

BOX 1: THE PALM OIL VALUE CHAIN

The global palm oil value chain is highly complex and the diversity of palm oil derivative products and end uses means that it spans several geographies and adjacent value chains. First, palm oil seeds are planted, maintained, and cultivated to generate fresh fruit bunches (FFB) and palm kernels (PK). Second, these fresh fruit bunches and palm kernels must be milled and crushed, respectively, within 48 hours to create crude palm oil (CPO), palm kernel oil (PKO) and other byproducts, such as palm kernel shells (PKS), which are burned for energy and palm kernel meal (PKM) which is used as animal feed. Third, CPO and PKO are refined (increasingly, onshore in Indonesia and Malaysia) into cooking oil, biodiesel fuels, oleochemicals, among other derivative products for local manufacturers, local use, or export. Exports are routed through bulking facilities, traded, and shipped to manufacturers across the globe.



Source: Concordian, GAPKI

Palm oil is one of the world's most important vegetable oil crops. With its high yields and low production costs relative to its soft oil substitutes, i.e. soy, sunflower, and rapeseed oils, palm oil has emerged as an important global commodity. In 2019/2020, crude palm oil (CPO) and palm kernel oil (PKO) together accounted for 61% of all major vegetable oil exports.[7] Palm oil products, including CPO, PKO, palm kernel meal (PKM) and palm kernel shells (PKS) are used as inputs, processed and/or refined for a wide range of uses, including cooking oil, biodiesel, and oleochemicals.

Relative to smaller producers in Latin America and West Africa, Indonesian palm oil operators have an operational and cost advantage but are more vulnerable to reputational risks given the industry's historical associations with environmental degradation.

Indonesia is the world's largest palm oil producer, following rapid growth over the past two decades. In 2019, Indonesia produced a record 52 million tons of palm oil product,[8] representing 72% of global supply.[9] This represents 4.5% of its GDP,[10] and is 92% higher than its 2010 production.[11] Of this production, approximately 70% was exported while the rest was directed to domestic markets or stockpiled.[12] China, the E.U., and India represent the largest foreign markets for Indonesian palm oil -- 75% of which is refined before export.

The Indonesian palm oil value chain (Box 1) comprises millions of actors, but a few powerful vertically-integrated conglomerates control downstream refining and trading. Millions of smallholder farmers and hundreds of medium-sized companies cultivate and process FFB and PK. But only a few large conglomerates -- Wilmar, Musim Mas, Golden Agri Resources/Sinar Mas, Cargill and Asian Agri -- control the flow of crude palm oil through their refining, trading activities, as well as sourcing from their own and third party plantations.[13]

The industry's rapid growth has led to significant environmental destruction. Indonesia's palm oil industry has historically relied on geographic expansion to increase production, often by clearing primary forests and draining peatlands -- the world's most important terrestrial carbon sinks. From 2001 to 2019, Indonesia lost 27 million hectares of tree cover primarily in provinces dominated by palm oil production -- the equivalent of 11 gigatons of carbon dioxide emissions.[14] In 2019 alone, 1.6 million hectares of land were burned.[15]

This destruction has created material risks for Indonesian companies, its export markets, and its investors. Despite the emergence of The Roundtable on Sustainable Palm Oil (RSPO) and its certification system to which many large palm oil companies subscribe, environmental destruction and its associated reputational risks persist. For instance, 32% of companies surveyed by the Carbon Disclosure Project cited existing reputational or brand damage from associations with palm oil. These reputational risks have led to an uptick in cancelled partnerships and investor divestment over the past five years. In the past two years alone, Norway's $1 trillion sovereign wealth fund divested from 33 palm oil companies ; the EU announced a phase-out of palm oil in its biodiesel[17]; and PepsiCo and Nestle severed ties with Indofoods, one of Indonesia's largest palm oil suppliers[18].

Figure 2: CLIMATE TRANSITION RISKS AFFECTING INDONESIAN PALM OIL

TCFD Risk Category	Risk Event	Example or Potential Source
Policy & Legal	Government restrictions on deforestation and peat land conversion for agricultural uses.	Indonesian government moratorium on new concessions that clear primary forest or peatland within a 66 million hectare area.
	Introduction of greenhouse gas (GHG) taxes or pricing systems that cover agricultural producers.	Indonesia's commitments to reducing greenhouse gas emissions by between 29 and 41% by 2030.
	Importing countries restrict or ban non-certified products or those associated with deforestation.	The E.U. plans to phase out palm-oil derived biodiesel.
Technology	New planting technologies enable higher yields.	Emerging agroforestry techniques indicate opportunities to boost yields, diversify income, and reduce emissions.
Market	Purchasers or standard-setting bodies require the implementation of better environmental standards (and social, where relevant) from suppliers.	At least 16 major Indonesian palm oil producers and refiners have committed to "No Deforestation, No Peat, No Exploitation" (NDPE) policies, including through the High Carbon Stock Approach (HCSA).
	Corporate and consumer demand for sustainable palm oil grows	Sustainable palm oil can command a price premium in some markets; some corporate purchasers only buy sustainable palm oil.
	Capital providers link financing to improvements in greenhouse gas emissions, among other ESG factors.	Rabobank and others arranged a sustainability-linked credit facility for Olam International.
Reputation	Shareholders or capital providers divest or express concerns about environmental commitments.	In 2019, Norway's GPFG sovereign fund divested from 33 palm oil companies over deforestation concerns.
	Increased NGO and stakeholder concern about issues such as deforestation, social and labor impacts, or climate change increase scrutiny of tropical commodity supply chains.	NGOs play an important role in standard-setting bodies like the Roundtable on Sustainable Palm Oil.

Source: Concordian and Reuters.

The industry's environmental failures also increase its exposure to emerging policy, legal, market and technology risks (Figure 2). Indonesia has committed to reducing its greenhouse gas emissions by 29-41% by 2030. While it is unclear how these commitments will take shape, the country will continue to face increasing international pressure and incentives (such as carbon border tax adjustments) to reduce deforestation -- a primary driver of its national emissions. Most recently, from 2011 to 2019, Indonesia signed, renewed, and ultimately made permanent restrictions on clearing primary forest and/or peatland clearing within a 66 million hectares area.[19] Similarly, at least 16 major Indonesian palm oil producers and refiners -- including Wilmar, Musim Mas, and Golden Agri -- have committed to "No Peat, No Deforestation, No Exploitation" (NDPE) policies, including the commitment to implement High Carbon Stock Approaches that identify and avoid high carbon stock and high conservation value lands.[20] Notably, these regulations and voluntary commitments are poised to reduce future land availability for palm expansion.

The Indonesian palm oil value chain comprises millions of actors, but a few powerful vertically-integrated conglomerates control downstream refining and trading.

Section III
Climate Transition Projections

KEY TAKEAWAYS

AS CLIMATE AMBITION INCREASES, PRODUCERS WILL SEE HIGHER DEMAND AND CPO PRICES, BUT ALSO FACE ASSET STRANDING, RISING LAND PRICES, AND NEW EMISSIONS COSTS.

To assess the Indonesian's palm oil industry's exposure and vulnerability to climate transition risks we rely on three plausible global and national climate transition scenarios. This section presents these three scenarios, projects how these scenarios will impact commodity prices and production, and shows how climate transitions create stranded asset risks, growth constraints, and new production costs for producers.

A. CLIMATE TRANSITION SCENARIOS (GLOBAL AND INDONESIA)

Indonesian producers face a range of potential climate transition scenarios that could impact palm oil demand, production, and expansion. To assess this potential range of impacts, we constructed three global-local climate transition scenarios[21] as outlined below and in Figure 3.[22] These scenarios draw from emerging global trends described in a separate Orbitas report, "Transition Scenarios in Tropical Agriculture," as well as the local trends described in Section II.

1. **Historical Ambition ("Historical"):** The Historical scenario assumes the world's future ambitions reflect past practices and laws -- including Indonesia's permanent moratorium on any new palm oil concessions in designated forest or peat areas. This scenario corresponds to a world in which temperatures catastrophically warm to over 4°C by 2100.
2. **Modest Ambition A and B ("Modest A" and "Modest B"):** The Modest scenarios both assume slightly greater global ambition than the Historical scenario, but this ambition still inadequately limits warming to around 3°C by 2100. In line with global trends, Indonesia bars future deforestation and peat conversion by industrial actors and imposes modest GHG emissions cost on palm oil producers. In Modest A (hereafter, "Modest" or "Modest A") smallholders are restricted to the same extent as industrial production. In Modest B, we run this same scenario but with no restrictions on smallholders' expansion into forest and/or peat.
3. **Aggressive Ambition ("Aggressive"):** The Aggressive scenario represents the greatest but necessary global ambition to address the climate crisis. Here, societal actions limit warming to a 1.5°C increase by 2100 in line with the Paris Agreement. Locally, the Indonesian government enforces industry-wide NDPE restrictions, reclaims peatlands, and imposes aggressive costs on GHG emissions.

B. MARKET SENSITIVITY TO CLIMATE TRANSITIONS

Our projections indicate that palm oil prices would rise substantially under the Aggressive scenario. The combination of higher land and production costs in the Aggressive scenario alongside rising palm oil demand drives these trends. In contrast, palm oil prices stay flat or even decline in the long run in the Modest and Historical scenarios (Figure 4). By 2040, the Aggressive scenario's palm oil prices and productivity levels are 29% and 9% higher, respectively, compared to the Historical pathway.

As a result, the Aggressive scenario offers the most favorable conditions to producers provided they can mitigate the following three concurrent climate transition risk events:

A. **Asset Stranding:** Land use restrictions make existing concessions on forest and/or peatland unviable -- i.e., the concession's asset's book value (less depreciation) drops below the current market value as it is no longer available for legal palm oil development.
B. **Growth Constraints.** Reduced land availability alongside expected forest expansion (driven by emissions payments for projects that preserve or restore forest and peatlands) will increase land competition, leading to higher acquisition costs for new NDPE-compliant concessions.
C. **Emissions Costs:** The introduction of GHG emissions pricing can materially drive up production costs for emissions-intensive palm producers; key sources of emissions costs include fertilizer and diesel fuel on plantation, diesel fuel use for transportation, and operational emissions from milling, waste, and refining. Our transition scenarios restrict land clearing and peat drainage activities; otherwise, these types of activities would also result in significant emissions costs.

Each of these risks is material for Indonesian palm oil producers as demonstrated below by our climate transition scenario analysis:

C. TRANSITION RISK 1: ASSET STRANDING

Seventy-six percent (9.2 million hectares) of the industry's unplanted concessions -- i.e., land permitted for palm development -- are at risk of stranding under climate transitions that restrict deforestation.[23] Provinces most impacted include Kalimantan Barat (2.4 million hectares), Papua (2.1

Continued
Climate Transition Projections

Figure 3: CLIMATE TRANSITION SCENARIO ASSUMPTIONS

	Historical Ambition	**Modest Ambition (A and B)**	**Aggressive Ambition**
Warming Target (Degrees Celsius)	4+	3	1.5
Global Land Sector Carbon Prices* (2019 USD per ton CO2)	None	\$3 in 2030 \$7 in 2040	\$14 in 2030 \$69 in 2040
Regional Carbon Price: Land Sector* (2019 USD per ton CO2)	None	\$1 in 2030 \$5 in 2040 Not applicable to smallholders	\$6 in 2030 \$44 in 2040 Not applicable to smallholders
Global Protected Natural Areas (Mha)**	352	352	2,707
Indonesian Land Use Restrictions for Industrial Actors	No new palm permits allowed on primary natural forest, peat forest, or peat within the government's current moratorium map.	No conversion of primary or secondary forests or peatlands, even where already permitted.	"Modest" restrictions + all existing plantations on peat soil must relocate or abandon without compensation.
Indonesian Land Use Restrictions for Smallholders	No restrictions on smallholders.***	A. Smallholders face the same restrictions as industrial actors. B. No restrictions on smallholders.***	Smallholders face the same restrictions as industrial actors.
Bioenergy Pathways (EJ by 2100)	27	70	70

Source: Concordian and Vivid Economics, based on MAgPIE assumptions and REMIND carbon price modeling results from the report "Agriculture in the Age of Climate Transitions."
Notes: *Carbon prices presented are averages in 2019 USD; this report's financial analysis uses regional GHG prices. GHG emissions prices reflect land sector GHG prices, rather than energy or economy-wide GHG prices which may be higher. **Global Protected Natural Areas are defined by the International Union for the Conservation of Nature (IUCN). The Historical and Modest Scenarios protect IUCN Categories I and II while the Aggressive Scenario protects IUCN Categories I to VI, both designated and proposed. While our global pathways and resulting projections reflect global trends, we replace these global area protections with local land use restrictions for our industry level analyses. See Technical Annex (available as a separate document at www.orbitas.finance for additional assumptions. *** In the Historical scenario smallholders are restricted to historical rates of deforestation and the Indonesian moratorium map, but in the Modest B scenario there are no restrictions on smallholder deforestation rates.

million hectares), Kalimantan Tengah (1.7 million hectares), and Kalimantan Timur (1.1 million hectares). Under an Aggressive transition that supports peatland restoration, a further 2.2 million hectares of currently planted oil palm on peatlands -- 15% of total industrial and smallholder palm plantation area in 2015 -- would also face write-offs.[24] **Korindo and PT Austindo Nusantara Jaya Tbk are among those who face high stranded asset risks (Figure 5 and the Appendix).[25]**

D. TRANSITION RISK 2: GROWTH CONSTRAINTS

Climate transitions constrain the industry's geographic expansion. Historically, both the global and Indonesian palm oil industries have grown by expanding their operational footprints, largely at the expense of high conservation value lands and high carbon stock forests. Under climate transitions, this approach to growth will not be feasible because of 1) NDPE restrictions and 2) the potential for landowners to earn revenues from forest/peat preservation and restoration projects. The combination of these two policies will spur increases in forest cover at the expense of agricultural land, thus limiting overall land availability for palm expansion. In turn, this land competition will drive up land prices and make palm expansion expensive even where legally feasible.

Climate transitions reduce the maximum potential footprint of industrial plantations in 2040 to 28.3 million hectares in the Aggressive scenario -- 31% lower than in the Historical scenario. As previously discussed, existing concessions on forest and/or peatlands will be stranded. Beyond this, an additional 67 million hectares of future "expansion potential" -- i.e., land that is biophysically suitable, currently unplanted, and not already permitted for palm -- become unusable under NDPE restrictions. Figure 6 shows the spatial overlap between bio-physically suitable land and current forest and peatlands.

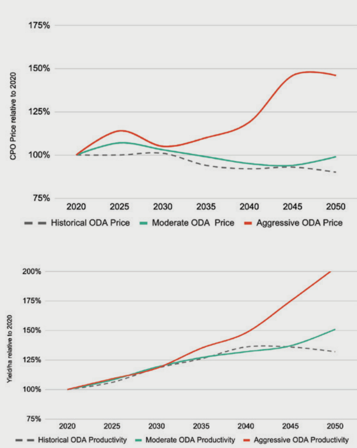
Projected net forest gains[26] under the Modest and Aggressive scenarios will further shrink industrial palm expansion potential relative to a Historical pathway.

Continued
Climate Transition Projections

15% of total industrial and smallholder palm plantation area in 2015 - would also face write-offs.

Note to Readers: These calculations are based on the most recent and reputable publicly available concession data from Greenpeace, but may not fully capture current concession footprints. Nevertheless, these calculations provide a useful indication of the extent of potential stranded assets under climate transitions.

Figure 4:
REGIONAL CPO PRICES AND OIL PALM PRODUCTIVITY



Source: Concordian, based on results from the report "Transition Scenarios in Tropical Agriculture"
Notes: See Technical Annex for additional details on methods.

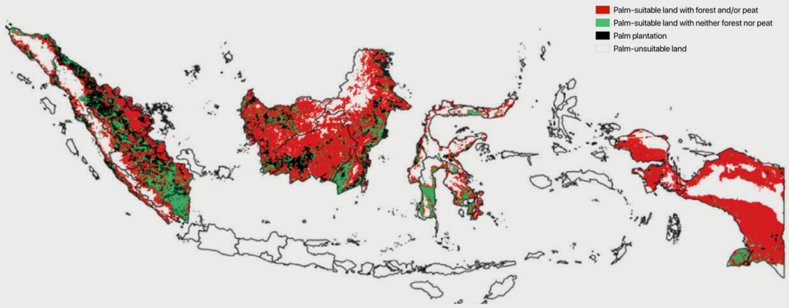
Figure 5:
STRANDED CONCESSIONS ORDERED BY CONCESSION AREA AT RISK (TOP 15)

Company	Total concession area (ha)	Unplanted concession area (ha)*	Stranded concession area (ha)	% of unplanted concession area that is stranded	Provinces most impacted
Golden Agri-Resources Ltd.	1,024,000	373,000	242,000	65%	Kalimantan Tengah, Sulawesi Tengah, Kalimantan Barat
Wilmar International Ltd.	549,000	334,000	229,000	69%	Kalimantan Barat, Kalimantan Tengah
PT Perkebunan Nusantara XII	660,000	252,000	166,000	66%	Kalimantan Barat, Riau, Aceh
Korindo	193,000	128,000	126,000	99%	Papua
PT Incasi Raya Group	215,000	152,000	116,000	77%	Kalimantan Barat
Musim Mas	220,000	108,000	93,000	86%	Papua, Kalimantan Barat
KPN Plantation	186,000	114,000	90,000	79%	Papua, Kalimantan Barat
Indofood Agri Resources Ltd.	294,000	141,000	87,000	62%	Kalimantan Barat, Kalimantan Timur
PT Austindo Nusantara Jaya Tbk	100,000	81,000	80,000	99%	Papua Barat
PT Eagle High Plantations Tbk	214,000	98,000	74,000	75%	Kalimantan Barat, Papua Barat
First Resources Ltd.	180,000	95,000	67,000	71%	Kalimantan Barat, Riau
PT Makin Group	129,000	79,000	64,000	81%	Kalimantan Tengah
Bumitama Agri Ltd.	173,000	71,000	46,000	65%	Kalimantan Barat, Kalimantan Tengah
Sungai Budi Group	58,000	51,000	43,000	85%	Sumatera Selatan, Kalimantan Barat
PT Triputra Agro Persada	165,000	66,000	41,000	62%	Kalimantan Barat

Source: Concordian, using mill location and ownership data from the Universal Mill List 2019 (available on Global Forest Watch) and mill capacity data compiled by Harahap et al 2020. See Appendix for a description of data limitations for this figure and for further detail on additional datasets used as input to the BeWhere model. Data sources and limitations related to unplanted concession areas at risk are detailed in our Indonesia analyst report available at http://orbitas.org

Continued
Climate Transition Projections

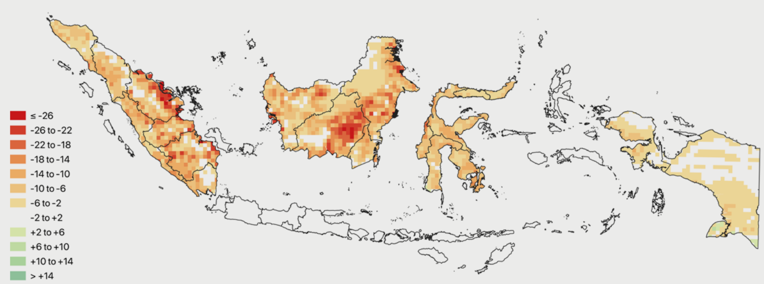
Figure 6:
PALM SUITABILITY AGAINST CURRENT FOREST AND PEAT



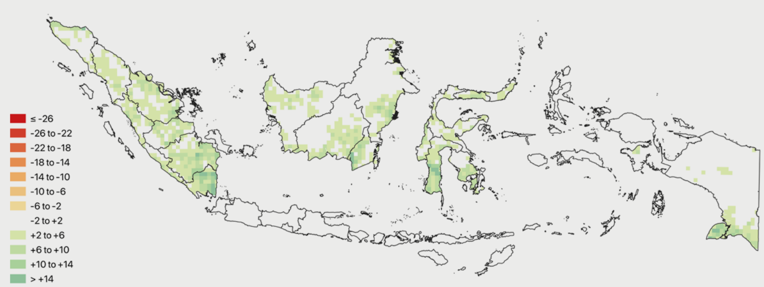
Source: Figure roughly representative of 2015 compiled by Concordian using the following data sources: Oil palm plantation data for 2015 from Austin et al. 2017, more recent updates from Kemen Austin for Sulawesi and Papua, and supplemental ~2017 data from Danylo et al. 2020; peat data from the Indonesian Ministry of Agriculture (2012, obtained from Global Forest Watch); 2015 forest cover derived from tree canopy cover dataset of Hansen et al. 2013 by assuming a 50% canopy cover threshold to define forest; and a map of biophysical suitability for growing oil palm from Pirker and Mosnier 2018. All datasets are shown here at 1-kilometer x 1-kilometer spatial resolution. Land categories are shown only for the analysis region covering the mainlands of Sumatra, Kalimantan, Sulawesi, and Papua. Administrative boundaries are from GADM (version 3.6, https://gadm.org). See Appendix for more information.

Figure 7:
20-YEAR FOREST COVER PROJECTIONS

A. Historical Ambition: 11.2 Million Hectares Total Net Loss



B. Aggressive Ambition: 3.8 Million Hectares Total Net Gains



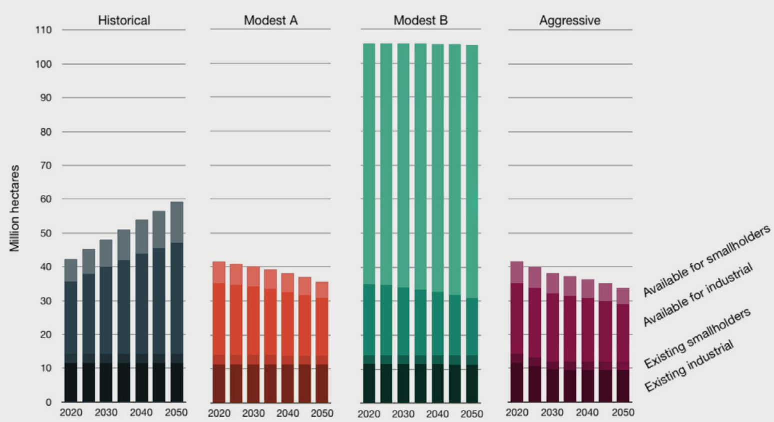
Source: Concordian using forest cover projections from the OSIRIS model (Busch et al. 2019). Administrative boundaries are from GADM (version 3.6, https://gadm.org). Notes: Forest projections at ~25 km x 25 km spatial resolution are shown only for the analysis region covering mainland Sumatra, Kalimantan, Sulawesi, and Papua. Plotted values indicate the percentage of the grid cell area that has experienced a net increase (positive) or net decrease (negative) in forest cover over the period 2020 to 2040. Nationally, grid-cell-level net forest cover changes range from -34.0% to +7.3% for the Historical scenario and 0% to +18.8% for both the Modest and Aggressive scenarios. The Modest scenario is not shown since the projected forest cover changes are very similar to those for the Aggressive scenario.

- Under the Historical scenario, Indonesia will see net forest losses as high as 5.5 and 11.2 million hectares within 10 and 20 years, respectively.
- These are net forest loss figures that, by accounting for both gross forest loss and gross forest gain, can mask the full extent of forest removal in some high-loss provinces, such as Kalimantan Tengah, Kalimantan Timur, Kalimantan Barat, Sumatera Selatan, Riau, and Papua (Figure 7 A). These projected net forest losses would make space for up to 29.5 million hectares of biophysically suitable and legally compliant industrial palm expansion within 20 years (Figure 8).
- Under the Modest A and Aggressive scenarios' zero deforestation restrictions as well as carbon sequestration payments for forests, Indonesia sees net forest gains of 3.8 million hectares within 20 years, especially in Sumatera Selatan, Papua, Kalimantan Tengah, and Riau provinces (Figure 7 B). These net forest gains occur in lands with carbon stocks high enough that carbon sequestration payments are greater than potential agricultural returns. Net forest gains under the Modest and Aggressive NDPE-compliant scenarios limit economically and legally feasible industrial palm expansion to ~18.6 million hectares within 20 years (Figure 8).

Land use constraints on independent[27] smallholders are pivotal to determining how industrial producers expand production. In the Modest B scenario where independent smallholders (hereafter, "smallholders") are exempt from the NDPE restrictions imposed on industrial producers, our models show that the expansion potential for smallholders within 20 years is 72.8 million hectares, which is 13 times larger than the

Continued
Climate Transition Projections

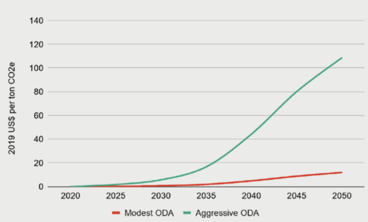
Figure 8:
INDUSTRIAL PALM OIL EXPANSION POTENTIAL



Source: Concordian calculations. See Technical Annex for additional information.
Notes: Except for the Modest B scenario, potential is defined as biophysically suitable land in NDPE-compliant areas, taking into account land use restrictions and projected net forest cover gains and losses resulting from GHG pricing. For the Modest B scenario, only industrial plantations -- not smallholders -- face NDPE restrictions, so potential area for smallholders in this scenario includes forest area and peatland that is biophysically suitable for palm production.

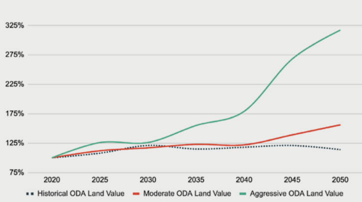
Contractions in palm plantation expansion potential drive up NDPE-compliant land prices.

Figure 9:
REGIONAL CARBON PRICES (LAND SECTOR)



Source: Concordian, based on results from the report "Transition Scenarios in Tropical Agriculture"

Figure 10:
REGIONAL LAND VALUES



Source: Concordian, based on results from the report "Transition Scenarios in Tropical Agriculture"
Notes: These prices reflect land sector GHG prices, rather than energy or economy-wide GHG prices.

expansion potential of smallholders in the Modest A scenario in which smallholders face the same NDPE restrictions as industrial producers (Figure 8). The maximum footprint of the oil palm industry in 2040 -- including both industrial and smallholder plantations -- is 105.6 million hectares in the Modest B scenario, which is nearly twice the size of the 53.9 million hectares for the Historical scenario.

Contractions in palm plantation expansion potential drive up NDPE-compliant land prices. As shown in Figure 9, land values -- a proxy for concession acquisition costs -- rise under climate transitions. Within 20 years, land prices are 2.5 times higher in the Aggressive scenario relative to the Historical scenario. These rising land prices will increase the market value of existing plantations and mills, but make it more expensive for palm oil companies to expand production through new land acquisitions.

E. TRANSITION RISK 3: GHG EMISSIONS COSTS

GHG pricing introduces new production costs for industrial producers; these emissions costs are limited at first but rise substantially with greater climate ambition. Under climate transition scenarios, industrial palm oil producers would pay GHG emissions costs primarily stemming from diesel fuel use, fertilizer application, and mill processing and waste-related emissions. We do not consider emissions related to land clearing nor peat drainage as our climate transition scenarios assume that forest and peat are restricted from palm development. Land sector GHG prices are relatively minor in the early years, but rise to $5 per ton of CO2 (Modest) or $44 per ton of CO2 (Aggressive) by 2040, respectively (Figure 10).

Section IV
Financial Analysis of Climate Transition Scenarios

KEY TAKEAWAYS

PRODUCERS STAND TO GAIN FROM AGGRESSIVE CLIMATE ACTION, ESPECIALLY THOSE WITH LOW CARBON, HIGH-YIELDING ("SUSTAINABLE") ASSETS.

UNDER ALL SCENARIOS, MOST PRODUCERS WILL FARE BETTER BY INVESTING IN EXISTING ASSETS AND TECHNOLOGY UPGRADES, RATHER THAN EXPANDING GEOGRAPHICALLY.

As discussed in Section II, climate transitions affect the Indonesian palm oil industry via:

- Rising global demand and prices that boost revenues.
- Write-offs and growth constraints via land use restrictions and rising land prices.
- Higher production costs tied to necessary yield improvements, as well as new GHG emissions costs related to fertilizer, diesel fuel use, and mill waste.

This section illustrates the materiality of these impacts on individual companies by:

A. Projecting how an Indonesian palm producers' Enterprise Value (EV)[28] would change under each transition scenario.

B. Testing how sensitive a company's EV and operational costs are to the spending required to increase productivity and pay for emissions costs.

C. Demonstrating how capital investments in biogas methane capture and cogeneration can both generate significant revenue and reduce emissions costs under transitions.

A. ENTERPRISE VALUE BY TRANSITION SCENARIO

First, we assess the EVs of three companies with varying productivity levels -- a high-yielding producer, an average-yielding producer, and a low-yielding producer -- under each climate transition scenario.[29] In all cases, we assume a portfolio of assets consisting of 60,000 hectares of plantations and 240 FFB tons per hour of milling capacity.[30] For each producer type, we consider a basket of "steady-state" assets, i.e., ones that are already in operation (i.e., no upfront capital costs; steady palm oil yields), versus ones that must be built anew (i.e., with upfront capital costs for land and permit acquisition; higher average yields; and yields increasing over time as trees mature).

As summarized in Figure 11, we find that:

- An Aggressive climate transition is always more favorable for all assets and producers.
- With existing assets, all company types see positive and rising EV under all scenarios.
- With new assets, under almost all scenarios and company types we see negative EV; the only exception is a "high-yielding" company under an Aggressive scenario.

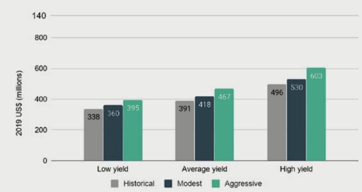
B. SENSITIVITY TO YIELD IMPROVEMENT AND EMISSIONS COSTS

Yield Improvements:
Climate transitions create new growth opportunities for the industry but also lead to rising concession acquisition costs, forcing producers to use existing land more productively. As a result, a key determinant of a company's positioning under climate transitions will be its ability to cost-effectively increase productivity. Figure 12 shows how a company's Enterprise Value changes under each scenario depending on the costs required to increase yields by 1% i.e., its cost-to-yield multiplier. A high yielding company would see its EV decrease substantially -- by 117% in this example -- if its cost to yield multiplier was 1.5 (i.e., a 1% increase in yields required a 1.5% increase in costs) rather than 0.5.

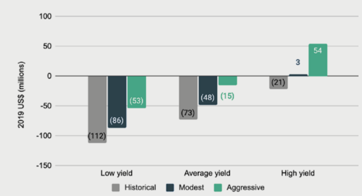
Emissions Costs:
Operational emissions costs only reach a substantial level in the Aggressive scenario (Figure 13). For example, a high-yielding producer's new assets would see operational GHG emissions costs

Figure 11:
ENTERPRISE VALUE: ILLUSTRATIVE MILL-PLANTATION COMPANY: BEST-IN CLASS PRODUCER

A. Existing Steady-State Assets:
Three 80 FFB Tons/Hr Mills,
60,000 Ha Plantations:



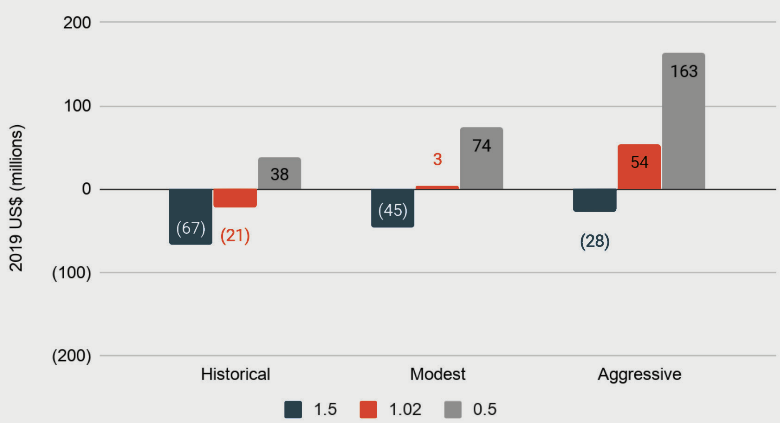
B. New Assets:
Three 80 FFB Tons/Hr Mills,
60,000 Ha Plantations



Source: Concordian. Notes: See Technical Annex for detailed calculations. This Figure is based on three illustrative companies with the same asset profiles -- 240 FFB tons per hour of milling capacity alongside 60,000 hectares of plantations -- but that vary by yield management strategies and their cost of capital. Key assumptions include i) a base CPO price of $656 (15-year average); ii) weighted average costs of capital (WACC) of 11.7% (Best), 13.7% (Average), and 15.8% (Low); iii) a cost-to-yield multiplier of 1, i.e., every 1% increase in yields requires a 1% increase in USD costs, and iv) a 2% growth rate in future cash flows after 30 years to calculate the assets' terminal value. For existing assets, we assume a constant replanting rate to achieve steady-state yields; for new plantations, we include upfront capital expenditures, land acquisition costs, and a FFB production yield curve reflecting tree productivity by age.

Continued
Financial Analysis of Climate Transition Scenarios

Figure 12:
ENTERPRISE VALUE BY COST-TO-YIELD MULTIPLIER: NEW HIGH-YIELDING MILL-PLANTATIONS



Source: Concordian
Notes: See Technical Annex for detailed calculations. This Figure is based on three illustrative companies with the same asset profiles -- 240 FFB tons per hour of milling capacity alongside 60,000 hectares of plantations -- but that vary by yield management strategies and their cost of capital. Key assumptions include i) a base CPO price of $656 (15-year average); ii) weighted average costs of capital (WACC) of 11.7% (Best); iii) a cost-to-yield multiplier of 1, i.e., every 1% increase in yields requires a 1% increase in USD costs, and iv) a 2% growth rate in future cash flows after 30 years to calculate the assets' terminal value. For existing assets we assume a constant replanting rate to achieve steady-state yields; for new plantations, we include upfront capital expenditures, land acquisition costs, and an FFB production yield curve reflecting tree productivity by age.
Readers should note that although we present results in dollar terms for visual ease, this analysis is meant to compare the overall magnitude and direction of impacts between scenarios rather than provide absolute results.

comprise 0.3% (Modest) to 2% (Aggressive) of total operational costs by 2030. By 2040, these percentages range from 2.1% (Modest) to 14.1% (Aggressive). As a reference, a significant cost item like fertilizer typically comprises 20% to 30% of operating costs.

C. PROFIT ENHANCING CAPITAL INVESTMENTS

Biogas methane capture and cogeneration facilities create higher and more dependable profits under all scenarios. Biogas generation facilities using palm oil effluent (POME) provide triple-bottom-line benefits, reducing costs for on-site diesel fuel and GHG emissions while contributing to rural electrification. A best-in-class producer that installs biogas capture and cogeneration technologies in its mills in 2030 (when GHG prices start to become material) would achieve a significant EV boost -- 3.7 times higher -- under an Aggressive scenario (Figure 14). Sustainable cultivation techniques like livestock integration[31] and less intensive management schemes[32] could further reduce operational emissions costs, and reduce dependence on costly fertilizer, pesticide, and weed killers.

Based on our analysis, we determine that a company's productivity, emissions intensity, and cost-to-yield multipliers are key determinants of vulnerability to climate transition risks. Sustainable and productive companies will survive and thrive under climate transitions, while others may face growth constraints or be better off selling their land to more efficient producers or other profitable commodities like rubber. Producers will need to prepare for these longer-term trends, but in the short term, they also need to consider likely price volatility under climate transitions as discussed in Box 2.

Based on our analysis, we determine that a company's productivity, emissions intensity, and cost-to-yield multipliers are key determinants of vulnerability to climate transition risks.

BOX 2:
REAL OPTIONS UNDER PRICE VOLATILITY

Real options represent the flexibility of asset managers to respond to risks and opportunities when operating conditions change, for example, in response to climate transitions. A forthcoming Orbitas report will use real options analysis (ROA) to simulate how a company can react to price volatility with a focus on two options: fertilizer application and replanting of mature land. Our preliminary ROA analysis indicates that to manage short-term price volatility, asset owners can and should temporarily reduce fertilizer use in favor of preserving capital for replanting, even at the expense of short-term yield losses. Otherwise, asset owners face the risk of losing land to a competitor and, consequently, losing all future returns.[33] As will be further explored in our future ROA analysis, optimal options are highly sensitive to a company's cost and access to capital.

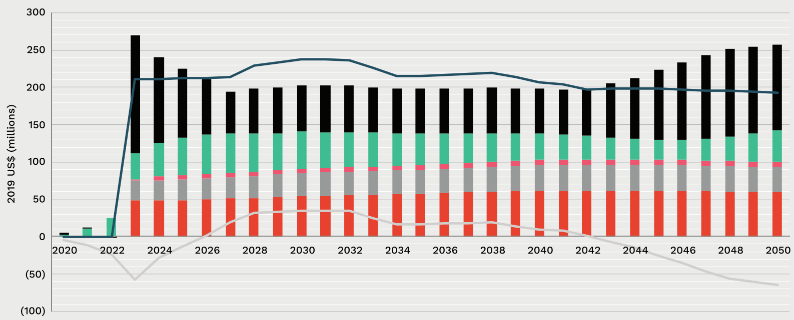
Source: IIASA

Continued

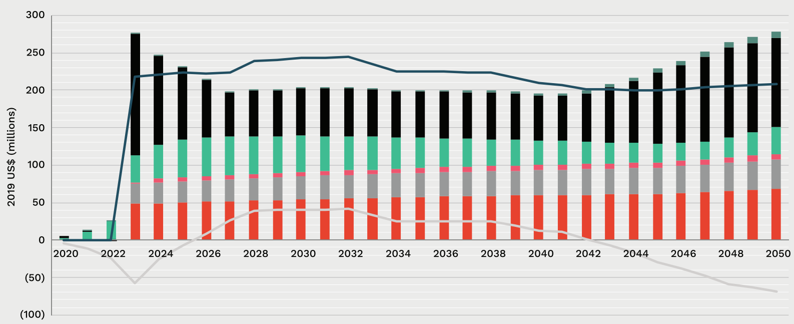
Financial Analysis of Climate Transition Scenarios

Figure 13:
PALM OIL REVENUES AND COSTS: NEW HIGH-YIELDING MILL-PLANTATIONS

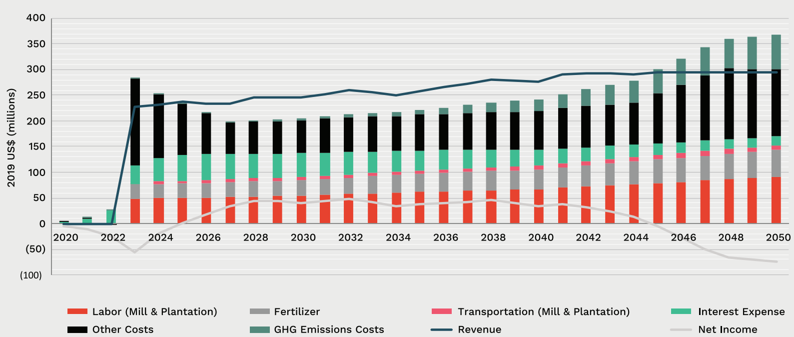
A. Historical Ambition



B. Modest Ambition

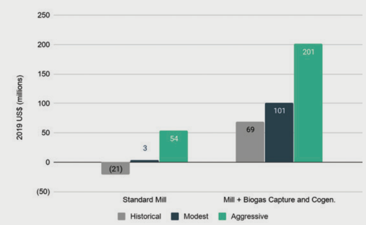


C. Aggressive Ambition



Source: Concordian. Notes: See Technical Annex for detailed calculations. This Figure is based on three illustrative companies with the same asset profiles -- 240 FFB tons per hour of milling capacity alongside 60,000 hectares of plantations -- but that vary by yield management strategies and their cost of capital. Key assumptions include i) a base CPO price of $656 (15-year average); ii) weighted average costs of capital (WACC) of 11.7% (Best); iii) a cost-to-yield multiplier of 1, i.e., every 1% increase in yields requires a 1% increase in USD costs, and iv) a 2% growth rate in future cash flows after 30 years to calculate the assets' terminal value. For existing assets we assume a constant replanting rate to achieve steady-state yields; for new plantations, we include upfront capital expenditures, land acquisition costs, and a FFB production yield curve reflecting tree productivity by age. Readers should note that although we present results in dollar terms for visual ease, this analysis is meant to compare the overall magnitude and direction of impacts between scenarios rather than provide absolute results.

Figure 14:
ENTERPRISE VALUE: 2030 STANDARD MILL V. MILL WITH BIOGAS METHANE CAPTURE MILL-PLANTATION COMPANY: BEST-IN CLASS PRODUCER



Source: Concordian. Notes: See Technical Annex for detailed calculations. This Figure is based on a best in class company with 240 FFB tons per hour of milling capacity alongside 60,000 hectares of plantations, with and without a biogas capture and cogeneration facility. Key assumptions include i) a base CPO price of $656 (15-year average); ii) weighted average costs of capital (WACC) of 11.7% (Best); iii) a cost-to-yield multiplier of 1, i.e., every 1% increase in yields requires a 1% increase in USD costs, and iv) a 2% growth rate in future cash flows after 30 years to calculate the assets' terminal value. For existing assets we assume a constant replanting rate to achieve steady-state yields; for new plantations, we include upfront capital expenditures, land acquisition costs, and a FFB production yield curve reflecting tree productivity by age.

Readers should note that although we present results in dollar terms for visual ease, this analysis is meant to compare the overall magnitude and direction of impacts between scenarios rather than provide absolute results.

Climate transitions create new growth opportunities for the industry but also lead to rising concession acquisition costs, forcing producers to use existing land more productively.

Section V:
Optimizing Under Climate Transitions

KEY TAKEAWAYS

A COMPANY'S GROWTH PROSPECTS UNDER CLIMATE TRANSITIONS ARE PRIMARILY TIED TO ITS FINANCIAL STANDING, SUSTAINABILITY STRATEGIES, AND FOCUS ON YIELD IMPROVEMENTS.

IF INDUSTRY ACTORS ACT OPTIMALLY, THE INDUSTRY'S OVERALL VALUE RISES BY UP TO $9 BILLION UNDER AN AGGRESSIVE CLIMATE TRANSITION RELATIVE TO A HISTORICAL PATHWAY.

Figure 15:
ASSUMPTIONS FOR COMPARISON OF TWO COMPANIES' EXPANSION TRAJECTORY

	Company A Strong financial and sustainability profile	**Company B** Average financial and sustainability profile
Initial Asset Mix	23 mills (various sizes), 2 kernel crushers, 219K Ha Planted Concessions 100K Ha Unplanted Concessions	
Cost of capital (WACC)	11.7%	13.7%
DSCR, minimum/current	1.75/2.60	2.00/2.10
% of unplanted concessions on forest or peat	15%	33%
% of planted land on peat	5%	15%
Write-offs from asset stranding	$92 million	$221 million

Source: Concordian

Figure 16:
CUMULATIVE EXPANSION BY 2040

Cumulative Expansion by 2040:	**Company A**	**Company B**
Historical	7 new mills 135,000 ha 26,000 annual tons methane captured, powering 56 Megawatts EV/Assets: 0.87	4 new mills 80,000 ha 15,000 annual tons methane captured, powering 32 MW EV/Assets: 0.71
Modest	11 new mills 213,000 ha 41,000 tons, 88 MW EV/Assets: 0.97	4 new mills 80,000 ha 15,000 tons, 32 MW EV/Assets: 0.72
Aggressive	18 new mills 406,000 ha 67,000 tons, 144 MW EV/Assets: 2.28	16 new mills 380,000 ha 60,000 tons, 128 MW EV/Assets: 1.70

Source: Concordian

As climate transitions come into effect, the industry's producers will need to adjust their growth strategies and production levels. In this section we discuss:

1. Why growth strategies are highly sensitive to climate transitions as well as differences in a company's financial and sustainability profile.
2. Where, geographically, it makes economic sense for producers to increase or decrease palm oil production under each climate transition scenario.
3. How the industry's overall value would be impacted by climate transitions.

A. GROWTH POTENTIAL UNDER CLIMATE TRANSITIONS

Below, we contrast the potential growth trajectory of Company A and Company B under each climate transition scenario. Both companies have the same mix of assets, but Company A has a stronger financial and sustainability profile than Company B, as summarized in Figure 15. To determine each company's expansion trajectory, we allowed each company to expand every year for which it met certain financial criteria. Specifically, we tested every year whether expanding would grow the company's 2020 EV and whether the debt service coverage ratio would stay above the defined minimum. For every year where these two criteria were met, we allowed an expansion of 20,000 hectares of newly planted land and, three years later when the new trees matured, a new mill of 80 tons FFB/hour.

For both companies, our modeling shows that the Aggressive scenario creates the greatest opportunities to expand: Company A and B's milling capacities are projected to increase between 2.5 to 2.7 times within 20 years, relative to 1.4 to 1.7 times in the Historical scenario as shown in Figure 16.

Under these expansion trajectories, Company B lags noticeably behind Company A in EV, even dramatically so under the Modest scenario as shown in Figure 17. Under the Aggressive scenario, within 20 years, Company A and Company B will see their EV grow to 735% and 767% of

Continued
Optimizing Under Climate Transitions

their 2020 pre-expansion values, and their EV/Assets ratios improve by 255% and 274%, respectively. Under the Aggressive scenario, both companies see EV growth ($10.8 billion and $7.9 billion, respectively) dwarfing the write-offs related to the portion of its existing planted land on peat and concessions due to NDPE restrictions ($100 million and $244 million, respectively).

Importantly, both companies' expansion is contingent on outfitting future mills with biogas methane capture and cogeneration facilities. Without the inclusion of these facilities, it is not likely that future mill and plantation expansion would make much financial sense for either company under most scenarios as detailed in Section IV. The returns from biogas capture and cogeneration-outfitted mills are significantly more attractive under an Aggressive climate transition which rewards profitable expansion with higher prices and emissions costs savings. Company A would capture about 67,000 tons of methane a year -- enough to generate 144 Megawatts (MW) of power -- 12% higher than Company B's corresponding capacity by 2040.

B. MAPPING VARIATION IN OPTIMAL PRODUCTION LEVELS

To understand where, geographically, it makes economic sense for producers and the industry as a whole to increase or decrease palm oil production under each climate transition scenario, we employed IIASA's "BeWhere" model. BeWhere optimizes how and where many different kinds of current palm oil assets -- including plantations, mills, kernel crushers, and biogas capture and cogeneration facilities -- would expand and contract production under each climate transition scenario.[34] This modeling relies on a detailed mapping of current palm oil assets, projected forest cover gains and contractions, future land use restrictions, and transportation routes, among other inputs.

Our modeling finds that optimal, industry-wide FFB milling capacity increases across all scenarios, but less so under an Aggressive climate transition (Figure 18).
Within 20 years:

- Nationwide optimal milling capacity is 37% higher in the Historical scenario relative to only 10 and 15% increases in the Modest and Aggressive scenarios, respectively.
- These production trends are not consistent across islands:
  - In Kalimantan, optimal milling capacity is 73 million metric tons lower in the Aggressive scenario relative to the Historical one.
  - In contrast, Sumatran milling capacity is 20 million metric tons higher in the Aggressive scenario relative to the Historical one.
- Provincial differences will be driven by a number of factors including the amount of economically-feasible forest expansion, each region's achievable yields, carbon storage potential, and distance to transportation routes and end markets, among other factors.

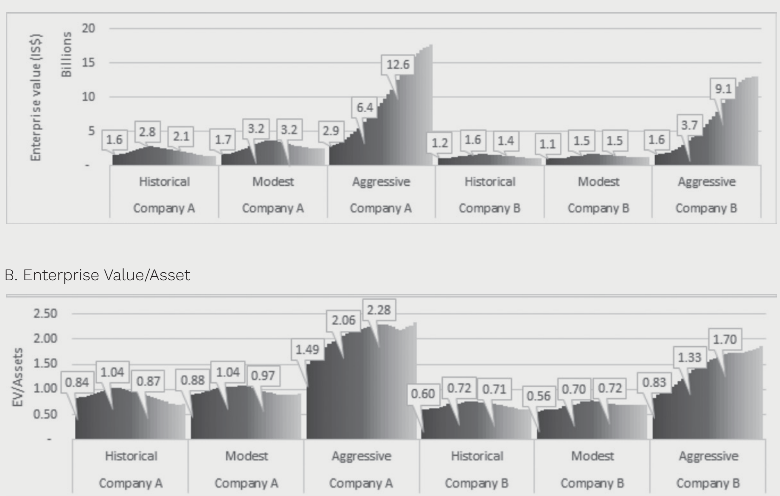
C. ASSESSING INDUSTRY POTENTIAL UNDER CLIMATE TRANSITIONS

Although optimal milling capacity declines under climate transitions, investors will see industry value as a whole rising under an Aggressive climate transition. To quantify these differences by region we conducted a spatially-explicit Net Present Value (NPV) analysis, which finds:[35]

- Industry-wide NPV stays relatively stable between the Historical and Modest A scenarios, but increases by 5% between the Historical and Aggressive scenarios.
- To benefit from these predicted gains under climate transitions, palm producers must diversify the products they produce and upgrade their mill technology -- particularly

Figure 17:
COMPARISON OF EV AND EV/ASSETS OVER TIME UNDER EXPANSION

A: Enterprise Value (US$ billion)



Source: Concordian
Notes: See Technical Annex for calculation methods

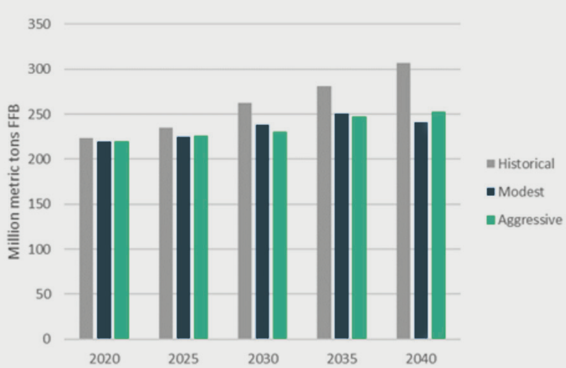
Continued
Optimizing Under Climate Transitions

through biogas capture and cogeneration facilities and kernel crushers.

- NPV impacts vary significantly at the grid cell level, with some areas benefiting strongly from climate transitions and other areas suffering large losses as shown in Figure 19.
- The largest NPV losses occur where forests are most likely to expand and where palm plantation and mill expansion would be limited by NDPE restrictions, underscoring the importance of implementing the High Carbon Stock Approach, a toolkit that helps companies identify and avoid high carbon stock and conservation value lands.
- Independent smallholders will play a key role in the industry's future development. We developed an alternate scenario, Modest B, which mirrors Modest A but allows for unrestricted independent smallholder expansion. In Modest B, the industry's NPV increases substantially; but this occurs at the expense of up to 5 million hectares of valuable forests and peatland as further described in Box 3.

Based on these findings, we conclude that it is possible for the Indonesian palm oil industry to both gain value[36] and preserve valuable forest and peatland, so long as governments institute robust and meaningful deforestation and peat development restrictions on both small and large holders.

Figure 18:
PROJECTED OPTIMAL FFB MILLING CAPACITY UNDER CLIMATE TRANSITIONS



Source: Concordian
Note: Predictions for total FFB processed closely tracks installed capacity over time in model results, so we show only installed capacity. See Technical Annex for calculation methods.

BOX 3:
THE ROLE OF INDEPENDENT SMALLHOLDERS IN CLIMATE TRANSITIONS

Independent smallholders can play an important role in increasing industry productivity while reducing future deforestation but will need the right support from both the public and private sectors to increase production sustainably. Local land use restrictions and moratoria could bypass smallholders, resulting in additional net losses in forest cover across Indonesia. To manage climate transition risks, large companies must improve supply chain traceability and transparency, and also provide smallholders with the education and support they need to embrace forthcoming RSPO standards and sustainable NDPE practices, including by implementing the High Carbon Stock Approach (HCSA). Ramping up this process now will not only ease auditing burdens but will also make a significant difference in reducing reputational risks.

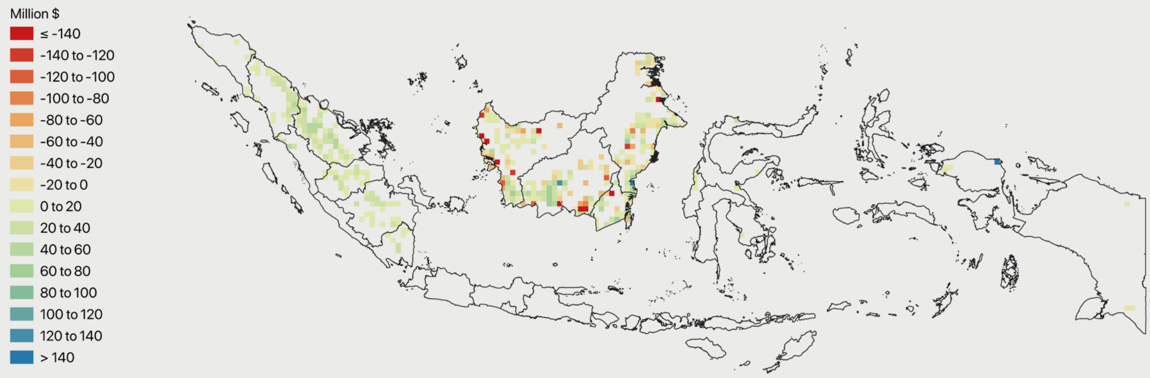
Access to credit is a significant barrier to smallholder intensification. Smallholders are both capital constrained and have limited access to credit, making it difficult for them to replant and use quality seeds once their land is past its prime -- an exercise that can cost more than $2,000 per hectare, roughly two years of full-time minimum-wage work. While the government does provide replanting subsidies to farmers, not all farmers are able to access these programs or can wait for the four years it takes for palm oil to mature. The resulting "yield gap" can be significant, with many farmers losing the opportunity to double their revenues and yields.

Figure 19 illustrates the impact of enforcing NDPE restrictions on smallholders (panel B vs. panel A). Excluding smallholders from NDPE restrictions and deforestation-related carbon costs allows for 27% higher industry-wide NPV than when smallholders are restricted but this comes at the expense of up to 5 million hectares of deforestation and/or peatland destruction relative to the Modest A scenario (equivalent to nearly 20% of total Indonesian deforestation since 2001). NDPE restrictions on smallholders, therefore, play a large role in determining palm oil expansion potential as well as industry-wide valuation.

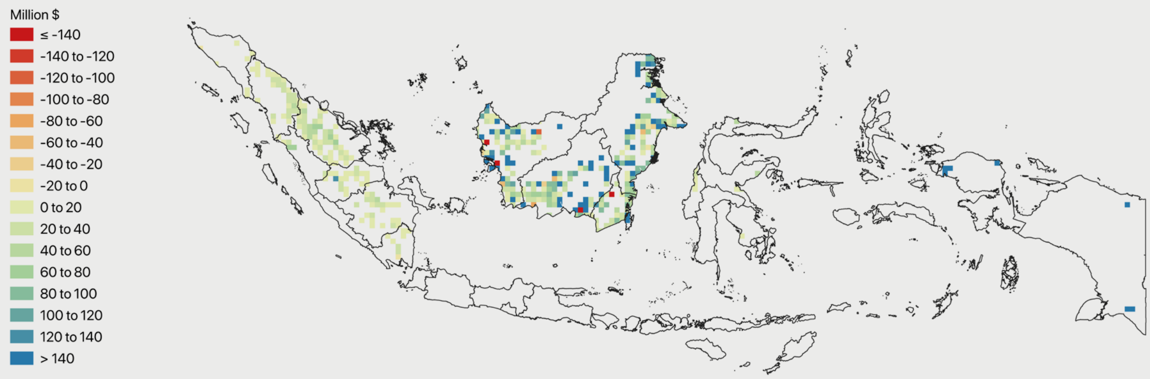
Continued
Optimizing Under Climate Transitions

Figure 19:
INDUSTRY NET PRESENT VALUE UNDER CLIMATE TRANSITIONS

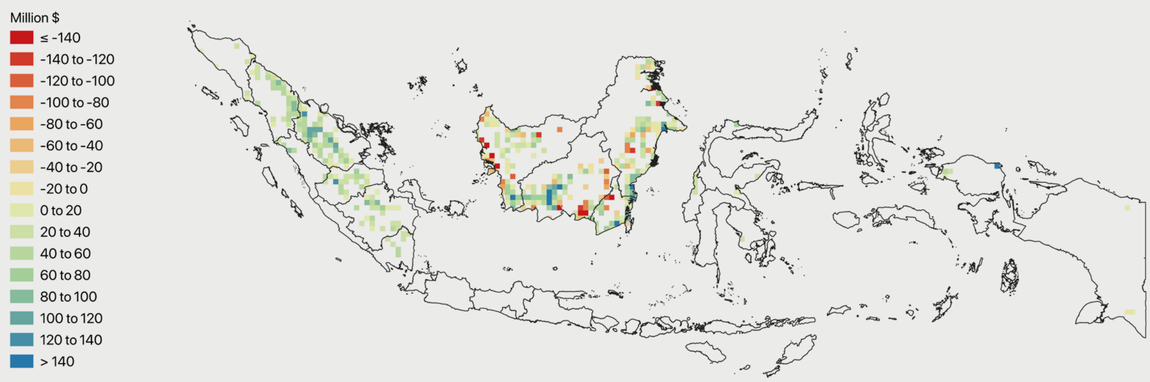
A. Modest: Gain of $1.8 billion of NPV Relative to Historical



B. Modest (Smallholders Exempt from NDPE Restrictions): Gain of $42.0 billion in NPV Relative to Historical



C. Aggressive: Gain of $9.4 billion of NPV Relative to Historical



Source: Concordian
Notes: Grid cell-level results show the difference in 30-year net present value (NPV) compared to the Historical scenario (red cells indicate NPV loss, blue cells indicate NPV gain). All profits for each mill and affiliated plantations are assigned to the grid cell in which the mill is located. In panel B, only smallholders can convert forests and peatland to palm plantation without incurring deforestation-related carbon costs. White cells indicate no NPV difference between the indicated scenario NPV and Historical NPV, typically because of an absence of mills in the grid cell (that is, NPV = $0).

Section VI:
Applying Orbitas' Analysis at a Company Level

KEY TAKEAWAYS

LARGE, VERTICALLY INTEGRATED COMPANIES TEND TO BE LESS VULNERABLE TO CLIMATE TRANSITION RISKS AND BETTER POSITIONED FOR EXPANSION, BUT ARE ALSO LESS ABLE TO CONVERT FAVORABLE PRICE SHOCKS INTO PROFITS.

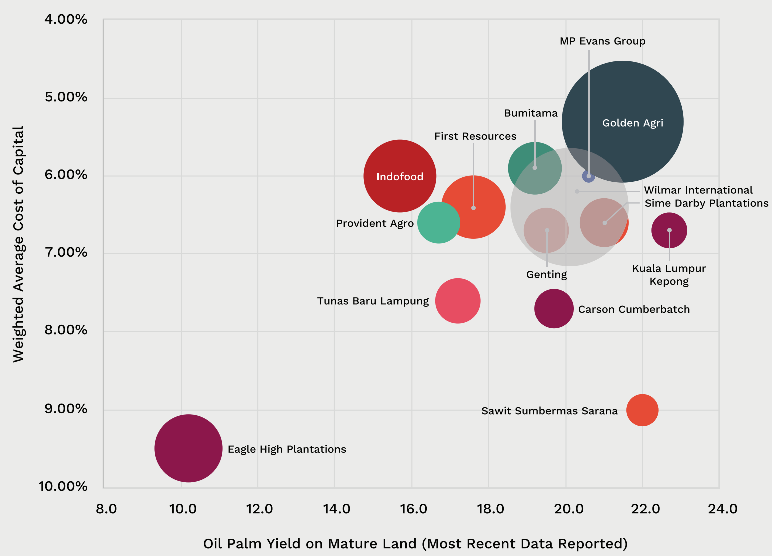
The financial and economic analyses presented in the previous sections of this report clearly underscore the materiality of climate transitions to palm oil producers. In this section we employ three different approaches to evaluating a company's -- and by extension an investment portfolio's -- vulnerability to climate transitions as summarized below:

1. Vulnerability Benchmarking: This simple, risk-focused benchmarking approach allows for a quick and easy qualitative evaluation of vulnerability to climate transitions by using metrics that are easily procured from public databases and company annual reports.
2. Net Present Value Company Analysis: This sophisticated approach quantifies, in dollar terms, the discounted value of a company's projected profits/losses under climate transitions based on its current operational footprint.
3. Market Power Analysis: This detailed economic modeling approach gives investors and companies insights into future industry dynamics and examines which types of business models are well-positioned under climate transitions.

In this section, we employ three different approaches to evaluating a company's vulnerability to climate transitions

Figure 20:
COMPANY VULNERABILITY TO CLIMATE TRANSITION RISK

Bubble size represents total concessions at risk, bubble color represents the percentage of concession at risk



Source: Concordian, based on data from: Damodaran; Bloomberg; Company Annual Reports; Greenpeace 2015 concessions map; 2015 forest cover derived from Hansen et al. 2013; 2012 peat map from Indonesian Ministry of Agriculture, obtained from Global Forest Watch; planted palm maps from Kemen Austin, Austin et al. 2017, and Danylo et al. 2020; and report analysis. Notes: This chart relies on dated maps of concessions, forest cover, and planted palm; and some incomplete or unavailable information on concession ownership for 5.2 million hectares of 2015 industrial palm area that occurs outside of the boundaries of the concession map. Since 2015, some of these concessions may have been planted with oil palm and thus no longer face stranded asset risks under climate transition scenarios unless these concessions are on peatlands and/or violate a company's existing NDPE policies. Yields are not adjusted to reflect the age of the plantation and use the most recent reported yields from company sources.

With a few exceptions, these three approaches result in similar results: generally, larger, vertically-integrated companies with a strong sustainability profile are well-positioned under climate transitions due to their access to capital and pricing power.

A. VULNERABILITY BENCHMARKING

Figure 20 draws upon Section V's identification of capital access, productivity, and sustainability as key vulnerability determinants to benchmark major palm oil companies against each other using the following metrics:

1. Weighted average cost of capital -- an indicator of how cheaply and easily a company can finance productivity and technology upgrades.
2. Current oil palm yields on mature plantations -- a proxy[37] for a company's management strategy and replanting discipline.
3. Concessions at risk -- i.e., how much of their unplanted concessions are on forest or peatlands -- a proxy for their sustainability profile.

Our vulnerability benchmarking analysis shows that, generally, larger companies -- which also tend to be vertically integrated -- are well-

Continued
Applying Orbitas' Analysis at a Company Level

positioned under climate transitions; these include Golden Agri, Sime Darby, and Wilmar.

While this approach provides a useful indication of a company's vulnerability to climate transition risks, it does not fully capture how a company can benefit from opportunities associated with climate transitions whether through rising prices and productivity, new revenue streams like electricity sales from biogas capture and cogeneration, and ability to set prices based on its market power within the palm oil value chain. These factors are considered in the second and third approaches detailed below.

B. NET PRESENT VALUE BY COMPANY

Under this approach, we follow the same methods employed in our industry-wide NPV analysis (see Section V) but then allocate NPV results to individual companies by finding each company's mill capacity in each grid cell as a proportion of total grid cell mill capacity, and summing this proportion of cell-level NPV across all grid cells where each company owns mills. This approach assumes that companies will maintain equal proportional mill and plantation capacity over time within each grid cell and that companies cannot relocate across grid cells over time. However, it does allow individual companies to expand and contract in accordance with trends predicted for each grid cell.

Using this method, we find that most companies are able to gain value under climate transition scenarios, though a few companies -- particularly BEST Industry Group -- are significantly and negatively impacted by forest area expansion, which results in mill and plantation retirements.[38] **In line with the vulnerability benchmarking approach, our company-level NPV analysis also identifies Golden Agri, Sime Darby, and Wilmar as beneficiaries under climate transitions (see Figure 21).**

Figure 21:
NPV DIFFERENCES (RELATIVE TO HISTORICAL SCENARIO) BY COMPANY

Company	NPV difference for Modest A vs. Historical (million $)	NPV difference for Modest B vs. Historical (million $)	NPV difference for Aggressive vs. Historical (million $)	SPOTT Score (%)	% of Unplanted Concessions at Risk
Best Industry Group	-117.2	-130.6	-59.2	1.3%	40
Teladan Prima Group	114.2	-39.6	4.5	NA	40
PT Multi Agro Gemilang Plantation Tbk	-0.1	-0.1	11.2	NA	86
PT Provident Agro Tbk	19.7	7.3	13.6	NA	74
PT Andira Agro Tbk	7.2	7.2	18.3	NA	NA
M.P. Evans Group Plc	12.3	10.8	21.6	63%	54
SOCFIN Group	10.9	10.8	30.5	NA	60
PT Duta Marga Lestarindo	12.2	11.9	33.6	NA	NA
Genting Berhad	41.6	22.7	37.2	50.9%	70
Anglo Eastern Plantations Plc	20.4	19	38.4	39.3%	55
Sipef	18.1	17.8	39.1	75.7%	71
PT Sinar Jaya Agro Investama Tbk	32	32.3	43.4	NA	NA
PT Austindo Nusantara Jaya Tbk	23	22.1	43.5	66.6%	99
PT Bakrie Sumatera Plantations Tbk	19.6	20.1	47.9	36.5%	71
PT Gozco Plantations Tbk	38.8	19.1	48.5	5.3%	79
PT Jaya Agra Wattie Tbk	149.1	31.1	76.3	NA	4
PT Makin Group	537.2	47.1	93.2	0%	81
PT Mahkota Global Investama	46.7	43.6	103	NA	NA
PT Darmex Agro	57.9	44.3	113.2	0.8%	61
KPN Plantation	123.1	40.9	114.3	NA	79
PT Citra Borneo Indah	125.2	38.5	117.1	NA	55
PT Agrindo	-117.2	-130.6	-59.2	1.3%	40
Kencana Agri Limited	114.2	-39.6	4.5	NA	40
Sungai Budi Group	-0.1	-0.1	11.2	NA	86
PT Dharma Satya Nusantara Tbk	19.7	7.3	13.6	NA	74

Continued
Applying Orbitas' Analysis at a Company Level

In line with the vulnerability benchmarking approach, our company-level NPV analysis also identifies Golden Agri, Sime Darby, and Wilmar as beneficiaries under climate transitions.

Figure 21: (Continued)
NPV DIFFERENCES (RELATIVE TO HISTORICAL SCENARIO) BY COMPANY

Company	NPV difference for Modest A vs. Historical (million $)	NPV difference for Modest B vs. Historical (million $)	NPV difference for Aggressive vs. Historical (million $)	SPOTT Score (%)	% of Unplanted Concessions at Risk
Carson Cumberbatch Plc	7.2	7.2	18.3	NA	NA
PT Sumber Tani Agung Resources	12.3	10.8	21.6	63%	54
PT Eagle High Plantations Tbk	10.9	10.8	30.5	NA	60
PT Incasi Raya Group	12.2	11.9	33.6	NA	NA
Cargill, Inc.	41.6	22.7	37.2	50.9%	70
Superventure	20.4	19	38.4	39.3%	55
Kuala Lumpur Kepong Berhad	18.1	17.8	39.1	75.7%	71
PT Sampoerna Agro Tbk and Related Companies	32	32.3	43.4	NA	NA
Musim Mas	23	22.1	43.5	66.6%	99
First Resources Ltd.	19.6	20.1	47.9	36.5%	71
PT Triputra Agro Persada	38.8	19.1	48.5	5.3%	79
Royal Golden Eagle	149.1	31.1	76.3	NA	4
Bumitama Agri Ltd.	537.2	47.1	93.2	0%	81
Indofood Agri Resources Ltd.	46.7	43.6	103	NA	NA
Sime Darby Plantations	57.9	44.3	113.2	0.8%	61
Wilmar International Ltd.	123.1	40.9	114.3	NA	79
PT Perkebunan Nusantara XII	125.2	38.5	117.1	NA	55
Golden Agri-Resources Ltd.	1,123.4	745.1	1,575.8	77.7%	65

Source: Concordian, using mill location and ownership data from the Universal Mill List 2019 (available on Global Forest Watch) and mill capacity data compiled by Harahap et al 2020. See Technical Annex for a description of data limitations for this figure and for further detail on additional datasets used as input to the BeWhere model. Data sources and limitations related to unplanted concession areas at risk are additionally described in Footnote 24 and the notes accompanying Figure 5.

BOX 4: INDONESIAN PALM OIL VALUE CHAIN

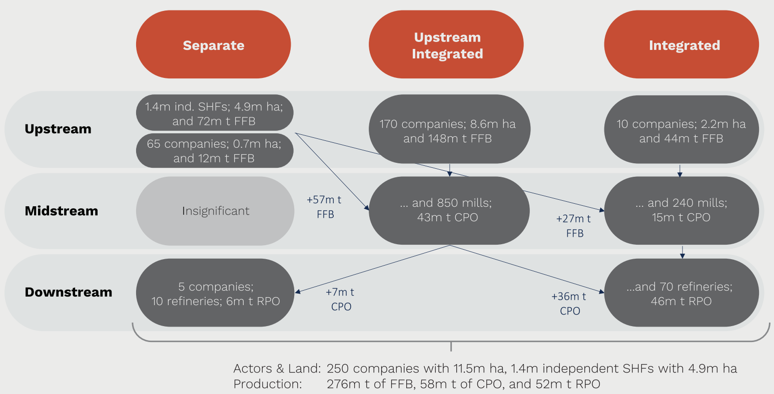
Drawing from government industry statistics, literature review, concession and planted palm maps, and expert feedback, we categorize the industry's value chain into three segments:

1. FFB producers (Upstream): 16.4 million hectares of plantations as of 2020[39] -- owned by 1.4 million smallholders and around 245 companies -- producing around 276 million tons of FFB[40] with a market value of $33 billion.[41] Over 90% of these plantations are located in Sumatra or Kalimantan[42].
2. CPO producers (Midstream): More than 1,100 mills with an average milling capacity of 40 FFB tons per hour[43] -- of which approximately one-fifth are RSPO certified[44] -- owned by 180 companies with a market value of $38 billion[45]; these mills exert local market power as FFB must be processed within 1-2 days of harvest.
3. Refined Palm Oil (RPO) producers (Downstream): This $40 billion[46] segment of the value chain produces 52 million tons[47] of refined palm oil product annually in 80 refineries, owned by 15 companies.

Fully integrated companies currently produce 70% of FFB in Indonesia while independent smallholder farmers command 26% of the upstream market. The milling industry is controlled by plantation owners who own 74% of the total production of CPO, and fully integrated companies own the remaining 26%. Most of the CPO produced by upstream integrated firms is sold to fully integrated companies. These large, fully integrated conglomerates buy 72% of total processed CPO from external sources and control 88% of the refined palm oil market. In comparison, independent refineries only produce 12% of the total RPO supply in Indonesia.

Continued
Applying Orbitas' Analysis at a Company Level

Figure 22:
INDONESIAN PALM OIL INDUSTRY BY LEVEL OF INTEGRATION



Source: Author's calculations, See Technical Annex for additional details on calculation methods
Note: 'Upstream' is the production of FFB in plantations, 'midstream' the production of CPO in mills, and 'downstream' the production of RPO in refineries; 'separate' companies are those that are only involved in one step of the production chain, 'upstream integrated' those involved in two (planting and milling), and 'integrated' those involved in the whole production chain; 'SHF' stands for independent smallholder farmers and includes those producers who have small, non-industrial oil palm estates without being tied to a company contractually.

C. MARKET POWER

Given the significant size and concentration of power in the Indonesian palm oil market, some producers will presumably be able to control market prices through their production levels. To shed light on these nuanced industry dynamics and their influence on company-level vulnerability, we employ a market power economic model called "RIMM" (Reduced Industrial Market Model).

RIMM projects how future profitability under climate transition scenarios varies by a company's ability to exercise market power. This kind of analysis is particularly important in the Indonesian palm oil industry context because the market is highly competitive at the plantation level, but becomes oligopolistic further down the value chain. Box 4 provides a detailed overview of the current Indonesian palm oil value chain, which provides a starting point for RIMM's analysis.

In Indonesia, a company's market power and revenue-cost structure (Figure 23) is largely determined by its level of vertical integration. FFB producers (smallholder farmers and large plantations) face FFB production costs that are almost as high as their revenues, leaving the average producer with thin profit margins. CPO producers have larger margins, in part because they have pricing power, which allows them to sell their products at prices above their marginal costs. Finally, downstream RPO producers show narrow margins because they sell their product in the international market, which limits their ability to influence prices. Fully integrated companies face international competition but are able to produce at slightly lower costs by eliminating CPO margins.

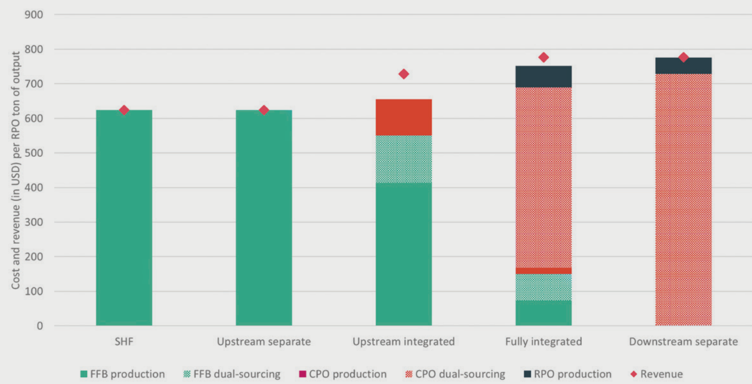
To reflect these differences in market power and level of integration, RIMM analyzes four archetypal business models that are representative of the industry, and whose characteristics are outlined in Figure 24:

1. Upstream Separate
2. Upstream Integrated
3. Fully Integrated
4. Downstream Separate

Profit projections throughout this report align on a discounted basis. But, unlike the financial models in previous sections of this report, the market power model predicts that an Aggressive climate transition drives profit declines after 2030. This is because under a market power framework, Indonesian palm companies are incentivized to decrease production to keep prices high. This discrepancy highlights that the ability of Indonesian palm producers to increase demand without depressing global prices is a relevant factor to consider when assessing the impact of climate transitions.

Continued
Applying Orbitas' Analysis at a Company Level

Figure 23:
COST-REVENUE STRUCTURE BY LEVEL OF INTEGRATION



Sources: Author's calculations, see Technical Annex for additional information.
Notes: This chart shows costs per ton of final output for each company (FFB for SHF and upstream separate; CPO for upstream integrated; RPO for fully integrated and downstream separate). This means that costs in each category are not comparable across different firm types in this chart.

Figure 24:
ARCHETYPAL INDONESIAN PALM OIL BUSINESS MODELS

	1. Upstream Separate	**2. Upstream Integrated**	**3. Fully Integrated**	**4. Downstream Separate**
Asset Types	Plantations	Plantations and Mills	Plantations, Mills, and Refineries	Refineries
Asset Characteristics	10,800ha of plantations producing 181,000 tons FFB per annum	50,000ha of plantations and five mills;	219,000ha of plantations 24 mills 7 refineries	2 refineries
Third party sourcing	N/A	28% of FFB	38% and 72% of FFB and CPO, respectively.	100% of CPO
Market Share of Archetype Model	4% of total Indonesian FFB production.	• 54% of FFB market share • 74% of the CPO market share.	• 17% of Indonesian FFB, • 25% of CPO, and • 87% of RPO.	13% market share in the RPO market.

In Indonesia, a company's market power and revenue-cost structure is largely determined by its level of vertical integration.

Our modeling confirms that climate transition impacts will vary by business model, with larger fully integrated companies most protected from downside risks. Figure 25 shows profitability trends by transition scenario for downstream separate (DS), upstream integrated (UI) and fully integrated (FI) business models. Key findings include:

- Under the Aggressive scenario, over the next 20 years:
  - Downstream separate companies see profits decline by 31%
  - Upstream integrated companies' see profits decline by 17%
  - Fully integrated companies lose the least: only an 8% decline.
- These trends hold in the Modest and Historical scenarios -- i.e., fully integrated companies do the best and downstream separate companies do the worst -- though the magnitude of difference is greatest under the Aggressive scenario.
- Vertically integrated companies are better positioned because of their ability to capture demand increases and pass-through costs onto final consumers through higher prices.
- Fully integrated companies also gain RPO market share relative to downstream separate companies under the Historical (+0.5 percentage points), Modest A (+0.4 percentage point) and Aggressive (+1.6 percentage points) scenarios.

Continued
Applying Orbitas' Analysis at a Company Level

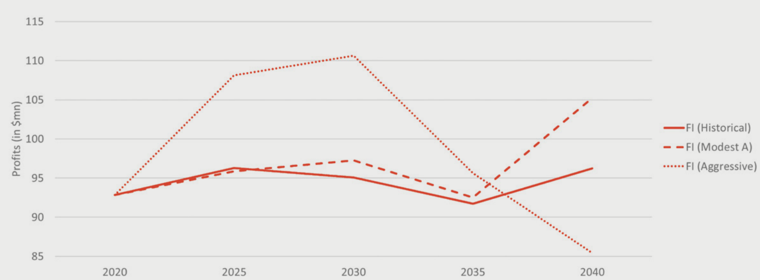
Broadly, our market power analysis finds that more integrated companies are less vulnerable to unfavorable exogenous events (i.e., cost increases, demand decreases), but that less integrated companies are better equipped to maximize the benefits from favorable exogenous events.

This finding, which holds across all climate scenarios and over time, is consistent with our benchmarking and company-level NPV approaches, which identify large companies like Golden Agri, Sime Darby, and Wilmar as likely beneficiaries of climate transitions.

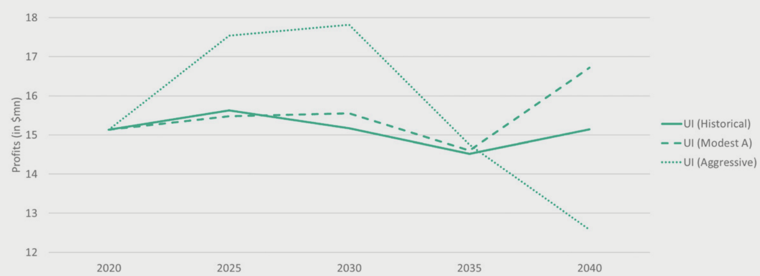
Our modeling confirms that climate transition impacts will vary by business model, with larger fully integrated companies most protected from downside risks.

Figure 25:
PROFITABILITY PROJECTIONS BY BUSINESS MODEL

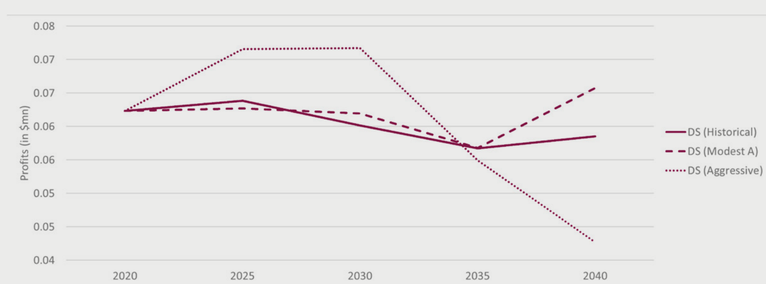
A. Fully Integrated (FI): Low Downside Risk Vulnerability, Low Upside Opportunities



B. Upstream Integrated (FI): Medium Downside Risk Vulnerability, Medium Upside Opportunities



C. Downstream Separate (DS): High Downside Risk Vulnerability, High Upside Opportunities



Sources: Vivid Economics; see Technical Annex for additional information.
Notes: FI: fully integrated companies (plantations + mills + refineries); UI: upstream integrated companies (plantations + mills); DS: downstream separate companies (refineries only)

Section VII: Recommendations

> Business as usual growth strategies on forest and peatlands will no longer be tenable, forcing producers to better use existing land rather than expanding geographically.

Our climate transition risk analysis finds the following key critical risk insights for agricultural stakeholders:

- Land use restrictions and greenhouse gas (GHG) pricing create stranded asset risks for operators who have unplanted concessions or recently acquired concessions in areas with high carbon stock or high conservation value lands.
- Business as usual growth strategies on forest and peatlands will no longer be tenable, forcing producers to better use existing land rather than expanding geographically.
- Low carbon, efficient producers with strong financial standing are best positioned for climate transitions -- capital access is especially important as companies will need to increase production through smart and sustainable yield enhancements.
- Emerging agroforestry techniques like intercropping and emissions reduction technologies like biogas cogeneration provide significant opportunities for companies to both survive and thrive under climate transitions.
- Independent smallholders represent low hanging fruit to increase industry yields and prevent further deforestation, underscoring the need for both public and private actors to provide technical and financial assistance to smallholders.
- While not analyzed in detail herein, rising reputational risks related to environmental and social performance could further erode margins and enterprise value across the palm value chain.

Based on these results we suggest financiers:

1. **Avoid investments in companies with unplanted or recently planted high-risk concessions and/or whose growth strategies rely on geographic expansion.** Not only do these companies face future stranded asset risks, but they also face immediate reputational risks as downstream purchasers increasingly adopt and enforce NDPE policies using HCSA. Instead, predicate lending to, and investment in, producers who are committed to and implementing sustainable practices and sourcing from sustainable suppliers, including smallholders.

2. **Request investees assess and disclose climate transition risk and vulnerability** per TCFD guidelines. Some global agricultural companies like Olam have already hired in-house practitioners to assess climate transition risks; investors should encourage and/or require all investees to do the same, drawing from the results and methods presented in this report. Relevant vulnerability KPIs include:
   - Operational efficiency and frequency of replanting.
   - Access to and cost of capital (WACC)
   - Percentage of concessions in forests and/or on peat soils
   - Emissions intensity, including emissions from peat drainage, fires, diesel fuel use, fertilizer application, and methane emissions per unit of palm oil product.
   - Asset portfolio mix and sustainable growth strategy.

3. **Provide results-based and other favorable financing** for profitable emissions mitigation measures, sustainable yield enhancements, and technology innovation such as
   - Biogas capture and cogeneration, which reduces onsite fuel costs and emissions while also improving rural electrification and diversifying income sources.
   - Agroforestry techniques like intercropping which provide opportunities for carbon sequestration payments, increased productivity, and lower costs.
   - Using information technologies like satellites, drones, and artificial intelligence to optimize productivity under unpredictable weather conditions.[48]
   - On-lending and dedicated credit facilities that provide subsidized lending, favorable financing, and technical assistance to small- and medium-sized producers adopting sustainable methods.
   - Better utilizing intermediate and waste products such as palm kernel shells and empty fruit bunches.

> Using information technologies like satellites, drones, and artificial intelligence to optimize productivity under unpredictable weather conditions.

Appendix:

Figure 5 extended:
COMPREHENSIVE LIST OF STRANDED CONCESSIONS ORDERED BY CONCESSION AREA AT RISK

Company	Total concession area (ha)	Unplanted concession area (ha)*	Stranded concession area (ha)	% of unplanted concession area that is stranded	Provinces most impacted
Golden Agri-Resources Ltd.	1,024,000	373,000	242,000	65	Kalimantan Tengah, Sulawesi Tengah, Kalimantan Barat
Wilmar International Ltd.	549,000	334,000	229,000	69	Kalimantan Barat, Kalimantan Tengah
PT Perkebunan Nusantara XII	660,000	252,000	166,000	66	Kalimantan Barat, Riau, Aceh
Korindo	193,000	128,000	126,000	99	Papua
PT Incasi Raya Group	215,000	152,000	116,000	77	Kalimantan Barat
Musim Mas	220,000	108,000	93,000	86	Papua, Kalimantan Barat
KPN Plantation	186,000	114,000	90,000	79	Papua, Kalimantan Barat
Indofood Agri Resources Ltd.	294,000	141,000	87,000	62	Kalimantan Barat, Kalimantan Timur
PT Austindo Nusantara Jaya Tbk	100,000	81,000	80,000	99	Papua Barat
PT Eagle High Plantations Tbk	214,000	98,000	74,000	75	Kalimantan Barat, Papua Barat
First Resources Ltd.	180,000	95,000	67,000	71	Kalimantan Barat, Riau
PT Makin Group	129,000	79,000	64,000	81	Kalimantan Tengah
Bumitama Agri Ltd.	173,000	71,000	46,000	65	Kalimantan Barat, Kalimantan Tengah
Sungai Budi Group	58,000	51,000	43,000	85	Sumatera Selatan, Kalimantan Barat
PT Triputra Agro Persada	165,000	66,000	41,000	62	Kalimantan Barat
Sime Darby Plantations	293,000	63,000	39,000	62	Kalimantan Selatan, Kalimantan Barat
Genting Berhad	91,000	49,000	34,000	70	Kalimantan Tengah
Kencana Agri Limited	78,000	39,000	33,000	85	Sulawesi Tengah
PT Agrindo	71,000	41,000	32,000	78	Kalimantan Tengah
PT Darmex Agro	181,000	53,000	32,000	61	Kalimantan Barat, Riau
PT Sampoerna Agro TBK and Related Companies	133,000	54,000	32,000	59	Kalimantan Barat
Royal Golden Eagle	201,000	56,000	31,000	55	Riau

Continued
Appendix

Figure 5 extended: (CONTINUED)
COMPREHENSIVE LIST OF STRANDED CONCESSIONS ORDERED BY CONCESSION AREA AT RISK

Company	Total concession area (ha)	Unplanted concession area (ha)*	Stranded concession area (ha)	% of unplanted concession area that is stranded	Provinces most impacted
PT Provident Agro Tbk	54,000	41,000	30,000	74	Sulawesi Tengah, Kalimantan Barat
PT Gozco Plantations Tbk	41,000	35,000	28,000	79	Kalimantan Barat
Carson Cumberbatch Plc	103,000	36,000	26,000	71	Papua
PT Citra Borneo Indah	95,000	45,000	24,000	55	Kalimantan Tengah
Kuala Lumpur Kepong Berhad	111,000	33,000	21,000	62	Kalimantan Timur
PT Bakrie Sumatera Plantations Tbk	67,000	22,000	15,000	71	Kalimantan Barat
Cargill, Inc.	122,000	25,000	15,000	59	Kalimantan Barat
PT Dharma Satya Nusantara Tbk	81,000	21,000	11,000	51	Kalimantan Timur, Kalimantan Tengah
Anglo Eastern Plantations Plc	28,000	13,000	7,000	55	Kalimantan Tengah
Teladan Prima Group	47,000	10,000	4,000	40	Kalimantan Timur
PT Multi Agro Gemilang Plantation Tbk	7,000	4,000	4,000	86	Aceh
PT Perkebunan Kaltim Utama I	13,000	12,000	4,000	30	Kalimantan Timur
M.P. Evans Group Plc	17,000	6,000	3,000	54	Kalimantan Timur
SOCFIN Group	8,000	4,000	3,000	60	Sumatera Utara, Aceh

Source: Concordian, based on Greenpeace 2015 concession map; 2015 forest cover derived from Hansen et al. 2013; 2012 peat map from the Indonesian Ministry of Agriculture (obtained from Global Forest Watch); and planted palm maps from Kemen Austin, Austin et al. 2017, and Danylo et al. 2020. Percentage stranded figures are based on unrounded data.
*These figures are roughly representative of 2015. Because of possible temporal and spatial discrepancies in our 2015 concessions map versus our current planted palm maps, this figure may over or understate the number of hectares at risk since it includes concessions that may have been planted since concessions data was compiled, because concessions since changed ownership, and/or because of differences in underlying spatial data. Additional potential sources of error are described in footnote 2

Report
References

(1) Physical impacts of warming temperatures as well as labor, social, and community issues will also materially impact the agricultural sector, but are out of the scope of this report. We do consider the chronic impacts of rising temperatures on yields. **(2)** This report and its accompanying Appendix are available at http://orbitas.finance. **(3)** Due to spatial and temporal misalignments between concession data sets and planted palm data sets, our calculations may over or understate the amount of unplanted concession area in forest and/or peat lands. Please refer to this report's Appendix for additional information on calculation methods and important caveats. **(4)** See highcarbonstock.org for definitions **(5)** Based on the most recent publicly available concessions data (around 2015) from Greenpeace. This data may not fully reflect current conditions as these areas may since be planted and because of data inaccuracies. Nevertheless, this data provides useful indications of the magnitude of risks. **(6)** See Box 3 in Section V of this report for calculations. **(7)** USDA, "Oil Seeds: World Markets and Trade," Foreign Agricultural Service, August 2020, https://apps.fas.usda.gov/psdonline/circulars/oilseeds.pdf
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(24) Approximately 53% of 2015 planted palm area on peat occurs outside of the boundaries of the Greenpeace 2015 concession map, with about three quarters of this area associated with industrial plantations and one quarter associated with smallholder plantations. **(25)** See footnote 23. **(26)** Forest projections are based on the OSIRIS model (Busch et al. 2019), which uses high-spatial-resolution historical observations of agricultural prices, yields, and forest area in each grid cell, finding the most likely relationship between agricultural value and forest area for a given ~5 km x 5 km grid cell. OSIRIS accommodates the effect of GHG prices on forest area by subtracting potential forest carbon value from the agricultural value in each grid cell and, along with the estimated historical relationship between agricultural value and forest area, separately predicts deforestation (if applicable) and reforestation in each grid cell. Historical forest cover is based on the tree canopy cover dataset of Hansen et al. 2013, applying a threshold of 50% tree cover to define forest. OSIRIS does not allow forest expansion into grid cells that lack forest in the historical dataset, which prevents forest expansion into non-forest-supporting ecosystems. Forest type need not be considered in this analysis because the forest cover projections are simply used as a constraint on future palm expansion. See Annex for more information. **(27)** We assume these smallholders typically hold less than five acres of land and on average around 3.5 acres of land. Importantly, these smallholders are not part of cooperatives and are not affiliated with commercial operations. **(28)** Enterprise Value (EV) is the measure of an asset's total value considering market capitalization as well as any short-term and long-term debt. **(29)** This analysis looks at a specific set of assets to compare the overall magnitude and direction of risks between scenarios; it is not necessarily representative of impacts on the industry as a whole and does not consider the ability of companies to set prices. direction of impacts between scenarios, rather than provide precise numbers. **(30)** See Appendix and Figure notes for additional details and assumptions. **(31)** Tohiran, Kamil, Frisco Nobilly, Raja Zulkifli, Adham Ashton-Butt, and Badrul Azhar, “Cattle-grazing in oil palm plantations sustainably controls understory vegetation,” Agriculture, Ecosystems & Environment, Vol. 278, June 2019, https://doi.org/10.1016/j.agee.2019.03.021. **(32)** Darras, Kevin, Marife Corre, Greta Formaglio, Aiyen Tjoa, et al., “Reducing fertilizer and herbicides in oil palm plantations – ecological and economic valuations,” Frontiers in Forests and Global Change, November 2019, https://doi.org/10.3389/ffgc.2019.00065. **(33)** In the indicative modeled case, a CPO/FFB price drops from a "normal" $118 to a low $85 per ton of FFB level for just one year and fully recovers the year after. The high-efficiency plantation that temporarily stops fertilizer use in the year of low price (and resumes it to the full extent starting from the year after) is experiencing yield losses of 7% and 5% in the two following years. These yield losses are well compensated by the zero fertilizer cost in the low price year which creates a positive impact on the NPV. Alternatively, losing a hectare of productive land (that has a positive NPV) negatively impacts the total company's NPV. **(34)** These projections assume that producers take into account capital needs, and are able to access the capital necessary to optimize their production and expansion in light of climate transitions. **(35)** Using spatially explicit data and projections, we calculated the NPV of Indonesian palm oil plantations and processing facilities at a 25 x 25 km grid cell resolution under each transition scenario. The NPV calculation considers 30 years of discounted post-tax profits for mills, plantations, kernel crushers, and biogas cogeneration facilities, and accounts for climate transition scenario-specific palm oil demand, prices, operational and capital costs, and policy constraints. **(36)** Notably, the industry’s long run profits are dependent on continued growth in global demand and ability of the Indonesian palm sector to continue expanding output without dampening global palm oil prices. **(37)** Current oil palm productivity is not always a reliable indicator of a company’s operational performance because yields can vary widely depending on the age of a plantation. Current data was not available for us to normalize each company’s productivity by the age of their plantations. **(38)** Even so, in reality, with adequate knowledge of coming transitions, these companies would have the option to relocate to more favorable areas and benefit from the gains predicted for other companies -- an option our NPV analysis is unable to consider at the company level. **(39)** Rahmanulloh, A., (2020). ‘Oilseeds and Products Annual’ in USDA Reports. **(40)** Based on yields provided by national industry experts **(41)** Based on 15-year average of FFB market price **(42)** Based on planted palm maps **(43)** Universal Mill List (2019)
(44) Universal Mill List (2019) **(45)** Based on 15-year average of CPO market price
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Navigating climate transition risks

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