



Rainforest Foundation
Norway

Neste, Biofuels and Environmental Risk

Briefing for investor engagement



Table of Contents

Main Recommendations	2
Brief overview of Neste	3
Biofuels and feedstocks	4
Investor risk analysis	7
Annex A: Note for investors – Neste, hydrotreated fuels and sustainability risk	9
Annex B: Alternative feedstock systems	18



Photo: Regnskogfondet

Main Recommendations

We recommend that responsible investors engage Neste on sustainable and scalable biofuel production systems. A viable and sustainable reorientation of Neste's business model would include the following*:

1. **Capital investments:** No further investments in HVO (Hydrotreated Vegetable Oil) capacity expansion.
2. **Raw materials:** Distinguish between feedstock materials without existing alternative applications and materials such as PFAD (Palm Fatty Acid Distillate) and animal fats that are already well utilized.¹
3. **Procurement:** Develop new lipid supply chains that do not interfere with food market to replace virgin oils, PFAD and animal fats.
4. **Research & Development:** Invest in advanced fuel production technologies with scalable resource bases, such as cellulosic biofuels and e-fuels.

** This memo concerns Neste's biofuel production only. Neste's production of fossil fuels, still larger than their biofuels production, does of course have its own sustainability issues, but these are not covered here.*

1) E.g., by identifying what fractions of feedstocks used and listed in Annex IX Part A and Annex IX Part B (respectively) to the EU Renewable Energy Directive

Brief overview of Neste

Neste is a crude and vegetable oil refining and marketing company. It is part-owned by the Finnish government and has historically focused on oil refining and marketing (having been the largest oil refining company in Finland for some time and been called 'Neste Oil' from 2005 to 2015), but that has more recently diversified into renewable fuels with some success.

Neste has been repeatedly included in a list of "the world's hundred most sustainable corporations" published by Corporate Knights and its communications focus on its renewable fuel output rather than its traditional refining business. As of 2022 Neste was still primarily engaged in the oil business. Its 2022 annual report

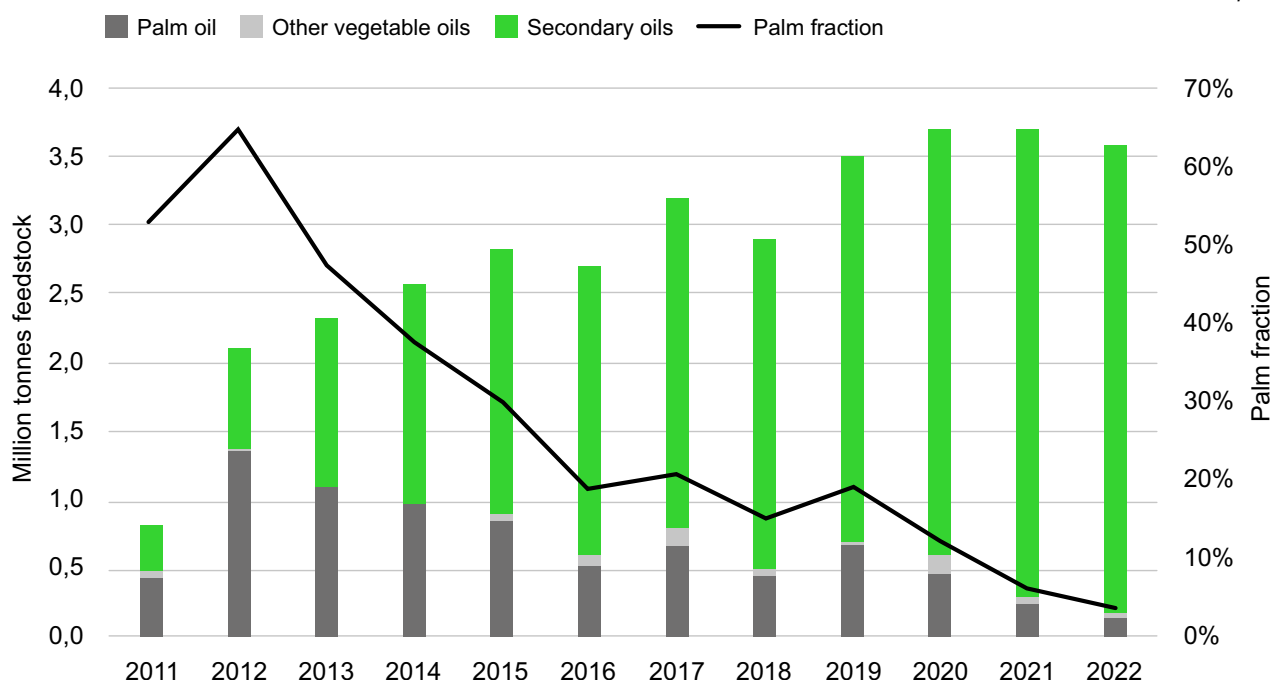
states that it processed 3.6 million tonnes of renewable resources but 12.7 million tonnes of crude oil and other fossil feedstocks, and that revenues from oil products were €15 billion versus €10 billion for renewable products. Neste's capital investments are overwhelmingly in renewables (90% in 2022).

Following the successful opening of the HVO (Hydrotreated Vegetable Oil) unit at Porvoo², Neste subsequently opened larger facilities in Singapore and Rotterdam. The Singapore facility has a production capacity of 1.3 million tonnes which is due to be doubled to 2.6 million tonnes by the end of this year. The Rotterdam facility can produce 1.4 million tonnes of fuel a year,

which Neste have announced they intend to almost double to 2.7 million tonnes by 2026. Neste is also engaged in a 50:50 joint venture with Marathon Petroleum Corporation to deliver a refinery conversion to produce HVO in Martinez, California. Once these expansions and retrofit are completed, Neste will have a global renewable fuel production capacity of nearly 7 million tonnes. Neste is a major player in the biofuel market – 7 million tonnes of output is roughly equivalent to total global HVO production in 2021.

FIGURE 1 NESTE USE OF RENEWABLE RAW MATERIALS

Source: Neste Annual Reports³



²) In this note, we refer to the portfolio of hydrotreated products from Neste's NexBTL facilities collectively as HVO.

³) 1) Secondary oils include some combination of PFADs, animal fats, fish oils, other food processing residues, and palm stearin; 2) In some years we have calculated consumption of other vegetable oils as the difference between other reported values, and the calculated values may be affected by rounding issues.

Biofuels and Feedstocks

Introduction

Neste has come a long way in replacing palm oil, but many of the products used to replace palm oil have their own and similar challenges when it comes to climate gas emissions and deforestation, due to market substitution effects. Most of them contribute to land use change, and thereby deforestation, peat loss, carbon emissions, land conflict and human rights violations. The effect of replacing fossil fuels with biofuels produced by Neste may therefore be to increase net carbon emissions, biodiversity loss and global food insecurity.

Policy driven market

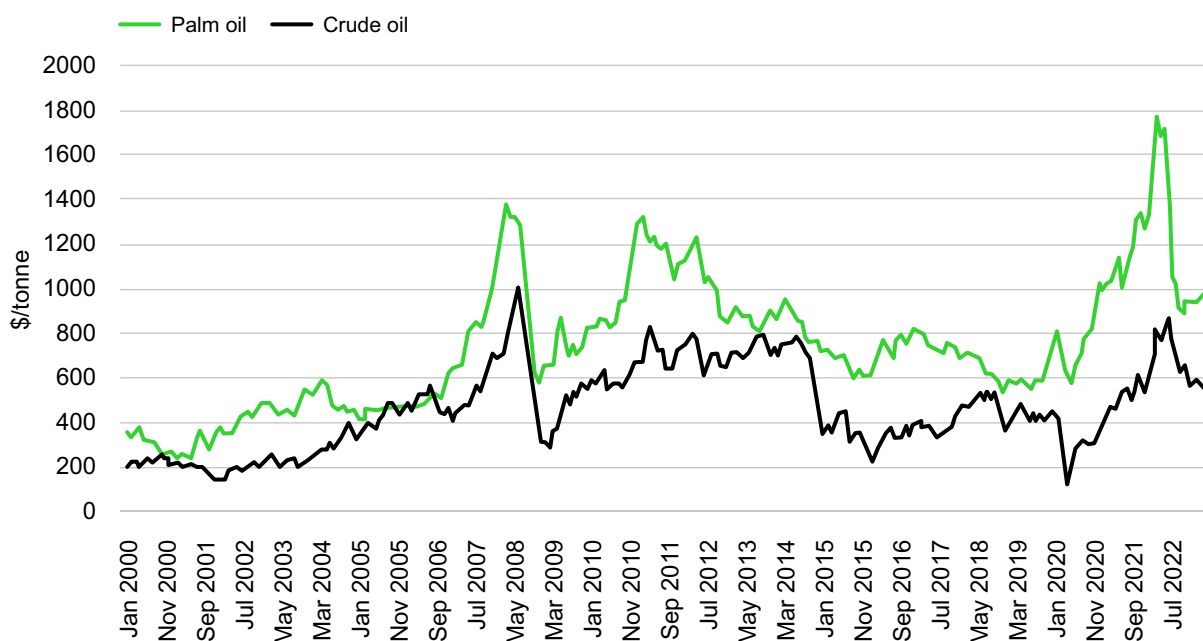
The market for HVO is completely policy driven. The hydrotreating process requires vegetable oils or animal fats as feedstocks. The cost of vegetable oils is almost always significantly above the price of crude oil (Figure 2) and producing fuels from vegetable oil is not cost-competitive with producing fossil fuels unless governments intervene through policy. In the future, it is likely that these policies will be complemented by new policies to drive alternative fuel use in aviation. The vast majority of HVO produced in the world is supplied to either the west coast of the United States or to Europe.

Diversion from food to fuel

As a result of the biofuel boom of the last 20 years, biodiesel and HVO production have become major sources of demand for bio-oils and fats. From 2000 to 2022 the amount of vegetable oil used for biofuel production increased from an equivalent to 6% of the EU vegetable oil supply to 51%. The use of vegetable oils for biofuel has exceeded the use of vegetable oils for food for human consumption in the EU in most years since 2010. At the global level, diversion of vegetable oils to biofuel markets has gone from 0.8% of production in 2000 to 16% in 2022, and the IEA anticipates that it will reach 23% by 2025.

FIGURE 2 NOMINAL PRICE OF PALM OIL VERSUS CRUDE OIL (WEST TEXAS INTERMEDIATE) 2000-2022

Source: World Bank 'Pink Sheet' Monthly Prices



Palm oil

The palm oil industry is associated with several sustainability issues. For climate change, the most problematic issues are the association of oil palm expansion with peat drainage and with deforestation, and the issue of methane emissions from palm oil mill effluent ponds. There are also concerns relating to biodiversity loss, land rights conflicts with local and indigenous communities, and with the treatment of workers.

Certification can deal with some environmental concerns, but it does not provide protection against indirect, market mediated, impacts – notably indirect land use change (ILUC) and impacts on food prices and food security. An extensive body of evidence suggests that the ILUC emissions associated with palm oil use for biofuel production eliminate any climate benefit from replacing fossil fuels with palm oil HVO. One modelling exercise for the European Commission estimates that the land use change GHG emissions associated with using palm oil biodiesel were about three times higher than the GHG emissions from diesel fuel. Research for Rainforest Foundation Norway estimated that the difference between low and high scenarios for global palm oil consumption for biofuel in 2030

ILUC

ILUC (Indirect Land Use Change) refers to the expectation that increasing demand for biofuel feedstocks leads more land to be converted to agricultural production, even if the specific batches of feedstock processed into biofuels are sourced from existing plantations or farms. Land conversion results in the emission to the atmosphere of carbon previously stored in vegetation and soils, with the highest carbon emissions being associated with deforestation and peat loss.

could be an additional 3.8 million hectares of deforestation (almost the size of Switzerland) and 6 billion tonnes of CO₂ emissions.

The identification of palm oil as a high ILUC-risk feedstock has led the EU to adopt rules requiring incentives for palm oil biofuels to be eliminated by Member States by 2030 at the latest – and at least nine Member States have already

enacted restrictions on palm oil biofuels. Similarly, in the USA, palm-oil-based biofuels are not eligible to receive support under the federal Renewable Fuel Standard or the California Low Carbon Fuel Standard due to ILUC concerns.

Neste has reduced palm oil from 64% in 2012 to 4% of its renewable feedstock in 2022 and has stated that it will fully eliminate conventionally produced palm oil from its feedstock base by 2025.

Palm fatty acid distillate (PFAD)

One of the materials Neste includes in its characterisation of waste and residues is palm fatty acid distillate, PFAD. PFAD is removed from the crude palm oil by distillation, resulting in a lower value product stream with about 80% free fatty acid content. The produced quantity of PFAD is typically about 4% of the produced quantity of crude palm oil.

Neste characterises PFAD as a residue and claims that, “*PFAD use does not increase pressure to expand oil palm farming*”, but PFAD has a range of established uses, and the market price per tonne of PFAD has typically been around 80% of the market price per tonne of crude palm oil. Even before the market for



Photo: Regnskogfondet

PFAD as a biofuel feedstock became available, PFAD was 100% utilised, with applications in oleochemicals, the soap industry and in livestock feed. This means that shifting the available supply of PFAD into biofuel production displaces it from other uses, where it needs to be replaced. The obvious replacement for PFAD in many applications would be palm oil, as the lowest cost readily available substitute. The net impact of increasing consumption of PFAD in biofuel production is to increase global palm oil demand by a proportionate amount. Given the high risk of deforestation, peat loss and ILUC emissions from increasing palm oil demand, it can be expected that diverting PFAD into biofuel production will result in net increases rather than reductions in global GHG emissions.

Neste continues to identify PFAD as a residue. In the EU, PFAD does not feature on the list of non-food materials that are identified as eligible for additional support in the Renewable Energy Directive and a review for the European Commission concluded that incentives to use PFAD would be likely to lead to market distortions. In the UK, PFAD is identified as a 'product' rather than as a residue under the Renewable Transport Fuel Obligation. In the United States, PFADs are excluded from the approved Renewable Fuel Standard pathway for biofuels from free fatty acids.

Animal fats

Like PFAD, animal fats have existing uses in the economy, and therefore using them for biofuel feedstock creates a need for replacement products. Prior to the growth of the biofuel market category 1 & 2 material (see fact box) was largely combusted for heat and/or power. The biofuel industry has therefore largely moved this material from one bioenergy application to another. Category 3 material has a much wider array of uses – and like PFAD, the alternative feedstocks for those feed and oleochemical applications are other vegetable oils, and in

ANIMAL BYPRODUCT CATEGORIES

In the EU, category 1 and 2 materials are considered high risk and have their uses strictly limited, while category 3 material is considered low risk and includes parts of animals that have been passed fit for human consumption in a slaughterhouse, but which are not intended for human food. Category 1 and 2 materials are eligible for additional support under the Renewable Energy Directive, but category 3 material is not. According to statistics from the European renderers' association EFPPRA, almost all category 1 & 2 material produced in Europe is now destined for biofuel production, but the use of category 3 material is divided between animal feed, oleochemical applications and biofuels.

particular palm oil. As with PFAD, there is therefore a considerable risk that increasing the use of category 3 animal fats for biofuel feedstock drives expansion of vegetable oil production (including palm oil) and causes indirect deforestation and net increases rather than reductions in global CO2 emissions.

Documents released in the context of the acquisition by Neste of the company Demeter Animal Fats and Proteins confirm that Neste (as of 2018 at least) has been active in purchasing category 3 animal fats for biofuel use. Neste's 2022 Annual Report states that, "*Animal fat is derived from the food industry's meat processing waste. Neste sources mixed animal fat waste that is unsuitable for human consumption.*"

This framing avoids making direct reference to the system of animal by-product categories in use in the EU.

Other secondary oils

Beyond animal fats and PFAD, a range of other waste or residual oils are available as by-products of various processes, and Neste has been proactive in developing supply chains for some of these materials. Some materials that have become biofuel feedstocks would otherwise likely have been unutilised. For example, Neste identifies oil recovered from palm oil mill effluent (POME) as one of its waste and residual feedstocks. Previously, the oily material in mill effluent ponds would not have been recovered, and therefore recovering this material is a positive step that will not cause displacement emissions. Other fatty residues may already have collection and supply systems in place, so that moving them into biofuel use would raise similar concerns to the use of PFAD and animal fats. For example, Neste have also identified "technical corn oil" as a waste or residue. Technical corn oil is produced as a by-product of corn ethanol production. If it were not separated out, then that oily material would be included in existing animal feed rations and having been separated from the distillers' grains it could still be supplied for animal feed use instead of biofuel use.

The larger picture is that the global supply of secondary oils is limited. Analysis by the IEA suggests that HVO production is set to rapidly exhaust the available global supply of residual oils if the HVO boom continues. Moving secondary vegetable oils from existing uses into biofuel production will lead to increased demand for virgin vegetable oils in those existing uses. It is therefore not realistic to believe that prioritising secondary oils can avoid ILUC impacts and vegetable oil price impacts.

Investor Risk Analysis

Sustainability risks

Systemic environmental risk

Neste may increasingly find themselves on the wrong side of institutional sustainable investment principles. While they have worked through sustainability schemes such as the Roundtable on Sustainable Palm Oil with a view to keeping its palm oil supply chain free of direct deforestation and has committed to improve traceability in its PFAD supply chain, investors are increasingly concerned with indirect impacts and the idea of systemic risk to the climate, forests, and biodiversity. There are already examples of investors adopting policies that demand the companies should understand and seek to reduce their indirect impacts, to have strategies to reduce indirect GHG emissions and have strategies to manage and reduce indirect impacts on tropical forest loss and on biodiversity loss.

Food security risk

Figure 3 shows the evolution of the price of palm oil over the period from 2000 to 2023.

There are three significant price spikes apparent in the period – the food price crises of 2007/08 and 2011/12, and a recent spike in prices which started during 2021 and was exacerbated by the start of the conflict in Ukraine. There is an extensive literature that discusses the contributing role of biofuel demand in driving the two earlier food price crises, and many commentators have identified surging HVO capacity as a contributing factor in the more recent price spike. HVO capacity expansion is expected to significantly outstrip global vegetable oil production growth and will therefore be in direct competition with forecast increases in demand for oils for human consumption.

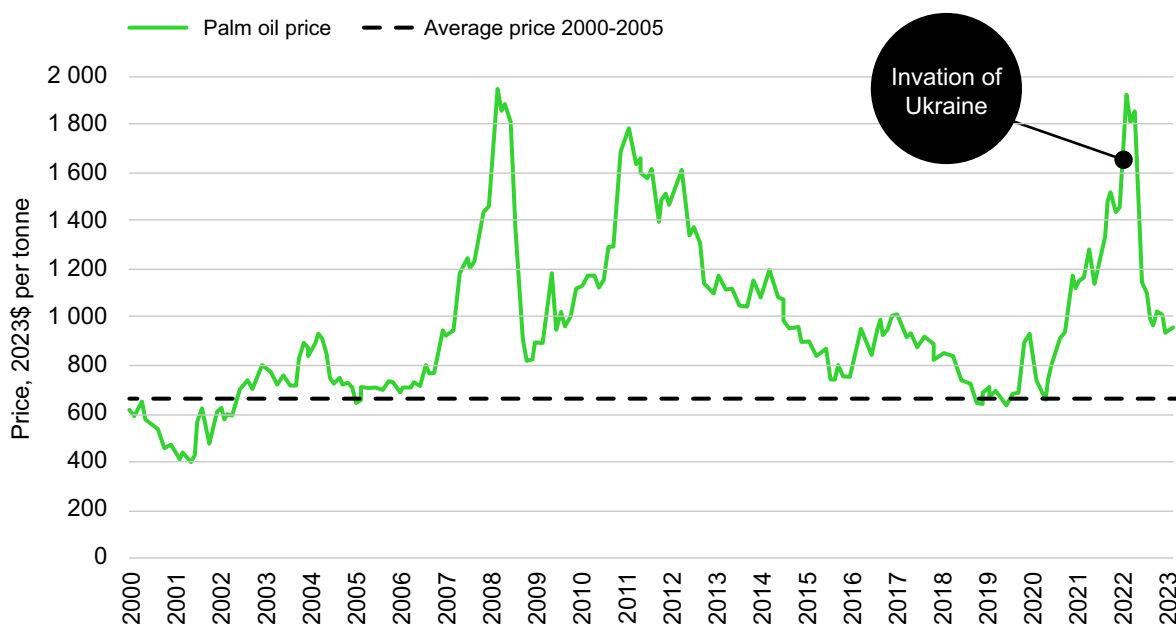
Business risks

Market risk

The world is in the middle of an HVO boom with HVO industry expanding capacity rapidly, especially in the USA. There is clear evidence that the HVO industry is expanding capacity faster than demand will follow, as this rapid expansion of HVO capacity is not reflected in the rate of expansion of government mandates for the use of biomass-based fuels. It is not unusual for a period of market adjustment to follow a rapid capacity expansion and the evidence suggests that we should anticipate a period of intense competition. According to the IEA, the current growth in HVO capacity and production threaten to lead to a feedstock crunch, which would increase costs in the industry, push vegetable oil prices higher and could have highly negative impacts on global food security.

FIGURE 3 PALM OIL PRICE (REAL, 2023\$) 2000 TO 2023

Source: World Bank 'Pink Sheet' monthly prices <https://www.worldbank.org/en/research/commodity-markets>



Note: Adjusted for inflation based on annual U.S. cpi values taken from <https://www.usinflationcalculator.com/>

Regulatory risk

These issues of indirect land use change (ILUC), of displacement of wastes from other uses and of food security impacts have caused policies to be gradually adjusted to give less favourable treatments for the most problematic feedstocks like palm oil and PFAD, and to signal that growth in the use of food oils for biofuel cannot be without limit. At each revision of the key biofuel mandates, the HVO industry faces the risk of stagnation or loss of market share. For example, The EU's "REFuelEU" mandate for use of renewable aviation fuels excludes food-based fuels from support but identifies HVO renewable jet from used cooking oil and animal fats as an important contributor to meeting 2030 aspirations.

In the likely event that growing production of HVO diesel and jet fuels contributes to further price spikes in the vegetable oil market over the coming decade, there is a considerable risk that regulators will start to see HVO as not only a dead-end in terms of contribution to the 2050 economy but as a pathway that has more downside than upside. This could lead to the adoption of new and stronger rules favouring more sustainable cellulosic biofuel and power-to-liquids technologies over HVO production.

Risk mitigation for Neste

For Neste, mitigating these risks would first require acknowledging that their consumption of PFAD and animal fats have indirect impacts on forest area by adding pressure to the palm oil market. While it is true that the adoption of alternative aviation fuel policies improves the short-term outlook for HVO producers, there is a growing recognition among policy makers that HVO is not a technology with long-term potential. It is generally accepted that HVO production is not scalable to make a major contribution to eliminating fossil fuels from road and aviation, because the feedstock base is limited.

At present, Neste is committed to the HVO industry. This is, however, an industry that turns food resources into fuel at the expense of food consumers while potentially driving deforestation, harming biodiversity, and increasing net GHG emissions, all to enable the transport industry to keep on growing. This will increasingly be identified by investors as posing serious systemic sustainability risks.

Just as Neste has started to pivot away from fossil fuel production over the past fifteen years, it's best chance for long-term success is to pivot away from HVO as well.

Neste's proudly held position on the Corporate Knights Global 100 is dependent on Corporate Knights identifying 69% of Neste's investments as sustainable.

Given the risks outlined above, investors should call on Neste to adopt the following measures:

1. No further investments in HVO (Hydrotreated Vegetable Oil) capacity expansion.
2. Distinguish between feedstock materials without existing alternative applications and materials such as PFAD and animal fats that are already well utilized.⁴
3. Develop new lipid supply chains that do not interfere with food market to replace virgin oils, PFAD and animal fats.
4. Invest in advanced fuel production technologies with scalable resource bases, such as cellulosic biofuels and e-fuels.



Photo: Regnskogfondet

⁴ E.g., by identifying what fractions of feedstocks used and listed in Annex IX Part A and Annex IX Part B (respectively) to the EU Renewable Energy Directive

Note for Investors – Neste, Hydrotreated Fuels and Sustainability Risk

SUMMARY

The issue: Neste has historically been an oil refining and marketing company but over the last 15 years has repositioned itself as a renewable fuels and chemicals company. Neste identifies 39% of its revenue as derived from ‘clean’ products, which Neste defines as products with “clear environmental and/or social benefits”. Neste hydrotreats biogenic oils and fats to produce hydrotreated vegetable oil (HVO) products that are marketed as ‘renewable diesel’ fuel and ‘sustainable aviation fuel’, and a range of lighter hydrocarbons. Neste’s hydrotreaters consume a combination of virgin vegetable oils (still including palm oil), by-product oils (including palm fatty acid distillate (PFAD) and rendered animal fats) and waste oils (including used cooking oil and palm oil mill effluent sludge). The problem for Neste is that several of these resources have existing applications, and that there may in fact be no environmental benefit from diverting them to renewable fuel production. The palm oil industry is strongly associated with deforestation and peat loss, and palm oil, PFAD and animal fats are interchangeable in several existing uses. Analysts have argued that producing fuel from these materials is likely to drive palm oil expansion to meet the increased demand, leading to deforestation and carbon emissions from land use change, increasing rather than reducing net global carbon emis-

sions. Recognizing the adverse environmental impacts of demand for these feedstocks, regulators have already used various tools to limit support for fuels produced from them. While the use of some other waste and residual oils and fats may be more sustainable, the global supply is limited. Other companies have followed Neste into the hydrotreating business, delivering rapid expansion in global hydrotreating capacity. Vegetable oil prices have been persistently higher in recent years than levels that were normal before the biofuel boom, and increased demand means more upwards price pressure. Most waste oils resources have already been mobilised, and feeding expanding HVO capacity with ever-increasing consumption of food oils threatens to drive deforestation and to reduce food security in the developing world.

Why is this relevant to investors?

Neste has made its green credentials central to its market positioning, but these credentials are at risk when Neste’s largest investments are in a hydrotreating technology that is problematic in terms of both net GHG emissions and food security impact. Having been a market leader in deploying HVO capacity and having had some success in improving the sustainability of its supply chains as it became apparent that its original palm oil focused business model would not be

acceptable, Neste now finds itself in an overcrowded market with a renewable technology that is not sustainably scalable. It is at risk of being targeted as a bad actor by environment and social campaigners, and of having regulatory support for its fuels reduced or cancelled. There is also an aspect of systemic risk to the HVO industry – investors should not support a technology that exacerbates food insecurity and deforestation while failing to address climate change.

What should investors ask for?

Investors should call on Neste to reorient towards sustainably scalable production systems. This means no further capital investment in HVO capacity expansion; providing transparency by identifying what fractions of feedstocks used and listed in Annex IX Part A and Annex IX Part B (respectively) to the Renewable Energy Directive; developing additional lipid feedstock supply chains where possible to replace virgin oils, PFAD and animal fats; investing in advanced fuel production technologies with scalable resource bases, such as cellulosic biofuels and e-fuels.

BACKGROUND

Neste is a Finnish company, part-owned by the Finnish government, that has historically focused on oil refining and marketing (having been the largest oil refining company in Finland for some time and been called 'Neste Oil' from 2005 to 2015), but that has more recently diversified into renewable fuels with some success. In 2007 Neste opened a facility at its Porvoo oil-refinery in Finland to hydrotreat vegetable oils and animal fats to produce 'hydro-treated vegetable oil' (HVO) fuels, sometimes referred to as renewable diesel and renewable jet fuel, alongside other lighter hydrocarbons for chemical applications. Hydrotreating involves reacting lipids with hydrogen in order to remove oxygen and produce hydrocarbon molecules.

Neste positions itself as a sustainable and forward-looking company. It has been repeatedly included in a list of "the world's hundred most sustainable corporations" published by Corporate Knights¹ and its

communications focus on its renewable fuel output rather than its traditional refining business. As of 2022 Neste was still primarily engaged in the oil business though – its 2022 annual report² states that it processed 3.6 million tonnes of renewable resources but 12.7 million tonnes of crude oil and other fossil feedstocks, and that revenues from oil products were €15 billion versus €10 billion for renewable products. This hierarchy of revenues may not last, however. Neste's capital investments are overwhelmingly in renewables (90% in 2022).

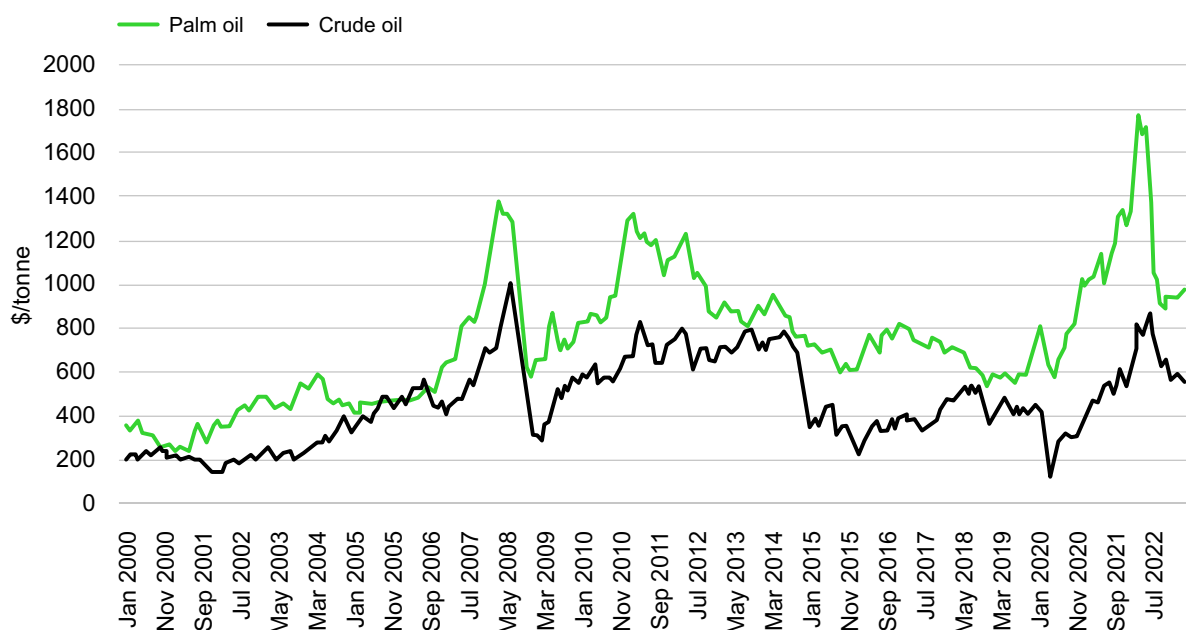
Neste refers to its version of the hydrotreating process as 'NexBTL'. The term BtL, short for bio-mass-to-liquids, is often used in relation to technologies that can turn a wide range of organic materials (and in particular cellulosic and ligno-cellulosic material) into fuels, but Neste's NexBTL is a technology for processing lipids only. Neste has also been engaged in trying to develop lignocellulosic biofuel

production technologies³, but has not yet been successful in delivering commercial scale production (other companies have also struggled to commercialise cellulosic biofuel technologies). In this note, we refer to the portfolio of hydrotreated products from Neste's NexBTL facilities collectively as HVO.

The market for HVO is completely policy driven. The cost of vegetable oils is almost always significantly above the price of crude oil (Figure 1) and producing transport fuels from vegetable oil is simply not costcompetitive with producing fossil transport fuels unless governments intervene through policy. The vast majority of HVO produced in the world is supplied to either the west coast of the United States or to Europe. In the United States, the market is driven by a combination of value from the Renewable Fuel Standard (RFS2), the Biomass-Based Diesel Tax Credit and the California and

FIGURE 1 NOMINAL PRICE OF PALM OIL VERSUS CRUDE OIL (West Texas Intermediate) 2000-2022

Source: World Bank 'pink sheet' monthly prices <https://www.Worldbank.Org/en/research/commodity-markets>



1) <https://www.corporateknights.com/rankings/global-100-rankings/>

2) <https://www.neste.com/for-media/material/annual-reports>

3) <https://journeytozerostories.neste.com/circular-economy/plant-based-waste-and-residues-biofuel-geeking-out-over-lignocellulose>

Oregon Low Carbon Fuel Standards (LLCFS). In Europe, the market is driven by national implementations of the EU's Renewable Energy Directive (RED). In the future, it is likely that these policies will be complemented by new policies to drive alternative fuel use in aviation.

Following the successful opening of the HVO unit at Porvoo Neste subsequently opened larger facilities in Singapore and Rotterdam. The Singapore facility has a production capacity of 1.3 million tonnes which is due to be doubled to 2.6 million tonnes by the end of this year⁴. The Rotterdam facility can produce 1.4 million tonnes of fuel a year, which Neste have announced they intend to almost double to 2.7 million tonnes by 2026⁵. Neste is also engaged in a 50:50 joint venture with Marathon Petroleum Corporation to deliver a refinery conversion to produce HVO in Martinez, California. Once these expansions and retrofit are completed, Neste will have a global renewable fuel production capacity of nearly 7 million tonnes. Neste is a major player in the biofuel market – 7 million tonnes of output is roughly equivalent to total global HVO production in 2021.

FEEDSTOCK

The hydrotreating process requires vegetable oils or animal fats as feedstocks. Bio-oils and fats have a degree of chemical similarity to hydrocarbon fuels, and therefore relatively little chemical processing is required to produce fuel molecules from these resources. Indeed, it is possible to run a diesel engine directly on vegetable oils (Rudolf Diesel's original engine ran on peanut oil) although it is not recommended to do this with a modern vehicle – it would probably work, but not indefinitely! One route to produce a diesel-substitute fuel from bio-oils and fats is called 'transesterification'

and involves reacting the oils/fats with methanol in the presence of a catalyst, which produces a 'fatty acid methyl ester' commonly referred to as biodiesel as well as crude glycerine as a by-product. Biodiesel still contains some oxygen atoms and is not a full substitute for fossil diesel in current engines – biodiesel blending is therefore limited (in Europe the standard limit is 7%). By using hydrogen to remove the oxygen atoms, hydrotreating produces a synthetic fuel consisting of molecules that are the same as paraffinic molecules in fossil diesel and that can be safely blended at any rate up to 100% with fossil diesel without reducing engine performance. This synthetic fuel actually burns more cleanly than fossil diesel as it contains fewer impurities, in particular being an exceedingly low sulphur fuel.

As a result of the biofuel boom of the last 20 years, biodiesel and HVO production have become major sources of demand for bio-oils and fats. According to statistics published by the OECD and FAO⁶ in the year 2000 an amount of vegetable oil equivalent to 6% of the EU vegetable oil supply⁷ was used for biofuel production – by 2022 this had increased to 51% (this does not include the use of waste and residual lipids such as used cooking oil and rendered animal fats). According to these statistics, the use of vegetable oils for biofuel has exceeded the use of vegetable oils for food for human consumption in the EU in most years since 2010. At the global level, diversion of vegetable oils to biofuel markets has gone from 0.8% of production in 2000 to 16% in 2022, and the IEA anticipates that it will reach 23% by 2025⁸.

2 shows the feedstocks that Neste has reported using for HVO production from 2011 to 2022, and the

percentage of their renewable feedstock that was palm oil in each year. It is apparent that Neste has successfully transitioned from a palm oil dominated feedstock base in the early years of operating its NexBTL facilities to a feedstock base dominated by 'secondary' oils, i.e. bio-oils and fats⁹ that are not the main oil products from an agricultural system. Neste refers to these secondary oils as 'wastes and residues', but the identification of materials as wastes and residues can be contentious, and the definitions of these terms varies between jurisdictions¹⁰. It is important to recognise that Neste's characterisation of waste and residual oils includes at least three oil-palm-based feedstocks – palm stearin, palm fatty acid distillates, and oil recovered from palm oil mill effluents. Palm stearin is the fraction of crude palm oil that is solid at room temperature, which can be separated from palm olein through a fractionation process. Palm stearin is generally understood to be one of the co-products of the palm oil industry, rather than a residue, and to the best of our knowledge palm stearin is not treated as a residue under the Renewable Energy Directive by any Member State. We believe that Neste revised its internal classification of palm stearin at some point around 2016 – the 2015 Annual Report identifies stearin in a list of utilised 'wastes and residues', but the 2017 annual report states that palm stearin is included in the resources identified as "certified palm oil".

Palm oil

As seen in 2, palm oil was a key feedstock for Neste's early expansion of HVO production. Indeed, the reliance on palm oil provides context for the placement of one of Neste's plants in Singapore, in Southeast Asia. The palm oil industry as a whole is associated with a number of

4) <https://www.neste.com/about-neste/who-we-are/production/singapore>

5) <https://www.neste.com/releases-and-news/renewable-solutions/neste-invests-its-world-scale-renewable-products-refinery-rotterdam>

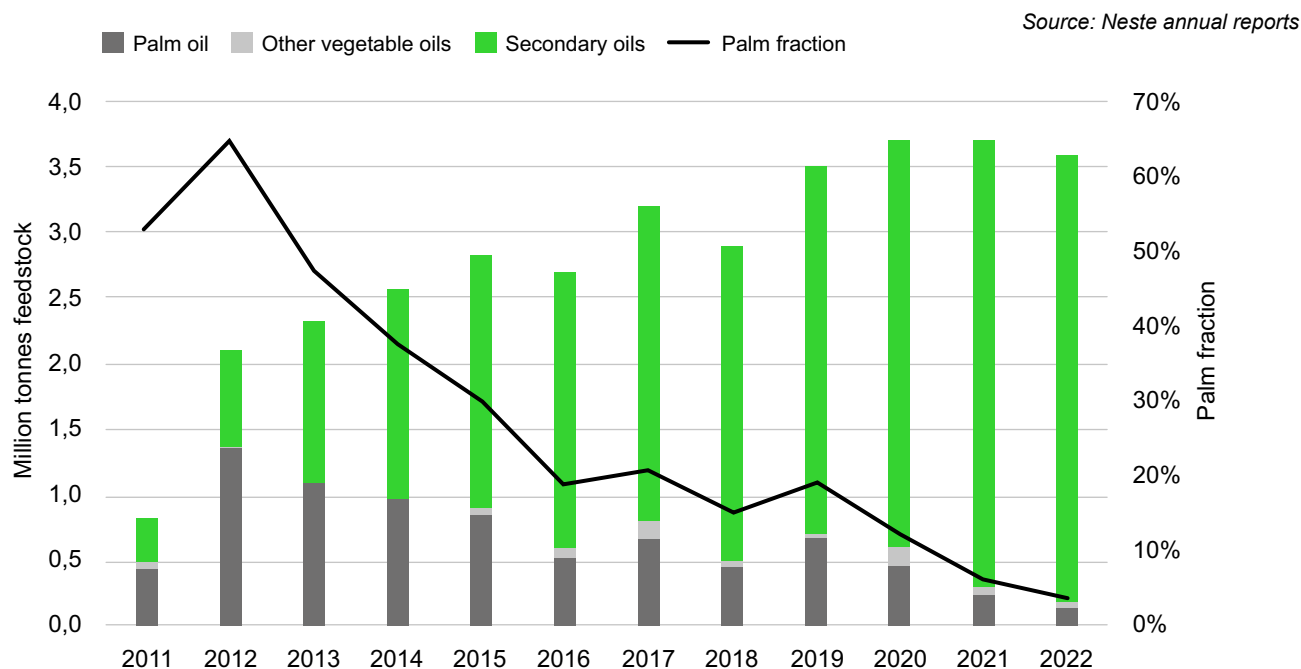
6) <https://stats.oecd.org/viewhtml.aspx?QueryId=114427>

7) Defined here as vegetable oil production plus net vegetable oil imports.

8) <https://www.iea.org/reports/is-the-biofuel-industry-approaching-a-feedstock-crunch>

9) In common parlance 'oils' refers to materials constituted of lipids that are liquid at room temperature, while fats refers to materials constituted of lipids that are solid at room temperature. In this note, for brevity we sometimes use the word oil to refer to both bio-oils and fats, of both vegetable and animal origin.

10) Cf. the 2015 ICF report Waste, Residue and By-Product Definitions for the California Low Carbon Fuel Standard https://theicct.org/wp-content/uploads/2021/06/ICF_LCFS_Biofuel_Categorization_Final_Report_011816-1.pdf

FIGURE 2 NESTE USE OF RENEWABLE RAW MATERIALS


Notes: 1) Secondary oils includes some combination of PFADs, animal fats, fish oils, other food processing residues, and palm stearin; 2) In some years we have calculated consumption of other vegetable oils as the difference between other reported values, and the calculated values may be affected by rounding issues.

fundamental sustainability issues. From a climate change point of view, the most problematic issues are the association of oil palm expansion with peat drainage and with deforestation¹¹, and the issue of methane emissions from palm oil mill effluent ponds. There are also well rehearsed concerns relating to biodiversity loss due to plantation expansion, land rights conflicts with local and indigenous communities, and with the treatment of workers.

Some of these sustainability issues can be addressed through sustainability certification schemes, and Neste has been proactive in achieving a fully certified feedstock supply chain. Neste reported that all the plantations from which they sourced crude palm oil had received sustainability certification from either the Roundtable on Sustainable Palm Oil (RSPO) or the International Sustainability and Carbon Certification (ISCC) by the end of 2013. Certification by these schemes provides assurance that various good practices are observed

in agricultural practices and environmental stewardship, and that key workers' rights and local community land rights are respected. Certification cannot provide a cast iron guarantee against problematic practices (for example Neste reported that they ceased sourcing material from the company IOI between April 2016 and December 2017 as a result of identified environmental issues at some of its plantations) but significantly reduces the likelihood of bad practice in the supply chain.

Certification can deal with some environmental concerns, but it does not provide protection against indirect, market mediated, impacts from feedstock use – notably indirect land use change (ILUC) and impacts on food prices and food security. ILUC refers to the expectation that increasing demand for biofuel feedstocks leads more land to be converted to agricultural production, even if the specific batches of feedstock processed into biofuels

are sourced from existing plantations or farms. Land conversion results in the emission to the atmosphere of carbon previously stored in vegetation and soils, with the highest carbon emissions being associated with deforestation and peat loss. There is an extensive body of evidence¹² to suggest that the ILUC emissions associated with palm oil use for biofuel production eliminate any climate benefit from replacing fossil fuels with palm oil HVO. One modelling exercise for the European Commission estimates that the land use change GHG emissions associated with using a litre of palm oil biodiesel were about three times higher than the GHG emissions from burning a litre of diesel fuel.¹³ Research for Rainforest Foundation Norway¹⁴ estimated that the difference between low and high scenarios for global palm oil consumption for biofuel in 2030 could be an additional 3.8 million hectares of deforestation and 6 billion tonnes of CO₂ emissions.

11) Cf. the 2019 Ceruly report Risk management <https://www.ceruly.com/risk-management/>

12) Ibid.

13) The land use change impact of biofuels consumed in the EU https://energy.ec.europa.eu/publications/land-use-change-impact-biofuels-consumed-eu_en

14) Driving deforestation, <https://www.ceruly.com/driving-deforestation/>

The identification of palm oil as a high indirect land use change risk feedstock has led the European Union to adopt rules requiring incentives for conventional¹⁵ palm oil biofuels to be eliminated by Member States by 2030 at the latest – and several Member States have already enacted restrictions on palm oil biofuels. Similarly, in the United States palm-oil-based biofuels are not eligible to receive support under the federal Renewable Fuel Standard or the California Low Carbon Fuel Standard due to ILUC concerns.

Neste had reduced palm oil to 4% of its renewable feedstock in 2022 and has stated that it will fully eliminate conventionally produced palm oil from its feedstock base by 2025.

Palm fatty acid distillate (PFAD)

One of the materials Neste includes in its characterisation of waste and residues is palm fatty acid distillate, PFAD. Palm oil, like other vegetable oils, is composed primarily of triglyceride molecules, but during the process of harvesting and transporting fresh fruit bunches and storing them prior to oil extraction some of these molecules can be degraded, resulting in the formation of free fatty acids¹⁶. These free fatty acids are removed from the crude palm oil by distillation, resulting in a lower value product stream with about 80% free fatty acid content that is referred to as PFAD. Gapor Md Top (2010)¹⁷ estimates that the produced quantity of PFAD is typically about 4% of the produced quantity of crude palm oil. Neste characterises PFAD as a residue and claims that, “PFAD use does not increase pressure to expand oil palm farming”¹⁸, but this assertion is strongly contested. PFAD has a range of established

uses, and the market price per tonne of PFAD has typically been around 80% of the market price per tonne of crude palm oil¹⁹. The price per unit mass of PFAD is higher than that of many primary agricultural products, including soybeans, maize, and wheat. Even before the market for PFAD as a biofuel feedstock became available, PFAD was 100% utilised, with applications in oleochemicals, the soap industry and in livestock feed. This means that shifting the available supply of PFAD into biofuel production displaces it from other uses, where it needs to be replaced. The characteristics of PFAD are similar to other vegetable oils, and the obvious replacement for PFAD in many applications would be palm oil²⁰, as the lowest cost readily available substitute. It is impossible to conclude from a balanced review that displacing PFAD from existing markets will not lead to increased palm oil demand: the net impact of increasing the consumption of PFAD in biofuel production is to increase global palm oil demand by a proportionate amount²¹. Given the high risk of deforestation, peat loss and ILUC emissions from increasing palm oil demand, it can be expected that diverting PFAD into biofuel production will result in net increases rather than reductions in global GHG emissions.

While Neste continues to identify PFAD as a residue, there are several jurisdictions where it is not eligible for the benefits granted to other residual feedstocks. In the EU, PFAD does not feature on the list of non-food materials that are identified as eligible for additional support in Annex IX of the Renewable Energy Directive and was not included in a recent list of proposed additions to

that Annex²² after a review for the European Commission concluded that incentives to use PFAD would be likely to lead to market distortions²³. In the UK, PFAD is identified as a ‘product’ rather than as a residue under the Renewable Transport Fuel Obligation²⁴. In the United States, PFADs are excluded by the U.S. EPA from the approved Renewable Fuel Standard pathway for biofuels from free fatty acids²⁵ because “additional analysis is needed to determine whether fuel produced from PFAD would qualify for the applicable GHG reduction thresholds”, and in California there is no approved pathway for PFAD-based fuels to be granted Low Carbon Fuel Standard credits (at least one application for an emissions pathway for PFAD based fuel under the Low Carbon Fuel Standard has been unsuccessful).

Animal fats

Another material stream identified in Neste’s lists of wastes and residues is ‘animal fat from food industry waste’, with the 2022 Annual Report stating that, “Animal fat is derived from the food industry’s meat processing waste. Neste sources mixed animal fat waste that is unsuitable for human consumption.” This framing avoids making direct reference to the system of animal by-product categories in use in the EU, where category 1 and 2 material are considered high risk and have their uses strictly limited, while category 3 material is considered low risk and includes parts of animals that have been passed fit for human consumption in a slaughterhouse but which are not intended for human food. Category 1 and 2 materials are eligible for additional support under the Renewable Energy Directive, but category 3

15) There is scope under these rules for certified ‘low ILUC-risk’ palm oil to continue to be used.

16) Cf. https://goldenagri.com.sg/wp-content/uploads/2020/06/PFAD-Factsheet_20200605-R.pdf

17) <https://onlinelibrary.wiley.com/doi/10.1002/lite.200900070>

18) <https://www.neste.com/products/all-products/raw-materials/pfad-residue-palm-oil-refining>

19) See the 2017 Cerulogy report *Waste not want not* <https://theicct.org/publication/waste-not-want-not-understanding-the-greenhouse-gas-implications-of-diverting-waste-and-residual-materials-to-biofuel-production/>

20) Ibid.

21) Noting that some existing uses of PFAD may not be replaced, and some may be met with other materials, so it is expected that net palm oil demand will increase by something less than one tonne for every tonne of PFAD displaced into biofuel use.

22) https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13484-Biofuels-updated-list-of-sustainable-biofuel-feedstocks_en

23) “The current demand for PFAD across several industries already matches its supply. Given that this supply is rigid, diverting PFAD away from these industries to biofuel production has a high risk of having distortive effect on these industries.” https://op.europa.eu/en/publication-detail/-/publication/ec9c1003-76a7-11ed-9887-01aa75ed71a1/language-en?_publicationDetails_PublicationDetailsPortlet_source=277176502

24) <https://www.gov.uk/government/publications/renewable-transport-fuel-obligation-rfto-feedstock-materials-used-for-creating-renewable-fuels/rfto-list-of-feedstocks-including-wastes-and-residues>

25) <https://www.epa.gov/sites/default/files/2021-12/documents/rfs-2020-2021-2022-rvo-standards-nprm-2021-12-07.pdf>

material is not. According to statistics from the European renderers' association EFPRA, almost all category 1 & 2 material produced in Europe is now destined for biofuel production, but the use of category 3 material is divided between animal feed, oleochemical applications and biofuels. Documents released in the context of the acquisition by Neste of the company Demeter Animal Fats and Proteins confirm that Neste (as of 2018 at least) has been active in purchasing category 3 animal fats for biofuel use²⁶.

Similar to PFAD, animal fats have existing productive uses in the economy, and therefore using them for biofuel feedstock creates a need for replacement products. Prior to the growth of the biofuel market category 1 & 2 material was largely combusted for heat and/or power.²⁷ The growth of the biofuel industry has therefore largely moved this material from one bioenergy application to another. Category 3 material has a much wider array of uses – and like PFAD, the alternative feedstocks for those feed and oleochemical applications are other vegetable oils, and in particular palm oil. As with PFAD, there is therefore a considerable risk that increasing the use of category 3 animal fats for biofuel feedstock drives expansion of vegetable oil production (including palm oil) and causes indirect deforestation and net increases rather than reductions in global CO₂ emissions.

Other secondary oils

Beyond animal fats and PFAD, a range of other waste or residual oils are available as by-products of various processes, and Neste has been proactive in developing supply chains for some of these materials. Some materials that have become biofuel feedstocks would otherwise likely have been unutilised. For

example, Neste identifies oil recovered from palm oil mill effluent (POME) as one of its waste and residual feedstocks, and data from the EU's SHARES system reports that 27 thousand tonnes of oil equivalent of POME-derived fuels were supplied in the EU in 2021. Previously, the oily material in mill effluent ponds would not have been recovered, and therefore recovering this material is clearly a positive step that will not cause displacement emissions (and POME is included Part A of Annex IX of the Renewable Energy Directive, so that fuels produced from POME count as advanced biofuels). Other fatty residues may already have collection and supply systems in place, so that moving them into biofuel use would raise similar concerns to the use of PFAD and animal fats. For example, Neste have also identified "technical corn oil" as a waste or residue. Technical corn oil is produced as a by-product of corn ethanol production. If it were not separated out, then that oily material would be included in existing animal feed rations (distillers' grains and solubles) and having been separated from the distillers' grains it could still be supplied for animal feed use instead of biofuel use.

The larger picture is that the global supply of secondary oils is limited. If Neste can mobilise resources that are currently underutilised that can make a real contribution to delivering GHG savings, but the volumes thus available are small compared to demand for transport fuels. Analysis by the IEA suggests that HVO production is set to rapidly exhaust the available global supply of residual oils if the HVO boom continues²⁸, with inevitable impacts for industries that currently rely on those materials. Moving secondary vegetable oils from existing uses into road biofuel production, or from road biofuel production to aviation biofuel

production, will predictably lead to increased demand for virgin vegetable oils in those existing uses. It is therefore not realistic to believe that prioritising secondary oils can avoid ILUC impacts and vegetable oil price impacts.

CAPACITY EXPANSION; MARKET RISK; REPUTATIONAL RISK; REGULATORY RISK

Neste has been at the forefront of the development of the HVO market, but favourable market conditions for HVO sales (as well as seeing Neste's success) have inspired numerous other companies to make investments and the world is currently in the middle of an HVO boom²⁹ with HVO industry expanding capacity very rapidly, especially in the United States. The U.S. Energy Information Administration reported in February of 2023 that planned capacity additions could double U.S. domestic capacity between the start of 2023 and the end of 2025.³⁰ This rapid expansion of HVO capacity is not currently reflected in the rate of expansion of government mandates for the use of biomass-based diesel fuels. In the EU, the use of vegetable oils from food crops under the RED has been capped, and the European Commission has given clear indications that it sees more advanced alternative fuel technologies as the future. In the U.S., the EPA has been cautious for several years about mandating excessive growth in the biomass-based diesel market due to concerns about feedstock availability. There is clear evidence that the HVO industry is expanding capacity faster than demand will follow³¹. The evidence suggests that in the next two to five years we should anticipate a period of intense competition for market face and for feedstock between incumbent HVO producers, new market entrants, and incumbent companies in the biodiesel industry. This competition

26) https://ec.europa.eu/competition/mergers/cases/decisions/m8823_317_3.pdf

27) <https://www.transportenvironment.org/discover/pigs-do-fly-growing-use-of-animal-fats-in-cars-and-planes-increasingly-unsustainable/>

28) IEA modelling suggests that by 2027 biofuel production will consume two thirds of the global supply of what it considers to be residual oils, up from 30% in 2020, <https://www.iea.org/reports/is-the-biofuel-industry-approaching-a-feedstock-crunch>.

29) See e.g. <https://www.reuters.com/article/us-global-oil-biofuels-insight-idUSKBN2AV1BS>

30) <https://www.eia.gov/todayinenergy/detail.php?id=55399>

31) Animal, vegetable or mineral (oil)? <https://www.cerology.com/animal-vegetable-or-mineral-oil/>

will put more upward pressure on feedstock prices, especially for waste and residual materials, and is likely to lead to reduced margins and to some players being forced out of the market.

It is not unusual for a period of market adjustment to follow a rapid capacity expansion, and while the outcome just described could exert a downward pressure on Neste profit margins, Neste is likely relatively well positioned to defend its feedstock supply chain, even if this requires a period of reduced profitability. A more fundamental risk to Neste in terms of reputation and future market opportunities arises from being committed to expand the production of biofuels from a portfolio of feedstocks that many analysts believe have very mixed climate performance, and that threaten food security by the scale of their production. Feedstocks like palm oil and PFAD have already been

subject to regulatory limitation. Animal fats remain well supported but are controversial. Even the growing consumption of used cooking oil has caused concerns about the vulnerability of supply chains to mislabelling fraud³².

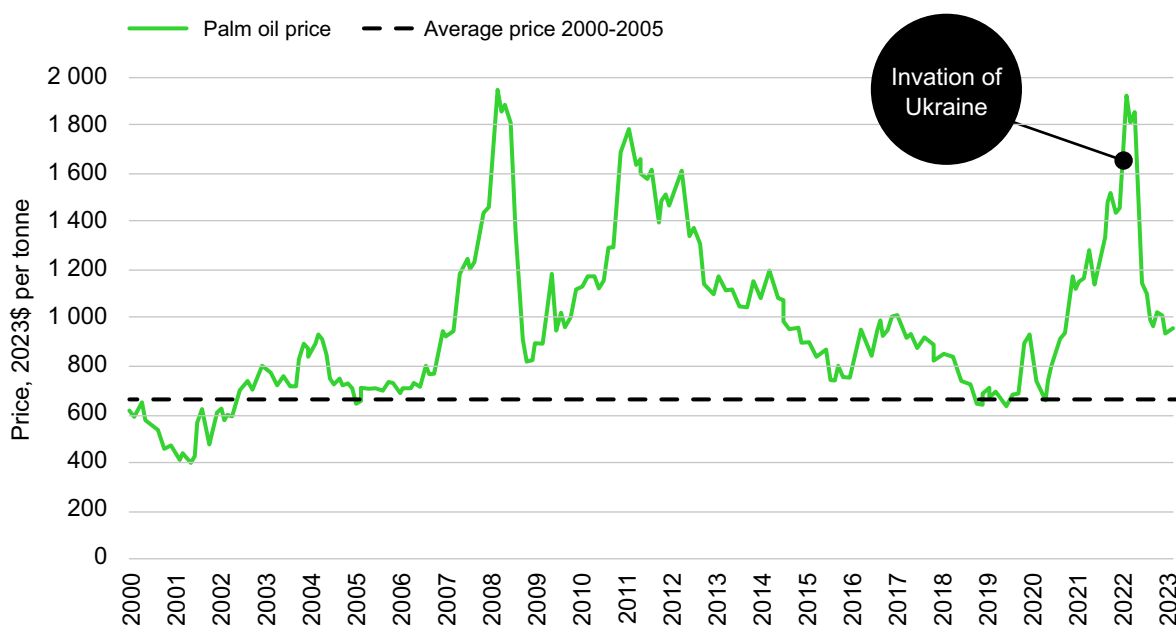
In the words of the International Energy Agency, the current growth in HVO capacity and production threaten to lead to a feedstock crunch³³, which would increase costs in the industry, push vegetable oil prices higher and could have highly negative impacts on global food security. 3 shows the evolution of the price of palm oil over the period from 2000 to 2023.

There are three significant price spikes apparent in the period – the food price crises of 2007/08 and 2011/12, and a recent spike in prices which started during 2021 and was exacerbated by the start of the conflict in Ukraine. Even though prices have now fallen back below

\$1,000 a tonne, the price reported for March 2023 was still about 50% higher than an inflation-adjusted average price for the period 2000–2005. These price rises have real impacts on consumers in many of the world's poorest nations – the International Food Policy Research Institute has pointed out in the context of the recent price spikes that most African nations import a large fraction (often more than half) of the vegetable oil they consume³⁴. There is an extensive literature that discusses the contributing role of biofuel demand in driving the two earlier food price crises³⁵, and many commentators have identified surging HVO capacity as a contributing factor in the more recent price spike³⁶ (alongside factors like residual labour shortages due to COVID and poor growing conditions in Malaysia). HVO capacity expansion is expected to significantly outstrip global vegetable oil production growth³⁷, and will therefore be in direct

FIGURE 3 PALM OIL PRICE (REAL, 2023\$) 2000 TO 2023

Source: World Bank 'Pink Sheet' monthly prices <https://www.worldbank.org/en/research/commodity-markets>



Note: Adjusted for inflation based on annual U.S. cpi values taken from <https://www.usinflationcalculator.com/>

32) <https://www.euractiv.com/section/biofuels/news/eu-incapable-of-detecting-fraud-in-biofuel-imports-complainant-says/>

33) <https://www.iea.org/reports/is-the-biofuel-industry-approaching-a-feedstock-crunch>

34) <https://www.ifpri.org/blog/impact-ukraine-crisis-global-vegetable-oil-market>

35) Cf. the Cerulogy report Thought for Food, <https://www.cerulogy.com/thought-for-food/>

36) See for example this article in the Wall Street Journal <https://www.wsj.com/articles/renewable-fuel-push-drives-soy-oil-prices-to-record-high-11622980800>; this article from CME Group <https://www.cmegroup.com/articles/2022/low-carbon-fuels-drive-vegetable-oil-price-volatility.html>; this article from Reuters <https://www.reuters.com/article/us-global-oil-biofuels-insight-idUSKBN2AV1BS>.

37) Cf. The Cerulogy report Animal, vegetable or mineral (oil)? <https://www.cerulogy.com/animal-vegetable-or-mineral-oil/>

competition with forecast increases in demand for oils for human consumption.

These issues of indirect land use change, of displacement of wastes from other uses and of food security impacts have been a focus of environmental and development groups for some years, and as we noted above policy has gradually adjusted to give less favourable treatments for the most problematic feedstocks like palm oil and PFAD, and to signal that growth in the use of food oils for biofuel cannot be allowed to grow without limit. At each revision of the key biofuel mandates, the HVO industry faces the risk of stagnation or loss of market share. Neste and other similar businesses may also increasingly find themselves on the wrong side of institutional sustainable investment principles. While Neste has worked through sustainability schemes such as the Roundtable on Sustainable Palm Oil with a view to keeping its palm oil supply chain free of direct deforestation and has committed to improve traceability in its PFAD supply chain³⁸, investors are increasingly also concerned with indirect impacts and the idea of systemic risk to the climate, forests, and biodiversity³⁹. There are already examples of investment banks adopting policies that demand the companies should understand and seek to reduce their indirect impacts⁴⁰, to have strategies to reduce indirect GHG emissions and have strategies to manage and reduce indirect impacts on tropical forest loss and on biodiversity loss. For Neste, understanding and managing these risks (and meeting these expectations) would first require acknowledging that their consumption of PFAD and animal fats have indirect impacts on

forest area by adding pressure to the palm oil market. This would not be the first time that Neste had had to accept that materials it had previously identified as wastes or residues are products with valuable existing uses – as late its 2013 Annual Report Neste was including palm stearin (a palm oil fraction used in applications including margarine) in its list of ‘wastes and residues’, but has had to accept that it is treated the same by regulatory as the slightly higher value palm olein fraction.

The limited prospects for growth in on-road HVO consumption give context for the enthusiasm of Neste and other HVO producers to pivot into alternative aviation fuels⁴¹. There is currently lively interest in renewable aviation fuels, as governments and industry try to justify continued expansion of the energy-intensive aviation industry in the context of the climate crisis. Low carbon aviation fuels are the only option currently on the table that would allow aviation to claim to be delivering significant in-sector emissions reductions without fundamental disruption to existing business models and the deployment of novel and untested hydrogen or electric aircraft (or drastically reducing the rate of aviation growth). The European Union’s proposal for a “REFuelEU” mandate for the use of renewable aviation fuels excludes food-based fuels from support but identifies HVO renewable jet from used cooking oil and animal fats as an important contributor to meeting 2030 aspirations. Similarly in the U.S. HVO renewable jet fuel is identified as an important part of the “SAF Grand Challenge Roadmap”⁴², which states that, “Lipids are the feedstock to produce SAF through the HEFA pathway and will make up

the vast majority of feedstock to meet the U.S. goal of 3 billion gal/yr by 2030”. The European policy in particular has looked to constrain the production of fuels that may not be sustainable, proposing that support should be limited to fuels from feedstocks that have been assessed to receive extra support under the RED. Neste has called for a broader range of secondary oils to be made eligible⁴³, presumably hoping to be permitted to supply aviation fuels from PFADs and other secondary products that have clear existing markets.

While it is true that the adoption of alternative aviation fuel policies improves the short term outlook for HVO producers, there is a growing recognition among policy makers that HVO is not a technology with long-term potential. It is generally accepted that HVO production is not scalable to make a major contribution to eliminating fossil fuels from road and aviation, because the feedstock base is limited. This recognition can be seen in the consultation on a UK renewable aviation fuel mandate, which proposes to cap the contribution of HVO renewable jet for the following reasons⁴⁴:

The purpose of a [HVO]⁴⁵ cap is to ensure that introducing a SAF mandate does not divert feedstock away from existing uses or raise concerns over sustainability by increasing demand for certain feedstocks. In particular, we want to ensure that [HVO] use in aviation does not lead to diversion of feedstocks that are still required for the decarbonisation of difficult-to-decarbonise road transport vehicles. ...

38) <https://www.neste.com/sustainability/sustainable-supply-chain/traceability-dashboard/pfad-dashboard>

39) See e.g. <https://www.lazardassetmanagement.com/references/sustainable-investing/demystifying-sustainability/why-biodiversity>

40) E.g. Norges Bank, <https://www.nbim.no/en/publications/expectation-documents/>

41) See e.g. https://www.neste.com/products/all-products/saf?gclid=CjwKCAJwuqiiBhBtEiWATgvixG-yamP3vNbZzkDcvh8GEuvqqkC-y0FKz4x3-KIH6auP-JNOTAxkpbxoCjGkQAvD_BwE

42) <https://www.energy.gov/sites/default/files/2022-09/beto-saf-gc-roadmap-report-sept-2022.pdf>

43) https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12303-Sustainable-aviation-fuels-ReFuelEU-Aviation/F513316_en

44) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147350/pathway-to-net-zero-aviation-developing-the-uk-sustainable-aviation-fuel-mandate.pdf

45) The UK consultation actually uses the abbreviation ‘HEFA’ (hydro-processed esters and fatty acids), which is a term that is essentially synonymous with HVO but is often used in an aviation context.

Additionally, a [HVO] cap can help ensure that a variety of SAF production pathways which use a wide range of feedstocks are incentivised. This would reduce the risks that come with reliance on only one type of feedstock or processing technology, and in turn increase energy security. This should also help to encourage investment into less commercialised SAF production technologies which will be needed to ensure a diverse portfolio of production methods exists in the future.

In the likely event that growing production of HVO diesel and jet fuels contributes to further price spikes in the vegetable oil market over the coming decade, there is a considerable risk that regulators will start to see HVO as not only a dead-end in terms of contribution to the 2050 economy but as a pathway that has more downside than upside right now. This could lead to the adoption of new and stronger rules favouring more sustainable cellulosic biofuel and power-to-liquids technologies over HVO production. This would be analogous to the downward revisions in ambition for food-based biofuels that were seen in the early 2010s because of concerns and ILUC and food versus fuels, which contributed to over-capacity and plant closures in the biodiesel market⁴⁶. Today, the existing biodiesel industry is facing a period of decline and plant closures due to competition from HVO⁴⁷. The current generation of HVO expansions may face a similarly uncertain future.

RECOMMENDATIONS

At the moment, Neste is firmly committed to the HVO industry. Even recognising the threats to the long-term outlook for the HVO business it would not be realistic to expect Neste to divest from 7 million tonnes of existing and planned production capacity. This is, however, an industry that has a questionable long-term outlook. Neste finds itself at an unfortunate nexus. A global HVO business that turns food resources into fuel at the expense of food consumers while potentially driving deforestation, harming biodiversity and increasing net GHG emissions, all to enable the aviation industry to keep on growing, is guaranteed to draw the unwelcome attention of climate change and social justice campaigners, and will be increasingly be identified by investors as posing serious systemic sustainability risks.

Just as Neste has started to pivot away from fossil fuel production over the past fifteen years, it's best chance for long-term success is to start to pivot away from HVO as well. Neste's proudly held position on the Corporate Knights Global 100 is dependent on Corporate Knights identifying 69% of Neste's investments as sustainable (2022 ranking, Neste are 24th). Given the pressure being exerted on vegetable oil markets and thereby on deforestation by the HVO industry, we would argue that additional investments in HVO expansion should not be considered sustainable. Investors should call on Neste to adopt the following measures if it is to live up to its goal of being a positive force combating climate change:

1. Commit to halting capital investment in expanding HVO capacity either at existing facilities or at new locations.
2. Provide transparency for investors by distinguishing in reporting between feedstock materials without existing alternative applications and materials such as PFAD and animal fats that are already well utilised and therefore may be subjected to further regulatory limitation.
3. Where possible, continue to develop new lipid supply chains that do not interfere with food market, as with the recovery of oil from palm oil mill effluent. This could include initiatives to increase collection of used cooking oils, to extract lipids that are currently unutilised from industrial waste streams, and to develop novel low ILUC-risk cropping systems to supply genuinely additional feedstock.
4. Redirect capital expenditures to developing more sustainable feedstock supply systems and into opportunities to commercialise more scalable renewable technologies such as cellulosic biofuel production and e-fuels.

46) E.g., <https://www.reuters.com/article/cargill-biodiesel-germany-idINL5E8M7BXX20121107>

47) See e.g. <https://www.dtnpf.com/agriculture/web/ag/news/business-inputs/article/2022/02/17/biodiesel-industry-bleeds-red-2021>

Alternative feedstock systems

The recommendations above include the development of alternative lipid supply chains to feed Neste's existing HVO capacity and investment in more scalable advanced alternative fuel technologies. This annex provides a brief discussion of the options that may be available to Neste in this regard.

1 Alternative lipids

The global vegetable oil market is under ongoing pressure due to growth in the production of biodiesel and renewable diesel. This pressure expresses itself through indirect land use change (agricultural area expansion in response to demand pressure) and increased food prices. At the time of writing, vegetable oil prices are reducing after an extended price spike (which was exacerbated but not caused by the war in Ukraine) but remain well above price levels from before the biofuel boom got going in the mid-2000s.

Operating HVO facilities without adding pressure to the vegetable oil market requires either sourcing waste and residual lipids that would not otherwise have had a high-value productive use, or sourcing crop-based lipids that would not otherwise have been produced.

The scope to source additional waste and residual lipids is believed to be limited. For example, in the U.S. the Environmental Protection Agency has observed that "Most of the waste oils, fats, and greases that can be recovered economically are already being recovered and used in biodiesel and renewable diesel production or for other purposes" in setting the 2021 biomass-based diesel obligations under the RFS. In the EU, an assessment of potential waste and residual biofuel feedstocks¹ identified some potential sources of lipids that may not yet be fully exploited, such as 'brown grease' from restaurant grease traps, residues from high oleic sunflower oil production and palm pressed fibre oil. There is also potential to increase household collection of used cooking oil resources, but these resources are diffuse by definition and mobilising them would require coordination with large numbers of local authorities². It is our understanding that Neste has been proactive in seeking to develop supply chains for alternative waste lipids, and therefore it is likely that Neste has as good an understanding as any institution in the world about the real potential to increase exploitation of these resources.

Increasing sourcing of these lowest value lipids may therefore be more a question of further shifting Neste's internal prioritisation of different feedstock streams than of fundamentally new practices.

Low ILUC-risk vegetable oil production models have a much greater potential in principle than increasing the collection of waste and residual lipids. A report by McKinsey for the World Economic Forum³ suggested a potential for 170 million tonnes of vegetable oil per year from a combination of 'oil trees' grown on degraded land and oilseeds grown as off-season cover crops, although these estimates of potential are extremely sensitive to assumptions about land competition (including from traditional use and from ecological restoration and rewilding), about achievable yields and about production costs and therefore should be taken only as very loose indications of the scale of the potential. Examples of oil crops that might be produced on low quality land include jatropha, pongamia and castor oil. Commercialising production of vegetable oils on low quality land has proved challenging in the past, for the same reasons that agricultural projects on low quality land are

1) <https://www.e4tech.com/resources/239-assessment-of-the-potential-for-new-feedstocks-for-the-production-of-advanced-biofuels-renewable-energy-directive-annex-ix.php>

2) https://theicct.org/wp-content/uploads/2021/06/Greenea-Report-Household-UCO-Collection-in-the-EU_ICCT_20160629.pdf

3) <https://www.mckinsey.com/~media/mckinsey/industries/travel%20transport%20and%20logistics/our%20insights/scaling%20sustainable%20aviation%20fuel%20today%20for%20clean%20skies%20tomorrow/clean-skies-for-tomorrow.pdf>

difficult for any market – the availability of land at low cost is offset by increased production and administrative costs associated with working on large areas at low yields. Jatropha has been through one major cycle of investment and disappointment before – around 2010 a first rush to develop jatropha plantations in the developing world failed with serious financial consequences for the investors and companies involved, and deleterious impacts on the livelihoods of farmers who had committed to planting jatropha⁴. Investment in new cropping models for unused or under-used land should be done cautiously, and if they are to be rolled out in the developing world they should be done in consultative partnership with local communities in order to avoid the appearance (or indeed the reality) of land grabbing.

Cover cropping models are based around the idea of growing an additional crop (generally a second crop but in some contexts potentially a third) during a period of the year in which a productive crop has traditionally not been considered possible/economically viable. One example of such a production system has been piloted by the Finnish company UPM, producing brassicas as a second crop in Uruguay⁵, another is planting camelina after a cereal crop in the U.S.⁶

2 Cellulosic biofuels

Cellulosic biofuel production refers to the production of fuels from resources such as woody and grassy material that cannot be processed with first generation biofuel technology because additional steps are needed to make the constituent chemical energy chemically available. This can be done through hydrolysing the lignocellulose and fermenting the resulting sugars (cellulosic ethanol) or by achieving thermo-chemical

breakdown of the lignocellulose through pyrolysis (producing pyrolysis oil that can be upgraded to a transport fuel, plus pyrolysis gas and biochar) or gasification (producing hydrogen and carbon monoxide syngas that can be turned into transport fuel using chemical processes such as the Fischer-Tropsch reaction). The commercialisation of some or all of these fuel production pathways has long been a goal of biofuel policy, but due to a combination of technical challenges and weak policy design⁷ success has been rather limited to date. With the adoption of revision to the RED under the Fit for 55 programme, however, support for developing these fuels in the EU is as strong as it has ever been (with a sub-target for advanced alternative fuels in the RED and extra support for aviation applications in REFuelEU) and there is also a strong framework in place in the UK through the development fuel mandate. Neste is already engaged in seeking to develop lignocellulosic pathways⁸, and therefore has an opportunity to accelerate this business strand by refocusing investment away from HVO capacity expansion and into commercialisation.

3 E-fuels

E-fuels refers to fuels produced by chemical synthesis processes using electrolytic hydrogen as a platform. E-fuels have been identified as a key technology for aviation in particular, and renewable e-fuels have the advantage of being much more land efficient than biofuel cropping (solar and wind farms generate more energy per hectare than is possible on a conventional farm). Under the RED, credit is also available for the use of renewable hydrogen in conventional refining operations, which can be a basis to expand electrolysis capacity in advance of deploying synthetic fuel production

systems. It may be possible to integrate e-fuels with cellulosic biofuels by combining electrolytic hydrogen streams with syngas from biomass gasification. Neste has announced its commitment to increase the use of renewable hydrogen at its refineries.⁹ At the Porvoo refinery in Finland it is committed to develop both renewable hydrogen capacity and cellulosic biofuel technologies, and this may therefore represent an opportunity to develop the complementary resources. Neste also has an opportunity to develop the use of renewable hydrogen as a hydro-treating input in its HVO facilities – investing in renewable hydrogen capacity in this way would be a better long-term step than expanding capacity to produce HVO fuels using fossil hydrogen.

4) <https://news.mongabay.com/2023/04/jatropha-the-biofuel-that-bombed-seeks-a-path-to-redemption/>

5) <https://www.upm.com/news-and-stories/articles/2018/06/brassica-carinata--a-new-profitable-winter-crop-alternative/>

6) <https://www.arec.vaes.vt.edu/arec/tidewater/arec-updates/introducing-camelina-in-southeastern-virginia-.html>

7) <https://theicct.org/publication/measuring-and-addressing-investment-risk-in-the-second-generation-biofuels-industry/>

8) <https://www.neste.com/releases-and-news/innovation/neste-progressing-its-projects-innovation-business-platforms-future-growth-renewable-and-circular>

9) <https://www.neste.com/products/all-products/raw-materials/future-raw-materials/renewable-hydrogen>

Rainforest Foundation Norway supports indigenous peoples and traditional populations of the world's rainforests in their efforts to protect their environment and secure their customary rights. RFN was established in 1989 and works with local environmental, indigenous and human rights organisations in the main rainforest countries in the Amazon region, Central Africa, Southeast Asia, and Oceania. RFN is an independent organisation, and part of the international Rainforest Foundation network, with sister organisations in the United Kingdom and the USA.

Rainforest Foundation Norway, Mariboes gate 8, 0183 Oslo Norway

rainforest.no/en