Scenario Analysis aligned with the TCFD recommendations: Methodology & Outcome

Borregaard

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Background

The growing attention to climate change and its financial impacts has created a call for businesses to disclose how climate change is affecting their financial performance and strategy. Historically, reporting of climate risk has been largely non-existent and highly fragmented. To bridge this information gap, the Financial Stability Board created the Task Force on Climate-related Financial Disclosures (TCFD), which came to develop a set of recommendations on climate change disclosures in the financial sector. In particular, the TCFD developed a framework for disclosing climate-related risks to businesses.

The TCFD recommendations take an investor-focused approach to climate-related reporting with the aim of providing investors with the information to ensure their investments are resilient to climate change risks and built for long-term value creation. The TCFD, therefore, recommends the use of Scenario Analysis in the disclosure of climate-related risks and opportunities. Scenario analyses aligned with the TCFD framework help companies explore different futures and the implications of climate-related circumstances on business strategy. It is one of the cornerstones of a complete TCFD report on climate-related risks and opportunities.

A scenario analysis is a process of analyzing future events by considering alternative possible outcomes. It is meant as a tool for companies to make strategic risk management decisions, providing insights and clarifying predictable and uncertain elements in different futures. It is meant to help frame and evaluate the strategic and financial consequences of climate change.

This report has been prepared by CEMAsys Manager Suvi Kaksonen, Senior Consultant Synne Helletun Næss and Consultant Jarl-Eirik Åsheim. Borregaard has contributed with quantitative and qualitative input and key insights.

The report has been updated in 2023 by Consultant Kristina Nordfjord. The update was mainly focused on the water aspect of the scenario analysis, however, there has been made structural changes, and updates according to republishing in 2023.

Methodology

This delivery is a scenario analysis in line with the recommendations laid out by the TCFD. TCFD recommendations state the importance of the development of a sound scenario narrative, before proceeding to quantifying the scenarios. Further quantifications and financial implications of each scenario should be an objective for future maturity reporting levels for Borregaard.

The defined scope and boundary of this project between CEMAsys and Borregaard were determined in collectiveness based on an analytical frame of three main risks and one opportunity, and two future scenarios, specified in the geographical area of Norway and to some extent in other relevant locations.

Identification of risks

A risk is identified by Borregaard to be substantive if the financial impact for the following quantifiable indicators occurs with a frequency of 1-4 years:

Low EBITDA effect:	0-25 mill NOK
Medium EBITDA effect:	25-50 mill NOK
High EBITDA effect:	> 50 mill NOK

EBITDA is defined by Borregaard as operating profit before depreciation, amortization and other income and expenses.

When determining what risks to include in the scenario analyses, the most significant risks were evaluated, in addition to TCFD's recommendations of including scenarios that explore alternatives that will significantly alter the basis for business-as-usual assumptions in a changing environment and society due to the implications of climate change.

Based on a discussion between Borregaard and CEMAsys, the following transitional risks have been included:

- The risk of carbon pricing mechanisms becoming more stringent and changes in energy prices which will increase operational costs and reduce economic activity.
- The risk of reduced wood availability impacting purchasing and operational costs.
- The risk of tighter regulation of water quality and emissions to water due to the EU's Zero emission vision. Water scarcity as a physical risk has also been included.

Further, the following physical risk has been included:

- The risks related to higher global temperatures which will trigger more frequent extreme weather events and chronic weather patterns such as storms, heavy precipitation, flooding, sea rise etc.

The following climate-related opportunity has also been included in the scenario analysis:

- The opportunity for increased demand for biobased products impacting Borregaard's market share and income.

Scenarios

The presented scenarios are descriptions of hypothetical, plausible futures (not forecasts) that help companies to answer the question "what would be the potential implications for our strategy in the future, described in a scenario, came to pass".

The assessed scenarios are mainly based on existing publicly available scenarios:

1. Well-below 2°C scenario: Transition Risk Increase
    - IEA World Energy Outlook (WEO) 2021
        i. IEA Sustainable Development Scenario (SDS)
        ii. IEA Net Zero Emissions (NZE)

2. 4°C scenario: Physical Risk Increase
    - IPCC 5th (RCP 8.5) and 6th AR (SSP5-8.5)
    - Business-as-usual (BAU) Scenario

The two scenarios inform the identified Transition risks and Physical risks:

A. Transition risks are related to the financial risks of not being prepared for the socio-economic changes of a world striving to meet the Paris ambition of limiting global warming to well-below 2°C.
B. Physical risks are related to the financial risks of not being prepared for the physical changes of a world where ambitious climate policies fail or fall short, and the global warming of the world pushes towards 4°C.

The scenarios were selected in order to test Borregaard's resilience and better understand future strategic and financial impacts in both favourable and non-favourable scenarios. Borregaard's short- (1-4 years), medium- (4-7 years (2030)) and long-term time-horizons (7-27 years (2050)) were taken into consideration. The defined reports from IEA and IPCC have functioned as the main sources of information for the analyses of both transition- and physical risks, with supportive input from geographical-specific and industry-specific reports and articles.

The identified risk levels and potential financial impact levels are drawn from professional assessments based on the defined sources in this Methodology.

Identification of water risk

A method for identification of water risk, the World Wide Fund for Nature (WWF) Water Risk Filter is used. The WWF's Water Risk Filter is a tool that aggregates three water risk types: physical, transitional, and reputational. The risk filter is aligned with the UN Global Compact CEO Water Mandate framework and shows overall water risk in a world similar to current socio-economic development trends (SSP2) and intermediate greenhouse gas emission levels.

Narrative well-below 2°C (RCP 2.6/SSP1-2.6 & IEA SDS and NZE)

In this scenario, we assume a rather orderly transition to limit global warming to well-below 2°C. The scenario assumes a rise in climate policy ambition and coordinated, global climate action to start gradually in immediate future. The well-below 2ºC scenario is dominated by transitional risks and opportunities. The well-below 2°C scenario assumes that global CO_2-emissions peaked in 2020 and decline fast. High carbon price is introduced in most economies, and global power is mostly generated using renewables. Due to low demand, fossil fuel prices are low. Customers and investors are increasingly becoming climate-conscious and demand more sustainable products from Borregaard.

In order to meet the goals set in the Paris Agreement to limit global warming to well-below 2°C, new and more stringent regulations will emerge. It is very likely that this will imply an increase in regulations directly impacting Borregaard when the world transitions to a lower-emission economy.

Policy assumptions include:

- Full implementation of EU Green Deal, updated to NDCs and 2030 Climate and Energy Framework, reducing GHG emissions to 55 % below 1990 levels.
- Long-term strategy for climate neutrality by 2050.
- Full implementation of EU Biodiversity Strategy 2030 and EU Forest Strategy 2030.
- EU Water Framework Directive.

The Norwegian government submitted an updated Nationally Determined Contribution under the Paris Agreement in February 2020. The new and enhanced climate target is to reduce greenhouse gas emissions by at least 50 %, and towards 55 % by 2030 (excluding carbon uptake by forests), compared to 1990 levels, in alignment with EU's decision to strengthen its 2030 target. Through the EEA and Norway Grants, Norway supports social and economic cohesion in Europe. A substantial share of the funds is aimed at protecting the environment and developing innovative green and blue economies in the beneficiary states. What the implications of the Commission's 'Fit for 55 package' are for Norwegian companies is yet to be determined. However, Norway has stated that for the next financing period of the Grants, Norway intends to emphasize even further on interventions that can underpin the core objectives of the European Green Deal.

The objective of EU's Water Framework Directive is to achieve good ecological and chemical status for alle water bodies by 2027, for several water bodies this is now prolonged to 2033. The EU's Taxonomy Regulation is designed to support the transformation of the EU economy to meet its EU Green Deal objectives. As a classification tool, it seeks to provide clarity for entities such as companies on which economic activities are sustainable. One of its environmental objectives is sustainable use and protection of water and marine resources. The Do No Significant Harm Criteria for this objective is linked to achieve a good status for the water body which your economic activities can impact.

Risk: Carbon pricing mechanisms and energy cost

An increase in both regional, national, international and industry specific regulations is likely to impact Borregaard financially through increased operating costs.

About 40 countries and more than 20 cities, states and provinces already use carbon pricing mechanisms, with more countries planning to implement them in the future. The choice of the instrument will depend on national and economic circumstances. However, as carbon pricing is seen as a key policy mechanism to curb and mitigate the dangerous impacts of greenhouse gas emissions and drive investments towards cleaner and more efficient alternatives, the EU Commission has stated that the EU ETS allowances in the market will be reduced by 61 % by 2030, compared to 2005. Further, the Commission proposes to apply emissions trading in other sectors, such as transportation, through a separate new system, to build on the result of the current trading system.

An increase in carbon pricing for existing activities and implementation of carbon pricing for new sectors have a significant risk to Borregaard. It will impact Borregaard's operating costs in Norway in the short and medium term before the company transition to lower emission technologies and solutions. Risk levels are expected to decrease in the long term due to the market readiness of new low/zero emission technologies. If society will limit global warming to well-below 2°C it will become more expensive to pollute. The carbon price for companies subject to the EU ETS is expected to increase in advanced economies between 2025-2040, reaching NOK 1 300/tonne in 2040 in the Sustainable Development Scenario. In the Net Zero Emissions Scenario, carbon prices are in place in all regions, rising by 2050 to an average of NOK 2 200/tonne (USD 250). In 2022, 143 000 tCO_2e of Borregaard's Scope 1 and 2 emissions were subject to EU ETS. With the projected carbon prices, this will mean a direct operation cost of more than MNOK 186 in 2040, and up to MNOK 315 in 2050. In 2022, Science Based Target Initiative approved Borregaard's near-term target in line with the 1.5°C scenario, committing the company to reduce its Scope 1 and 2 emissions by at least 42% by 2030. This indicates that the financial impact from increased carbon prices can be lower than the abovementioned projections, as Borregaard will almost halve its emissions subject to EU ETS. The Norwegian Government also recommends companies and activities not subject to the EU ETS to use a price of NOK 2 083/tonne in 2040 when putting a price on their emissions. This indicates that Borregaard's direct and indirect activities not included in the EU ETS, can be subject to high carbon prices in the coming years. Further, the Norwegian Government recommend companies conducting sensitivity analyses to test future resilience against climate change by using a price on carbon of NOK 5 940/tonne in 2040 and NOK 9 029/tonne in 2050. It is stated "in the pricing of greenhouse gas emissions, double counting must be avoided. In some cases, the market price may to a greater or lesser extent reflect the CO_2 tax or quota price. In such cases, a deduction must be made for the CO_2 tax / quota price in the analysis".

In terms of power prices, they are expected to be higher in Europe and in Norway than what we have seen historically. We are in a time of major changes in the energy system in Europe. Only in the last year have there been changes that are likely to have an impact on the power system and power prices in the long run. The EU has decided to raise its emission targets for 2030 and submitted proposals for changes in regulations to achieve

this. This has already contributed to raising the CO_2 price significantly and had a clear effect on power prices in Norway in the last year as countries and companies are demanding more renewable energy. The increased exchange capacity between the Nordic countries and Europe, and the low availability of natural gas in Europe are also impacting the power prices. Power prices will become more volatile, and the average energy price double towards 2040. Due to the increased demand for renewable energy and the increased energy prices, one can assume that increased power production will become more attractive to the suppliers. However, it is expected that the energy consumption will increase more than the energy production until 2030 as there are long planning and licensing processes for new power production. This assumption has been accounted for in NVE's energy marked analysis, and it is projected that the energy price will be lower than 50 øre/kWh in the longer term (after 2040) as renewable power production in Europe increases. In 2022, Borregaard's electricity consumption was about 546 GWh. With a more than doubling in energy prices in the coming years, Borregaard's indirect operation costs is likely to increase in the short to medium timeframe. It is challenging to predict how such a steep price increase will change the market dynamics, but the need for more investments in less energy intensive solutions to reduce yearly cost of energy could be a potential outcome for Borregaard.

Risk: Wood prices and availability

A strengthened forest protection and biodiversity restoration is likely to impact Borregaard's access to its most important raw material: wood. Borregaard's goal is to buy 100% certified wood, which can impact the availability.

Forests are a natural ally in adapting to and fighting climate change and will play a vital role in making Europe the first climate neutral continent by 2050. There is a rapidly accelerating climate and biodiversity crisis, and the next decade is crucial in terms of protecting the nature. The EU Commission is therefore presenting a concrete plan for 2030, combining regulatory, financial, and voluntary measures. It includes measures for strengthening forest protection and restoration, enhancing sustainable forest management, and improving the monitoring and effective decentralized planning on forests in the EU with a view to ensure resilient forest ecosystems and enabling forests to deliver on their multifunctional role. To further support sustainable forest-based bioeconomy for a climate neutral future, the strategy proposes measures for innovation and promotion of new materials and products to replace fossil- based counterparts as well as for boosting the non-wood forest economy. The plan also focuses on sustainable re- and afforestation and is accompanied by a roadmap for planting at least 3 billion additional trees in the EU by 2030.

EU Member States share responsibility for removing carbon from the atmosphere, so the Regulation on Land Use, Forestry and Agriculture sets an overall EU target for carbon removals by natural sinks, equivalent to 310 million tonnes of CO_2 emissions by 2030. This includes legally protecting ecosystems with the most potential to capture and store carbon e.g., boreal forests as they hold the largest terrestrial carbon stocks, also in Norway. Taking care of forest soil becomes particularly important, as there is a strong interdependence between trees and the soil on which they grow. Further, forest soil also works as a natural

carbon sink. Thus, the Commission recommends avoiding unsuitable machinery that cause negative environmental impacts such as soil compaction. EU Member States are also specifically encouraged to set up a payment scheme for ecosystem services to protect biodiversity, drinking water, carbon sequestration, etc. Given that Norway intends to emphasize even further on interventions that can underpin the core objectives of the European Green Deal, and thus, the EU's biodiversity strategy, forest protection could be prominent in Norway's climate strategy as well.

If the EU is going to reach its emissions reduction target of 55 % by 2030, the use of bioenergy and biofuel will increase. It is estimated that the total use of biofuel will increase by 30-70 % by 2030 and triple by 2050 compared to 2020 in a net zero scenario. Even though the type of biomass used in the biofuel is not specified, it could indicate an increased demand for wood and other woody biomasses.

A strengthened forest protection, more use of natural sinks and an increase in the use of bioenergy and biofuels all point in the direction of an increased demand for wood, which potentially can lead to wood shortage and price increase. As wood is Borregaard's most important raw material, higher demand for wood and increased prices can have a high potential financial impact on the company's direct operations in the short to medium term, before the market stabilizes and new technology is developed.

Risk: Changes in regulatory standards to improve water quality and scarcity

Borregaard expect a stricter permit for emissions to water due to revision of environmental regulations under European Green Deal, and the zero-pollution vision for 2050.

Borregaard's long-term water objective is according to the EU's Water Framework Directive which aim achieve good ecological status by 2033. To achieve the objective, Borregaard has set a reduction target of Chemical Oxygen Demand (COD) to more than 30% in 2030 with the base year of 2020, for Borregaard's operations in Norway. The investment plans to reduce COD was presented at their Capital Market Day in September 2022.

Borregaard report according to the EU Taxonomy framework, which will determine how many of their economic activities are considered sustainable. Stakeholders will be increasingly concerned with the reports for the new transparent reporting standards. This can lead to fewer investors based on the results from the reporting, as well as an increased cost associated with collecting and reporting according to the frameworks. Following the EU Taxonomy Do No Significant Harm (DNSH) criteria, environmental degradation risks related to preserving water quality and avoiding water stress are identified and addressed. The aim is to achieve good water status and good ecological potential and be able to define activities as green. If the activities are not identified as green, it could have a financial impact on the company.

The River Glomma is monitored in accordance with the requirements and standards in the EU Water Framework Directive (WFD), and the data is publicly available. The activities to reduce risks are part of Borregaard's long-term plans to be in line with the WFD and the

EU Green Deal Initiative and will help Borregaard achieve good ecological status in the River Glomma, as well as to be prepared for new requirements. A management plan to reduce the impact is communicated and sent to the environmental authorities and Environmental degradation risks related to preserving water quality and avoiding water stress are identified and addressed with the aim of achieving good water status and good ecological potential. Borregaard is aware that is is low natural reproduction of Atlantic salmon in the river. Emissions of COD have caused a proliferation of bacteria covering riverbed sediments. This causes conditions that have implications for the growth of the wild salmon stock. Operating costs of a salmon cultivation facility, commitment to 2032 (NOK 1 mill per year).

To understand the impact from physical, transitional, and reputational water related risk, the Water Risk Filter has been used, see Methodology chapter above. The tables below represent Borregaard's total risk in the three risk areas. A more detailed overview of the three risk types can be found in Appendix 1. The risk scale moves from very low risk (1) to very high risk (12).

Medium-term risks			
Sites	Physical risk	Transitional risk	Reputational risk
Sarpsborg, Norway	4	1	3
Paskov, Czech Republic	7	1	5
Wisconsin, USA	3	3	7
Fernandina Beach, USA	3	4	8
Karlsruhe, Deutschland	6	1	6
Warrington, UK	6	1	6

Table 1: medium-term risks from WWF's Water Risk Filter on Borregaard's production units

Long-term risks			
Sites	Physical risk	Transitional risk	Reputational risk
Sarpsborg, Norway	4	1	3
Paskov, Czech Republic	7	1	5
Wisconsin, USA	3	4	7
Fernandina Beach, USA	4	3	7
Karlsruhe, Deutschland	5	1	6
Warrington, UK	6	1	6

Table 2: long-term risks from WWF's Water Risk Filter on Borregaard's production units

Nevertheless, the production unit in Paskov has the highest physical water risk in both medium- and long-term time horizon. This is mainly due to the poor water quality in the area which score 11 of 12 on the risk scale (see Appendix 1-3). For transitional water risks, the sites located in the US score highest for both time horizons, meaning that the locations have a higher risk for changes in water regulations compared with the other sites. Yet, the risk indicator is not significantly high overall meaning this risk is not substantial. The production unit with the highest reputational risk is Fernandina Beach in Florida US for medium-term, and both locations in the US for long-term. For both sites and time horizons it is the risk category cultural importance which is high risk in the areas (see Appendix 1-3).

Opportunity: Market for biobased products

In this section, the focus is on the market for biobased products in the sectors of consumer goods application, transport, agriculture, and construction. These sectors are important to focus on as they were the four top segments in Borregaard's end market in 2021.

Borregaard is the world's leading supplier of lignin-based biopolymers as a dispersing and binding agent and is a viable option to the petroleum-based chemical alternatives. Borregaard's biopolymers are regarded to be more environmentally friendly and are used in several different end-market applications such as agrochemicals, feed, construction, batteries and industrial binders. Lignin is a renewable source of energy and chemicals and is continuously researched for new ways to be utilized in industry and material chemistry. It is considered to be among the most promising biomass components currently under development and is seen as an attractive renewable substitute for fossil-based chemicals. The growth of the global lignin market is attributable to the strong demand for these applications. The market for lignin is expected to increase As Borregaard has taken a market position as the largest supplier of lignin, this represents a good opportunity to exploit in the future.
The specialty cellulose industry represents 2.5 % of the entire processed cellulose spectrum. Borregaard is an established supplier of cellulose ethers, cellulose acetate, nitrocellulose, and other specialty cellulose applications. This industry has gained attention as its financial performance significantly has improved and the market is projected to grow in the coming years.

The segments in ethers, microcrystalline cellulose and casing are particularly interesting as they are expected to have an annual growth of 3-4 % by 2023, compared to 2020. Cotton based cellulose is used for production of some of the products in the segments mentioned above. However, cotton based cellulose is becoming increasingly controversial due to its influence on pesticides, water, and land.

Consumer goods application

The market for biovanillin is in its development stage and has a considerable growth potential in the future. The market is growing rapidly, and the trend is expected to continue in the future as a result of the world's growing sustainability focus. The trend in consumer preference in food is that they want to buy products made of natural and sustainable raw materials, and in this segment Borregaard biovanillin is already in a position to offer a renewable bio-based alternative to the synthetic ingredients made from oil. The market for biovanillin is anticipated to increase.

The main drivers of the market growth are consumer preference for natural products and its trait of being sustainable. Biovanillin has the potential of being one of the major ingredients in customized flavor blends in the future, and Borregaard is already in a good position to capitalize on this opportunity as we are the only producer of wood-based vanillin. Another opportunity for Borregaard to exploit is its potential to use biovanillin in the personal care and the cosmetic industry as consumers are demanding natural cosmetic products in order to avoid the use of products containing synthetic and chemical ingredients. While North America and Europa will remain the top consumers in the global

biovanillin market, the markets in South and East Asia are assumed to experience the highest growth in the coming years. Additionally, Borregaard's Exilva microfibrillar cellulose has the potential to replace acrylic copolymers used as thickeners in products related to cleaning products in personal care and home care.

The market for bioplastics is continuously growing as the demand is rising. The global production of bioplastics capacities is set to increase from around 2.11 million tonnes in 2020 to approximately 2.87 million tonnes in 2025 (figure 1). The key factors contributing to the growing market is the growing demand for sustainable packaging materials due to consumer awareness and government participation. The packaging and consumer durables segments are likely to be the two industries with the largest increase in demand.

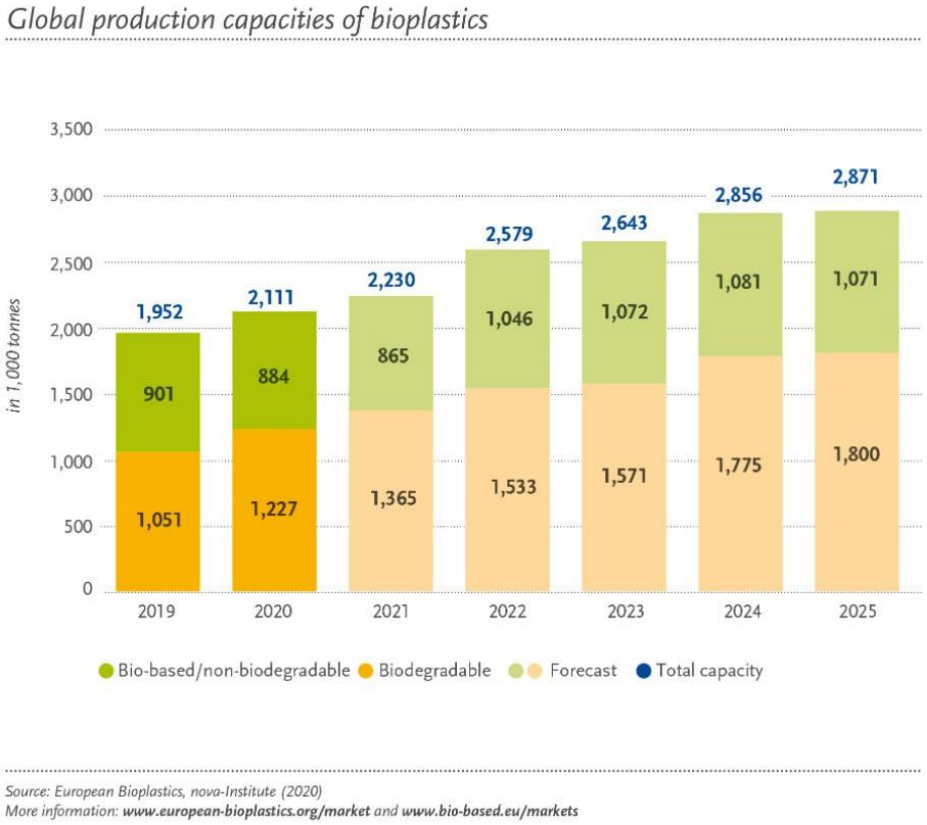

Figure 1: Global production capacities for bioplastics from 2019 to 2025.

Bioplastics are used in several different markets ranging from packaging, catering products, consumer electronics, automotive, agriculture/horticulture, toys, textiles etc. In the past years, the bio-based polymer markets have been dominated by food service applications and biodegradable food packaging. It can be argued that the production of biopolymers will lead to carbon dioxide being confined in the ground due to the biopolymers trait of being more stable, stronger and longer-lasting as well as having a higher ratio of recycling composting. With new durable bio-based polymer items (biobased PE, PP, and biobased PET) entering the market, the non-biodegradable plastics is expected to increase. Especially biopolymers such as PLA, PP, and PHA are expected to have continuous growth in the coming years. The limiting factor for continuous growth is the high manufacturing

costs which are higher than other polymers.

A particularly interesting opportunity for Borregaard to exploit is the possibility to use Borregaard's Exilva microfibrillar cellulose to enhance the strength in some of these polymers. As most bioplastics are made from polysaccharides, bioplastics made from lignin are experiencing growth due to new technologies making them more applicable in the future and is likely to be an important resource for future production of bioplastics. Moreover, Exilva can replace borates in certain adhesives for packaging products as it improves the sustainability of the packaging materials.

Transport

The market for biofuel is gaining increased attraction due to its traits being a viable alternative to fossil fuels. One of the primary approaches to decarbonise the transport sector is to replace fossil fuels with biofuels. The use of conventional biofuels produced from food crops is expected to be considerably reduced by 2050 due to the demand for sustainable bioenergy. Sustainable and more advanced biofuels can be made from wood retrieved from sustainably managed forests. A great advantage for the use of biofuels is that it can be utilized in already established distribution networks for petroleum-derived fuels and be used in vehicles with no or minor alterations.

The International Energy Agency (IEA) estimates that the global share of biofuel in the transport section is likely to rise to 27 % by 2050. IEA has worked out a scenario that shows a narrow but achievable pathway for the global energy sector to achieve net zero CO_2 emissions by 2050 (NZE scenario). According to the NZE scenario, the biofuel produced from wastes, residues, and dedicated crops (that do not compete with food crops) will have to increase from 7 % in 2020 to 45 % in 2030. This can be a good opportunity as Borregaard has taken a market position as a leading producer of second-generation bioethanol which has less CO_2 emissions than petroleum-based fuels. The market for bioethanol is projected to increase with a CAGR of over 4.5 % in the period from 2021 to 2026.

The EU has set a binding target of achieving climate neutrality by 2050. As part of this target, this deal has set a proposed 13 % decline in GHG intensity of transport fuels by 2030. To achieve the goal the renewable share of fuel in the transport section must be 28 % by 2030, with biofuel being a significant part of the solution. The deal also proposes a minimum target of 2.2 % for advanced fuels by 2030. Especially relevant for Borregaard is that the production of advanced ethanol is projected to reach 1.39 EJ in 2030, which is remarkable in comparison to the current production which is close to zero. According to the NZE scenario, the consumption of advanced biofuels is anticipated to increase from 0.1 mboe/d (million barrels of oil equivalent per day) in 2020 to 6.2 mboe/d in 2050.

The minimum content of biofuel in road traffic has had continuous growth and is currently at 24.5 % in Norway. In addition, the renewable energy directive RED II requires that member states must have a minimum of 14 % renewable energy share consumed by road and rail traffic by 2030. The increased demand for biofuel and changes in biofuel regulations represents a considerable opportunity for Borregaard as they are producers of bioethanol. Borregaard's bioethanol is regarded to have a lower CO_2 footprint compared

to other biofuels.

While electricity is expected to dominate road transport by 2050, advanced liquid biofuels is likely to be used in areas that are more complicated to electrify, like aviation and shipping. While bioethanol is considered to not be suitable for use in aviation due to its low energy density, it is believed to have the potential to replace some of the fossil fuels in the shipping sector. The NZE scenario estimates that the bioenergy share in the global energy consumption in maritime shipping sector can be around 20 % in 2050.

The demand for lithium batteries is expected to grow as a result of the global electrification trend. According to the IEA, the demand for lithium used in batteries grows 30-fold to 2030 and more than 100-fold by 2050. In addition, the annual battery demand for electric vehicles is estimated to go from 0.16 TWh in 2020 to 14 TWh in 2050. This might be an exciting opportunity for Borregaard to exploit with its production of additives for lead and lithium ion batteries to improve the sustainability profile and improving the life and performance of batteries.

Agriculture

The bio market in the agriculture sector is expected to grow significantly due to rising demand for organic food products, exploitation of the environment due to the use of harmful chemicals, increasing area for organic cultivation, rising incidences of pest outbreaks in crops, strict rules against the use of harmful agrochemicals and government subsidies for use agricultural biologicals.

In modern agriculture, biologically derived plant nutrition products have attained special significance due to its traits being an ideal alternative for synthetic chemical fertilizers. It is also helping achieve sustainability in agriculture with the enhancement and restoration of soil biomass. The increased market for biologically derived plant nutrition is mainly due to the growing demand for organic food products. The global fertilizers and bio stimulants market is expected to grow at a CAGR of 11-13 % by 2025 compared to 2018. The increasing demand for residue-free and organic food and agricultural products is likely to result in a broader distribution of biological plant nutrition products across the world.

Borregaard's investment in the production of Exilva microfibrillar cellulose (MFC) has the potential to replace similar products derived from petrochemicals. It can be used as a multifunctional additive in agricultural chemicals in pesticides. It is powerful against impermeable weeds and boosts the effect of many herbicides. Exilva has the advantages of being a natural product and has lower CO_2 emissions compared to its petrochemical alternatives.

Lignin applications in the agri-food sector are considered to be unexplored but with a big potential to develop in the coming years. The extraction and use of lignin in the agricultural sector are anticipated to increase due to its potential to be used as a fertilizer and in pesticides. Examples of interesting opportunities for Borregaard to explore are the possibility of utilizing lignin as a bio-sorbent for in situ treatment of agriculture and food industry wastewater, natural preservative in the food industry due to its antioxidant

potential, as a safe storage of food considering its proven antimicrobial activity and as an antimicrobial coating agent to provide protection from plant pathogens.

Lignin-based products can also be used in the production of animal feed due to their binding effect and may compete with alternative low-cost products such as mechanical compacting, starch residues or bentonite. An advantage of lignin-based products is that it is perceived as more natural and generally offer better performance. Borregaard's wood-based polymers may act as a suitable replacement for EDTA (ethylenediaminetetraacetic acid) to bind and hold on to micronutrients. These micronutrients provide nourishment to plants and aid them to grow larger and healthier. Using Borregaard's wood-based polymers as a replacement provides an improvement of sustainable food production and can lower the CO_2 emission by as much as 90 %.

Another opportunity for Borregaard to exploit is the possibility to conserve valuable feed products for farm animals in a more sustainable manner. The most common method of conserving by-products from the fishing and aquaculture industry is by using formic acid. Borregaard's wood-based biopolymers can act as a suitable substitution to formic acid by reducing CO_2 emission by 19 % as well as being remarkably less corrosive than formic acid.

Construction

In the construction sector, the market for Borregaard's wood-based biopolymers is attractive as a result of its traits of being a sustainable and less CO_2-intensive alternative to the traditional fossil-based products. The market for biopolymers in the construction sector is driven by the increasing demand for more environmentally friendly raw materials. According to the NZE scenario, the production of chemicals, steel and cement will have to have a considerably higher rate of bio content in 2050 than it is today. The global demand for primary chemicals is anticipated to be 30 % higher in 2050 than today, for steel it is estimated to be 12 % higher and the cement demand is assumed to be relatively flat.

Borregaard is already in the market for replacing traditional petroleum-based products with their wood-based biopolymer which is emerging as a viable alternative. For this sector, the wood-based biopolymer may be used as a substitute for plasticisers used in concrete to increase the flow of the material and reduce the amount of water going into the concrete. It may also replace cement made from inorganic clay and bitumen produced from crude oil in the process of improving the quality of rads. Another opportunity is to use Borregaard's wood-based biopolymer to replace salts like calcium chloride and magnesium chloride in order to suppress dust on gravel roads.

Replacing phenolic resin with Borregaard's wood-based biopolymer in the process of gluing plywood boards has the potential to grow further in the market. These plywood boards are used for roofing and flooring in buildings in addition to furniture construction. An interesting opportunity for Borregaard to explore is to investigate the possibility of lignin being used as an ideal substitute to replace petroleum-based phenol in green building products where phenol previously has been used as glue. Studies show that the biobased adhesive made of lignin exhibited similar shear strength under both dry and wet conditions.

For the four sectors examined in this report, it is evident that Borregaard is well-positioned for exploiting the market for bio-based products in the coming years. The demand for bio-based products is increasing in the sectors of consumer goods application, transport, agriculture, and construction. The global trend of consumers wanting more natural products and products that are more environmentally friendly will drive the market further in the future. Borregaard's Exilva microfibrillar cellulose has a remarkable potential in the future market as it is applicable to several different sectors. Borregaard's biovanillin is unique in the market and is likely to be even more sought after due to its trait of being natural and have less CO_2 impact than its competitors. Additionally, Borregaard's bioethanol is likely to be attractive as the demand for advanced bioethanol is increasing.

Opportunities: higher water prices

Water prices could have a substantive financial and strategic impact on Borregaard's due to the opportunity of increased competitiveness of Borregaard's products because water usage is sustainable and not a scarcity at their main operating unit.

The calculation on financial impact related to water is compared to the cost of total water withdrawal from the biorefinery in Sarpsborg with cost of water in central Europe. Europe has the highest water costs in the world and this trend is likely to continue (https://www.dailyscandinavian.com/highest-water-prices-in-the-world/). The internal water price from Borregaard's water treatment facility is about 1 NOK/m^3. Germany and Denmark pay the highest prices for water on the Continent, at $1.78 and $1.72 per cubic meter, respectively. Rates in the United Kingdom, France, Belgium and The Netherlands were all above $1 per cubic meter of water. In the calculation, we have compared it with a cost of 1.5$/m3, which is about 15 NOK/m^3.

Narrative 4°C (RCP 8.5/SSP5-8.5 & BAU)

The 4ºC Business as Usual scenario is dominated by increasing physical risks, due to a lack of coordinated policy actions to limit climate change. In this scenario, economic growth is preferred over climate action and the overconsumption of resources continues. The world is still dependent on fossil fuels and energy intensity continues to be high. The growth of greenhouse gas emissions will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts on people and ecosystems. Customers are not prioritizing climate in their decision making. Water becomes a key resource with limited availability and climate-related conflicts increase in number as a result of poor agriculture and living conditions. Tens of millions of people are defined as climate refugees and move northwards in hope of a more secure life. As the globe is warming up, the severity and frequency of extreme weather events are increasing. Flooding, heavy precipitation and sea level rise could impact Borregaard's operations and value chain. The ambition for economic growth is not met, as GDP losses occur due to increased physical risks as the temperatures rise.

Impacts from climate change-related extreme events are projected to increase further with

warming. Increased urban flood damage from extreme precipitation is a key climate-related risk in most world regions, including in Europe. Increased drought stress and associated water restrictions and wildfires are expected in southern Europe, Australia, and parts of Africa, Asia, and North America. Global mean sea level will continue to rise during the 21st century.

Chronic and acute weather events

Norway is less vulnerable to climate change than most other countries, and one of the countries with the greatest adaptive capacity. Norway has the lowest score on the ND-GAIN Index which ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. The less vulnerable a country is, the lower its score is, while the more resilient a country is the higher the score will be. Norway is ranked 1st due to better functioning institutions, a higher level of education and a more diversified business sector. Higher income levels and flexible labor markets also give greater capacity to absorb the costs of a transition to a low-emission society.

Due to a combination of political, geographic, and social factors, the US is recognized as more vulnerable to climate change impacts than Norway, ranked 19th out of 181 countries in the 2020 ND-GAIN Index. The US is also more exposed to natural disasters such as coastal flooding, rising sea levels and hurricanes.

Acute risk: Extreme weather (flood, wind and drought)

Extreme weather events such as increased frequency of extreme heat or cold can potentially also have a financial impact on Borregaard's transportation costs. Much of Borregaard's wood is transported by rail and in dry summers, like 2018, the water level was too low to enable transportation. Rails are sensitive to heat, and they tend to expand during warm summer days, leading to stop or delay in transportation. When the number of days with extreme heat increases, it is likely that number of events causing stops or delays in rail transportation will correlate. The same is expected for snow- and ice-related incidents in the winter. More disruptions to Borregaard's transportation routes (road, rail, and water) can further present the need for larger storage volumes to account for delays in transportation. This will have a medium financial impact on Borregaard's indirect operations.

Extreme weather such as flooding and droughts will impact the logistic cost (operating cost) for the supply of raw materials and lead to delays in the value chain:

- Ships must go to other ports, and we will have extra cost from unloading, handling, and transportation of the goods by trucks
- Load factor of ships can decrease and potentially increase the number of shipments from the sourcing locations
- Shortage/delay in deliveries can result in production downtime.

Flooding

The probability of compound flooding (storm surge, extreme rainfall and/or river flow) has

increased globally in later years and will continue to increase due to both sea level rise and increases in heavy precipitation, including changes in precipitation intensity associated with tropical hurricane (high confidence). Flooding is an acute risk due to the geographical locations of Borregaard's sites close to rivers and on the dock, and for the company's transportation routes.

In Norway, climate change is expected to intensify the global hydrological cycle. This may lead to an increase in the intensity and frequency of hydrological extremes, including floods. Events with heavy rainfall will be more intense and occur more frequently. The median projections for Norway indicate an 18 % increase (span: 7 to 23 %) in annual precipitation towards the end of the century and a doubling of days with heavy precipitation. Preliminary analyses suggest that rainfall intensity for durations of a few hours may increase by more than 30 %. In river systems dominated by snowmelt-floods, a reduction of up to 50 % is expected in spring floods. In river systems that are dominated by rain floods, the magnitude of floods is projected to increase by up to almost 60 %. WWFs Water Risk Filter predicts a low risk of flooding in both medium- and long-term time horizon. For inland waterways, more frequent high-water levels are expected by 2050, especially during winter. However, from 2050, the number of days with low water levels during the summer will also increase. Both too high and too low water levels in rivers are likely to impact the load factor, meaning that each load Borregaard transports on inland waterways is smaller. The river Glomma is important for supply by boat of raw materials like salt, wood, limestone, sodium hydroxide and sulphuric acid to Borregaard's port Melløs in Norway. In Sarpsborg, where the biorefinery is located, the precipitation will increase throughout the whole year, and the frequency of the acute physical risk of flooding in the river Glomma will increase (Ref: Vormoor, K., Lawrence, D., Schlichting, L., Wilson, D. & Wong, W.K. (2016)). An increased number of shipments from sourcing locations to the Sarpsborg site could potentially impact operational costs if not alternative transportation routes are used during periods of too high or too low water levels.

High-tide floods – also called nuisance floods or sunny day floods – are already a familiar problem in many cities on the US coasts. However, the alignment of rising sea levels due to climate change with a lunar cycle will start a decade of increases in flood numbers and their severity. Coastal flooding in the US is projected to start in the 2030s, impacting Borregaard's site in Fernandina Beach. According to WWF's Water Risk Filter, the site in Fernandina Beach has a medium score (7 out of 12) risk of flooding in the medium-term time horizon meaning that the risk of flooding could possibly impact the site and Borregaard's operations.

Wind

Ingoing and outgoing logistics can be highly impacted, in addition to the damage to equipment. Tropical hurricane events also have a high probability of occurrence in Florida. Although much of the state can be affected by high winds, there are areas, such as Fernandina Beach, where winds will be stronger due to its geography. More wind will further increase the probability of storm surge. Borregaard has already had to close the production at the Fernandina Beach site twice due to strong winds. Both times, the site was closed for a week, stopping the entire production. With the increased frequency of

strong winds and storm surges, it is likely that the site will be closed more often in the coming years, impacting Borregaard's income.

Drought

At Borregaard's production unit in Germany, Karlsruhe, which has transport of raw materials on the river Rhine, Borregaard has experienced the opposite phenome to flooding; drought.

Increased rate of extreme weather events is also potentially damaging to the forests where Borregaard source its wood. According to IPCC 6th Assessment Report, it is projected that drought will with high confidence increase for predominant fraction of land areas in a well-below 2°C scenario, and drought is very likely to increase in a 4°C scenario. In addition, the frequency of drought is likely to increase. Further, boreal forests are likely to experience stronger local warming than the global average. One of the risks of increased temperatures and drought is how this increases the risk of forest fires which then potentially threatens the very core of Borregaard's operations: wood.

Acute Risk: heavy precipitation

Heavy rainfall can trigger an increased frequency of landslides, debris flows and slush avalanches. According to Norge's Vassdrag- og Energidirektorat (NVE) areas in eastern Norway has a risk of landslide as it were historically seabed. Historic seabeds contain salt, and over time the salt is rinsed and transformed clay to quick clay. Quick clay is more unstable than regular clay and can result in severe landslides. Climate change leads to more heavy rainfall and therefore disturbances in the natural stability of a slope which leads to landslides.

According to Norge's Vassdrag- og Energidirektorat (NVE) Borregaard's site in Sarpsborg has a medium to high risk of quick clay landslide. Through their risk analysis, NVE has classified the risk at the site as class 4 and 5 risks (scale 1-5), where the consequences are 'very severe'. Sarpsborg municipality has initiated programs to prevent quick clay landslides. As Borregaard has several buildings on high-risk land, they must apply to the municipality for approval to for example build or restructure new and existing buildings and change fends or roads. After the municipality receives the application, they do thorough investigations to examine the risk of the action. Outside the Sarpsborg site, increased frequency of landslides can impact both Borregaard's road and rail transportation routes as the routes might get blocked. This can lead to delays in the value chain impacting operational costs.

Chronic Risk: Sea level rise

Sea-level rise threatens significant physical changes to coastal zones around the world. Approximately two-thirds of the global coastline has a projected regional relative sea level rise within ±20% of the global mean increase (medium confidence). Due to relative sea level rise, extreme sea level events that occurred once per century in the recent past are projected to occur at least annually at more than half of all tide gauge locations by 2100 (high confidence). Relative sea level rise contributes to increases in the frequency and severity of coastal flooding in low-lying areas and to coastal erosion along most sandy

coasts (high confidence).

To examine whether Borregaard's sites in Sarpsborg and Fernandina Beach are exposed to sea level rise, we have used NASA's Sea Level Projection Tool, which is based on the IPCC 6th Assessment Report on Sea Level Projections.

Calculations of the sea level off the Norwegian coast indicate that most coastal areas will experience rising sea levels to some extent. However, due to the Sarpsborg location, the NASA Sea Level Projection Tool does not show any indication of sea level rise in this area. For Fernandina Beach, on the other hand, NASA's Sea Level Projection Tool projects a sea level rise to be 0.15 meters in 2030 both for the well-below 2°C scenario (SSP1-2.6/RCP 2.6) and for the 4°C scenario (SSP5-8.5/RCP 8.5). In 2050 the NASA tool projects the sea level in Fernandina Beach to rise 0.28 meters for the well-below 2°C scenario and 0.32 meters for the 4°C scenario.

Chronic Risk: Changing temperature (air)

A chronic temperature rise can have a negative impact on the forests where Borregaard sources its wood, as insect damage is likely to increase. Higher temperatures can lead to longer growing seasons in forests, increasing insect activities, such as spruce bark beetles having two egg-laying periods during one summer. The spruce bark beetle is the insect that does the most damage to coniferous forests. There are also many indications that the spruce bark beetle thrives in a warmer climate. The northern spruce forests in Europe have so far not experienced extensive damage from spruce bark beetles, but there are indications that this will change in correlation with a warmer climate.

Chronic Risk: Declining water quality

Borregaard's main water challenge is the emissions of organic matter (COD) in the river Glomma. A failure to reduce COD emissions to the Glomma River, located by the Sarpsborg site, could have significant impacts on the ecosystems and balance in the river. According to WWF's Water Risk Filter the ecosystem services status risk in Sarpsborg is medium (6 out of 12) in the medium time horizon. For the same time frame, the water quality is also medium (8 out of 12), indicating a medium risk in freshwater around Sarpsborg. In the long-term perspective, the risk is even higher for ecosystem services status (9 out of 12), however, lower for water quality (6 out of 12). A management plan to reduce the impact is communicated and sent to the environmental authorities and other relevant stakeholders.

In Paskov, Czech Republic Borregaard has its highest water risk in water quality and ecosystem services status, according to the Water Risk Filter. The water quality risk is very high for both the medium- and long-term time horizon (11 out of 12). The water quality will be prioritized, alongside CO_2 emissions to air, in Borregaard's long-term plan. The ecosystem service status mas a medium risk (7 out of 12) in Paskov.

Acute Opportunity: Development of sustainable products

Borregaard's current and future B2B customers sell products/chemicals into water-intensive industries like agriculture, mining, and oil. Borregaard considers this as an

opportunity and a growing market for Borregaard's specialized lignin biopolymer products, as customers get more aware of the water-related risks and look for more sustainable alternatives, this could represent a long-term substantial change in opportunities for new products. Borregaard's strategy is to utilize the different components of wood, to produce biopolymers, speciality cellulose, biovanillin, cellulose fibrils, and bioethanol for a variety of applications, in sectors like agriculture and aquaculture, construction, pharmaceuticals and cosmetics, foodstuffs, batteries, and biofuels. Borregaard's products are alternatives to petroleum-based products. And address many long-term, global challenges related to population growth, resource access, and environmental and climate impacts. We pursue a consistent strategy over time, and we have a long-term perspective on innovation and investments.

Opportunity: Chronic weather events

A warmer climate is not only a potential risk to Borregaard - it also poses an opportunity for the company. There is a positive effect of moderate increases in temperature (up to 2°C) on boreal tree growth in a short to medium timeframe. Warming extends the growing season and increases growth rates, reducing potential cold-temperature injuries. For Borregaard, it means that they can source a larger volume of wood during one harvest season, potentially increasing their production volume. This could result in increased income in the short to medium time frame. However, if global warming continues well beyond 2°C, the additional warming may cancel out part of the gains.

Summary

In this scenario analysis, we have explored several of Borregaard's physical and transitional climate-related risks and opportunities. In a well-below 2°C narrative, Borregaard faces the risk of more stringent carbon pricing mechanisms, increased energy prices and reduced wood availability. In a 4°C narrative, Borregaard also faces the risk of reduced wood availability as forests are more likely to be destroyed by weather events and insects. In this section of the report, we will make some reflections on how these risks may be connected.

Higher carbon prices will impact operational costs for companies subject to the EU ETS, and thus, the demand for renewable energy is likely to increase to reduce emissions costs. This can incentivize renewable energy suppliers to invest in technology to increase their production at a faster pace than predicted by NVE, making it easier for Borregaard to transition to a greener production, which further reduces emissions costs.

If NVE's predictions are correct, and the demand for renewable energy is higher than the production capacity until 2030, companies subject to carbon prices are likely to feel the impacts of the increased prices as the green transition may take longer. An increased carbon price might be reflected in an increased price on Borregaard's products. If Borregaard has competitors offering the same type of products as them, and these competitors are not subject to strict carbon pricing mechanisms such as EU ETS, they can have an advantage as their products might not face the same surcharge as Borregaard. Borregaard's main production site in Sarpsborg is less vulnerable for risks connected to

high water prices due to the products water usage and water not being scarcity at the operating unit. This can potentially reduce Borregaard's market share. On the other hand, increased carbon prices can potentially increase the demand for Borregaard's fossil-free products (e.g., bioethanol) as companies subject to carbon prices need to reduce their emissions to meet emissions targets and reduce emissions costs.

Reduced wood availability due to e.g., increased forest protection is a significant risk to Borregaard. However, increased demand for wood due to more stringent carbon pricing mechanisms in Europe is also a factor that can potentially impact wood availability, and thus, also the prices. When emissions cost increase, companies producing fossil-based products might look to substitute their raw materials with wood as it has a much lower carbon footprint, increasing the market demand for wood. Increased forest protection and increased demand for wood will inevitably increase prices. Borregaard has a strong market position and will be able to pay a higher price for wood than they do today. For other companies with less advanced products and less well-established value chains than Borregaard however, a price premium may result in these companies going out of business. Thus, the demand for wood might not increase uncontrollably and the wood price is potentially stabilized.

In a business-as-usual scenario, acute and chronic weather events will likely impact Borregaard's direct operations and value chain. Borregaard faces extreme weather threats such as drought, wind and flood in several of the production units. Borregaard has several sourcing areas and alternative transportation routes and transportation modes, thus reducing the impact of climate change. On the other hand, in a world not concerned with climate change, Borregaard's low-carbon products are likely to be less demand, reducing the company's income. However, the company has the capital to make investments in climate change adaptation measures, even though the future return on investments would not be as high as it is today. Even so, such investments will increase Borregaard's future resilience to climate change.

As the abovementioned reflections show, the market can develop in either direction due to increased carbon prices. Borregaard has a strong market position selling products with high current and future demand, it has planned for ambitious emissions reductions and can purchase wood even if the price increases. Further, following the recent passage into law of the EU's taxonomy disclosure regulation, investors are positioning their portfolios to capture taxonomy compliance, and Borregaard is planning to make investments to be both taxonomy and Green Deal aligned. This, in addition to producing reliable low-carbon products and having an ambitious low-carbon transition plan, will likely attract investors and further increase Borregaard's resilience. In a BAU scenario, further investments in climate change adaptation measures can also offset some of the effects of lower product demand. Thus, it can be assumed that Borregaard can meet the climate-related risks and opportunities they are facing in the coming years.

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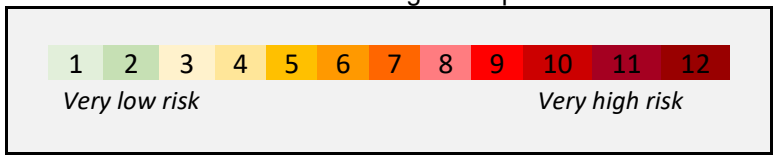
Appendix

WWF's Water Risk Filter for Borregaard's production units. The risk scale moves from very low risk (1) to very high risk (12) as shown in table 1 below.



Appendix 1: risk scale WWF's Water Risk Filter

Medium-term risks (towards 2030)

	Physical Risk				Transitional Risk				Reputational Risk			
Sites	Water scarcity	Flooding	Water Quality	Ecosystem Services Status	Enabling Environment	Institutions & Governance	Management Instruments	Infrastructure & Finance	Cultural Importance	Biodiversity Importance	Media Scrutiny	Conflict
Sarpsborg, Norway	2	4	8	6	2	1	3	1	1	4	3	3
Paskov, Czech Republic	5	6	11	7	1	3	1	1	1	9	6	4
Wisconsin, USA	2	2	5	3	5	3	3	1	9	6	6	9
Fernandina Beach, USA	3	5	3	2	5	3	5	1	9	4	6	6
Karlsruhe, Deutschland	3	7	10	5	1	1	1	1	5	10	6	5
Warrington, UK	3	7	10	6	2	1	1	1	5	9	6	4

Appendix 2: medium-term risks on Borregaard's production units WWF's Water Risk Filter

Appendix 3: long-term risks on Borregaard's production units WWF's Water *R*isk *F*ilter

Long-term risk (towards 2050)												
	Physical Risk				Transitional Risk				Reputational Risk			
Sites	Water scarcity	Flooding	Water Quality	Ecosystem Services Status	Enabling Environment	Institutions & Governance	Management Instruments	Infrastructure & Finance	Cultural Importance	Biodiversity Importance	Media Scrutiny	Conflict
Sarpsborg, Norway	1	2	6	9	3	1	1	1	1	3	3	3
Paskov, Czech Republic	5	6	11	7	2	3	1	1	1	9	6	4
Wisconsin, USA	2	2	6	4	6	3	2	1	9	6	6	10
Fernandina Beach, USA	2	3	4	5	6	3	3	1	10	6	6	7
Karlsruhe, Deutschland	1	7	10	7	2	1	1	1	5	9	7	5
Warrington, UK	3	7	10	6	1	2	1	1	5	9	7	4