The Green Bond:
Your insight into sustainable finance

10 December 2020

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Pathways to Paris

Letter to the reader

Essential challenges and human values

In a year of both stress and ongoing trials, one could easily imagine that finance would go to a safe haven. However, with an open door to liquidity with some limitation to how the stimulus can be removed without a collapse, the world has gone sustainable.

Reflections from our conversations with both borrowers and investors leave no doubt that there is pressure to have a strategy of how, where, and when to engage – and that there is full awareness that sustainability factors will have an important role in both access to and the price of capital, driven by both investors and regulators. It is worth pointing out that this pressure is mostly supported by individuals who want to make a footprint.

Total Green Bond markets have just passed USD 1Trln since inception and there is an expectation of next year's issuance moving towards USD 500bn (assuming that the Council of Europe will get started and issue around 35% of the indicated Euro 225bn). Social Bonds are rocketing by creating a platform on emergency funding which is likely to be followed up by unemployment and re-employment programs. Sustainability-Linked Bonds are providing access for asset light as well as transitional capital. Considering all this, we can safely say that there will be plenty of issuance in 2021, and a need for support that will fit any investor's appetite for engagement.

However, we don't expect this to be the core driver of growth! With the amount of human capital currently becoming devoted to various sustainability areas, we are seeing a rapid increase in strategies targeting Alpha - and with the complexity of a global re-assessment of materiality, including scenario assessments, there will be plenty of opportunities for those who know where to look - how to structure and when and where to engage.

From the regulatory side, there are clear indications of coordination across industry bodies and regulators – so we expect to see an increasing degree of harmonization of vocabulary and focus moving forward. This should enable more systematic engagement.

As a bank, we are looking into the best ways to guide our clients on this journey. We are also building systems for enabling a forward-looking mapping of our clients', and thereby our own, climate footprint. We expect that the aggregation of activities by banks and regulators will reduce access to capital for those who fail to come up with transition strategies and willingness to disclose them.

As usual, in this issue, we have the pleasure of sharing some external contributions – this time from Vattenfall, which will share their transition story, Material Economics sharing a net-zero pathway study for heavy industries, IFAD reflecting on food insecurity, Haldor Topsoe reflecting on the role and potential of electrolysis in the transition, Danish ship finance on the potentials a transition brings and lastly – our two summer interns' insight on sustainable cities. A huge Thank You to all of you for your contributions!

Enjoy your reading,

Christopher Flensborg

Head of Climate and Sustainable Finance
christopher.flensborg@seb.se

Transition update

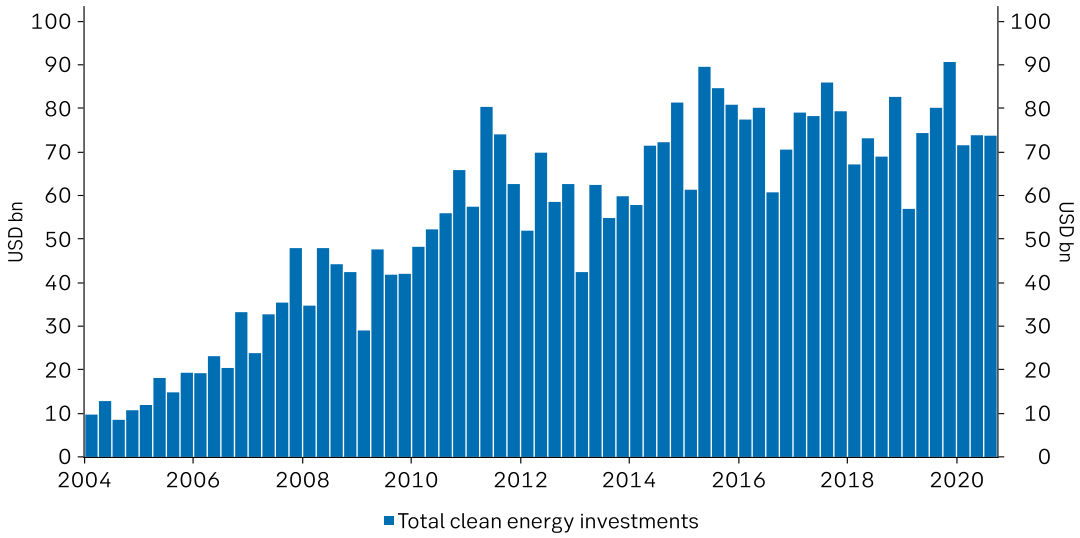
The economic transformation has started

With just a few weeks left in a highly unusual year, 2020 is still shaping up to be a lost year in terms of the actual progress made in the transition to a zero-emission. It is also looking like it might be the year where we finally ran out of excuses for delaying the necessary reaction to the climate crisis. Vaccines are now lined up for distribution next year. The conditions for extending the time horizon in the policy response beyond the initial shock are likely to fall into place. Looking back, this could very well be a turning point in the transition: the point where we stop talking about it and start executing it instead.

However, all of this is still in the future, and the current reality is a lot bleaker. The pandemic is not over yet. It continues to delay investment decisions and direct policy focus towards short-term damage control. In Q3 2020, BNEF estimates that world investment in renewable energy in dollar terms was stuck at around USD 70bn. This is roughly 20% lower than where we were ultimo 2019. With restrictions being reintroduced on both sides of the Atlantic, it no longer looks likely that we will get any of the lost activity back before year-end.

Due to the low investment in the first quarter of 2019, the decline in investment for the full year could be limited to around 10%. In order to get back to the trend-line, we need to see an increase in invested amounts of 30-40% in 2021. However, this is not unrealistic if we get the full reopening, that vaccines should make possible, and policymakers do not return to their old ways once the immediate crisis is over.

Figure 1: Renewable investment flat since 2015, in spite of governments Paris promises



Source: BNEF, SEB

Thomas Thygesen
thomas.thygesen@seb.dk

Elizabeth Mathiesen
elizabeth.mathiesen@seb.dk

Renewable energy is about to disrupt

Behind the short-term volatility, the underlying fundamental drivers for the transition are still gaining strength. The cost of renewable energy, which was already cheaper than fossil fuels, has continued to decline for solar energy. As illustrated in Figure 2, the disruptive learning curve pattern remains intact.

The learning curve effect is the key to the disruption: it suggests that increased investment will also lead to faster price declines. This is similar to Moore's law for microprocessors, but it is really a general principle; learning curve effects have been present in all technological revolutions since the beginning of industrialisation. They were identified already in the 1930s as 'Wright's Law' after a study of efficiency in fighter plane production.

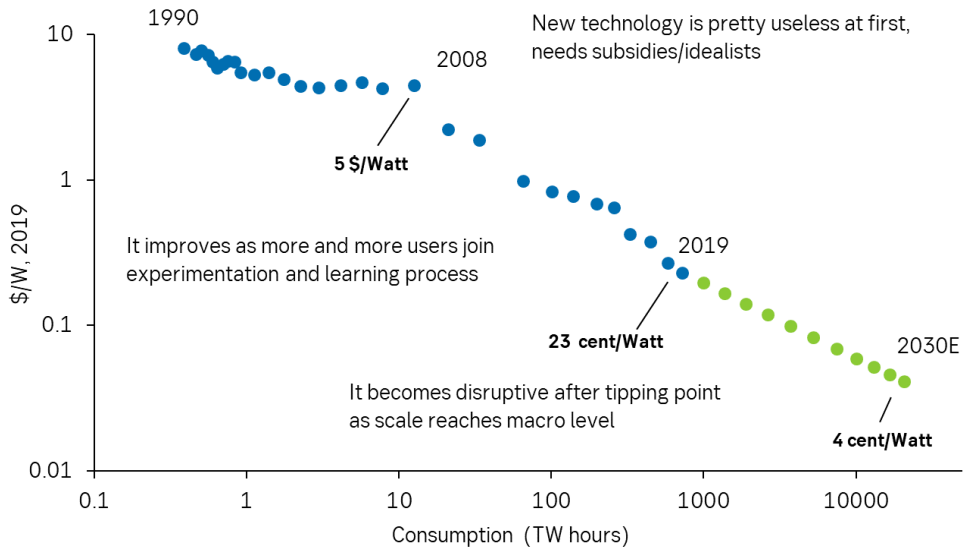
The learning curves in primary energy production are already well advanced and have passed the 'tipping point' where they are cheaper than the incumbent alternative. Scale effects, innovation feedback loops and 'learning by doing' will continue to drive prices lower over the coming decades as supply expands. In addition, a surge in renewable investment in dollar terms could speed up the price declines and lead to an even bigger impact on the supply increase in volume terms. This is likely to become apparent within the next few years as public sector infrastructure investment ramps up.

Second wave of innovation is coming

There is also a secondary wave of innovation among users of the renewable energy supply. This cannot get started properly until the primary technologies reach the tipping point. 2020 has, however, seen a surge in investment in storing clean energy and deploying it into processes that today can only be run on fossil fuels.

Batteries and EVs were first to move. As you can see in Figure 3, there are similar learning curve effects at play here. 2020 will see a setback in the deployment as the pandemic slows global car sales, but the underlying trend remains strong, powered by the decline in the cost of batteries. We suspect that a tipping point, where EVs become clearly superior to similarly priced fossil-powered vehicles, will emerge within two-three years in this area.

Figure 2: Renewables learning curve started in the 1980's



Source: BNEF, SEB

Things are more complicated in the production sectors, where energy technology often is embedded deep inside the capital stock currently being used. However, as wind- and solar-based electricity become cheaper and more abundant, the development of new solutions is picking up. For heavy transportation and production, batteries are unlikely to be the main storage tool. However, real resources are now being deployed into developing alternative solutions. Hydrogen, ammonium or other ways of converting renewable electricity into fuel can be used to replace diesel or coal in steel works, cement works, shipping, trucks and other key high-emission areas.

As an example, the Danish shipping company DFDS has announced that they will introduce a hydrogen-powered ferry between Copenhagen and Oslo already in 2027. This is to be developed in collaboration with partners across the value chain. Across the Nordics, we see more and more examples of this kind of vertical integration typically involving renewable energy companies that have a clear interest in increasing demand for their output, as well as some kind of public collaboration. The pilot projects are typically more costly than fossil alternatives, but this is likely to change as the cost of clean electricity comes down and the new technologies improve and scale up.

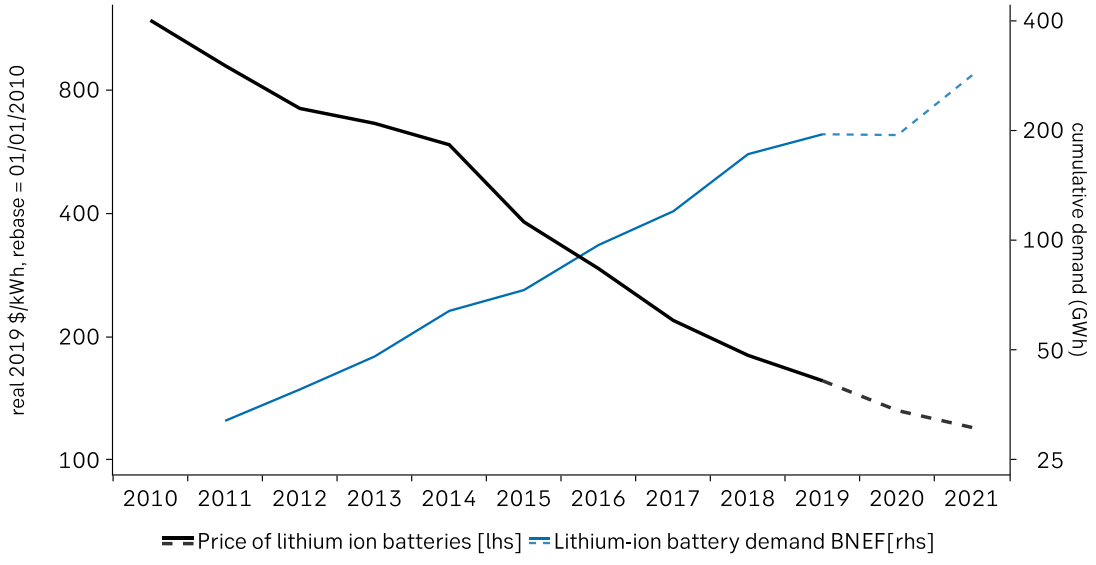
EU Taxonomy becomes reality

These new technologies are still some way from a cost tipping point, so they will need to be subsidised at first. Once prototypes are ready, it will require decades of massive investment to replace all the existing capital stock in these sectors, and companies that lag may not complete that journey. This is a massive and complex undertaking, and it will require new investment tools to identify winners and losers. Fortunately, 2020 also saw major breakthroughs in this arena.

In late November, the first two taxonomies were turned into a draft delegated act which will become EU law. After a short consultation period. The new regulation will come into force from the beginning of 2022. From an equity investor's perspective, the current iteration of the taxonomy will only have limited impact. However, over the coming years, the framework will broaden and evolve into an important driver of relative returns. The taxonomy's key characteristics reflect the ambition to build a framework that can accelerate the transition to a more sustainable economic model.

1. It is market-based. This means that there is no obligation for companies or investors to align with the emission thresholds indicated. However, both parties will have to report what they do.

Figure 3: Price and demand of lithium ion batteries



Source: BNEF, SEB

2. To begin with, it is limited to GHG emissions, and it only covers a limited group of sectors. If you are not in energy, manufacturing, materials, utilities, transportation, construction or agriculture, there is limited direct relevance now, but the framework is evolving. Four more taxonomies are planned covering circular economics, pollution, biodiversity and water. This will expose a broader range of sectors to the regulation.

3. The emission thresholds are dynamic and will adjust in the future as new technology becomes available. The intention is that only a small part of each sector should be aligned at any point in time DURING the transition in order to keep up the pressure to improve. Meanwhile, the ambition is for everyone to end up becoming aligned when a sector completes transition.

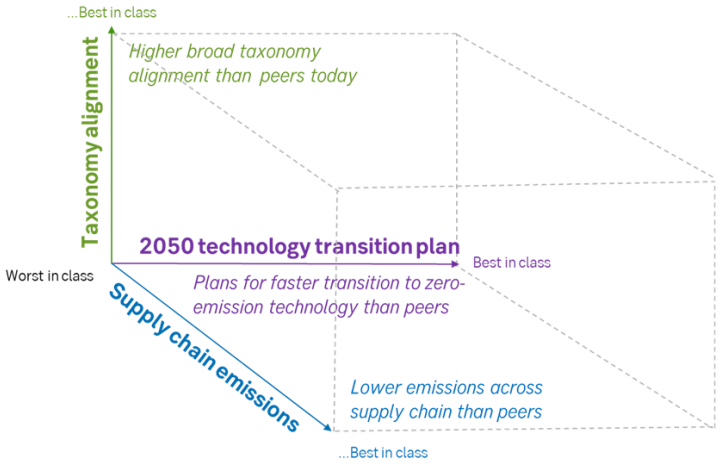
4. The taxonomy understands that technology transition must be coordinated along the value chain. The inclusion of scope 3 emissions (emissions for the whole supply chain) will make emissions a shared responsibility. This will create strong incentives for companies to cooperate on developing and investing in shared solutions.

For the time being, the taxonomy is primarily about sharing information. The implications depend on how that information is used. Our interpretation is that the framework invites investors to evaluate companies' progress in the transition along three dimensions: 1. Taxonomy alignment today, 2. Emissions across the supply chain and 3. 30-year decarbonisation plans.

The first and most obvious dimension is to measure alignment with the existing thresholds. Today, this means measuring specific measures of GHG intensity in each activity, in some cases even life-cycle emissions. In the future, however, alignment will be measured against a whole range of parameters related to the new taxonomies as well. Companies must eventually report the numbers called for by the taxonomies. Within a few years, we should therefore have access to all the data, while we today have to estimate the numbers for most companies.

In any event, alignment with today's thresholds is only the starting point. It is not going to tell you much about whether the company is headed in the right direction. The most important dimensions from a return and valuation perspective are likely to be the ones that we cannot measure directly anytime soon. These include the shared emissions (and collaboration to reduce them) across the supply chain and the credibility of the plan to replace fossil-powered technology with zero-emission technologies over the next 20-30 years. Any numerical screening of taxonomy alignment will thus have to be accompanied by a traditional deep bottom-up analysis of the company's plans in order to make a proper assessment.

Figure 4: Align with taxonomy today, cap supply chain emissions, plan pathway to zero



Source: SEB

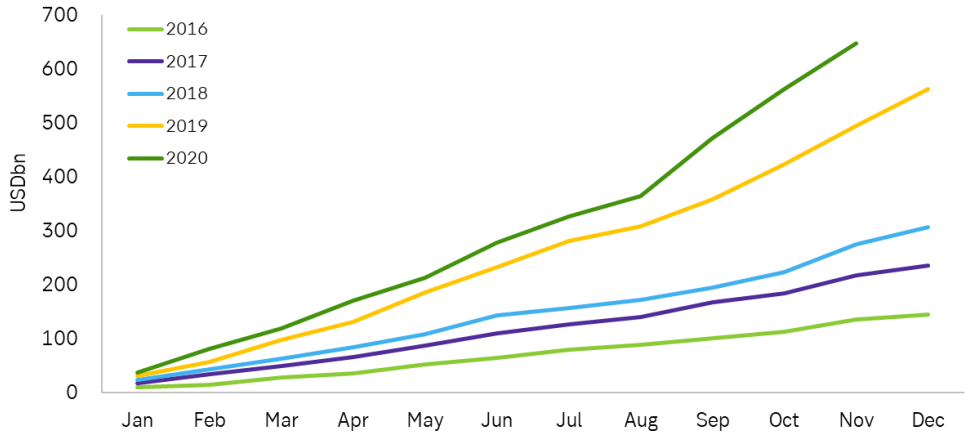
Sustainable Debt Market Update

Financing the transformation

The sustainable finance market has continued to expand in the last two months with total issuances of 176.1bn in October and November. The total for the year is already close to USD 649.0bn (see figure 5), which is already significantly a significant increase from previous years.

As evident from figure 6, the growth in 2020 is to a great extent due to social bonds which so far in 2020 have increased eight-fold since last year, primarily due to COVID-19 related issuances. However, it should be noted that most of the social bonds in recent months are targeting the economic recovery more broadly and not COVID-19 directly. Together with sustainability bonds, which have also doubled in size since last year, the sustainable finance market has shown a clear trend of diversification from green bonds to a larger palette of instruments. That being said, green bond issuances have made a strong comeback in Q4 after a disappointing start to the year. September set a record volume of issuances at USD 62.0bn, with October and November following up this trend with USD 30.4bn and USD 33.2bn, respectively. As such, total issuances for the year at USD 287.7bn are already higher than last year. There is still some way to go to our Organic Evolution Scenario (Full-year green bond issuance of USD 350bn) and Green Growth Scenario (USD 375bn), but the development has nonetheless been very encouraging in recent months.

Figure 5: Cumulative annual sustainable finance issuance (USDbn)



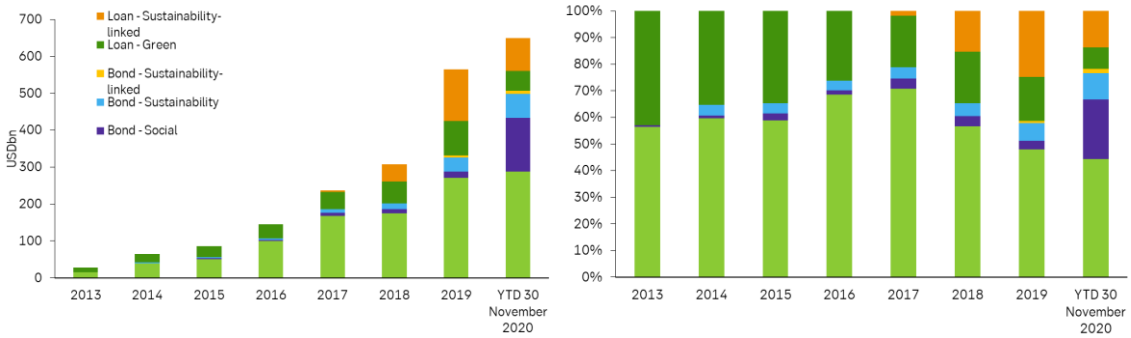
Source: Bloomberg New Energy Finance, as of 30 November 2020

The sustainability-linked market continues to evolve with USD 20.5bn worth of new bonds and loans materialising in October and November, taking the total for the year to USD 98.3bn. This is still below the total for 2019. However, it should be noted that the total YTD 30 November figure for 2019 was USD 63bn, when we wrote the December publication last year. Due to the private nature of the loan market, sustainability-linked loans are often registered some time after the signing date and we therefore expect the total amount for 2020 to match or surpass last year's total of 144.7bn. This is also supported by anecdotal reflections from SEB's loan units who are seeing a significant increase in the demand of sustainability-linked products.

Kristoffer Nielsen

kristoffer.nielsen@seb.se

Figure 6: Sustainable finance market growth by type (USD bn)



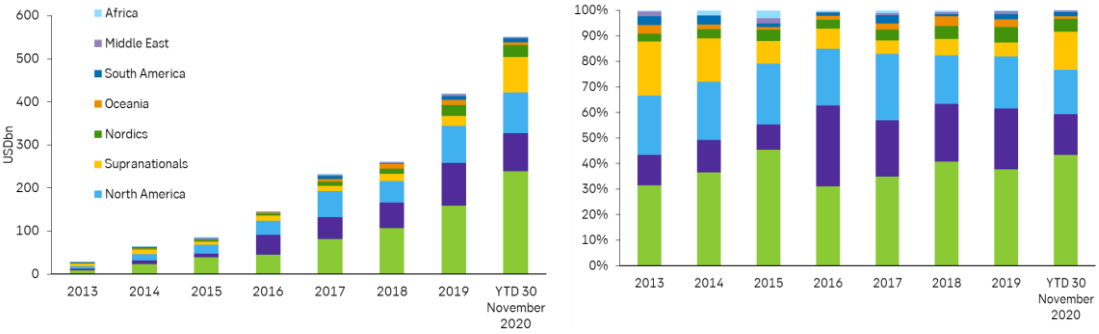
Source: Bloomberg New Energy Finance, as of 30 November 2020

Use of proceeds

Regional update

Europe excl. Nordics continues to be the region responsible for the highest volume of use of proceeds products, with total issuances of USD 236bn so far in 2020, accounting for 43% of the use of proceeds total market. USD 57.4bn has been added in the last two months. Green bonds account for USD 151bn of this, while social bonds total USD 60.4bn so far this year in the region. North America has been the second largest use of proceeds market so far in 2020 with USD 94.9bn of total issuance, of which 17.0bn has been added in the last two months. The US market is primarily focused on environmental aspects with USD 75.6bn of issuances being green bonds and loans. Asia has been surprisingly slow in 2020 with total use of proceeds issuances of USD 86.9bn, of which green bonds and loans accounted for USD 53.5bn. Social bonds in Asia totalled USD 20.2bn, which came almost exclusively in the form of government agencies supporting students, SMEs and social housing in South Korea and Japan.

Figure 7: Use of proceeds market growth by region (USD bn)



Source: Bloomberg New Energy Finance, as of 30 November 2020

Green Bonds

The corporate sector remains the largest sector for green bonds (see figure 8). Total issuance in October and November was 15.2bn, taking the total YTD 30 November 2020 to 78.2bn. As such, it has exceeded the total amount issued in 2019. Four of the five largest corporate issuers in October and November came from European countries. The largest was French energy company Engie SA with an 8-year EUR 850m (USD 1.0bn) green bond, which takes its total funding raised through green bonds to USD 14bn since 2014. Engie's green bond framework consists of several existing technologies, but they also allow for financing of forward-looking technologies such as low carbon hydrogen, marine energy, energy storage, as well as CCS and CCU. The eligible project categories defined in the framework supports Engie's key transition

levers, which are 1) complete the coal phase out, 2) expand the ambitious renewable energy strategy, 3) energy efficiency and development of green gas & clean transportation. The second largest corporate green bond in the last two months was the 11-year USD 1.0bn issuance from US energy company AES.

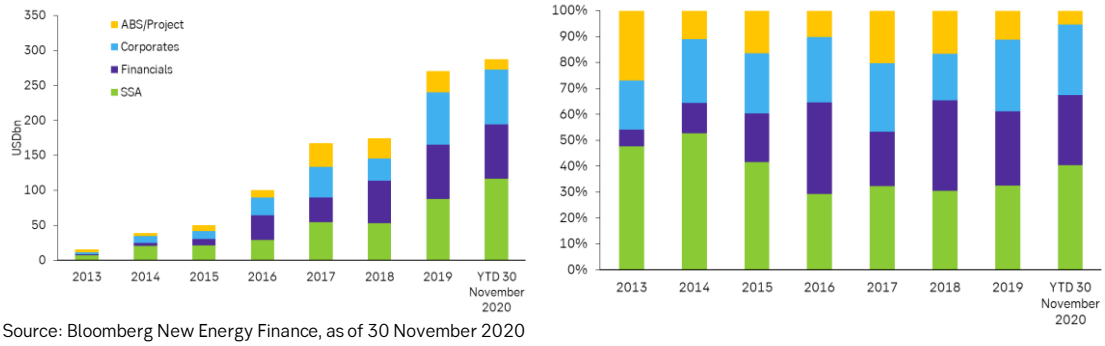
The project types included in AES' green financing framework are renewable energy and energy efficiency. They have also included exclusions to these criteria, stating that net proceeds will not be allocated to fossil fuel generation and fossil fuel energy efficiency investments or gas transmission and distribution infrastructure. The third largest corporate green bond issuance in the period came from Finnish forestry company UPM who entered the market for the first time with their 8-year EUR 750m (USD 890m) green bond. The eligible project categories listed in the green finance framework include sustainable certified forest with FSC and PEFC certification, sustainable forest management, R&D to develop next generation biochemicals and biofuels, biorefineries as well as other water, forest, renewable energy and energy efficiency project categories. UPM has also signed a EUR 750m sustainability-linked RCF.

The financial sector added USD 15bn of green bonds in October and November. As a result, the total volume as of YTD 30 November was USD 77.9bn, which was slightly ahead of the total for 2019. The three largest issuances in the period came from Spain and France, but the sector overall is very diversified with 15 countries from continental Europe, the Nordics, North America, Asia and Oceania represented in the top 20 issuances for the period.

Spanish CaixaBank issued a 6-year EUR 1.0bn (USD 1.1bn) inaugural green bond in November after having already issued two social bonds in 2019 and 2020. All of these issuances were done through their 2019 sustainable development framework that organises eligible projects under SDG categories. French bank Groupe Credit Mutuel was responsible for the second largest financial green bond with a 7-year EUR 750m (USD 880m) bond under their sustainability bond framework which includes the green categories green buildings, renewable energy and low carbon transport.

The SSA sector issued a total of USD 29.7bn worth of green bonds in October and November 2020, taking the total for the year so far up to USD 116.3bn. The sector has in recent months been dominated by the sovereign issuances from Sweden, Germany and Hungary in September, but government agencies were by far the most prominent SSA sector in October and November with total issuances of USD 18.4bn. Societe de Grand Paris, the French transport network government agency, was responsible for the largest green bond issuance in October and November with their dual-tranche 10/50-year EUR 6bn (USD 7.1bn) green bond that will support low carbon transport solutions. Other notable government agencies that issued green bonds in October and November include KfW with an 8-year EUR 2bn (USD 2.4bn) tap and Province of Ontario with a 7-year CAD 1.0bn (USD 1.1bn) tap. The ABS/Project sector totalled USD 3.7bn in October and November, of which Fannie Mae accounted for USD 2.8bn. The total for the sector by YTD 30 November was as a result USD 15.3bn.

Figure 8: Green bonds market growth by sector (USD bn)



Source: Bloomberg New Energy Finance, as of 30 November 2020

Social Bonds

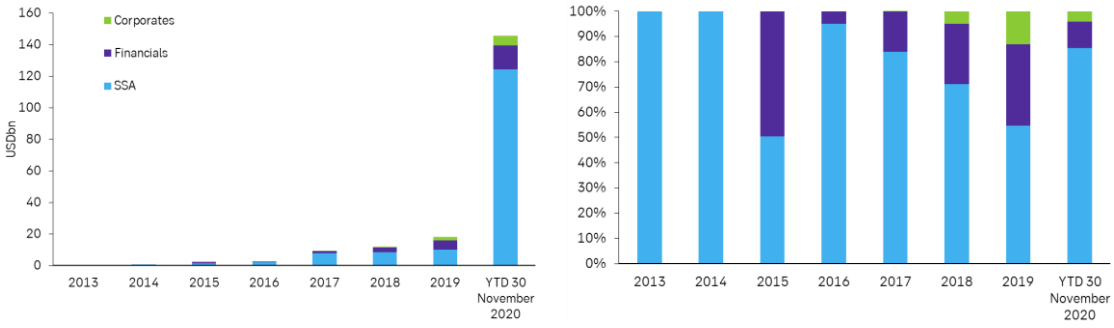
The social bond market for 2020 was at the end of November eight times larger than it was in all of 2019 at USD 145.6bn. This has developed across three stages. The first stage was early 2020 as the volume of social bonds, most prominently from South Korean government agencies focused on SMEs and student aid, increased from previous years. However, social bonds did not take off properly until March when the COVID-19 related issuances started to enter the market, primarily from SSAs. As a result, the social bond market totalled USD 29.7bn in Q2 2020 alone, which was more than USD 10bn above the whole of 2019 and USD 18bn above 2018.

The third stage is currently underway and is defined by social bonds focusing on supporting economic activity overall rather than issuances directly related to COVID-19. This has seen another jump in issuance, from slightly below USD 30.0bn in the previous two quarters, to USD 72.7bn in October and November alone. The European Commission was responsible for issuances totalling USD 46.8bn in this period. These consisted of two SURE (Support to mitigate Unemployment Risks in an Emergency) social bonds, a 10-year EUR 10bn (USD 11.8bn) and a 20-year EUR 7bn (USD 9.5bn), issued in October, which was followed up by another round of SURE social bonds in early November that totalled USD 20.1bn. More social bonds under the European Commission can be expected as they plan to issue up to EUR 100bn of social bonds under the social bond framework that was developed in October. The eligible social expenditures under this framework are for short time work schemes, to protect employees and self-employed, and for workplace health related issues.

The other major issuers of social bonds in October and November were two French government agencies – Cades (Caisse d'Amortissement de la Dette Sociale) and Unedic. Cades issued two social bonds in EUR and USD totalling USD 6.6bn in October. Cades' mission is 'to finance and extinguish the cumulative debt of the general Social Security system', with the agency creating a social bond in September with the purpose of financing or refinancing deficits in France's social security branches. Unedic manages unemployment insurance in France and issued in June the largest social bond (at that time) of EUR 4.0bn. With additional issuances throughout the year, including four EUR social bonds totalling EUR 9.0bn (USD 10.0bn) in October and November, Unedic has now raised USD 21.1bn of financing through social bonds in 2020. The social bond framework that defines how the proceeds from these social bonds are used and the eligible expenditures consists of benefits and allowances for the involuntarily unemployed as well as support programmes for (re)integration and training.

The issuances described above are supranationals (European Commission) or government agencies (Cades and Unedic) which account for 83% of the social bond market YTD 30 November and 90% of the market so far in Q4. However, it should also be noted that total issuances from financials (USD 15.3bn by YTD 30 November), corporates (USD 6.0bn by YTD 30 November) and sovereigns (USD 3.4bn by YTD 30 November) are at a total volume of USD 24.6bn - already more than double that of 2019.

Figure 9: Social bonds market growth by sector (USD bn)



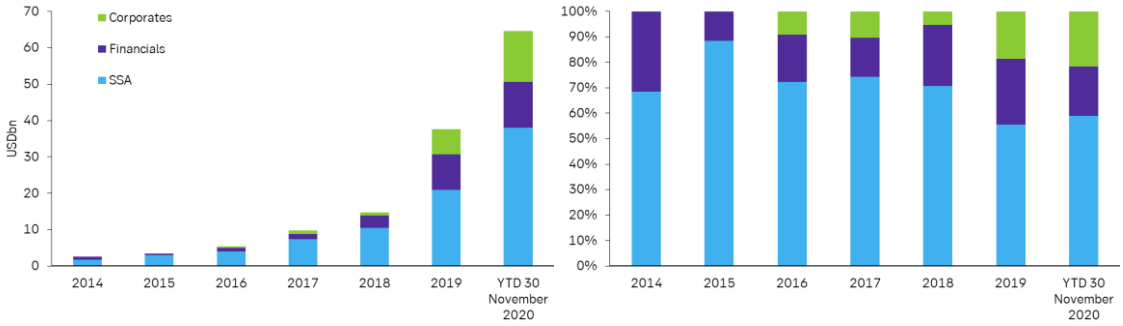
Source: Bloomberg New Energy Finance, as of 30 November 2020

Sustainability Bonds

The Sustainability bond market has also increased significantly in 2020 with total issuances by YTD 30 November 2020 at USD 64.6bn compared to 37.7bn last year. The largest sector is SSA at USD 38.1, of which government agencies account for USD 21.0bn while supranationals have increased total issuance from USD 4.3bn last year to USD 12.8bn YTD 30 November. The private sector has also increased its volume of sustainability bonds with corporates at USD 14.0bn and financials at USD 12.6bn so far in 2020.

The eight largest issuances in October and November were SSA and six of these were government agencies. The State of North Rhine-Westphalia issued the largest sustainability bond in this period with a 15-year EUR 2.5bn (USD 2.8bn) under a sustainability bond framework that includes the eligibility project categories education and sustainability research, inclusion and social coherence and sustainable urban development. The second largest sustainability bond in the period was issued by French government agency AFD (Agence Française de Développement) with a 7-year EUR 2.0bn bond under a new SDG bond framework with a wide range of eligible project categories that must meet one of the sustainable development goals and respond to one of the six transitions in AFD's strategic plan (demographic and social transition, energy transition, territorial and ecological transition, digital and technological transition, economic and financial transition or political and civic transition).

Figure 10: Sustainability bonds market growth by sector (USDbn)



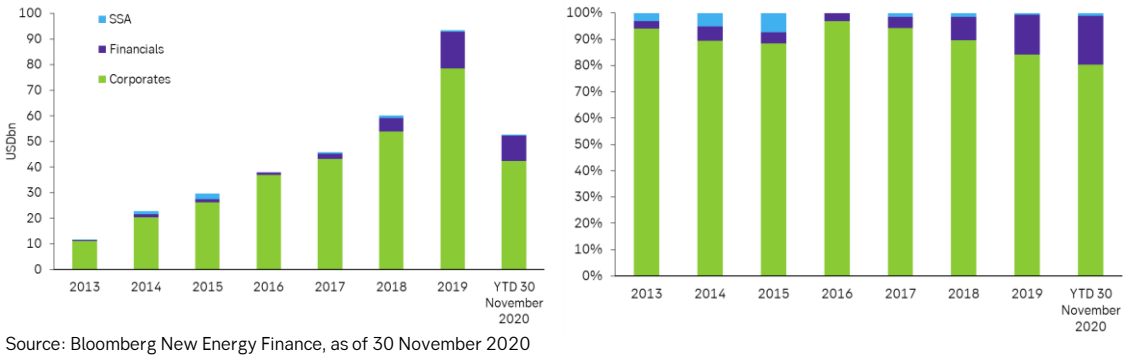
Source: Bloomberg New Energy Finance, as of 30 November 2020

Green Loans

Note on data: The green loan market is a private market with limited access to information. We use the loans listed in Bloomberg New Energy Finance, which we think provides a good reflection of the overall market.

The green loans market is at USD 52.0bn at YTD 30 November about half of the total for 2019. However, it should be noted that the loan market is far less transparent than the bond market. Due to this, green loans that have been signed may be registered later. The corporate sector dominates the market with more than 80% of transactions in 2020. Three of the four largest green loans so far in 2020 has been provided to companies involved in the offshore wind industry, of which the largest was a EUR 1.5bn green loan to Eoliennes Offshore Des Hautes Falaises.

Figure 11: Green Loans market growth by sector (USD bn)



Source: Bloomberg New Energy Finance, as of 30 November 2020

Pandemic Bonds

Another category of bonds that has played a significant role in 2020 are bonds related to COVID-19. Bloomberg New Energy Finance (BNEF) are tracking a category they have named 'Pandemic bonds', in which "Bond proceeds are designated for projects related to COVID-19". The total amount of bonds issued under this definition was USD 334.4bn by YTD 31 October, which is more than twice the amount of social bonds issued so far in 2020. It should be emphasized that this captures bonds that do not necessarily adhere to the social or sustainability bond principles developed by ICMA and we therefore do not necessarily consider them sustainable finance products. It is nonetheless an interesting reflection of the amount of financing that has been directed to combating the COVID-19 and its effect on the economy worldwide.

Sustainability-linked

Regional Update

90% of sustainability-linked transactions in 2020 that are covered in this section have been loans, but the number of loans is probably even higher as the loan market is less transparent than the bond market. The main region for both loans and bonds is Europe excluding the Nordics, with a 67% share of the market, where the Nordics account for an additional 13%. Within Europe, German borrowers and issuers are by far the largest with loans and bonds totaling USD 15.9bn in 2020. This is followed by Spain, Italy, France and the United Kingdom all within the USD 8-10bn range for 2020.

Sustainability-linked loans (SLL)

Note on data: The sustainability-linked loan market, whereby the loan margin is typically linked to a set of targets or an ESG score, is a private market with limited access to information. We use the loans listed in Bloomberg New Energy Finance, which we think provides a good reflection of the overall market.

Sustainability-linked loans emerged as a major pillar of the sustainable finance market in 2019 with issuances totalling USD 139.6bn. However, more than half of that total was registered after November. This was partly because the market for sustainability-linked loans was very strong at the end of last year, with total loans of USD 62.2bn in October and November, but also because there is often a time-lag for loans due to the private nature of the product.

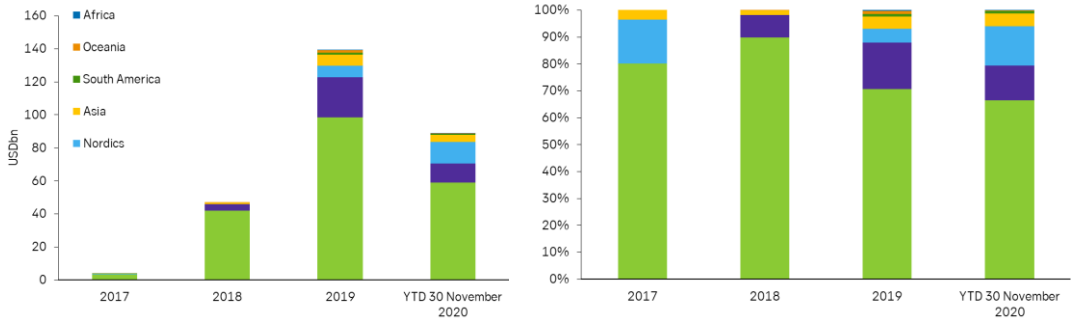
In 2020, the total market for sustainability-linked loans as of YTD 30 November is USD 88.9bn. However, we believe the volume for full year 2020 will be substantially higher due to the aforementioned challenge with late registrations of loans, combined with anecdotal experiences from SEB loan units across Northern Europe that reports a significant increase in demand and knowledge of sustainability-linked loans.

Italian energy company Enel and Danish shipping company Maersk are responsible for the largest transactions so far in 2020 with a loan of 2-year EUR 5.0bn in April (USD 5.4bn) and 5-year USD 5.0bn RCF in February, respectively. Enel's loan

was borrowed in accordance with their Sustainability-Linked Financing Framework, the first of its kind, which was also used for issuing a 7-year GBP 500m (USD 650m) sustainability-linked bond and another 6-year EUR 1.0bn SLL in October. All these transactions are governed by the KPIs defined in their framework, which are 1) Direct Greenhouse Gas Emissions Amount (Scope 2) and 2) Renewable Installed Capacity Percentage. Sustainability Performance Targets (SPTs) will be attached to these KPIs as applicable at the time of the transaction. Maersk's USD 5.0bn SLL had SPTs that were in line with their target of reducing emissions per cargo moved, by 60% by 2030, which is more ambitious than the IMO (International Maritime Organization) target of a 40% by 2030 from a 2008 baseline, the most frequently used benchmark in the shipping industry.

The two largest transactions in October and November were SLLs from Michelin and Vattenfall. Auto part manufacturer Michelin with a 3-year EUR 2.5bn (USD 2.9bn) in which the three KPIs are percentage engagement of employees, reduction of scope 1 and 2 emissions and reduction of the environmental impact from sites. Vattenfall signed a 3-year EUR 2.0bn (USD 2.4) SLL which was linked to the company's 2030 carbon dioxide (CO2) emissions intensity target.

Figure 12: Sustainability-linked loans market growth by region (USD bn)



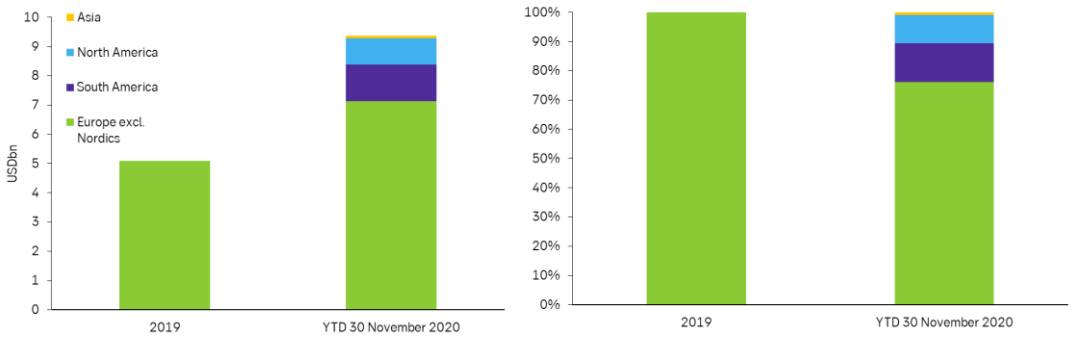
Source: Bloomberg New Energy Finance, as of 30 November 2020

Sustainability-linked bonds (SLB)

The sustainability-linked bond market YTD30 November totalled USD 9.4bn, which was almost twice that of full year 2019. This is a new addition to the sustainable finance palette, but it has seen increased activity after ICMA's sustainability-linked bond principles were issued in June. In fact, USD 8.3bn of the issuances in 2020 have been added in the last three months and extrapolating that to the whole year would indicate a full-year issuance estimation of USD 25.2bn.

The sustainability-linked market is almost completely dominated by corporates with 17 of the 18 issuances in 2020 coming from this sector. All issuers in 2019 were European while the market for the current year consists of 16 European issuers, of which Switzerland is the largest in terms of volume due to an 8-year EUR 1.85bn (USD 2.2bn) RCF from Novartis and an 11-year EUR 850m (USD 1.0bn) from Holcim Finance. The Novartis RCF is actually the largest SLB of 2020 so far and is linked to targets of increasing the patients reached in low- and middle- income countries. The two non-European issuers were Hulic Co based in Japan and Brazilian pulp producer Suzano, whom issued the second largest SLB of the year with a 11-year USD 1.25bn issuance under their new sustainability-linked framework where the KPI is GHG Emissions intensity tCO2e/t produced and the SPT is a 15% by 2030.

Figure 13: Sustainability-linked bonds market growth by region (USD bn)

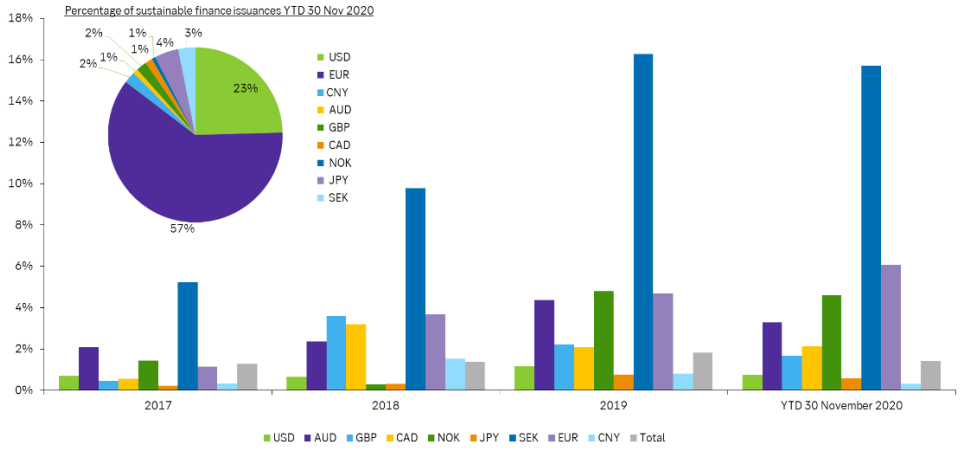


Source: Bloomberg New Energy Finance, as of 30 November 2020

Currency analysis

Figure 12 shows the ratio of green, social, sustainability and sustainability-linked bonds to total bonds within each of the currencies listed. There is an upward trend for most major currencies and EUR, in particular, stands out with a good growth rate for the last four years. SEK has by far the highest ratio at 15%, which is also reflected in the pie chart showing that 3.0% of all green, social, sustainability and sustainability-linked bonds are issued in SEK, which compares very favorable to the total bond market where SEK only represents 0.3% of the market.

Figure 14: Green, social, sustainability and sustainability-linked issuance as a percentage of total bond issuance

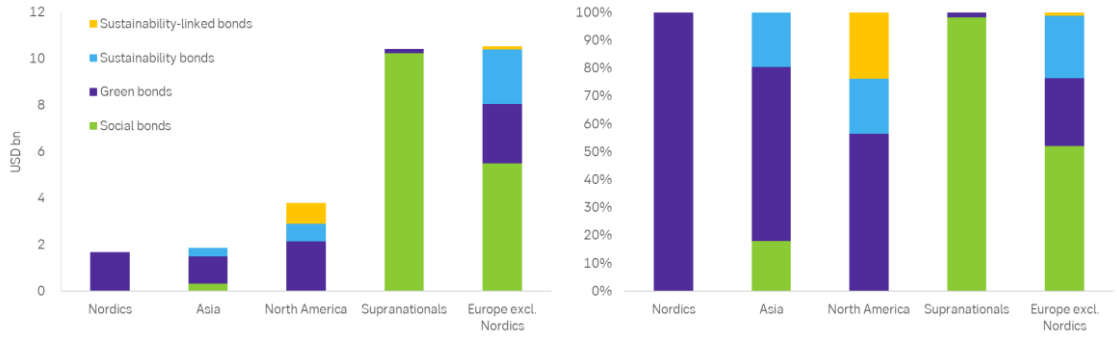


Source: Bloomberg New Energy Finance, as of 30 November 2020

December update (YTM 9 December)
The December market update only includes figures for bonds as information on the loan markets are not available yet.
A total volume of USD 28.3bn have already been issued in green, social, sustainability and sustainability-linked bonds. The most notable issuance so far this month was from the European Commission with a 15-year EUR 8.5bn (USD 10.2bn) SURE social bond. The European Commission is classified as a supranational institution, but Europe exc. Nordics was nonetheless the largest region, primarily due to social bonds that accounted for more than 50% of the volume in the region. The two largest European social bonds came from Cades with a 5-year EUR 3.0bn (USD 3.6bn) issuance and Credit Agricole with a 7-year 1.0bn (USD) issuance.

Green bonds were more prominent in the Nordics, Asia and North with notable issuances from the US utility company AES who issued an inaugural dual-tranche 6/11 years USD 1.8bn green bond and Stora Enso with a EUR 500m green bond issuance.

Figure 15: Green, Social and Sustainability Bonds market update – 9 December



Source: Bloomberg New Energy Finance, as of 30 November 2020

Publicly Announced Green, Social & Sustainability Bond Pipeline[1]

- France plans to issue second green bond in 2021
- Italy plans to release green bond framework
- Audax Renovables EUR 7-year green bond mandated
- JR East sustainability bond mandated
- Akershus Energi green bond mandated

[1] As of 9th December2020

Outlook for green, social and sustainability bonds in 2021

The scenario in this outlook for 2021 is only based on estimates for green, social and sustainability bonds. We have looked at the outlook for green loans and sustainability-linked loans and bonds, but have concluded that we do not have sufficient transparency of the loan market as it consists of private agreements and we still believe it is too early to put a figure on the sustainability-linked bond market as it still in its infancy. That being said, we are confident that the sustainability-linked concept will continue to play a larger role in the sustainable finance market going forward and expect to see significant growth in 2021 and beyond.

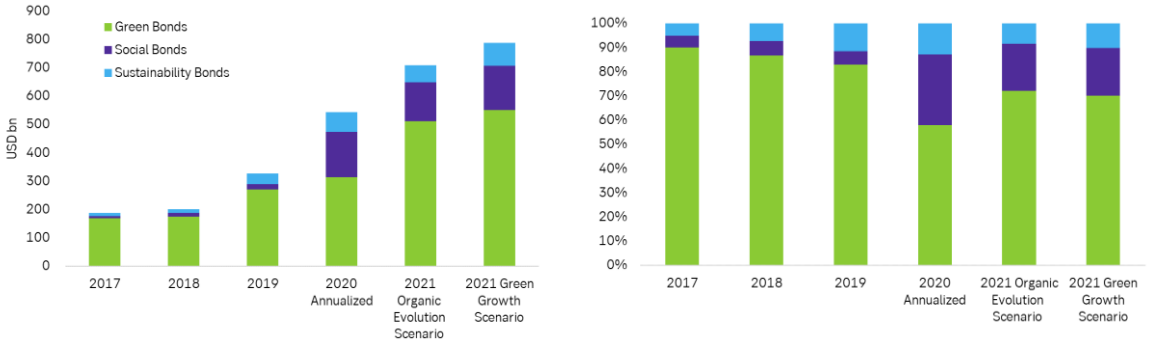
The sustainable finance market has increased each year since the first labelled green bond was issued in 2008 and exceeded USD 1trn in 2020. This year is also the first time that other sustainable finance products than green bonds accounts for more than 50% of the market. The SEB outlook for 2021 reflects this with an estimate for all the main use of proceeds bond types - green, social and sustainability.

2020 turned out a bit different than most of us envisioned last December, both for the green bond market and for our daily lives. Our outlook for the year, USD 350bn for the Organic Evolution Scenario and USD 375 bn in the Green Growth Scenario, will not be met even with a strong comeback in the last few months as the annualized volume by the end of November is at USD 314.2bn. On the other hand, we would not have estimated that social bonds would be on track to exceed USD 150.0bn for the full year either, which indicates that the labelled bond market is responsive and growing even in challenging circumstances.

We expect continued growth for green, social and sustainability bonds in 2021. As such, we envision a total market size for green, social and sustainability bonds of 708.bn in our Organic Evolution Scenario and USD 786.0bn for our Green Growth Scenario. This would represent an increase of 30% and 45%, respectively, over the annualized 2020 volume of these product types at USD 543.2bn.

As figure 16 below illustrates, we expect a significant comeback from the green bond market, but also continued growth of sustainability bonds. The growth of the social bond market in 2020 was, at least in Q2, a reflection of the response to COVID-19. As such, we expect the market to be slightly lower in 2021.

Figure 16: Outlook for green, social and sustainability bonds in 2021



Source: Bloomberg New Energy Finance, as of 30 November 2020

Our estimate for the green bond market is USD 510.0bn in the Organic Evolution Scenario and USD 550.0bn in the Green Growth Scenario. Under this scenario, we expect both the corporate and financial sectors to increase to USD 120bn to USD 130bn in our Green Growth Scenario from an annualized level of USD 85.3bn and USD 84.9bn, respectively. We expect the majority of the growth from the current year to come from the SSA market with an estimated volume of USD 240bn in the Organic Evolution Scenario and USD 255bn in the Green Growth

Scenario. This is to a large extent based on the European Commission's plan to issue green bonds worth USD 100bn in the near future.

We expect the social bond market to be USD 138.0bn in the Organic Evolution Scenario and USD 156.0bn in the Green Growth Scenario. Hopefully, we will not need the type of urgent social bonds that dominated the market after the COVID-19 outbreak. However, we do think issuers, SSAs in particular, will continue to use social bonds to support the economic recovery and it is encouraging to see that this is already being done by the French government agencies and the European Commission. The latter has announced a USD 100bn social bond program, of which USD 56bn was issued by mid-December.

We estimate that each of the sectors in the sustainability bond market will have a modest increase in 2021. As such, we estimate USD 60bn in the Organic Evolution Scenario and USD 80bn in the Green Growth Scenario. Several corporations and financial institutions, including Alphabet, Pfizer, Bank of America and Adidas, have created sustainability frameworks in 2020 and this will hopefully encourage other large corporates to create their own framework. However, some corporations and financials institutions may also issue sustainability-linked bonds, which could complement but also in some instances eat into the sustainability bond market.

Sustainable cities

A case study of leading sustainable cities for respective regions

Note that this is a summary of a larger report.

Today, 55% of the world's population lives in cities and this proportion is expected to increase to 68% by 2050, according to the United Nations. These urban areas generate more than 80% the global GDP, but urban economics is even more compressed than this figure suggests. Only 600 urban centers, with a fifth of the world's population, generate 60% of global GDP. In this increasingly urban world, cities are centers of power and the engines of the global economy, blazing the path to economic growth. Nonetheless, cities are being challenged. Many cities are already struggling with environmental degradation, traffic congestion, inadequate urban infrastructure, unemployment, and a lack of basic services such as water supply and waste management.

However, while cities are particularly at risk from the climate crisis, they are also behind some of the most powerful solutions. The transition to sustainable cities needs to start at the local level, in which cities and its stakeholders must work together. City governments are closer to their and can more easily connect with the public sentiment. Municipalities are also able to act faster and innovate on climate change mitigation and social sustainability at a smaller scale by acting as hubs for experimentation.

Although cities are crucial to tackle sustainability challenges and create a social and climate-resilient future, lack of understanding of sustainable financial risk assessment is a major barrier preventing cities from realizing their sustainability ambitions.

Capital mobilization does not seem to be the main reason behind the financial gap in these selected cities, but they still need to foster creative partnerships with the private sector and encourage increased private sector participation to help them meet urban sustainable infrastructure demands within their budgetary constraints.

The report on sustainable cities has been based on the study of Stockholm, Copenhagen, Toronto, Singapore, Barcelona, and New York divided in eight different categories that have been analysed through qualitative interviews and best practices and quantitative relevant indicators. The categories analyzed are water, waste, food, housing, transportation, energy, public access and social equity and digital connection. The findings are very diverse and do not only help explain the current challenges and opportunities but also help shed some light on how urban sustainability will develop in the near future.

After a thorough analysis of the urban sustainability practices in the different categories for the chosen cities, several conclusions can be made.

There is a strong correlation between high ratings on social sustainability and ecological sustainability, possibly because social exclusion generates resistance towards changes, so to sustain an urban green transition, cities have to be inclusive enough that each citizen takes ownership of the common space.

Regardless of the causal relationship, there is a strong tendency for cities that perform well in terms of social sustainability to also perform well in ecological sustainability.

Juliana Chiva

Summer Intern
Climate & Sustainable Finance

Eliel Stenström

Summer Intern
Climate & Sustainable Finance

Access to finance isn't the key issue for large cities. They tend to have a sufficient tax base and credit rating to borrow on terms similar to states. Yet multiple creditors and municipal officers interviewed have stated that they struggle with connecting sustainability projects with sources of urban finance.

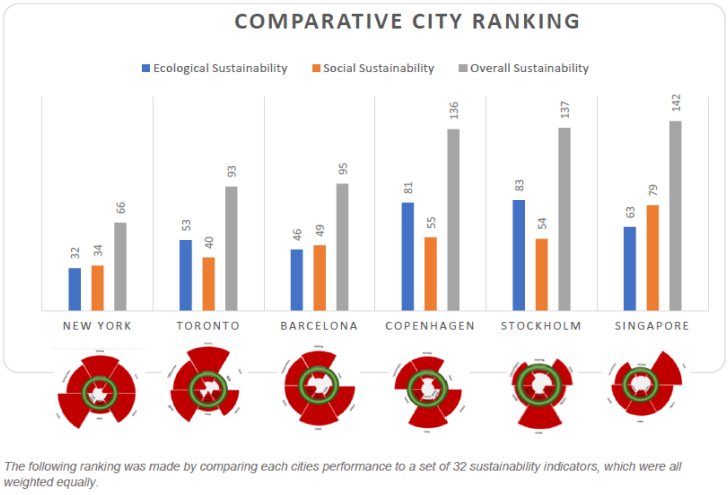
Some financial institutes have sought to take a proactive approach by helping cities and private initiators identify projects and sources of finance, often successfully, and cities have sought to replicate this and invest in accelerators. Nevertheless, in sustainability the demand for urban sustainability finance seems to remain lower than the supply of it.

Contracting private actors to deal with issues such as waste refinement, public transport, waste management, and energy provision can be effective and often necessary. However, to achieve sustainability in these fields, providers need adequate incentive structures. For example, in New York private waste management providers have traditionally been paid based on tonnes of waste managed - which experts have said generated inefficiency in reducing waste streams. New contracts have sought to adjust this, and since then, waste streams have declined.

The most common denominator for leading sustainability cities is extensive investments in a smart- city infrastructure that can collect real-time data on sustainability challenges (e.g. energy surveillance, waste streams, air and water pollution, or traffic movements). Municipal officers routinely identify the lack of real-time data as a major paint point in their sustainability challenges, and the cities that perform the best on measured sustainability indicators tend to have smart city assets that collect real-time data on these indicators. Better access to data helps cities identify the challenges in existing sustainability strategies, but also enables more innovative solutions to major sustainability challenges, like smart bins, automatic plugging of energy leakages, effective incentives for housing retrofits, and centralized traffic flow control, which all require smart city infrastructures.

Finally, technological innovations are likely to radically alter the physical and digital space of cities in the upcoming decades. The clearest example is transportation - where automated cars, a growing number of individual transport options, three-dimensionally, and exponentially higher rail speeds - are all poised to radically alter the landscape. The issue is that it is difficult to be certain about which trend will dominate, and when, making the design of future urban spaces and long-term urban sustainability strategies difficult to envision.

Figure 17: Summary of key findings



Source: SEB report "Sustainable Cities"

Meeting the climate finance gap for small-scale agriculture

Liza Leclerc

Lead Technical specialist, Environment and Climate Division
leclerc@ifad.org

Natalia Toschi

Senior Finance Officer
n.toschi@ifad.org

Global tracked annual climate finance flows passed the USD half-trillion mark for the first time in 2017/18[2] from all sources of finance, domestic, international, public and private. While this is a positive trend, only 1.7%, a fraction of what is needed - goes to small-scale farmers in developing countries despite their disproportionate vulnerability to the impacts of climate change[3] and, at the same time, their vital role in achieving food security and the achievement of the Sustainable Development Goals.

Food insecurity affected 820 million people in 2018, rising from 785 million in 2015 (SOFI, 2019), while 736 million people still live in extreme poverty. Food insecurity and poverty tend to be concentrated in areas most vulnerable to climate change such as sub-Saharan Africa, and particularly in the rural areas of low-income countries, where as much as 75 per cent of the world's extremely poor people live[4]. While hunger is on the rise in almost all African sub-regions, making Africa the region with the highest prevalence of undernourishment, at almost 20 percent, it is also slowly rising in Latin America and the Caribbean, although its prevalence is still below 7 percent. In Asia, Western Asia shows a continuous increase since 2010, with more than 12 percent of its population undernourished today[5].

Small-scale farmers currently produce 50 percent of the world's food calories. In Asia and Sub-Saharan Africa, small-scale farmers are estimated to provide up to 80% of the food produced. Most of the world's small-scale farmers live in these regions, where the agricultural sector contributes around 15% of the GDP and provides over 40% of all the jobs all along the value chain.

IFAD has been operating the largest trust fund of dedicated climate finance for small-scale producers since 2012 through its Adaptation for Small-scale Producers (ASAP) programme since 2012 through grants. Since then, demand for climate finance has translated into allocating over 25% of finance to climate change interventions and are being scaled up by countries and across regions and present tremendous opportunities for tapping into the innovation and ingenuity of small and medium sized enterprises developing the sector and bringing well-being to people.

Restoring pastureland in Niger, Tajikistan, Kyrgystan and Mozambique improved the productivity of small livestock by up to 30%. In Madagascar, integrating the management of organic fertilizers, mulching, zero tillage and agroforestry has increased vegetable yields by 300% but this

[2] Global Landscape of Climate Finance 2019 https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2019/#:~:text=Climate%20finance%20flows%20reached%20a,2018%20to%20USD%20546%20billion

[3] Examining the climate finance gap for small scale agriculture https://www.ifad.org/en/web/knowledge/publication/asset/42157635

[4] IFAD, 2019. Rural Development Report

[5] SOFA 2019

can be increased further still. Introducing drip irrigation technology coupled with solar water pumping in Chad, Bhutan and Mozambique, while eliminating the consumption of fossil fuels, optimizing water use and reducing labour requirements has shown yield increases from 15 to 40 t/ha for tomatoes and from 12 to 48 t/ha for cabbage6.

Moreover, green value chains can create jobs and sustainable income streams. Marketing of sustainably produced neem oil in The Gambia and Madagascar, transforming banana leaves instead of plastic bags for the production of seedlings in Burundi, establishment and management of tree nurseries in Niger, manufacturing of improved ovens or production of solar energy, certification of coffee and cocoa in Nicaragua have all contributed to increased monetary income and represent untapped potential for greater investment7.

Climate finance from the public sector and official development assistance must increase, but the scale of the challenge will not be addressed without tapping into more innovative sources of investment.

In line with the Addis Ababa Action Agenda, IFAD's ambition is to increase financing to all eligible borrowers to support their national priorities.

IFAD's proven and measurable contribution to the 2030 Agenda for Sustainable Development and the link to several of the Sustainable Development Goals make it a natural partner for private institutional investors with a focus on environmental and social returns.

That is one of the underlying reasons for IFAD to go through the credit rating process, where it recently received a AA+ rating from both S&P and Fitch: To prepare itself for borrowing from private sector investors through the issuance of private placements. IFAD will introduce its own Sustainable Development Finance Framework to clearly show investors how their financing supports the achievement of the SDGs.

[6] ASAP Technical Paper: Food Security and Nutrition (in draft)

[7] Ibid.

Why investors need to understand Power-to-X

The technology that can electrify the world.

Tore Sylvester Jeppesen

Senior Vice President, Business Development.
tosj@topsoe.com

Climate changes are at the top of the agenda and as a consequence, governments, companies, and investors around the globe are looking for viable solutions. The hope is to secure both acceptable living conditions for the growing world population as well as a significant and quick reduction in greenhouse gas emissions.

This scenario demands an energy transition from fossil fuels, such as oil, gas, and coal, to renewable energy. Some areas can be electrified directly. A well-known example is private cars. However, it is not possible to electrify airplanes, international shipping, and heavy transport with today's technologies. Therefore, an essential step in the energy transition is to develop technologies that can produce carbon-neutral fuels and chemicals from renewable power at a competitive – or at least tolerable – cost.

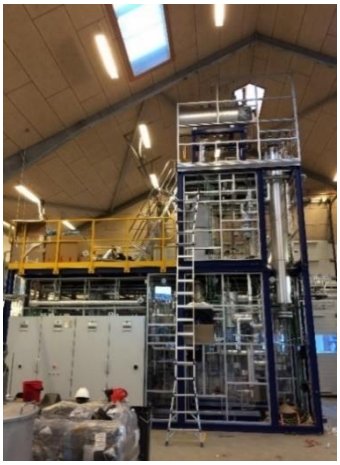
Power-to-X has received very significant attention as an advantageous route to producing high-value carbon-neutral fuels and chemicals from the increasing volume of low-cost renewable electricity available from wind turbines and solar panels.

A transition based on experience
Haldor Topsoe is a world-leader in today's technologies to produce hydrogen, ammonia, and methanol.

This competence is essential for developing Power-to-X technologies, as these chemicals are preferred end-products from Power-to-X. In addition, Haldor Topsoe is developing next-generation electrolysis cells based on two decades of research – electrolysis is the technology at the very heart of a Power-to-X plant. This combination of experience is unique and puts Haldor Topsoe in a central position in the industrialization of Power-to-X technologies globally.

Currently, Haldor Topsoe is a partner in some of the world's largest Power-to-X projects, including the 4 GW NEOM project in Saudi Arabia, which will use Topsoe ammonia technology.

Figure 18: This demonstration plant, based on SOEC, has delivered proof of the technology's stability and efficiency for some years.



Source: Haldor Topsoe

Hydrogen from water

In its most basic and common form, a Power-to-X plant produces hydrogen by electrolysis of water. This requires electrical power that is fed into an electrolysis cell that splits water into oxygen and hydrogen.

Hydrogen is a carbon-free fuel that can be used in engines based on a fuel cell, but today it is almost exclusively used for industrial applications, particularly in the refining and chemical sectors.

Approximately 60 million tons of hydrogen were produced in 2018; the global market has an estimated value of more than USD 130 billion and is forecasted to reach a value of around USD 200 billion in 2023.

According to the International Energy Agency (IEA)[8] hydrogen is almost entirely supplied from fossil fuels, with 6% of global natural gas and 2% of global coal going to hydrogen production. As a consequence, production of hydrogen is responsible for CO_2 emissions of around 830 million tons per year, equivalent to the combined emissions of the United Kingdom and Indonesia. In contrast, the hydrogen production process in a Power-to-X plant using renewable power emits no CO_2.

Hydrogen is the base for more carbon-neutral fuels and chemicals

As the 'X' in Power-to-X implies, the end-product can be several other fuels and chemicals than hydrogen. However, this requires that an additional production loop is added to the electrolysis plant so that hydrogen can be processed to form the desired end-product. The additional loops are basically similar to the technologies that Haldor Topsoe design for conventional producers, but they must be adapted to a more dynamic production based on intermittent renewable power.

Figure 19: The first commercial Power-to-X plant based on Haldor Topsoe's SOEC technology ready to be shipped for a US customer.

Source: Haldor Topsoe

Ammonia, methane, and methanol are all widely traded chemicals and future fuels that can be produced in this way. They are all significantly cheaper to store and transport than hydrogen and are more energy dense - indicating that they offer more energy per volume. These attributes make these chemicals attractive alternatives to hydrogen in some cases.

Ammonia is of special interest because it is the only product from Power-to-X, besides hydrogen, that does not contain carbon and therefore cannot lead to CO_2 emissions when used as a fuel. In addition, ammonia can be used in conventional diesel engines with only minor alterations.

This is the reason why ammonia is considered a very promising carbon-neutral marine fuel. Recently, Haldor Topsoe and partners have published a report that offers a detailed look at ammonia as a marine fuel[9]. The report concludes that, in the future, green ammonia will be the most economic carbon-neutral fuel for marine use, and that critical factors such as safety, availability, and business risk are all favorable for the use of ammonia as a marine fuel.

The energy consumption in the maritime sector is huge. It takes 400 GW power to meet just 30% of future marine fuel demand. In 2019, a total of 184 GW additional renewable power production was installed globally. Already today, conventionally produced ammonia is produced, transported, and used as artificial fertilizer in large quantities across the globe. Haldor Topsoe technologies are involved in half of the global production of ammonia.

[8] https://www.iea.org/fuels-and-technologies/hydrogen

[9] https://info.topsoe.com/ammonfuel

The energy storage challenge
In the fossil-free future, large amounts of electricity will be produced from intermittent renewable sources like wind and solar energy. This scenario brings a significant challenge. Some days, the system will produce more power than can be absorbed in the grid, and the excess power must be stored for later use. This is known as 'grid balancing'.

Among the available energy storage technologies, analyses have shown that chemical storage is by far the best option for large-scale, long-term storage. This means using Power-to-X to produce a chemical or fuel that can be stored for later use.

Also as an energy storage solution, ammonia stands out as a desirable option. Its energy density is superior to that of hydrogen, and because it does not contain carbon, it is cheaper to produce than methane or methanol. In addition, the logistics of handling ammonia are well-known and much simpler than that of the other carbon-free energy vector, hydrogen. Currently, 120 ports are equipped with ammonia trading facilities worldwide.

Efficient electrolysis is crucial for the success of Power-to-X.
Electrolysis cells produces hydrogen by splitting water using electrical power. To a large degree, this central process in Power-to-X determines the price of the end-product. The two most common electrolysis technologies today – alkaline and polymer electrolyte membrane (PEM) electrolysis –achieve efficiencies around 70%. In other words: Only 70% of the electrical energy that goes into the process is preserved in the produced hydrogen; 30% is lost.

Haldor Topsoe has come far in developing a significantly more efficient technology – the Solid Oxide Electrolysis Cell (SOEC). The SOEC delivers efficiencies above 90%, and in some cases close to 100%. This gain can prove to be a gamechanger in making Power-to-X technologies drastically more competitive.

The first small-scale commercial plants based on SOEC have been installed, and Haldor Topsoe expect to deliver SOECs in an industrial scale in 2023.

Figure 20: Haldor Topsoe's SOEC are considered next generation electrolysis cells because of a significantly higher efficiency than today's technologies.

Source: Haldor Topsoe

Building a favorable investment climate
The ongoing transition toward an electrically dominated energy supply will require huge investments with considerable risk. The chemical industry and the power industry are investing, but requirements for capital go beyond what these sectors can muster.

It is apparent that the energy transition in general, and the industrialization of Power-to-X in particular, will require capital from public/private partnerships and financial investors.

To create a favorable climate with acceptable risk for financial investors, it is necessary to offer coherent solutions that span the full value chain from renewable power to sellable chemicals and fuels. Haldor Topsoe collaborate with project developers and investment funds to offer an end-to-end Power-to-X license, very similar to what has previously been achieved in renewable power generation projects. This includes not only chemical production technology, but also electrolysis and, in some cases, CO_2 capture. The goal is to reduce technical risk in the projects and increase the transparency of investment opportunities within Power-to-X, especially for investors outside the chemical sector.

A pathway to zero-carbon shipping

How to turn the climate agenda into a business opportunity.

DANMARKS SKIBSKREDIT

Christopher Rex

Head of Innovation and Research

rex@shipfinance.dk

This executive summary is written as part of a larger publication – Shipping Market Review[10] *.*

We present a vision that aims to identify how ships, as an asset class, can re-emerge as an attractive investment opportunity in a zero-carbon future. This is, to some extent, a discussion of end-game scenarios. Whether or not the scenarios actually materialise is not that important; the key thing is exploring them may allow up to open our minds to alternative trajectories and help us escape the rut of linear thinking.

The shipping industry is struggling to identify a clear pathway towards decarbonisation. The asset base is owned by small and medium-sized players. The fragmented industry structure complicates the articulation and development of an industry-wide strategy for zero-carbon fuels. Many initiatives are currently being reviewed. Costs remain a major issue. There is currently no zero-carbon fuel that can offer a global distribution network at scale which is price competitive with current bunker fuels.

The short-and medium-term outlook is shrouded in uncertainty. The industry's low return on invested capital combined with the increased need to invest has dried up the supply of equity investors and created an environment where there are more sellers than buyers of vessels. We foresee a bumpy transition in the absence of clear long-term guidance from regulators that works to bridge and facilitate the energy transition.

The long-term value play is about reducing the global economy's CO2 footprint by decarbonising the underlying industries and sectors. To some extent, this means replacing the oil and gas industry, which requires a standardised, scalable and cost-competitive zero-carbon fuel solution that can work across sectors to be identified. The transformation is likely to reshape industries and redistribute value creation.

Shipowners' access to cargo, capital and ports could be at risk if they are considered not to be doing enough to reduce their CO2 footprint. Their ability to offer a cost-competitive zero-carbon service to their customers will, at some point, be a critical element in the renewal of their licence to operate.

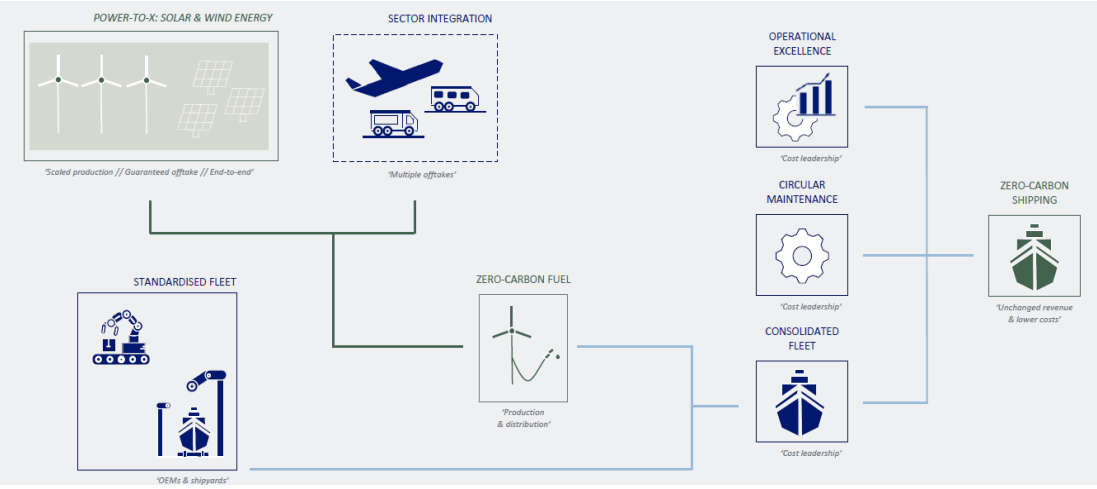
We set out a vision for the future that aims to turn the climate agenda into a business opportunity. The next-generation zero-carbon-fuelled vessels could emerge as an attractive asset class. The route to additional value creation is primarily cost

[10] Full report: https://www.shipfinance.dk/media/2054/shipping-market-review-november-2020.pdf

savings through standardisation and economies of scale.

The barriers to entry could be raised – if only for a period – via the development of a zero-carbon fuel supply available to players that actively engage in sector integration. Sector integration is about pooling various sectors' fuel demand to reach critical mass and allow prices to come down. The zero-carbon fuel choice of the future is a global challenge facing all industries and sectors of the economy, not just maritime players. The shipping industry is unlikely to be the trailblazer, but some maritime players actively engaging in the decarbonisation process would be likely to benefit from the change.

Figure 21: A pathway to zero-carbon shipping. Higher ROE – a standardised fleet, operating on low-priced zero-carbon fuel would outperform the market through cost leadership.



Source: Danish Ship Finance

Industrial Transformation 2050

Pathways to Net-Zero Emissions from EU Heavy Industry

Per Klevnäs (Lead Author)

Partner
per.klevnas@materialeconomics.com

Per-Anders Enkvist

Founder and CEO
pa.enkvist@materialeconomics.com

Robert Westerdahl

Partner
robert.westerdahl@materialeconomics.com

This study[11] by management consultancy Material Economics explores multiple ways to achieve net-zero emissions from EU steel, plastics, ammonia and cement production while keeping that production in the EU. It quantifies the potential impact of different solutions and finds that emissions from those industries can be reduced to net zero by 2050, confirming the findings of the pathways presented in the Commission's A Clean Planet for All. Many new solutions are emerging, thanks to a more circular economy with greater materials efficiency and extensive recycling of plastics and steel, as well as innovative industrial processes and carbon capture and storage.

Many different industrial strategies and pathways can be combined to achieve net-zero emissions. The analysis finds that the impact on end-user/consumer costs will be less than 1% regardless of the path pursued – but all pathways require new production processes that are considerably costlier to industry, as well as significant near-term capital investment equivalent to a 25–60% increase on today's rates. Keeping EU companies competitive as they pursue deep cuts to emissions will thus require a new net-zero CO2 industrial strategy and policy agenda. There is a need to accelerate innovation, enable early investment, support costlier low-CO2 production, overcome barriers to circular economy solutions, and ensure that companies can access the large amounts of clean electricity and other new inputs and infrastructure they need. Time is short, with 2050 only one investment cycle away, and any further delays will hugely complicate the transition. As the EU ponders its industrial future, this transformation should be a clear priority.

[11] Full report can be found here: https://materialeconomics.com/publications/industrial-transformation-2050

Net-Zero Emissions from EU Heavy Industry Is Possible By 2050

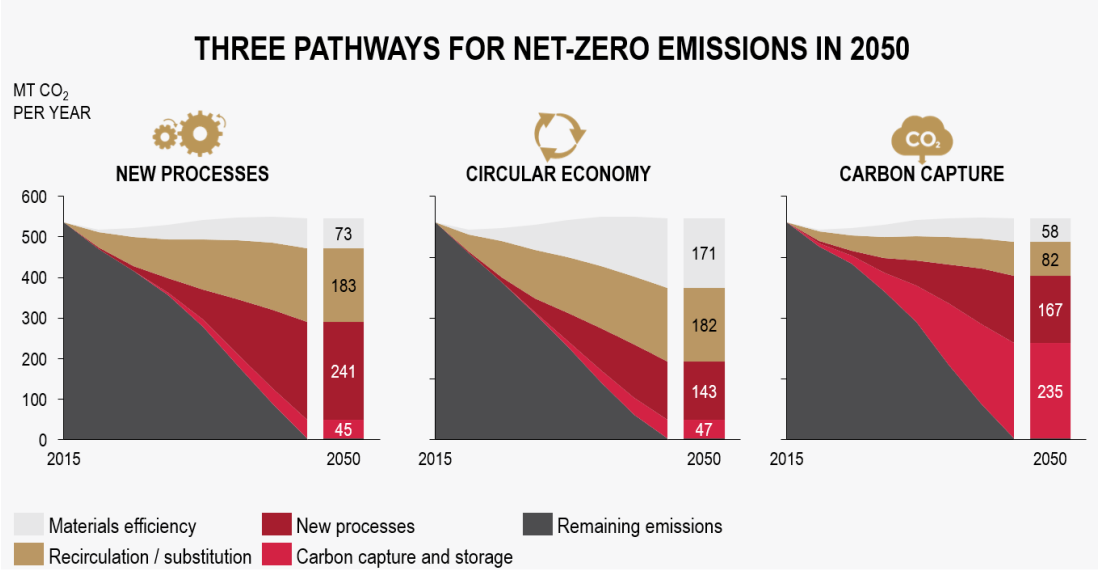
The EU has set out a vision to achieve net-zero greenhouse gas emissions by mid-century as a contribution to achieving the Paris Agreement objectives of limiting global warming. Resource and energy intensive industry holds a central place in this vision. The production of key materials and chemicals – steel, plastics, ammonia and cement – emits some 500 million tonnes of CO2 per year, 14% of the EU total. Materials needs are still growing, and on the current course, EU emissions from these sectors might increase as well. Globally, these emissions are growing faster still, already accounting for 20% of the total. The EU needs to lead the way in combining the essential industrial base of a modern economy with the deep cuts to emissions required to meet climate targets.

To date, emissions from these sectors have been considered especially 'hard to abate'. Existing industrial low-carbon roadmaps left up to 40% of emissions in place in 2050. This would make industrial emissions one of the main roadblocks to overall net-zero emissions. The European Commission's A Clean Planet for All broke new ground by also considering pathways that eliminate nearly all emissions from industry.

This study confirms that it is possible to reduce emissions from industry to net zero by 2050. It reaches this conclusion by considering a much wider solution set than what is often discussed. Whereas most existing analyses have emphasised carbon capture and storage as the main option for deep cuts, a range of additional solutions are now emerging. A more circular economy is a large part of the answer. Innovations in industrial processes, digitisation, and renewable energy technologies can also enable deeper reductions over time.

Crucially, these deep cuts to emissions need not compromise prosperity. Steel, chemicals and cement fulfil essential functions, underpinning transportation, infrastructure, packaging, and a myriad of other crucial functions. The analysis of this study is based on the premise that all these benefits continue, and also that the EU continues to produce the materials it needs within its borders to the same extent as today.

Figure 22: Pathways for net-zero emissions



Source: Material Economics

A wide range of solutions for net-zero Industry is available and emerging

There are many paths to net-zero emissions, and a wide portfolio of options provides some choice and redundancy. At the same time, industry will need a clear sense of direction, so there is a need to debate and investigate the pros and cons of different options.

This study seeks to enable such discussion. It aims to be as comprehensive as possible in describing the available solutions and finds an encouraging breadth of available options. It explores multiple different pathways, each with its own benefits and requirements, and facing different roadblocks. All pathways reach net zero, reducing emissions by more than 500 Mt per year in 2050, but reflect different degrees of success in mobilising four different strategies for emissions reductions:

A. Increased materials efficiency throughout major value chains (58–171 Mt CO2 per year by 2050). The EU uses 800 kg per person and year of the main materials and chemicals considered here. However, there is in fact nothing fixed about these amounts. This study carries out a comprehensive review of opportunities to improve the productivity of materials use in major chains such as construction, transportation, and packaged goods. All offer major opportunities for materials efficiency: achieving the same benefits and functionality with less material.

The opportunity is surprisingly wide-ranging, including new manufacturing and construction techniques to reduce waste, coordination along value chains for circular product design and end-of-life practices, new circular business models based on sharing and service provision; substitution with high-strength and low-CO2 materials; and less over-use of materials in many large product categories. For example, many construction projects use 30–50% more cement and steel than would be necessary with an end-to-end optimisation. Similarly, new business models could cut the materials intensity of passenger transportation by more than half, while reducing the cost of travel.

Much like energy efficiency is indispensable to the overall energy transition, improving materials efficiency can make a large contribution in a transition to net-zero emissions from industry. In a stretch case achieving extensive coordination and a deep shift in how Europe uses materials, these solutions can reduce material needs from today's 800 kg per person per year to 550-600 kg, reducing emissions as much as 171 Mt CO2 per year by 2050. In a more traditional pathway, emphasising supply-side measures instead, the reductions could be at a lower 58 Mt CO2.

B. High-quality materials recirculation (82–183 Mt CO2 per year by 2050). Large emissions reductions can also be achieved by reusing materials that have already been produced. Steel recycling is already integral to steel production, substantially reducing CO2 emissions. The opportunity will grow over the next decades as the amount of available scrap increases, and as emissions from electricity fall. The share of scrap in EU steel production can be increased by reducing contamination of end-of-life steel with other metals, especially copper. With plastics, mechanical recycling can grow significantly but also needs to be complemented by chemical recycling, with end-of-life plastics that cannot be mechanically recycled used as feedstock for new production.

Unlike most other forms of recycling, chemical recycling of plastics requires lots of energy, but is almost indispensable to closing the 'societal carbon loop', thus escaping the need for constant additions of fossil oil and gas feedstock that in turn becomes a major source of CO2 emissions as plastic products reach their end of life. By 2050, a stretch case could see 70% steel and plastics produced through recycling, directly bypassing many CO2 emissions, as steel and plastics recycling can use green electricity and hydrogen inputs. The total emissions reductions could be 183 Mt CO2 per year in a highly circular pathway, but just 82 Mt if these are less successfully mobilised.

C. New production processes (143–241 Mt CO2 per year by 2050). While the opportunity to improve materials use and reuse is large, the EU will also need some 180–320 Mt of new materials production per year. As many current industrial processes are so tightly linked to carbon for either energy or feedstock, deep cuts often require novel processes and inputs. Ten years ago, the options were limited, but emerging solutions can now offer deep cuts to CO2 emissions. For steel, several EU companies are exploring production routes that switch from

carbon to hydrogen. In cement, new cementitious materials like mechanically activated pozzolans or calcined clays offer low-CO2 alternatives to conventional clinker.

For chemicals, several proven routes can be repurposed to use non-fossil feedstocks such as biomass or end-of-life plastics. Across the board, innovations are emerging to use electricity to produce high-temperature heat. Many solutions are proven or in advanced development, but economics have kept them from reaching commercial scale. They now need to be rapidly developed and deployed if they are to reach large shares by 2050. In addition, large amounts of zero-emissions electricity will be needed, either directly or indirectly to produce hydrogen. In a pathway heavily reliant on new production routes, as much as 241 Mt CO2 could be cut in 2050 by deploying these new industrial processes, falling to 143 Mt in a route that emphasises other solutions instead.

D. Carbon capture and storage / use (45–235 Mt CO2 per year by 2050). The main alternative to mobilising new processes is to fit carbon capture and storage or use (CCS/U) to current processes. This can make for less disruptive change: less reliance on processes and feedstocks not yet deployed at scale and continued use of more of current industrial capacity. It also reduces the need for electricity otherwise required for new processes.

However, CCU is viable in a wider net-zero economy only in very particular circumstances, where emissions to the atmosphere are permanently avoided. CCS/U also faces challenges.

Additional costs to consumers are less than 1%, but companies face 20–115% higher production costs

An analysis of the costs of achieving net-zero emissions reveals a telling contradiction. On the one hand, the total costs are manageable in all pathways: consumer prices of cars, houses, packaged goods, etc. would increase by less than 1% to pay for more expensive materials. Overall, the additional cost of reducing emissions to zero are 40-50 billion EUR per year by 2050, around 0.2% of projected EU GDP. The average abatement cost is 75-91 EUR per tonne of CO2.

In steel, the main one is to achieve high rates of carbon capture from current integrated steel plants. Doing so may require cross-sectoral coupling to use end-of-life plastic waste, or else the introduction of new processes such as direct smelting in place of today's blast furnaces. For chemicals, it would be necessary not just to fit the core steam cracking process with carbon capture, but also to capture CO2 upstream from refining, and downstream from many hundreds of waste incineration plants. Cement production similarly takes place at around 200 geographically dispersed plants, so universal CCS is challenging.

Across all sectors, CCS would require public acceptance and access to suitable transport and storage infrastructure. These considerations mean that CCS/U is far from a 'plug and play' solution applicable to all emissions. Still, it is required to some degree in every pathway explored in this study. High-priority areas could include cement process emissions; the production of hydrogen from natural gas; the incineration of end-of-life plastics; high-temperature heat in cement kilns and crackers in the chemical industry; and potentially the use of off-gases from steel production as feedstock for chemicals.

In a high case, the total amount of CO2 permanently stored could reach 235 Mt per year in 2050, requiring around 3,200 Mt of CO2 storage capacity. However, it also is possible to reach net-zero emissions with CCS/U used mainly for process emissions from cement production. In this case, the amount captured would be around 45 Mt per year.

On the other hand, the business-to-business impact is large and must be managed. All pathways to net-zero require the use of new low-CO2 production routes that cost 20-30% more for steel, 20-80% for cement and chemicals, and up to 115% for some of the very 'last tonnes' that must be cut. These differences cannot be borne by companies facing both internal EU and international competition, so supporting policy will be essential.

Cost alone is not a basis for choosing one pathway over another. Total costs are similar whether the emphasis is on CCS or on new production technologies. The attractiveness of solutions will vary across the EU, not least

depending on electricity prices. A more circular economy and affordable electricity are among the most important factors to keep overall costs low.

Most EU companies know the current status quo offers little intrinsic advantage in a situation of trade uncertainties, global over-capacity, and often lower fossil feedstock and energy costs in other geographies. Low-carbon routes emphasising deep value chain integration, continued process and product innovation, and reliance on local end-of-life resources may well prove a more sustainable route for EU competitiveness. It will also offer a head start in developing solutions that will eventually be needed globally. In the longer run, low-CO2 production systems may in fact be the more promising route to keep EU industry competitive.

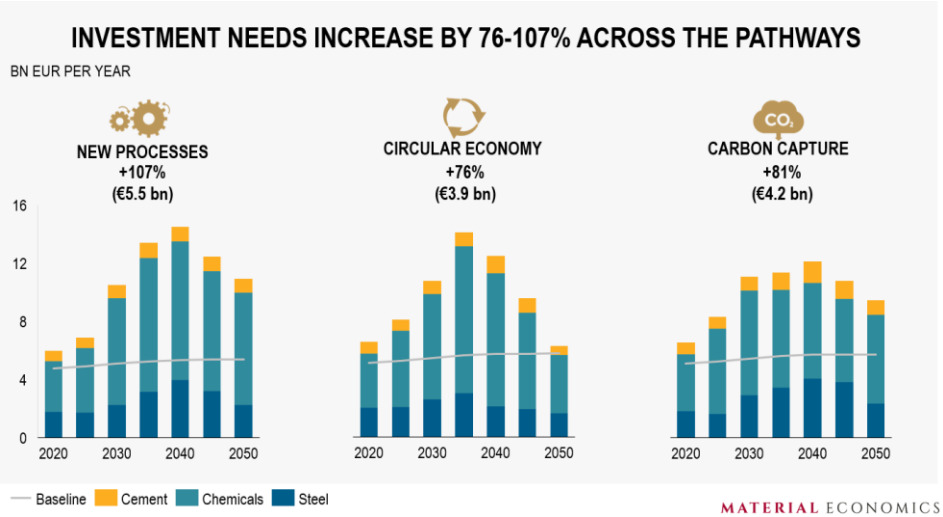
A low-CO2 industrial transition can offer similar employment levels as today, provided that economic activity does not migrate from the EU. Overall, circular economy solutions are more rather than less labour-intensive, so implementing them would create additional jobs in the overall value chains. Changes to industrial production, meanwhile, would likely still occur on current sites and in existing clusters, with little systemic impact on industrial employment.

The transition will require a 25–60% increase in industrial investment, with important near-term decisions

All pathways also require an increase in capital expenditure. Whereas the baseline rate of investment in the core industrial production processes is around 4.8–5.4 billion EUR per year, it rises by up to 5.5 billion EUR per year in net-zero pathways, and reaches 12–14 billion EUR per year in the 2030s. Investment in other parts of the economy also will be key, including some 5–8 billion EUR per year in new electricity generation to meet growing industrial demand.

How much is invested and where depends on the pathway, with generally much lower investment requirements for materials efficiency and circular economy solutions than for traditional production. Some additional investment occurs because low-CO2 routes are inherently more capital-intensive, but many others are one-off transition costs for demonstration, site conversion, and to provide redundancy in uncertain situations. Investment also will be required in infrastructure for electricity grids, CO2 transportation and storage, and handling of end-of-life flows.

Figure 23: Pathways for net-zero emissions



Source: Material Economics

For society as a whole these are not, in fact, large amounts. They correspond to just 0.2% of gross fixed capital formation and would be fully covered, including a return on capital, by paying on average 30 EUR per tonne more for plastics and steel that often cost 600-1,500 EUR per tonne in today's markets.

For companies, however, the investment will be a major challenge. The case for investment in the EU's industrial base has been challenged for more than a decade. All investment relies on a reasonable prospect of future profitability. In capital-intensive sectors, choosing a low-CO2 solution instead of reinvesting in current facilities can amount to a 'bet the company' decision – especially when future technical and commercial viability is uncertain. Investment in demonstration and other innovation often has highly uncertain returns. For all these reasons, strong policy support will therefore be needed in the near term.

In all pathways, EU companies will make important investment decisions in the next few years. Each will create a risk of lock-in unless low-CO2 options are viable at these forks in the road. Changes to value chains and business models, meanwhile, may take decades to get established. There is time for deep change until 2050, but it will have to happen at a rapid pace, and any delay will hugely complicate the transition.

Enabling fossil-free living within one generation

Johan Sahlqvist

Head of Investor Relations
johan.sahlqvist@vattenfall.com

Vattenfall is one of Europe's largest producers and retailers of electricity and heat. Our main markets are Sweden, Germany, the Netherlands, Denmark, and the UK. We have approximately 20,000 employees and the Parent Company, Vattenfall AB, is 100%-owned by the Swedish state, and the headquarters are located in Solna, Sweden.

At Vattenfall we are determined to enable fossil-free living within one generation and to help our customers to power their lives in ever climate smarter ways. To succeed we must become fossil free ourselves. We are transforming our production portfolio by phasing out fossil-based generation and growing in renewables. But that's not enough. By bringing fossil-free electricity to new sectors and contexts, we can contribute to economic growth and social progress while minimising climate impact. We are looking beyond our own industry to see where we can really make a difference. Together with our partners, we are taking on the responsibility to find new and sustainable ways to electrify transportation, industries and heating. We see great potential to continue to develop and build sustainable and profitable business models connected to these areas where electrification is an enabler for phasing out fossil fuels.

The below milestones are intended to show our contribution and commitment to fossil-free living within one generation, and as our journey unfolds, more proof points will be added along the wa

Figure 24

Source: Vattenfall

Coal will be phased out from our operations and one recent step in that process was the participation in an auction for closure of the Moorburg coal-fired power plant in Hamburg. On 1 December it was announced that the German Federal Network Agency (Bundesnetzagentur) decided to award compensation for a complete phase-out of Moorburg. If Moorburg is not classified as system relevant, the firing of coal will be stopped at the latest on 1 July 2021.

Together with our industrial partners in industries like steel, cement and refining, we are taking electricity from a power source to a source of innovation, paving the way for a new generation of industries and materials, free from the constraints of a carbon-heavy past.

One prominent example is the HYBRIT initiative, which is a joint cooperation with SSAB and LKAB with the aim of developing a fossil-free steel manufacturing process. A pilot plant for the production of fossil-free sponge iron was inaugurated in August 2020. The aim is to replace coking coal, traditionally needed for ore-based steel making, with green hydrogen. The result will be the world's first fossil-free steel, with virtually no carbon footprint. The potential in terms of positive climate impact is massive, as the steel industry is one of the highest CO_2-emitting industries, accounting for 7% of global and 10% of Swedish total CO_2 emissions. The business case is also very attractive for fossil-free electricity production. We estimate that this process would increase electricity demand by 15TWh for conversion of Swedish steel making.

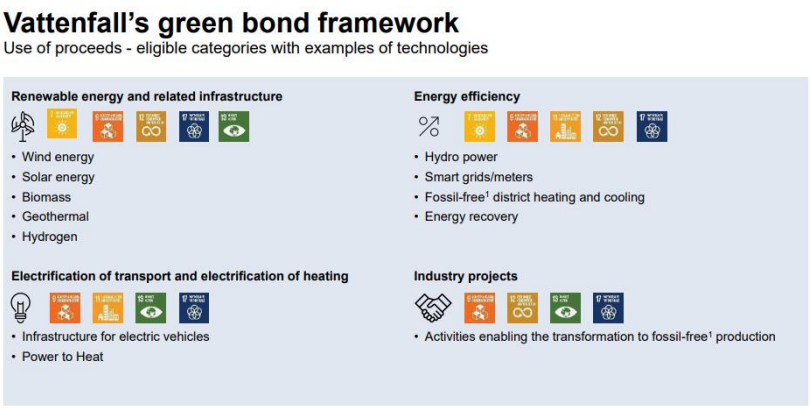
Beyond this, including electrifying the process of reducing even more iron ore to iron for exports would imply an even greater increase in demand.

Green financing at Vattenfall

Vattenfall's business operations are capital intensive with major seasonal fluctuations, which makes it necessary to have both short-term and long-term funding available to secure the financial flexibility. Senior bonds are issued under a Euro Medium Term Note programme (EUR 10 billion). For short-term funding, Vattenfall has a European Commercial Paper programme (EUR 4 billion).

Vattenfall has decided to use green financing in its funding activities. Investors should expect all future long-term financing to be made under Vattenfall's green bond framework. Sustainability is at the core of our business and we are firmly committed to be a leading company in the energy transition. Green financing is a way for us to articulate this in our funding as we invite investors to support the transition to a more sustainable energy system. So far Vattenfall has issued two green bonds with a volume of EUR 500 million each. Vattenfall's Green Bond Framework follows the ICMA 2018 Green Bond Principles and the Framework has the highest rating, "Dark Green", in a second opinion by CICERO. Vattenfall intends to allocate an amount at least equal to the incremental net proceeds of its green bonds to a portfolio of eligible green projects. Vattenfall will not finance nuclear or fossil fuel-based production projects with the proceeds of green bonds.

Figure 25:



Source: Vattenfall

Link to Vattenfall's green bond framework: https://group.vattenfall.com/siteassets/corporate/investors/funding_ratings/doc/vattenfall-green-bond-framework.pdf

Link to green bond second opinion (CICERO):https://group.vattenfall.com/siteassets/corporate/investors/funding_ratings/doc/vattenfall-second-opinion-29may2019.pdf

Link to green bond investor report September 2020:https://group.vattenfall.com/siteassets/corporate/investors/funding_ratings/doc/green_bond_investor_report_september_2020.pdf

In November, Vattenfall also signed a sustainability-linked multicurrency revolving credit facility of EUR 2 billion. The new credit facility replaces Vattenfall's existing and undrawn EUR 2 billion revolving credit facility signed in 2014. The new facility, which is available for general corporate purposes, carries a three-year tenor with two one-year extension options. The margin is linked to Vattenfall´s CO_2e emissions intensity target. SEB acted as Facility agent and Sustainability Advisor.

Vattenfall's 2030 CO_2e emissions intensity target covers Scope 1 and 2 emissions and is approved by the Science Based Targets initiative. The margin of the new facility is based on Vattenfall´s progress to meet this target. A margin reduction will be applied if the CO_2e emissions intensity is below a specified level and a margin premium will be applied above a certain level.

Sustainability reporting
In our sustainability reporting, we want to be as open and transparent as possible. We use GRI Reporting Guidelines as guiding principles for our sustainability reporting. In addition, as a signatory of the UN Global Compact, we report the company's sustainability performance every year and in our Annual and Sustainability Report we disclose our climate-related risks and opportunities in accordance with recommendations of the Task Force on Climate related Financial Disclosures (TCFD). We have joined the Green Asset Wallet platform to support the transparency on the green bond market. We also engage with several sustainability rating agencies and are proud of our high rankings. As an example, for the second year in a row, we recently received the highest score, "A", for our climate efforts by the Carbon Disclosure Project (CDP). More than 9600 companies were rated and this score leaves Vattenfall amongst the top 3% performers worldwide.

The Green Bond Editorial Team

Thomas Thygesen
Head of Strategy, Head of Research
Climate & Sustainable Finance
thomas.thygesen@seb.dk

Elizabeth Mathiesen
Senior Strategist
Equity Strategy Research
elizabeth.mathiesen@seb.dk

Kristoffer Nielsen
Advisor, Climate & Sustainable Finance
kristoffer.nielsen@seb.se

Lina Apsheva
Climate & Sustainable Finance
lina.apsheva@seb.se

Contacts at SEB

The Climate & Sustainable Finance Team
greenbonds@seb.se

SEB Norway:
Susanne Gløersen
Head Climate & Sustainable Finance in Norway
susanne.gloersen@seb.no

SEB Finland:
Ruut Pihlava
Head of Sustainable Banking in Finland
ruut.pihlava@seb.fi

SEB UK:
Roger Gifford
Senior Banker, LC&FI
roger.gifford@seb.co.uk
Renato Beltran
Client Executive, LC&FI
renato.beltran@seb.co.uk

SEB USA:
Anna Andren
Head of Markets in the Americas
anna.andren@sebny.com
John Arne Wang
General Manager
john.wang@sebny.com

SEB Demark:
Lars Eibeholm
Head of Sustainable Banking in Denmark
lars.eibeholm@seb.dk

SEB Germany:
Stefan Pletzer
Head of Financial Institutions Coverage
stefan.pletzer@seb.se
Alexandra Themistocli
Senior Client Executive
alexandra.themistocli@seb.de

SEB Hong Kong:
Carol Au-Yeung
Client Executive, Financial Institutions Coverage
carol.au.yeung@seb.se

SEB Singapore:
Eng Kiat Ong
Financial Institution Coverage Singapore
eng-kiat.ong@seb.se

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You may be wondering why a Scandinavian bank chose a picture of bamboo for the cover. There is a reason for that too! Bamboo is one of the fastest growing plants on the planet, which makes it an efficient mechanism of carbon sequestration. Moreover, once grown, bamboo can not only be used for food, but also used as an ecological alternative to many building materials and even fabrics. Its great environmental potential makes bamboo a perfect illustration of our work and aspirations.

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