The Green Bond

Your insight into sustainable finance

15 September 2022

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From crisis to opportunity

Letter to the reader

It is not easy to write when there are so many conflicting signals and core priorities flying through the room daily.

However, we don't lack intelligence or initiatives. In fact, we just finalised a great dual for Amprion (together with four other bookrunners). The dual-tranche green bond for a total of EUR 1.8bn was heavily oversubscribed from a large amount of real money accounts – so no lack of demand despite growing uncertainty in global capital markets.

From our client interactions we know that an increasing number of Europe's leading firms are integrating sustainability into their risk assessment, their business planning, as well as their financial communication. They all want to do more, see more and act more. We also expect that the recent climate bill in the US will lift the labelled US bond market to European levels. This would mean that the American market for sustainability-themed bonds could more than double over the next couple of years.

At the same time the current energy crisis is stressing the system. Some regulators are talking about delaying the phase out of fossil to avoid a collapse. Others have pointed out the danger such a delay would mean for the global climate negotiations. Asking developing countries to refrain from using fossil energy in their growth would be difficult to defend if it is ok for Europe to delay the phase out of carbon emitting fuels to safeguard its position.

At the end of the day this all points to the fact that the climate crisis is more of a human and structural challenge than a physical challenge. We can solve it when we get our act together.

There has been a lot of talk about various alternatives, and we have dedicated this issue of The Green Bond to investigating a few of them. We have the pleasure of having contributions from the Technical University of Berlin and Copenhagen Business School about the economics of nuclear power, the company Fermi Energia about Small Modular Nuclear reactors, our SEB colleagues on fusion energy, as well as the Red Cross on Nature Based Solutions and carbon credits to fund humanitarian assistance. All are worth reading to get an insight about where we are heading.

Last, but not least, you will notice that I seldomly use the term ESG in this letter. The reason is quite simple. It is easier to argue with numbers and efficiency and I hate wasting time by having to explain common sense when I can move forward with a more structured approach. In times where energy security, geopolitical priorities and economic stability are competing with medium to long term benefits – i.e. sustainability – my firm believe is that converting our findings into numbers saves time and avoids unnecessary hurdles. Additionally, it is important to note that we see no indications that investors are changing their strategy!

Enjoy your reading

Christopher Flensborg

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

Transition update

Accelerated transition held up before 2023 take-off

Energy shortages requiring short term fixes continue to delay long-term investment. However, in 2023 we expect a surge in renewable energy investment in all major economies. This will turn the focus to the complicated challenges of an accelerated transition.

During the summer, short term challenges to the energy transition kept mounting as Europe's energy crisis became even more acute. At the least a painful adjustment of energy consumption is necessary over the coming winter. To limit this adjustment European governments will use coal and substitute gas for oil where possible. This will lead to a more CO_2 intensive global energy system, and it has already become clear that pandemic relief was temporary with emissions in the first five months of 2022 exceeding pre-pandemic levels from 2019.

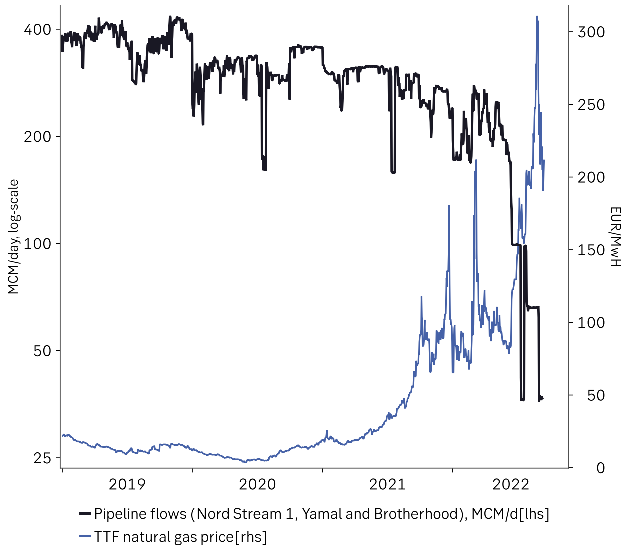
However, while all of this suggests that the transition to a zero-emission economy will be held up in 2022, we still expect a major acceleration in transition investment, with an emphasis on renewable energy which is the cheapest alternative, to kick off in 2023. This reduces the risk of future energy shortages and climate risks but also comes with significant challenges in the shape of obsolete assets, resource requirements and capital needs.

War and energy shortages

Europe's energy crisis deepened further this summer as pipeline flows from Russia through Nord Stream 1 first were temporarily and later indefinitely suspended. A decline in Russian supply of natural gas of 90% corresponds to around 10% of Europe's total energy supply. The result has been an explosion in energy prices (Figure 1). So far, there have not been any outright shortages, but we are currently in the seasonally low period of energy consumption.

Europe is thus racing to replace the lost supply before winter, but it takes time. Major renewable energy projects take 5-10 years to complete so initial focus must be on short term measures. LNG is the most direct substitute, but while three new terminals are expected to come online this winter, global supply is limited. Europe is competing with Asia, driving up global LNG prices and forcing China to burn more coal too.

Figure 1 Natural gas pipeline flows and TTF



Source: Bloomberg

Even if you add the return of coal plants and nuclear life extensions, it will only restore a fraction of the supply loss within 3-6 months. This winter is thus likely to see an energy supply shortfall in Europe of maybe 6-7% that cannot be replaced. One way or another, GDP will have to adjust accordingly.

Politicians can shield consumers from the worst impact, but that will increase the necessary production cuts in other parts of the economy. Prices will settle at a level where the most energy-intensive sectors simply have to shut down.

Looking further ahead, the winter is likely to mark the peak in the crisis. By next summer, new capacity from LNG terminals and pipelines, combined with renewable energy projects already underway that add another 1.5% of total energy consumption, could eliminate half of the remaining shortfall. This will turn the focus to more long-term solutions. But first, we have to see a GDP contraction that aligns production with current energy supply.

Thomas Thygesen

thomas.thygesen@seb.dk

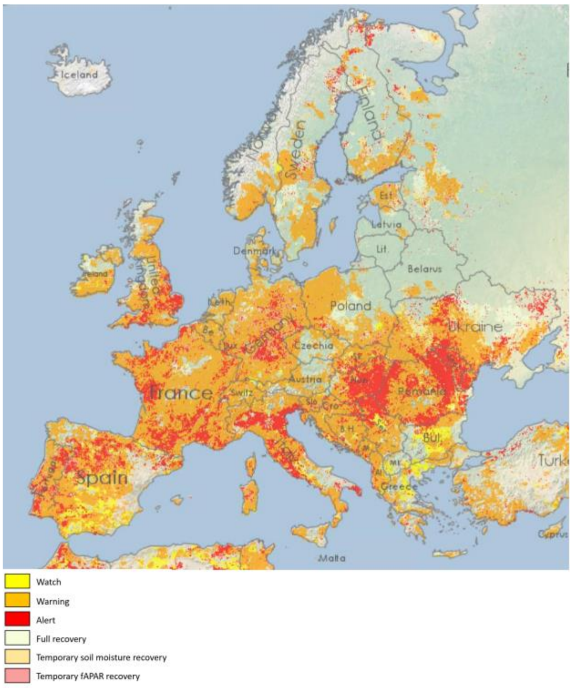
Elizabeth Mathiesen

elizabeth.mathiesen@seb.dk

Cost of climate crisis comes due

The energy crisis reflects underinvestment over the past 1-2 decades combined with geopolitical shocks, and the short-term problem could be fixed by investing. However, the negative effect is compounded by mounting evidence suggesting the climate crisis is starting to have very real economic effects that could also hamper the transition.

Figure 2 Combined drought indicator (Europe)



Source: GDO-EDODroughtNews202208_Europe.pdf (europa.eu)

During the summer, Europe thus experienced the worst drought in 500 years according to Global Drought Observatory (Figure 2), while temperatures reached extreme levels above 40°C across a range of countries.

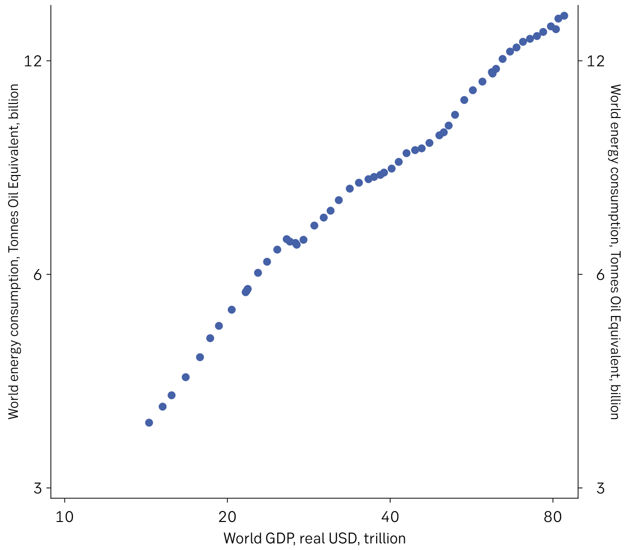
The economic effects were widespread as hydropower production was curtailed, dry rivers limited transportation and some nuclear power plants were forced to shut down due to lack of cooling. This was not only a European experience. China also suffered extreme drought and hydropower cuts, while Pakistan has experienced extreme flooding, highlighting how the climate crisis is likely to amplify all kinds of extreme weather.

Unlike the acute energy crisis, climate shocks are not temporary by nature. Temperature increases are driven by elevated CO_2 levels in the atmosphere that are bound to continue rising for another 10-20 years regardless of our current actions. The economic cost will reduce the capital that is available for scaling new infrastructure.

Short- and long-term solutions

The energy and climate crises will lead to painful adjustments in Europe this winter but will also serve as catalysts for long-term solutions. From an emission perspective, the decline in GDP will at least temporarily offset the effect of a more emission-intensive energy mix. However, this will not provide any lasting relief, and the relatively brutal adjustment also highlights the limits of using reduced energy consumption to reduce emissions.

Figure 3 World energy consumption and GDP



Source: Macrobond

The problem is the close correlation between GDP and energy consumption (Figure 3), which is difficult to change more than incrementally by energy-saving measures. Shutting down energy intensive metal production in Europe does not mean we will not need metals for the new energy infrastructure, just that they must be transported from outside Europe. However, shifting the burden to consumers is likely to be socially and politically destabilizing.

Figure 4 Kaya identity[1]

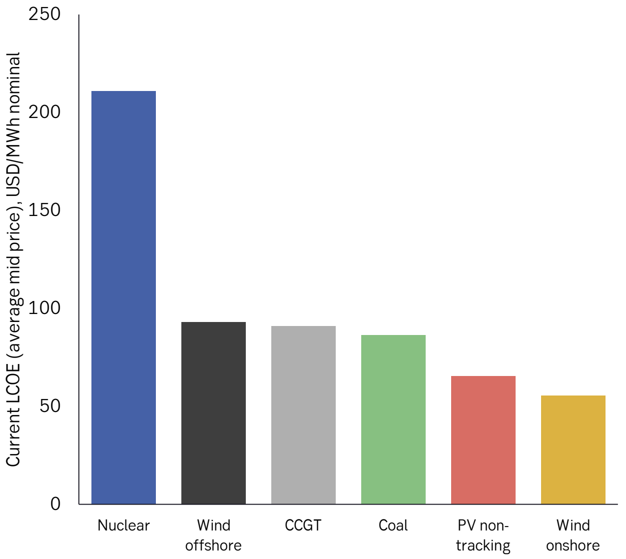
Source: SEB

The Kaya identity illustrates this (Figure 4). CO_2 emissions can be reduced via lower population, lower living standards or using less energy per unit of GDP. But unless we are willing to return to living standards from before the industrial era, these methods will not reduce emissions enough. The only solution tolerable from a humanitarian perspective is to reduce the emissions per unit of energy.

[1] Kaya, Yoichi; Yokoburi, Keiichi (1997). *Environment, energy, and economy: strategies for sustainability*.

From an economic perspective, renewable energy currently also offers the cheapest way to expand energy supply regardless of emission levels. According to BNEF's levelized cost of electricity (LCOE) estimates, on-shore wind and solar are 30-40% cheaper than coal and gas from a cradle-to-grave perspective (Figure 5). Both have reached the tipping point in the technology diffusion process.

Figure 5 Current LCOE for different technologies

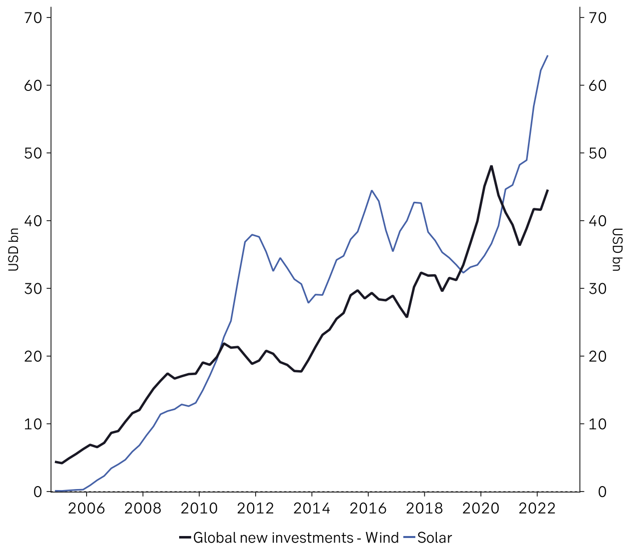


Source: Bloomberg New Energy Finance, Data: H1 2022 as of 18.08.2022

Traditional nuclear power, which also is emission-free, is significantly more expensive than fossil alternatives. In western markets, the learning curve which had driven nuclear costs lower in the 1960s and 1970s went into reverse after the installation of new plants slowed in the 1980s, most likely due to increased safety costs. BNEF estimates China's LCOE for nuclear power to be much closer to the cost of gas and coal.

The renewable energy investment boom that is needed to solve the structural imbalances in the energy supply and deal with climate risks at the same time is already underway. Solar energy investment has almost doubled since 2020 to more than USD 250bn annually. A parallel surge in wind energy investment, which appears to be more exposed to supply chain problems, paused during the pandemic years and it still has not exceeded the 2020 peak (Figure 6). We expect exponential growth in both segments to continue, with Europe taking the lead once acute shortages have been dealt with, leading to a sharp increase in renewable energy's share of total energy consumption.

Figure 6 Global new investments



Source: Bloomberg New Energy Finance

Europe is likely to lead because the war in Ukraine exposed serious geopolitical risks associated with dependence on foreign energy supplies. This realization is likely to drive a powerful political support for accelerated investment in local energy production.

The US, which unlike Europe and China has not suffered any major fossil energy shortages, is trailing badly when it comes to renewable energy production and EV adoption, but that could be about to change, too, due new political initiatives from the Biden administration.

US passes comprehensive climate legislation

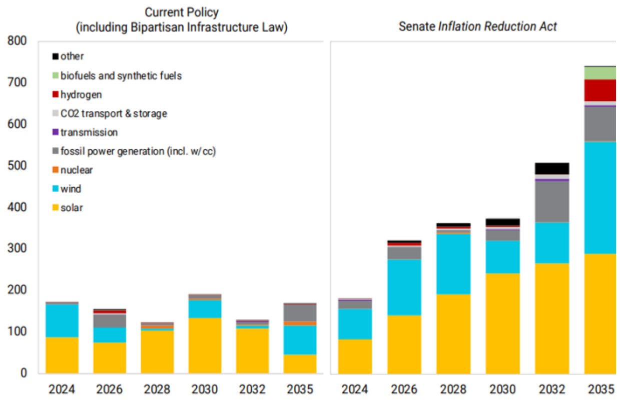
To the big surprise of many observers, the Biden administration managed to pass the Inflation Reduction Act – the US's first-ever national climate bill in all but name. The act will provide at least USD 369bn in support to energy transition technologies. Initial assessments suggest that the IRA is likely to reduce US emissions by 40%[2] and drive nearly USD 3.5tn in cumulative capital investment in new energy supply infrastructure until 2032[3] (Figure 7).

Unlike the Building Back Better bill which failed early this year, the IRA is mostly using carrots rather than sticks to entice investments in clean tech. The bill includes around USD 195bn in tax credits focused on decarbonizing the US power sector through mature technologies such as wind, solar and storage. Tax credits to battery makers and suppliers require that materials are sourced from the US or free-trade agreement nations. Made-in-the-US restrictions also apply to the expanded tax credits for electric vehicles.

[2] https://repeatproject.org/docs/REPEAT_IRA_Prelminary_Report_2022-08-04.pdf
[3] https://repeatproject.org/docs/REPEAT_IRA_Prelminary_Report_2022-08-04.pdf

The bill is also boosting US leadership when it comes to solving the most challenging problems of the transition. The 92-reactor US nuclear fleet would get a safety net with a new tax credit worth as much as USD 15/MWh. Furthermore, the IRA contains a tax credit of up to USD 3/kg for green hydrogen, and increases the existing tax credit for Carbon Capture, Usage/Storage to up to USD 180/tCO_2. The latter provision reflects findings by the IPCC that carbon removal to counterbalance hard-to-abate emissions are needed to achieve net-zero targets[4].

Figure 7 US Inflation Reduction Act



Source: Rapid Energy Policy Evaluation and Analysis Toolkit

Challenges: resources, capital, obsolescence

With Europe and China pushed into action by the past years' experiences of outright energy shortages and the US belatedly swinging into political action mode to avoid falling too far behind, the world is finally about to embark on the accelerated transition to a new energy system.

After 30 years of innovation and development, wind and solar power have both reached the cost parity tipping point. Thus, the accelerated transition is relatively easy, as governments no longer need to subside the investment in renewables. Governments at all levels will have a strong incentive to spend their own capital and share the risk with private investors. However, while a combination of motivation and financing can go a long way in boosting the supply of clean energy quickly, there are still substantial unsolved challenges.

Accelerated obsolescence

Perhaps the most important risk is that of accelerated obsolescence. In the 30-30-30 model that captures most dynamics of historical technology cycles, prices decline as volumes increase for almost 60 years before improvements become more incremental.

Ford's assembly line-built model T was a far cry from the first prototype made by Karl Benz 30 years earlier in terms of performance and cost. However, the cars Americans were driving 30 years later when half of all households were motorized would make a Ford T look like a relic (Figure 10). It was the same in other transitions. Any users of today's digital equipment would feel the same if they had to operate a PC from around 1990.

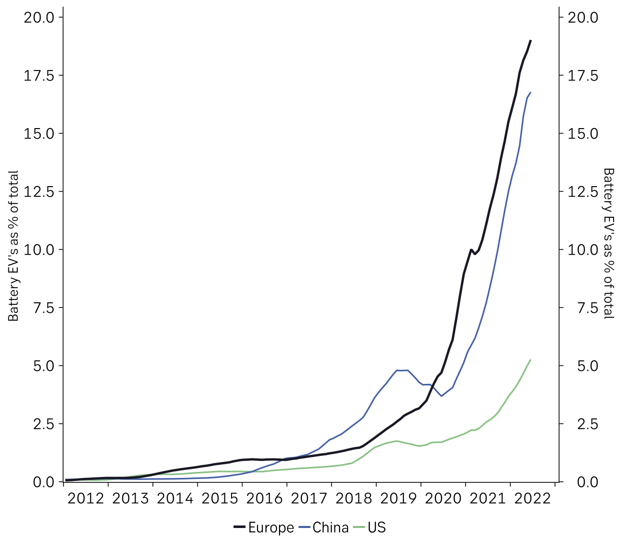
In an accelerated transition, this innovation would presumably also be twice as fast as in historical cycles. This is good from society's perspective but risky from an investment perspective because the marginal price will be set by more effective capital than you can buy today.

This is already part of the energy transition - renewable companies agree on long-term price levels for new projects to avoid being undercut by future energy suppliers before they have received the full return on their investment.

Governments and utilities often underwrite these power purchase agreements to support investment in new capacity. A sharp increase in clean, cheap electricity production is likely to be accompanied by a rapid electrification in sectors where these technologies are close to cost parity.

The automotive sector is the only major sector where this is currently the case, showing the same exponential diffusion pattern as renewable energy. EVs' share of total car sales has almost quadrupled in Europe and China since 2020 and is now close to 20%. The US is far behind with only 5% of total sales being battery powered (Figure 8).

Figure 8 EVs' share of total across regions



Source: Bloomberg New Energy Finance

[4] AR6 WIII SPM IPCC

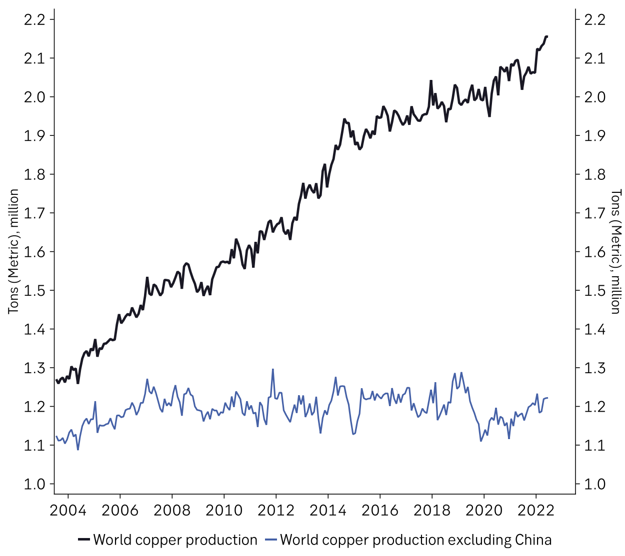
EVs are close to the point where subsidies no longer are needed for zero-emission alternatives. However, that is not the case yet for most other energy-intensive sectors like commercial transportation, commodity extraction and metal production, and the storage and distribution technologies like green hydrogen that they depend on. The zero-emission ships that are currently available are more like the Toyota Prius of 1997 than the Tesla model S of 2011. It seems to be a fair bet that the zero-emission ships built in the early 2030s will be radically different, but it is not yet clear how they will be different.

It is not yet obvious how to align objectives in the energy consuming sectors that need to invest in new electrified production equipment in areas where technologies have not even reached the tipping point. Investing in the currently available equipment initially may reduce profits. Faster transition also means need for more subsidies in technologies that are not ready and some kind of risk-sharing to provide incentives for companies to engage in risky technological experiments.

Increased resource intensity

Another challenge is that in an accelerated transition, the physical resources required during the transition are substantially higher. However, after the pandemic, it turned out that global supply chains were unable to provide enough inputs for even modest economic activity.

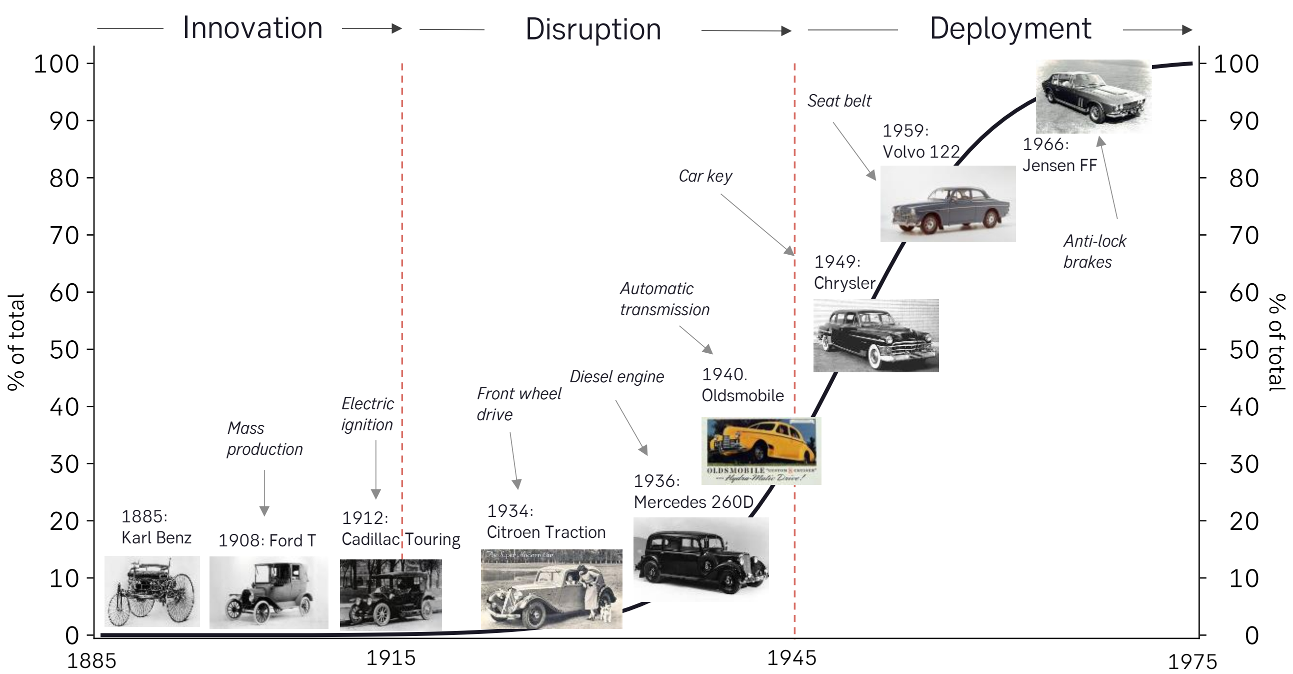
Figure 9 World copper production



Source: Macrobond

If we are to double the level of transition investment twice in the coming decade, then we will need to more than double the supply of inputs for this very resource-intensive endeavor. This will require substantial investment not just in new energy infrastructure, but also in a range of sectors supplying key inputs to this infrastructure, sectors that in many cases currently are unable to produce without fossil fuel inputs. Successful transition requires that these sectors expand their production significantly, at the same time as they transition to a new production system.

Figure 10 S-curve for automobile transition in 1900s

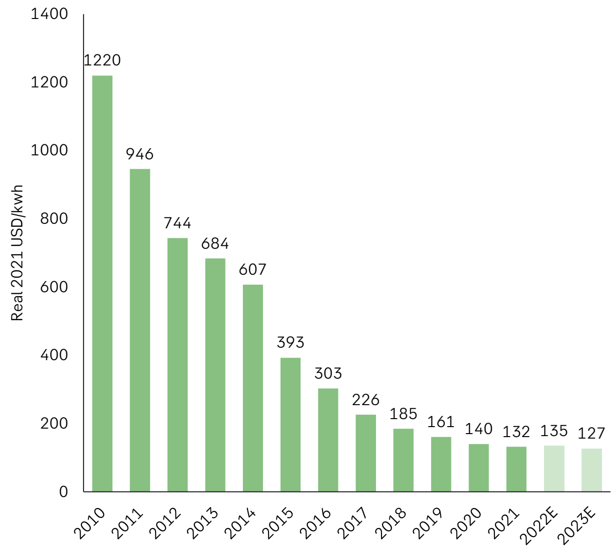


Source: SEB

The implications for the transition if we do not change this trend could be significant. Shortages in the sectors providing inputs could disrupt the long-term learning curve, which normally reduces the cost of new technologies as the installed base grows. This could not only make the new energy infrastructure more expensive by increasing the cost of solar panels and wind turbines but could ultimately limit the pace of investment that is physically possible.

It will also make complementary technologies more expensive and delay the diffusion of new technologies for energy users. A case in point is the stalling decline in the price of batteries. According to BNEF, 2022 could be the first year in more than a decade where the battery price does not decline (Figure 11). BNEF suggests that the reason is the rising cost of the commodities that are key inputs in battery production.

Figure 11 Battery price survey



Source: Bloomberg New Energy Finance

Importantly, the decline in costs has levelled off just as batteries were poised to match the cost of fossil-based alternatives, which could slow the diffusion of battery-powered vehicles and limit the investment in other battery-powered solutions.

Batteries are just one example. Resources will be needed for many other components in the energy transition and the electrification investment that will follow in its wake. At the same time, energy transition investment will be competing with investment in near shoring of supply chains in general and increased defense spending for inputs. An accelerated transition is thus likely to require a significant increase in capital flows to capital-intensive sectors.

The final challenge: capital

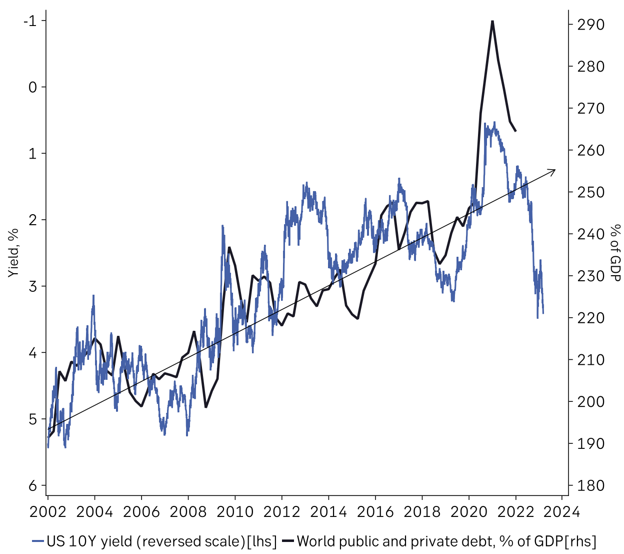
The practical challenges make the transition more risky, expensive and resource intensive, which in turn means it will require more capital.

Investment in renewable energy production and the accompanying infrastructure alone is likely to require an additional USD 2-2.5tn annually to compensate for the lack of investment in the past decade. This number could grow even larger if it turns out that rising input costs halt the structural price decline that would normally follow when technologies start to scale.

Energy users will have to replace most of their capital stock at an expedited pace, meaning new capital will be brought in before the old one has been fully depreciated, this will add another USD 1.5-2tn to total annual transition investment. And all of this requires resources, so there will be a need for substantial secondary investment in sectors mining and producing metals and other commodities.

Meanwhile, nascent supplementary technologies like batteries and green hydrogen still need to be subsidized, and governments also have to deal with the most likely escalating cost of 'adaptation' or paying for the damage caused by the climate crisis.

Figure 12 World public and private debt and US 10Y



Source: Macrobond

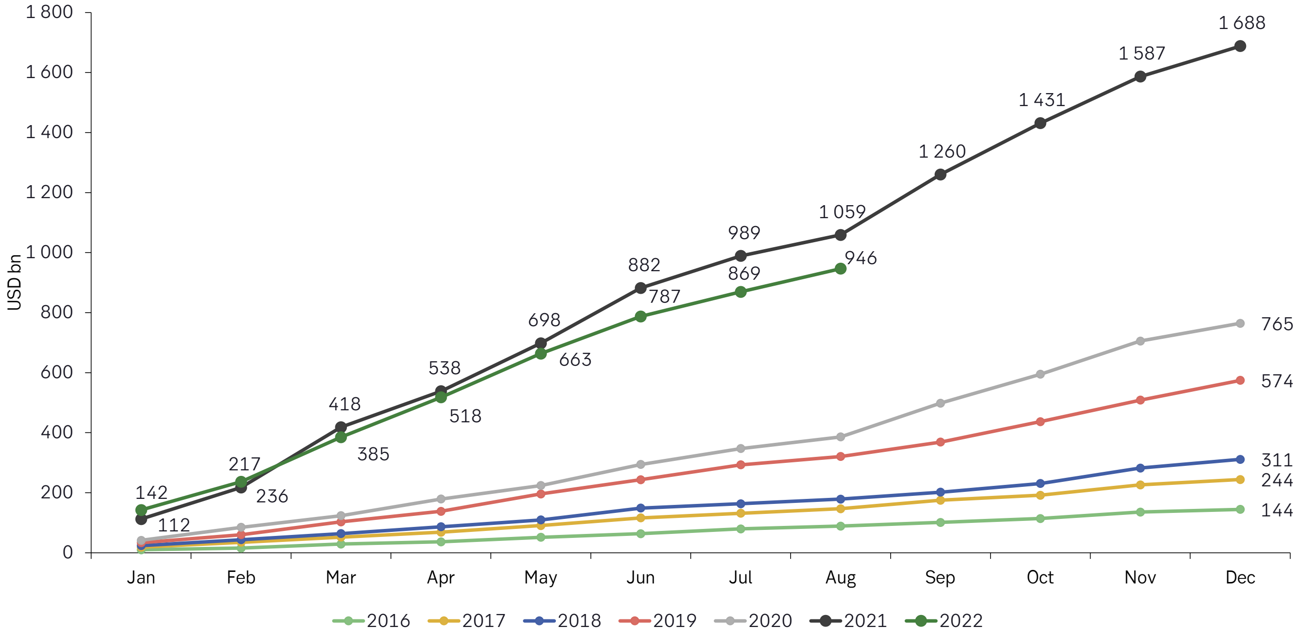
This will be a challenge with both private and public debt already at historical highs and bond yields that start to increase the burden of that debt (Figure 12). Raising enough capital will most likely require both supportive central banks and innovative capital markets.

Sustainable Finance Market Update

Setting more realistic expectation

There are initial signs that the issuance of sustainable debt is recovering, and it is now clear that the underperformance of the Green Bond Index was due to base effects and not the 'green' factor. In equities, it is becoming clear that equity strategies restricting portfolio outcomes based on ESG scores or emission levels should not be expected to deliver market returns.

Figure 13 Cumulative sustainable debt transactions



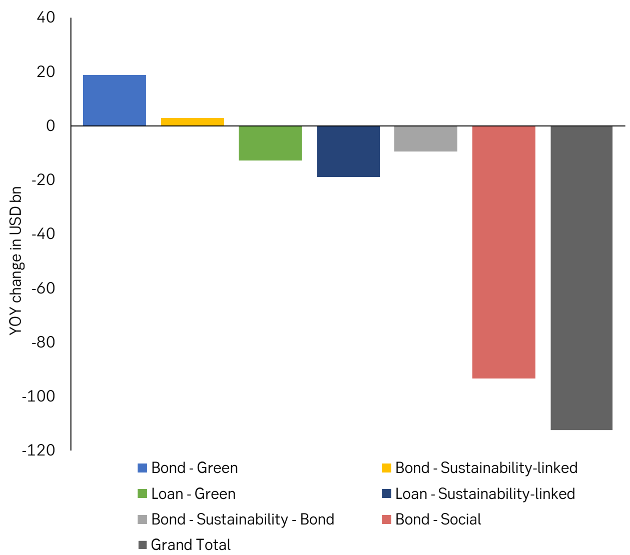
Source: Bloomberg New Energy Finance 31 August 2022

Long and winding road to recovery

The market for sustainability-themed bonds and loans continues to lag last year's record with total transactions at the end of August standing at USD 946bn, 11% behind Y/Y. Figure 14 shows that the decline in sustainable debt continues to affect almost all product categories with social bonds and sustainability-linked loans down the most in terms of nominal value.

Nevertheless, there are some indications that the market is recovering. Green bonds and sustainability-linked bonds continue to outperform last year's result with new issuances ahead by 5% for each category (USD 19bn and USD 2.7bn, respectively). Furthermore, August marked the first time since April that new issuances exceeded those of the same month last year. Our expectation is that when transaction data is updated later this fall, the gap between this and last year's result will have narrowed to around 5%.

Figure 14 Y/Y change in issuance, Jan-Aug 2022



Source: Bloomberg New Energy Finance 31 August 2022

Gregor Vulturius, PhD gregor.vulturius@seb.se

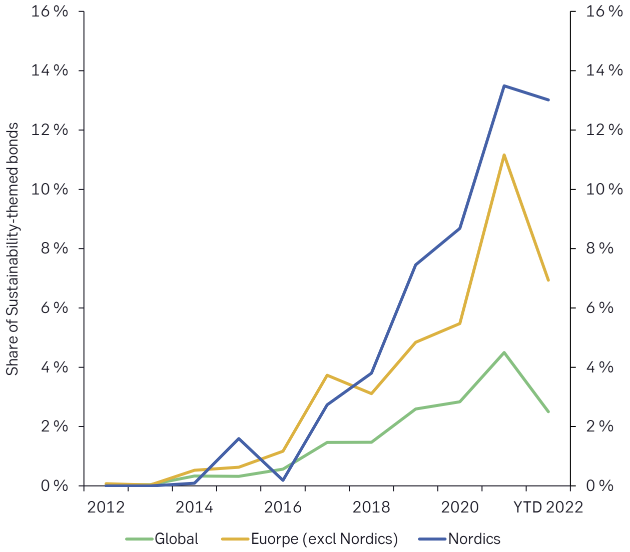
Filip Carlsson filip.carlsson@seb.se

Thomas Thygesen thomas.thygesen@seb.dk

Tine Vist tine.vist@seb.dk

Even though there are some signs that sustainability-themed bonds in 2022 are no longer falling behind last year's result, the market has an even steeper mountain to climb when it comes to regaining its share of the bond market. Figure 15 shows that the share of green, social, sustainability and sustainability-linked bonds of all bonds on the global, European, and Nordic level. The share has fallen for all three markets and most for the European market.

Figure 15 Share of Sustainability-themed bonds of the global, European, and Nordic bond markets



Source: Bloomberg, 1 September 2022

Equities: ESG backlash calls for more realism

The emergent ESG pushback has gathered momentum over the summer, culminating in a political backlash in the US, where Florida and Texas have gone as far as to exclude ESG funds from local pensions.

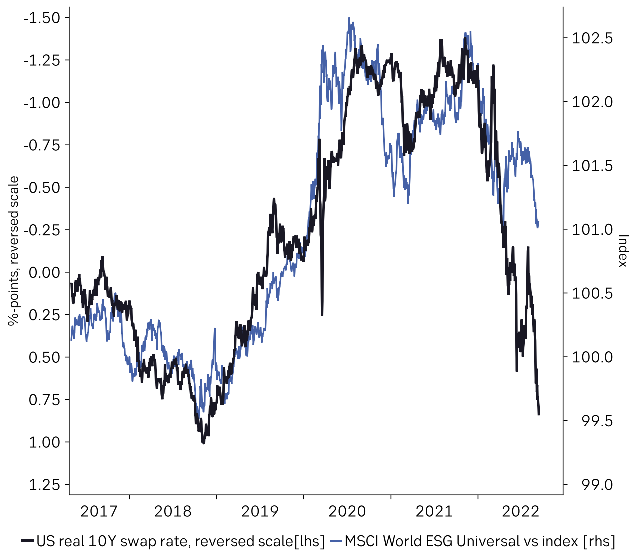
This regulation is ideological in nature and makes little financial sense. In principle, investors should be allowed to allocate their savings as they wish. If ESG factors are important inputs in determining investment risks, it could reduce expected returns to exclude them.

At the same time, the debate highlights the difference between using ESG as an input in the investment process and as a portfolio objective. In the latter approach, which many Socially Responsible Investment (SRI) funds use, you also reduce the number of possible portfolio permutations and thus the expected risk-adjusted return compared with an unrestricted portfolio.

At best, if ESG is a highly material driver for investment returns, the market portfolio and the ESG portfolio sets will be the same. However, if some sectors with reduced weight due to bad ESG scores for instance turn out to be important for the economy or even for the energy transition itself, the ESG portfolio will have a lower expected return.

This issue has become more obvious after the reversal in relative return for several ESG indices and funds in 2022. During the period of large inflows into ESG funds from 2019-2021, relative returns were positive because the ESG index process resulted in a tilt towards high P/E growth stocks that were supported by falling real rates. Investors rarely ask questions when they are making money. However, relative returns for ESG indices turned negative when real rates started rising (Figure 16).

Figure 16 MSCI World ESG and US real 10Y swap rate



Source: Bloomberg

A more fundamental concern is that ESG investment may not actually lead to more sustainable outcomes at the company level. In a 2022 study, researchers at Columbia University and London School of Economics found that the companies in ESG portfolios had worse compliance record for both labor and environmental rules. Additionally, they found that companies in ESG portfolios did not subsequently improve compliance with labor or environmental regulations[5].

In addition, equity strategies restricting portfolio outcomes based on ESG scores or emission levels also tend to reduce capital allocation to sectors that it is now clear will play a vital role in the transition. Both suppliers of the physical inputs and companies embarking on transition will initially struggle to qualify for inclusion. It is thus not clear that a lower return comes with a bigger impact in these funds.

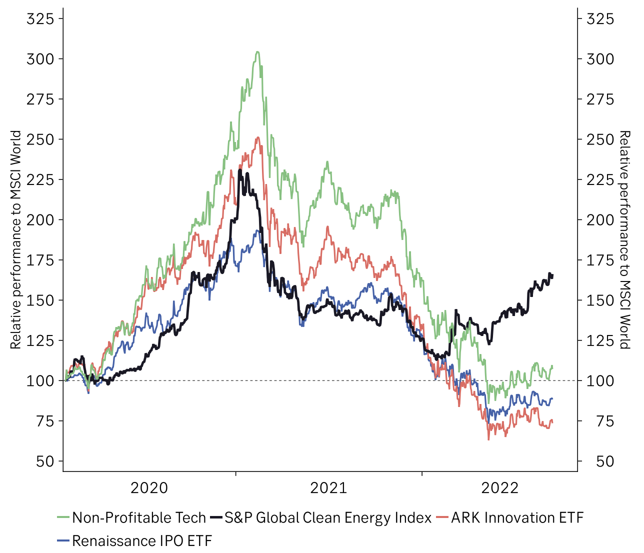
[5] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3826357

This does not mean there is no role for funds with ESG or emission constraints, just that there is a need for transparency and realism. An equity strategy that excludes or limits exposure to certain stocks based on a preference for 'strong' ESG outcome should not be sold as a return-maximizing strategy. In theory, if you want to claim that the strategy does something which the market would not have done anyway, it has to be that way.

Clean energy equities remain expensive

Clean energy stocks are another popular theme for sustainability-oriented investors, but this always seemed to be different in nature because it clearly is an active strategy where the risk of underperforming is clear from the start. Buying the shares in the secondary market means the direct impact on the companies in the portfolio is limited – they don't get more capital because you invest. This strategy makes financial sense if you subjectively believe the clean energy segment will experience faster growth and/or higher profitability than markets currently anticipate. As with any other active strategy, you probably should not let it dominate your entire allocation.

Figure 17 Clean energy, growth indices vs. MSCI World

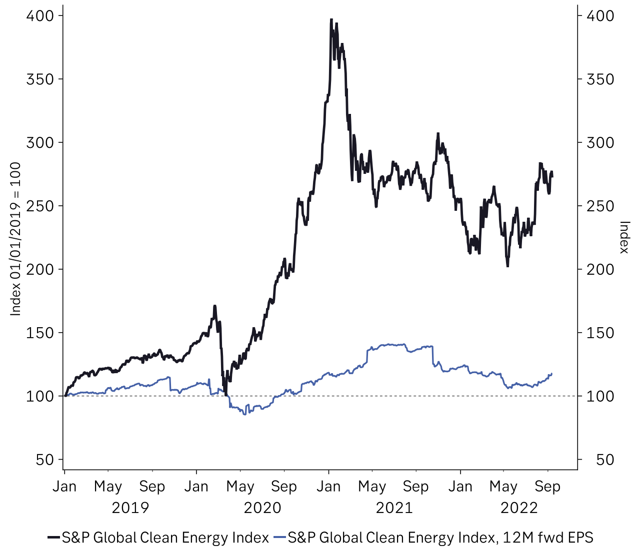


Source: Bloomberg

The problem with this kind of concentrated investment theme is that if it is too successful, it may lead to unsustainable short-term returns and elevated valuation that reduce forward-looking returns even if the underlying thesis is correct.

The S&P Clean Energy Index appears to have gone through a development of this kind in recent years. The index naturally comes with a growth bias and attracted large inflows during the liquidity surge around the pandemic but underperformed by 50% along with other 'speculative' growth themes after that move peaked (Figure 17).

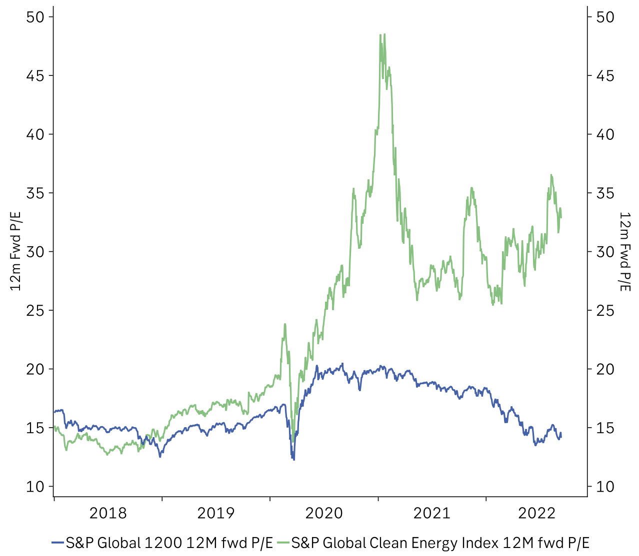
Figure 18 Clean energy index and 12M fwd EPS



Source: Bloomberg

However, in 2022 the Clean Energy Index has decoupled and outperformed both other growth segments and the broader global stock market. The timing of the decoupling was closely connected to the Russian invasion of Ukraine, which makes sense as this was a watershed event in the unfolding energy crisis.

Figure 19 Global and clean energy 12M fwd P/E



Source: Bloomberg

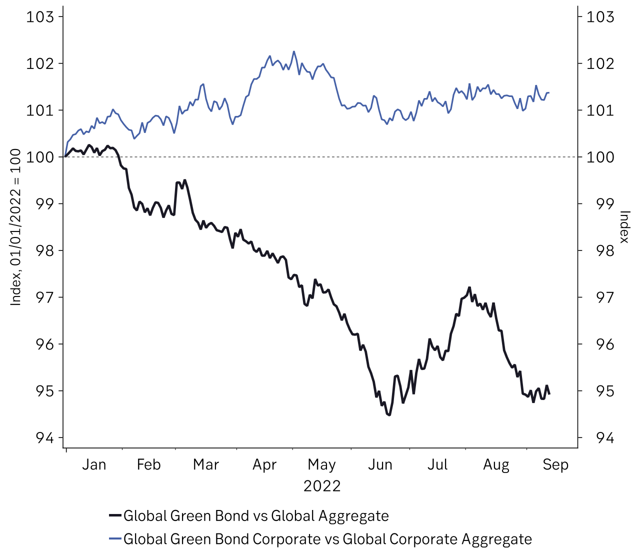
However, while the long-term case for rising volumes for companies with exposure to clean energy appears stronger today, it has yet to materialize in earnings estimates. Clean energy stocks are thus still trading at a very substantial valuation premium (Figure 19). With real interest rates that continue to rise, it may still be too soon to expect future growth to be reflected in current returns.

Green bond performance: divergence

In the last issue of The Green Bond, we noted that the Bloomberg MSCI Global Green Bond Index (GGBI) had underperformed the Bloomberg Global Aggregate Index (GAI) substantially in the first half of the year. This trend has continued during the summer and the GGBI has now underperformed by more than 5% since the start of the year.

In our original analysis we found that the underperformance seemed to be driven by changes in long government bond yields and credit spreads. Both indices are very broad, and the inclusion of safe government bonds may complicate the comparison due to base effects. To get a better understanding of green bond return drivers, we looked at the corporate bond only version of the same two indices above. Bloomberg has also constructed a Global Green Bond Corporate Index (GGBCI) and a Global Corporate Aggregate Index (GCAI).

Figure 20 Relative performance since start of year

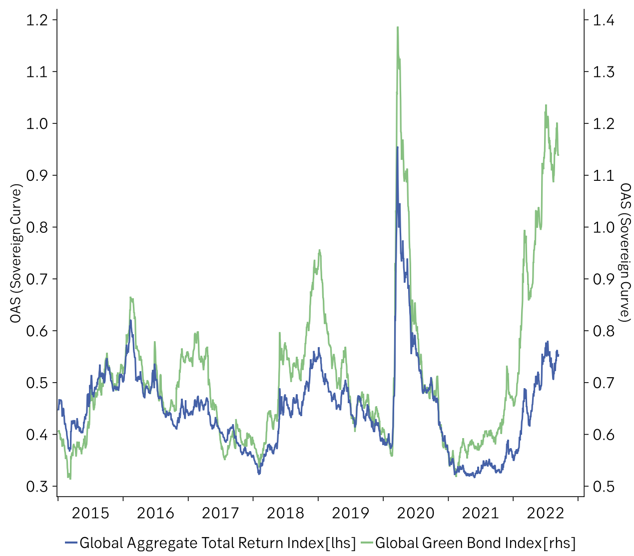


Source: Bloomberg

Comparing these two indices suggests that whatever the difference in the broad indices, it disappears when you only focus on corporate issuers, so while the GGBI has underperformed its counterpart by 5%, the green corporate bonds have outperformed their counterpart by 1% in the same period (Figure 20).

This suggests that the original result for the broad market is not caused by a change in the value of begin 'green' but rather reflects a difference in the composition between various bond types. This is also consistent with the message from looking at the option adjusted spread to the sovereign curve. The OAS for the GGBI is higher than for the GAI (Figure 21), and in relative terms the spread has widened by close to 50 bps since the start of 2022, a period where credit spreads have generally been widening.

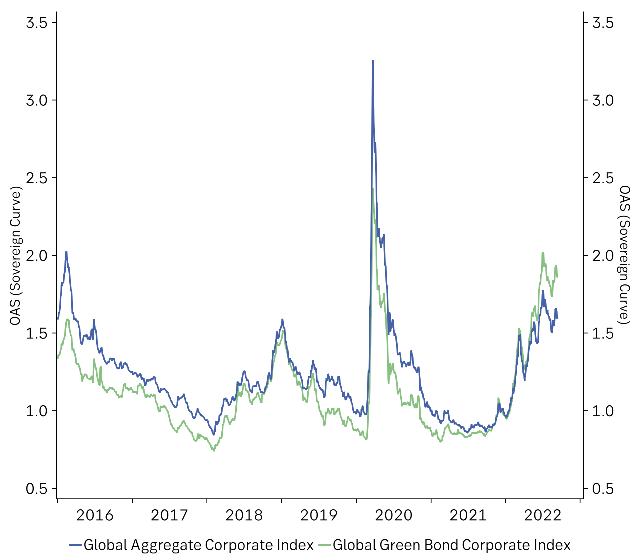
Figure 21 OAS, the GGBI and the GAI



Source: Bloomberg

Looking at corresponding corporate indices, the divergence in OAS developments seems to be a lot smaller. Both indices have seen spreads widen relative to the GAI. In fact, it looks like the OAS widening has been a bit more pronounced for the GGBCI than for the broader corporate market, but the degree of co-movement is relatively high (Figure 22).

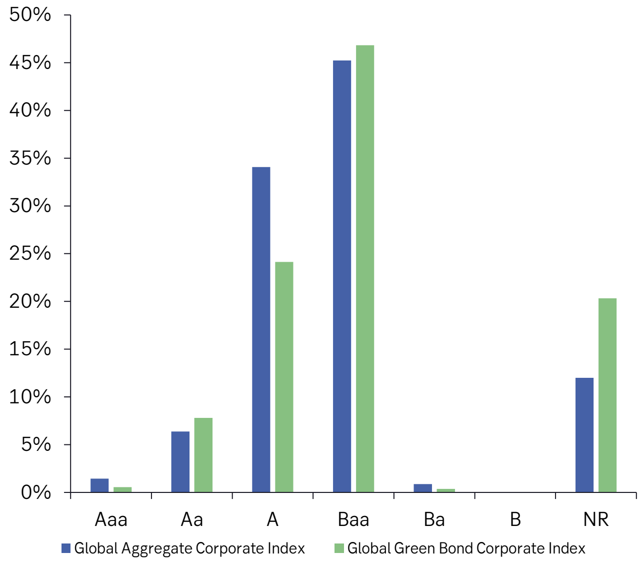
Figure 22 OAS, corporate indices



Source: Bloomberg

When it comes to credit quality and ratings, both appear to be slightly better in the GCAI than in the GGBCI. However, the GGBCI has a higher share of non-rated companies, almost double the amount of the GCAI (Figure 23). A difference in credit rating could thus explain the outperformance we have seen for the for GGBCI. However, we cannot know for sure and there has not been any major changes in rating distribution over the past year.

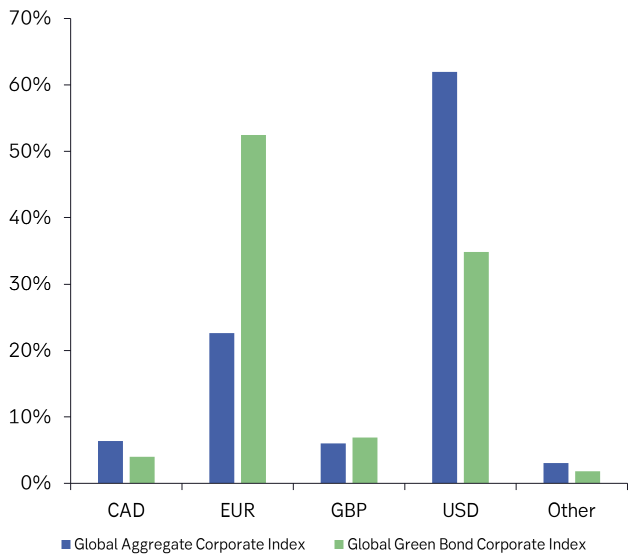
Figure 23 Moody's rating distribution, corporate indices



Source: Bloomberg, 9 September 2022

Another possible explanation for the performance divergence could be regional differences. In line with the more prominent role in Europe for sustainable finance, the GGBCI is also heavily weighted in Europe, while the GCAI is more heavily weighted in the US (Figure 24). This does not explain why the GGBCI outperforms this year as war and energy crisis have been weighing more on credit in Europe than in the US.

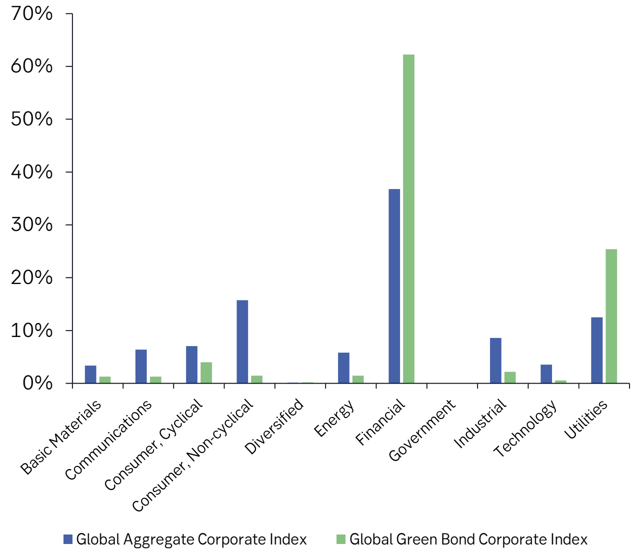
Figure 24 Currency distribution, corporate indices



Source: Bloomberg, 9 September 2022

The final area where the two indices could diverge is in sector distribution. Again, this is an area where the characteristics of sustainable finance issuers is clear. The GGBCI is heavily concentrated in the financial and utilities sectors which together makes up almost 90% of the bonds while the GCAI is more evenly distributed across sectors (Figure 25).

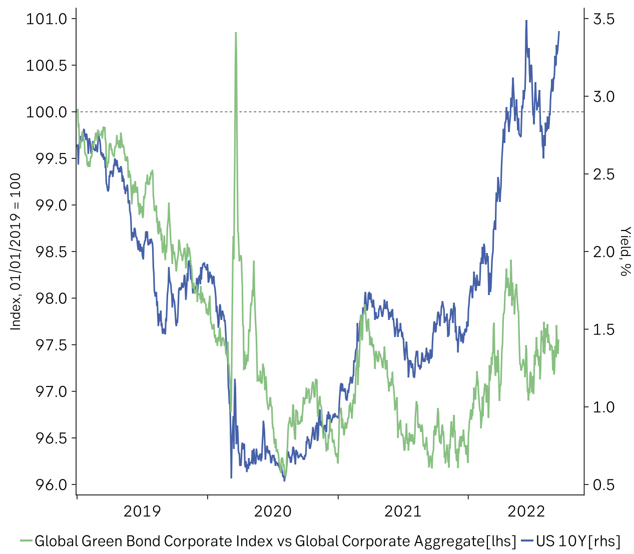
Figure 25 Sector distribution, corporate indices



Source: Bloomberg, 9 September 2022

In the light of the difference in composition of the broad and the corporate only indices, we can now revisit our relative return analysis and be more confident that we are comparing apples to apples. First of all, the relative performance between the GGBCI and the GCAI tends to be stronger when bond yields are rising (Figure 26).

Figure 26 Relative performance and US 10Y yields



Source: Bloomberg

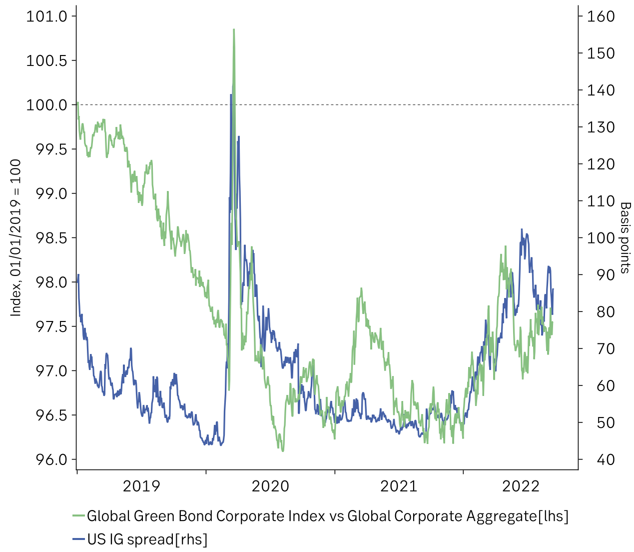
Part of the reason why the GGBCI outperforms their peer group is that it has lower duration (Figure 27) which is an advantage when bond yields are rising. This is the opposite pattern of what we observed in the broad indices.

Figure 27 Option adjusted duration, corporate indies

Source: Bloomberg

Similarly, the GGBCI tend to outperform when credit spreads are widening, which is the opposite of what we found for the broad indices. This suggests green corporate bonds have higher credit ratings than peers, although as described above we could not confirm that.

Figure 28 Green vs all corporate and IG spread



Source: Bloomberg

In conclusion, most suggests that the divergence in the broad indices is due to the composition rather than the 'green factor'. Hence, we are unable to disprove that the divergence can be explained by base effects, rather it looks like that is the case. Thus, it makes more sense to compare corporate indices, because, despite some differences, we are comparing apples with apples to a greater extent. The GGBCI tends to perform better than its peer group when bond yields are rising as well as when credit spreads are widening. The first is explained by lower duration in the GGBCI compared to its peers, while a possible explanation for the latter is higher overall credit rating in the GGBCI.

The Economics of Nuclear Power

Jens Weibezahn, PhD
Copenhagen School of Energy Infrastructure (CSEI) at Copenhagen Business School (CBS)
Jew.eco@cbs.dk

Björn Steigerwald
Technical University of Berlin
bs@wip.tu-berlin.de

Today, steep declines in generation costs of renewable energy systems, particularly solar photovoltaics (PV) and wind energy, combined with a recent spur in storage and flexible technologies driven by batteries and increasingly renewable hydrogen, drive a paradigm shift in energy systems: renewable energy now dominates investments in electricity generation systems installed around the world[6].

In the last year, 13% of generated electricity came from renewable energy sources with a conjugated growth rate of 10.7% between 1974 and 2021 in contrast to a share of 10% for nuclear-generated electricity from 413 nuclear reactors operated by 33 countries with an average age of 30.9 years and a worldwide conjugates growth rate of 1.5% between 1974 and 2021[7].

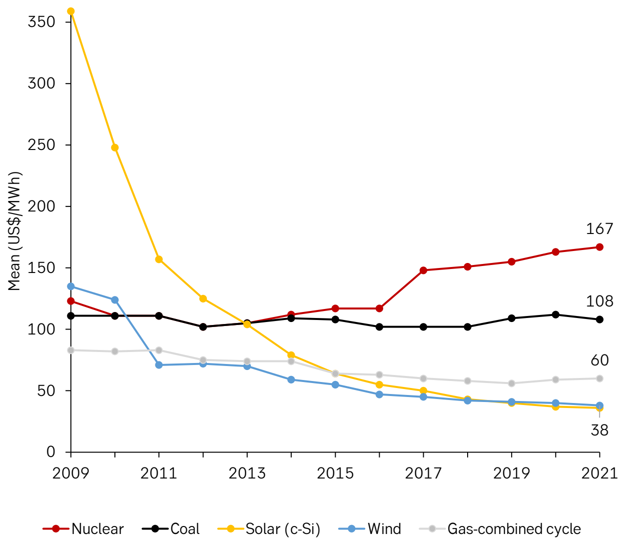
On the other hand, direct public energy research, development, and demonstration (RD&D) spending during this year is estimated at about 2021 USD 4.8bn for nuclear-generating technologies, which equals a share of 21% and a conjugated growth rate of -1% between 1974 and 2021, while renewable energy generating technologies received about 2021 USD 3.2bn, which equals a share of 14% and a conjugated growth rate of about 6% between 1974 and 2021[8].

Some countries, international organizations, private businesses, and scientists accord nuclear energy a role in the pursuit of climate neutrality and in ending the era of fossil fuels. The IPCC, too, includes nuclear energy in its scenarios. Yet, the experience with commercial nuclear energy generation acquired over the past seven decades points to significant technical, economic, and social risks[9].

Economic efficiency

The described estimation of current public research expenditures in electricity generating technologies provides a first implication of greater efficiencies in renewables since less direct spending and the right policies delivered a greater worldwide share in renewably generated decentralized electricity.

Figure 29 Levelized cost of electricity for selected technologies



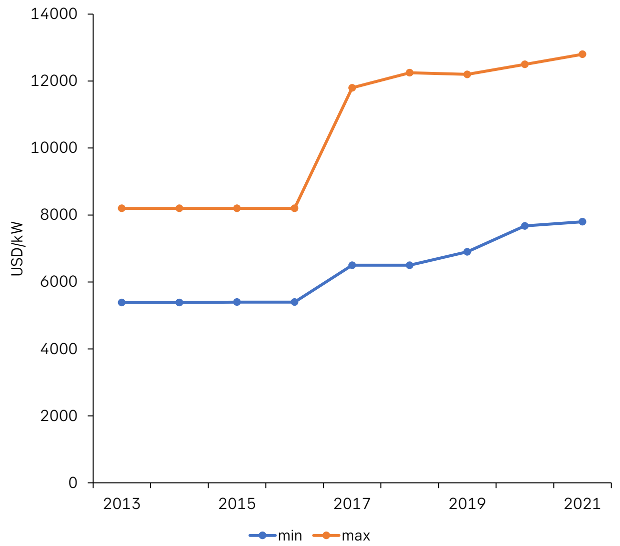
Source: Lazard[10]

[6] Ram et al. (2022) https://doi.org/10.1016/j.energy.2022.123419
[7] BP (2022) https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html
[8] IEA (2022) https://www.iea.org/reports/energy-technology-rdd-budgets-overview/public-energy-rdd-in-iea-countries
[9] Wealer et al. (2021) https://www.diw.de/documents/publikationen/73/diw_01.c.812103.de/dwr-21-07-1.pdf
[10] Lazard (2021) https://www.lazard.com/media/451881/lazards-levelized-cost-of-energy-version-150-vf.pdf

From an investor's perspective, the cost of electricity generation for different technologies provides a more interesting insight to evaluate a project. A commonly used comparable metric is the so-called levelized cost of electricity (LCOE). Here, CAPEX and OPEX over the economic life of a power plant are broken down over the expected energy produced, yielding a comparable number between technologies with different cost structures.

Figure 29 shows that renewable technologies like wind and photovoltaics are by far the cheapest source of electricity with around 38 USD per MWh in 2021. For PV this means a cost decrease by around 90% over the last 12 years and around 70% for wind. During the same time, the cost of nuclear increased by 35% to 167 USD per MWh. This is largely due to the increased investment costs (Figure 30).

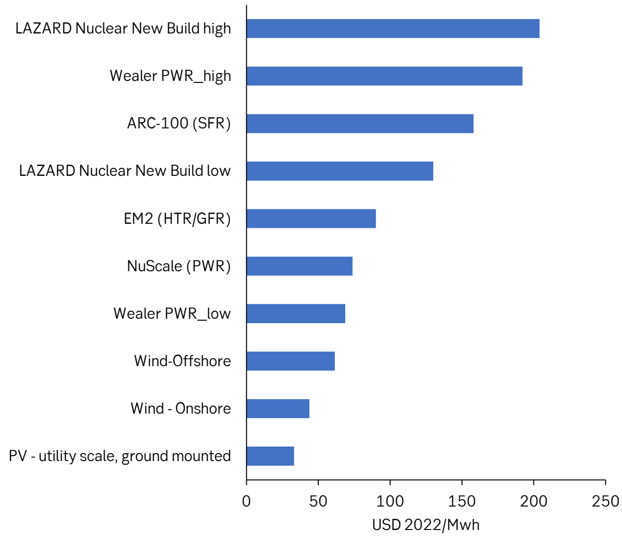
Figure 30 Average capital costs for new-build nuclear power



Source: Lazard[11]

Figure 31 shows more detailed calculations based on a Monte Carlo investment simulation and expands the picture to assumptions on Small Modular Reactor (SMR), where – based on available data – the cost development does not look any better but overall, could potentially achieve safety advantages compared to power plants with a larger power output, as they have a lower radioactive inventory per reactor and aim for a higher safety level especially through simplifications and an increased use of passive systems. Yet, the first projects also went over budget and even the highly advertised NuScale project is still not realized with costs increasing[12].

Figure 31 Levelized cost of electricity in 2022



Source: Authors' own calculations

From an energy system perspective, it is often argued that a purely renewables-based system is not viable due to the intermittency of solar irradiation and wind such that nuclear would be a natural complement[13].

Yet, studies focusing on 100% renewable energy systems conclude that the cost of system integration of renewables via flexibility options will only about double the LCOE[14]. This is still not in the realm of nuclear power. Also, conventional nuclear power plants are mostly operated as baseload power plants with a low degree of capacity regulation (+/-5%) making them not flexible enough to complement renewables.

Current nuclear power projects in the Global North have shown tremendous cost and time overruns, for example, Vogtle Station (two AP1000 reactors) rose from 2018 USD 16,400mn to 2021 USD 28,500mn or V.C. Summers (units 2 and 3) started in 2013 and were abandoned in the year 2017 due to the bankruptcy of the US company Westinghouse.

The MIT found that the recent experience of nuclear construction projects in the United States and Europe has demonstrated repeated failures of construction management practices in terms of their ability to deliver products on time and within budget[15].

[11] Lazard (2021) https://www.lazard.com/media/451881/lazards-levelized-cost-of-energy-version-150-vf.pdf
[12] https://ieefa.org/wp-content/uploads/2022/02/NuScales-Small-Modular-Reactor_February-2022.pdf).
[13] OECD and Nuclear Energy Agency(2019) Nuclear Energy Agency (NEA) - The Costs of Decarbonisation: System Costs with High Shares of Nuclear and Renewables (oecd-nea.org)
[14] Bogdanov et al (2019) https://doi.org/10.1038/s41467-019-08855-1
[15] MIT (2018) http://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf

Four categories determine whether there will be delays and cost overruns:

- Design and supply chain maturity
- Effectiveness of project management
- Nuclear safety regulation stability and predictability
- Policy framework (in terms of political leadership and multi-unit projects).

In addition to that, there are still largely unknown cost components for the dismantling of nuclear power plants as well as the safe storage of spent fuel and other nuclear waste. Nuclear safety is another political issue: should society take on more nuclear energy with the risk of accidents, terrorism, and proliferation when other less risky renewable technologies are available at lower costs?

Role of nuclear power in the transition

In conclusion, it can be said that nuclear power – neither in its current form and envisioned advanced or modular technologies – is not viable from an economic point of view. In the light of budget and construction time overruns given the short time remaining for a sustainable energy transition to tackle climate change, all efforts should now be concentrated on building a flexible and renewables-based system with high European integration. The inclusion of nuclear power as transitional activities in the EU Green Taxonomy certainly makes these investments more attractive. Yet, given the financial, project, and technological risks it should be doubted that investors will start to crowd in at a large scale.

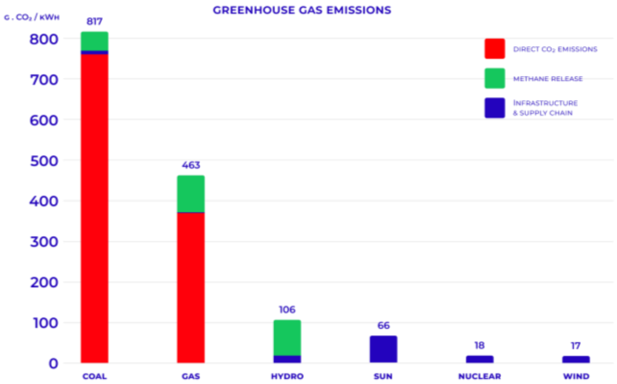
Clean and stable nuclear energy for achieving climate neutrality

FERMI.

Kalev Kallements PhD
CEO and co-founder, Fermi Energia
+372 5649 2044
kalev.kallemets@fermi.ee

Nuclear energy will be increasing as Europe requires near zero lifecycle carbon and dispatchable energy to achieve climate neutrality by mid-century. Dispatchable energy is needed to stabilize the unpredictability of wind and solar energy production. To achieve full decarbonization in the EU, we need to replace at least 75GWe of coal power, 100GW of gas power generation and increase dispatchable power generation by additional 100GWe to replace fossil fuels in heating, transport, industry and produce synfuels, ammonia fertilizers etc. In total, 275GWe of dispatchable power generation is needed.

Figure 32 Emission intensity of power generations technologies



Source: Author's own calculations based on IPCC[16]

By 2050, nuclear energy could be around 45% of total power generation in the EU (26% in 2021). Likely two-thirds of new capacity of nuclear will come from Small Modular Reactors (SMRs) and one-third will be conventional large Nuclear Power Plants (NPPs). Only few nations will commit to given enormous capital cost. The share of SMRs will rise as construction of large conventional NPP is very capital heavy and will be available only to larger nations.

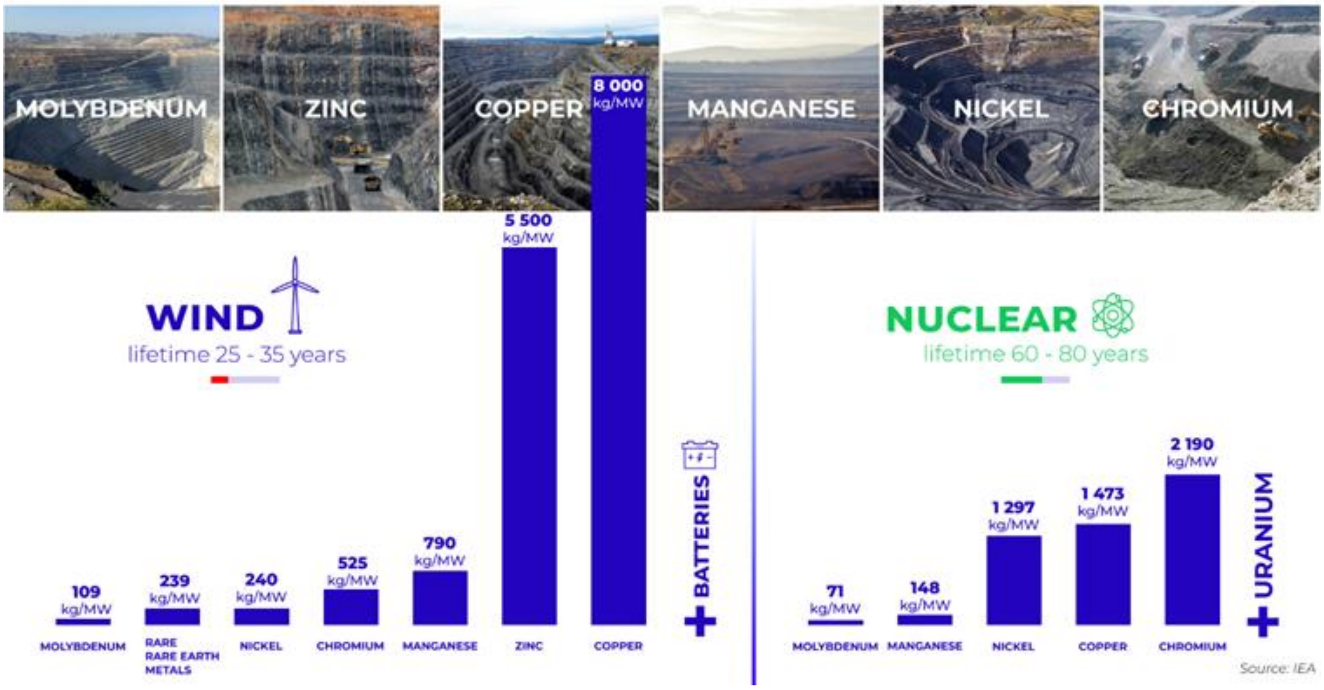
Advantages of Small Modular Reactors

There are several reasons as to why nuclear power will generate almost half of Europe's power by 2050. First, high energy density of nuclear fuel in comparison to wind and solar and higher capacity utilization factor (90% for nuclear instead of 28-45% for wind and 12-25% for PVs). Second, grid construction requirements and need for grid stabilization and back up for wind and solar. Third, useful life of NPP (60 years and up in comparison to wind and solar (20-30 years). Fourth, relatively low raw material requirements of nuclear power, limited land usage, high-capacity utilization with predictability, low carbon life cycle emissions and long asset life gives nuclear energy opportunity to be very competitive in the energy market.

Indeed, large nuclear has been historically more capital extensive and slower than expected (construction times 5-10+ years), due to 1400-1600MWe size reactors that lead to complicated construction, safety, and financing issues. Water-based SMRs with around 300MWe size, EUR 1bn investment per reactor, 3-year construction time can overcome these problems. Reasons being smaller size, modular construction, simpler siting, smaller staffing, and simplification of safety systems towards passive systems (safety systems without electrical input need). At the same time, large scale wind projects have suffered from long lead and construction times. Estonia, for example, has not been able to construct any sizable wind project for the last 10 years and solar has hit the massive grid upgrade requirements.

[16] https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf

Figure 33 Resource used in the construction of nuclear and wind energy



Source: Author's own calculations based on IEA[17]

Drilling solution for nuclear waste repository

Radioactive waste volumes from SMRs are relatively small in comparison to conventional NPPs. Sweden, Finland, and many other countries have made good progress on developing geological repositories over last decades. They have provided ample empirical evidence for international consensus that deep geological repository is suitable solution for spent nuclear fuel repository.

Applying shale gas advanced drilling solutions to small volume spent fuel enables promises faster and lower cost execution of deep geological repository due to no need to have manned presence underground. Drilling requires less venting, accessibility for humans, transportation, safety, energy etc. and is thus a less invasive and resource intense solution.

Fermi Energia will have access to a final repository in cooperation with Estonian government and an already existing State-owned radioactive waste handling company. Estonia is having a similar geological profile to Finland and Sweden. The final repository will be in place and operational by 2049 thus meeting technical requirement of the EU Taxonomy. Spent fuel and decommissioning prefinancing would start as soon as power generation commences with annual pro rata payments to special government managed fund.

Investing in nuclear power

Fermi Energia has been financed through private equity. The company's equity finance rounds have been oversubscribed by Estonian and international shareholders. We see continued interest in investing both equity and debt in energy production that can decarbonize dispatchable energy supply in large volumes and ensure price stability for the Baltic region business and retail customers.

EU Taxonomy requirements were adopted in 2022 including for nuclear power. Sustainability requirements have evolved both in the EU and globally based on scientific evidence and evolvement of technology. Thus, Western and evidence-based financing platforms and funding principles will likely include well regulated, safe, well planned nuclear energy which can be included in sustainable finance frameworks and products in the future.

[17] https://www.iea.org/data-and-statistics/charts/minerals-used-in-clean-energy-technologies-compared-to-other-power-generation-sources

The moment of truth for fusion is getting closer

Mika Myrseth
Macro and FICC Research, SEB
mika.myrseth@seb.no

Bjarne Schieldrop
Trading Strategy, SEB
bjarne.schieldrop@seb.se

Retired Princeton professor Daniel Jassby says fusion enthusiasm comes and goes in waves of grand optimism, which then gradually dies away. Recently there have been a lot of news about fusion, again awakening this wave of optimism. If you're unfamiliar with fusion, it can be summarized as the holy grail of energy. Fusion power promises to be an emission-free and limitless source of energy, by replicating the process that powers the sun. Scientists have been pursuing it as a source of energy for about 70 years but have generally been over-promising and under-delivering.

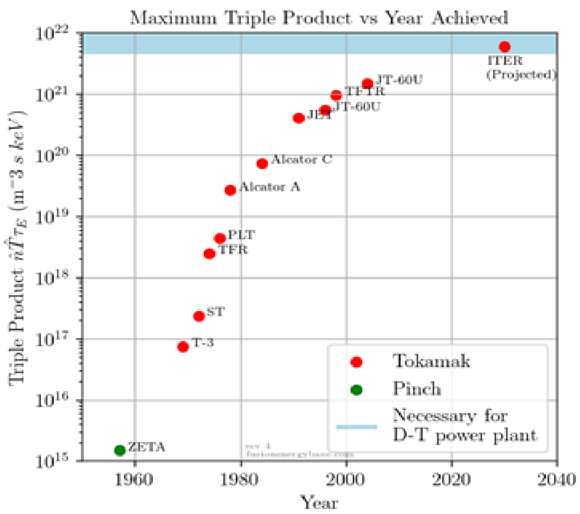
Why did progress in fusion stop?

The trick that has yet to be solved by scientists is not figuring out how to create fusion reactions on earth. They achieved that back in 1932. Since then, scientists have been struggling to get enough fusion reactions to happen so that they produce more energy than it takes to create them.

The performance of fusion energy is expressed in Q. This is a measure of energy out divided by energy in. A Q-value greater than 1 would imply a net positive energy. Note that this is a scientific metric, only accounting for energy ins and outs of the reaction itself. A reactor would need to account for things such as, steam turbines, resistance, and other inefficiencies. Therefore, commercial reactor would need a Q closer to 10-50, depending on the design. The current record is held by the JET-reactor in the UK, with a Q of 0.70 set in 1997.

For a long time, progress was going well. Figure 34 shows the fusion "triple product" for different experiments. Simply put, this is a measure of reactor performance that can be used approximately as a proxy for Q. The graph shows that progress has been exponential for around 40 years. Since the late 1990's however, we have seen very little progress in this metric.

Figure 34 Performance of fusion energy



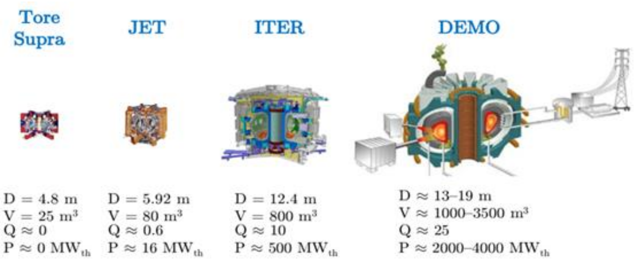
Source: Fusionenergybase

The progress in fusion stagnated due to size, not physics. One reactor design has been dominating the academic pursuit for fusion. The Tokamak is a design where magnets are used to contain and send plasma around in the shape of a doughnut. Over 170 such reactors have been built, and their performance is mostly a function of magnetic strength and size. To progress past where it has been in the 1990s, the scientific community concluded it had to make a much, much, bigger reactor, called ITER (Figure 35).

A total of 35 countries, more than USD 22bn in funding, and more than 34 years of waiting characterizes the biggest fusion project ever. Not just in fusion, ITER is the second biggest science experiment ever, only after the International Space Station. The ITER project was officially initiated in 1988, site construction began in 2007, and is currently doing assembly. After countless delays already, it is expected to be completed in 2025, but probably delayed again until 2026.

"The ITER sponge" as it is sometimes called, has been sucking up pretty much all funding and public effort since the project was initiated in the 1990s, and it is still not completed. Yet, it is no hope for the energy crisis, as results are not expected before 2035, and a commercial design would not be completed before 2050.

Figure 35 Size of ITER and DEMO reactors

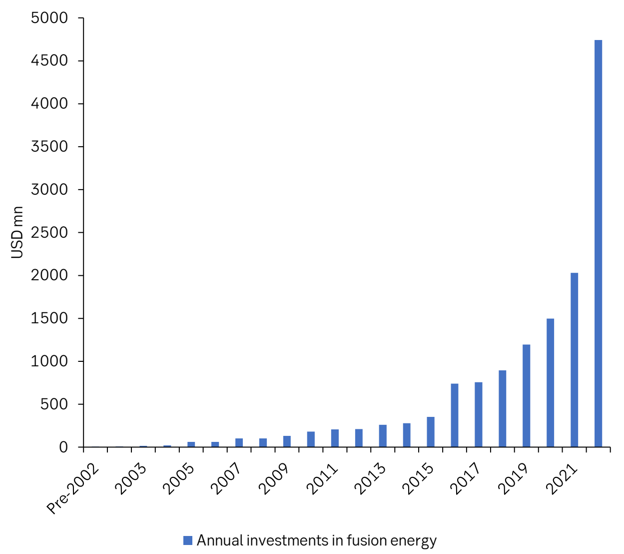


Source: Gregor and Dubus (2014)

Something is happening to fusion

While academic science has been focusing its effort on ITER, a swarm of private companies are now entering fusion energy. Only in the past 3-5 years, many new private ventures have emerged, all claiming they can do it much faster than ITER. In 2016 there were 12 private fusion companies, today that number is 33. Figure 36 shows that more private capital has been invested in fusion in the last 12 months, than in sum in the past decade.

Figure 36 Accumulated fusion funding



Source: Bloomberg and Fusion Industry Association

Why now? This trend is primarily driven by new technology. A lot of things have changed since ITER was designed in the 1990s. Back then, Tokamaks seemed to be the only approach generating meaningful returns. Today, new technology opens brand new doors for fusion. Companies are either picking up approaches that were previously abandoned by the scientific community or using new technology to drastically improve upon existing designs. Some examples are companies using brand new materials to create stronger magnets than ever before, or a company partnering with Google that is using supercomputers to create simulations and diagnostics that promise to drastically improve reactor stability.

Should we believe in this?

Private companies have less transparency than publicly funded research, and they are generally more secretive about their actual results due to competitive concerns. Thus, it can be difficult to believe in their grand promises, with timelines generally promising commercial fusion reactors in the early 2030s. A common criticism is that timelines are overly optimistic to drum up funding.

While investors should certainly be cautions, we believe there are also some signs that certain companies might be onto something. One company we spoke with has created six prototypes over many years, and the results have apparently been good enough to get the same investors to keep investing in each new prototype. Another company, with four prior prototypes under their belt, says every round of funding is linked to specific prototype-milestones that they need to reach in every step of the way. The company claims that their latest prototype delivered well above these milestones. Some of these companies were not even interested in more private funding, as they believed they already had secured what they needed to reach "the finish line".

Even though it is frustrating to be kept in the dark by many of these companies, we believe transparency might increase in the next few years. In the period 2024-2026, numerous companies are coming out with what they aim to be the last or next-to-last prototypes before commercialization. Companies tell us that their communication strategy will change as they get closer to the finish line. They are very concerned with supply chains, regulations, etc., and they acknowledge that this will take time. Thus, we could see a moment of truth for fusion already in the next few years, with the potential of new results being published that would prove that fusion will become a viable source of energy.

Fusion is nearing the "point of truth"

There is an old saying: "The difficult we do immediately. The impossible takes a little longer". So, while the quest for a working, commercial fusion power plant has been going on for decades and decades it doesn't at all mean that it won't happen. It only means that it is a hard problem to solve technically. One of the things which stood out amongst the long line of people we interviewed in our deep dive into fusion power was a common, deep conviction that this is possible. That this will happen. That this can be done. To a large degree the focus amongst the companies now working hard to make fusion power a reality, was engineering and not so much science.

What we have called "The moment of truth" is the point in time where one of the start-ups or government backed facilities provides a physical prototype which irrefutably shows that a commercial fusion power plant is indeed feasible. The viewpoints of the fusion start-ups we interviewed was basically that all this knowledge and technology has now accumulated to the critical point which enables them to cross the finish line to a commercial fusion power plant. The conviction amongst the start-ups we interviewed was extremely high on this point. And not the least amongst those who neither wanted publicity nor money.

Our interviews lead us to believe that fusion is no longer a scientific mystery or challenge. It is the engineering part which is the challenge. Today's fusion power start-ups are all standing on the shoulders on all the research, science and technological advances which have been made over the past 90 years.

What would happen if fusion became reality?

Most of the fusion start-ups argue that fusion will reach commercial viability within 2-3 years. If that indeed turns out to be the case, it will be a momentous point in time. Politicians, engineers, and investors from all over the world would flock to see the prototype. Since "seeing is believing" it would change their minds from "impossible" to "possible". A new door would open for humankind. Funding for fusion power would explode. It would be the saviour in many ways. Our view of global climate disaster would look much less unavoidable. We could make a common, global effort to build fusion power at enormous scale and speed to the point where we almost eradicate consumption of fossil fuels around 2050/60.

Gigafactory-style ramp-ups could potentially allow fusion to quickly take a chunk out of global energy mix. This would mean a greatly accelerated end to fossil fuels, a green hydrogen boom, cheaper food production, cheaper water desalination, and probably an unseen acceleration in economic development.

For today's large, fossil fuel producers and exporters it would of course be a disaster as their products would be redundant. Access to infinite amounts of clean and affordable energy for everybody on earth would help us solve many of today's problems.

Supply of endless power, however, could come with a caveat. And that is that humankind's impact on the earth's ecosystem, barring CO_2 emissions, is to a large degree proportional to our consumption of energy. The more energy we consume, the bigger is each human being's impact on the global ecosystem. Even if we then will be able to circumvent the climate problem, we would still need to make every single step of our societies squeaky clean.

In a world powered by fusion, a super-clean and circular economy across the world would be even more important than it is today. Indeed, it would be imperative to avoid that we drown in garbage and pollution.

Nature Based Climate Solutions and humanitarian financial innovation

Adam Bornstein
Innovative Finance & System Change
adbor@rodekors.dk

"Glass, friends, and metal roofing were flying in the air, clinging to coconut trees, or being washed away. What gave me courage where the mangroves. Many hectares were damaged by Superstorm Haiyan, but these trees stood tall, strong and prevented absolute damage" recounts Aurora of the day the typhoon hit her village in Busuanga, Philippines in 2013.

Nearly a decade later, Aurora, now a program manager with a local environmental nonprofit dedicated the restoration and reforestation of mangrove forests across Palawan, continues to promote mangroves as an important nature-based disaster mitigating solution. Indeed, there are multiple examples that support Aurora's intuition.

Figure 37 Mature Rhizophora mangrove forest with secondary growth in Busuanga, Palawan, Philippines

Source: Danish Red Cross

For example, in 2017, during Hurricane Irma, over 626,000 people living behind mangrove forests saw reduced flooding in census tracts across Florida; representing a 25% savings equivalent to USD 1.5bn.[18]

The Red Cross and Red Crescent Movement is taking a systems level approach at blending innovative humanitarian financing and Nature Based Climate Solutions. This is part of a humanitarian push to energize climate financing, and specifically in the context of developing new financial solutions to protect communities from natural disasters, whilst at the same time contributing to the restoration of valuable and vulnerable ecosystems like mangroves.

Investment case for Nature Based Solutions

Nature Based Solutions (NBS) blend natural features or processes into a preexisting environment to promote continuous adaptation and resilience. As of end 2021, there were over 200 NBS active projects, and 88 of these NBS transactions incorporated repayable investments equivalent to USD 1.5bn.[19] When structured properly, balancing risk adjusted returns against meaningful climate centric outcomes, NBS programs may provide the single largest untapped opportunity to help unlock the estimated USD 200tn climate adaptation and mitigation market.[20]

While there are numerous terrestrial ecosystems to embed in NBS, globally, mangroves and other coastal ecosystems provide one of the most universal, cost-effective opportunities for natural defense to reduce the risks from flooding and erosion. For example, a recent report from the

[18] https://www.nature.org/content/dam/tnc/nature/en/documents/Mangrove_Report_digital_FINAL.pdf
[19] https://finance.earth/wp-content/uploads/2021/05/Finance-Earth-GPC-Market-Review-of-NbS-Report-May-2021.pdf
[20] https://www.paulsoninstitute.org/conservation/financing-nature-report/

Global Adaptation Commission highlights that the benefits of mangrove protection (e.g., disaster risk reduction) and restoration (e.g., abandoned fishponds) are up to 10 times the costs.[21]

From a financing perspective, USD 11.1bn investment is needed over the next 20 years to tackle the full restorable potential of over 700,000 hectares across 25 countries (representing 90% of all mangrove forests).[22] While this USD 11.1bn is a fraction of the trillions required to satisfy the UN's Sustainable Development Goals, it is a significant number for a humanitarian sector that annually confronts sizable budget deficits in the face of growing needs.

Novel ways to fund NBS projects needed urgently

According to the UN, in 2022, approximately 274 million people, up from 235 million in 2021, will need humanitarian assistance and protection at an estimated cost of over USD 61bn[23]. However, OECD reports humanitarian assistance from Ordination Development Assistance (ODA) only accounted for USD 18.8bn in 2021.

With slightly more than 10% of ODA assistance channeled to humanitarian interventions on the back of more frequent, protracted, and severe climate instigated humanitarian operations, the traditional humanitarian financing paradigm is under siege.

One of the most significant problems humanitarian organizations face, is mobilizing capital to continuously finance mainstream operations that respond to pre-existing and protracted incidents. Clearly, this is partially driven by not enough humanitarian assistance, in absolute terms, funneling to the system but, and with growing frequency, it is also due to donors prioritizing emergency response not systems and resilience building.

What humanitarian organization are most in need of is long term, stable cash flow to support these entrenched operations so that systems can be installed, local capacity enhanced, rural development supported, and resilience strengthened.

To this end, Nature Based Climate Solutions and humanitarian interventions share a common thread – the investment cases that can attract commercial investors are challenging to identify without locking down continuous, medium to long term cash flow required to sufficiently compensate investors.

Carbon credits offer opportunity to fund NBS investments

Financing commodity dependent NBS programs requires appropriate risk-sharing arrangements between public and private stakeholders which is another way to signal that the majority of NBS transactions are debt financed. Humanitarian organizations like the Red Cross and Red Crescent Movement are prepositioned to avoid debt financing; mainly due to a lack a familiarity with debt products but also because NGOs have organizational bylaws (or Boards) preventing the encumbrance of their balance sheets.

While debt financing may still be a hurdle too high, securitizations, pioneered by the precedent setting volcano catastrophe bond sponsored by Danish Red Cross in 2021, is rapidly becoming a viable and practical humanitarian monetization modality.

In this spectrum, it is reasonable to assume an organization can evolve from deploying one risk transfer solution, such as insurance linked securities, to finance disaster risk reduction to another solution, for example carbon credits, to finance climate adaptation and resilience. And what's more, NBS programs funded through quality carbon credits provide a continuous cash flow hurdle that remains aloof to many international organizations. There currently exist at least 30 NBS projects that are financed through the sale of carbon credits to the voluntary carbon market.[24]

Putting aside the protection and resilience qualities propagated by mangroves, one of the most interesting and attractive qualities of mangroves are their ability to store carbon up to 400% faster than terrestrial forests. If 700,000 hectares of mangroves were replanted nearly 90% of the earth's mangrove forests would be restored; and in doing so, nearly 380 megatons of CO_2 is[25] sequestered by 2040.[26] To put this in context, in 2020, Australia and UK emitted the equivalent of 386 megatons and 313 megatons, respectively.[27]

There already exist at least 30 project NBS projects that sell carbon credits through voluntary carbon markets. Based on the current voluntary market value of USD 8.47/ton of CO_2 sequestered specifically from a NBS program, the equivalent revenue of 380 megatons of

[21] https://gca.org/global-commission-on-adaptation/report
[22] Viewed in: https://earthsecurity.org/news/global-investment-in-mangrove-regeneration-could-return-11-8-billion-by-2040/
[23] https://gho.unocha.org/ and Danish Red Cross Innovative Finance Team estimates
[24] https://finance.earth/wp-content/uploads/2021/05/Finance-Earth-GPC-Market-Review-of-NbS-Report-May-2021.pdf
[25] Financing the Earths Assets: The Case for Mangrove as a Nature Based Climate Solution
[26] https://carboncredits.com/carbon-prices-today/
[27] https://worldpopulationreview.com/country-rankings/carbon-footprint-by-country

carbon offsets would be valued at only USD 3.2bn. Why only? Because at a cost of USD 11.1bn to reforest 700,000 hectares, purely from an investment posture, the case for financing mangroves restoration with carbon credits is unattractive.

Figure 38 Impact of planting mangroves propagules in sea grass 10-year-old stunted mangroves in Busuanga, Palawan, Philippines

Source: Danish Red Cross

The case for investing in mangrove restoration and reforestation

So, what would it take to drive investor interest to mangrove restoration and reforestation NBS transactions? Three things must happen: (1) the price of NBS carbon offsets need to increase to USD 30/ton to breakeven and USD 50/ton cover an investor's cost of capital; (2) the quality of the offsets need to improve; and (3) the cost of restoration per hectare needs to come down dramatically.

Betting on higher carbon offset prices is what has been driving investor interest in California's compliance and voluntary offset markets. While the median allowance price at California Air Resources Board's August 2022 offset auction was slightly softer by 3% over May 2022 results, speculative investors continue to play a significant role in the market.[28] For example, in the August 2021 compliance auction bought 30.4% of the allowances sold which is nearly double the amount reported in 2019.[29] Furthermore, at the end of 2021, speculative investors held 46% of allowances in the US mid-Atlantic and Northeastern market known as the Regional Greenhouse Gas Initiative, up 9% from the beginning of the year, according to the program's annual market monitor report.[30] And finally, there has been a spike in the number of carbon offset focused project developers and asset managers raising hundreds of millions of US dollars to build carbon credit portfolios through IPOs and new fund creation.

However, with speculation comes volatility, as witnessed by the fact that both compliance and voluntary carbon offset markets are off as much as 50% from their higher in early 2022. To credibly play in these markets an organization requires a treasury team that understand hedging risk and illiquid markets. While the Red Cross has very talented finance teams Movement wide, trading securities, and specifically carbon credits, is not one we've staffed up for.

Though where the Red Cross does have a sizeable competitive advantage is mobilizing community organizations and creating transformation partnerships with private sector climate and financial specialists. To paraphrase the late great Harvard Professor Michael Porter, value is calculated by dividing the service rendered by the associated costs. If you seek higher value, focus on the cost of the deliverable without degrading the service.

In the context of mangrove NBS transactions, there is massive opportunity to reengineer the cost side of the equation while in parallel increase the quality of both outcomes and credits. Here is how: (1) significantly reducing mangrove reforestation and restoration costs from USD 7.9mn/500 ha to under USD 200K/500 ha; and (2) increase the quality of the offsets with insurance, specifically a catastrophe bond, and additionality which could demand a 40% premium over lower quality voluntary market offsets.[31]

Mangrove Trust Fund

To this end, The Red Cross and Red Crescent, together with Replexus (UK), has established the Asia Pacific Protection, Restoration and Resilience Financing Facility (or the Facility). The Facility will cover multiple Nature Based Climate Solutions that protect communities from natural disasters, whilst at the same time contributing to the restoration of valuable and vulnerable ecosystems. The program seeks to covers up to 30,000 hectares of mangrove restoration and reforestation in the Philippines.

This Facility enables capital markets to contribute to climate adaptation efforts, by setting up a value proposition that serves both the humanitarian sector and

[28] https://ww2.arb.ca.gov/sites/default/files/2022-08/nc-aug_2022_summary_results_report.pdf
[29] https://www.bloomberg.com/news/articles/2021-11-17/hedge-funds-seek-riches-in-california-s-carbon-market
[30] https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/private-investors-flocking-to-cap-and-trade-markets-as-prices-and-returns-soar-70450498
[31] The cost to plant 700K ha is calculated by dividing USD 11.1bn by 700K and multiplying by 500. Additional research by DRC indicates the range for prior mangrove restoration projects is USD 5mn to 4mn/500ha. Costs are driven by location, labor and material costs, and maintenance. The 40% premium is based on indicative offers sourced through a syndicate of potential investors; for example, if voluntary NBS market is USD 10/ton, the Red Cross offsets would be priced at USD 14/ton.

commercial investors. By structuring commercially viable financial solutions, such as carbon credits and a weather linked catastrophe bonds, that embrace global capital markets, humanitarian organizations, like the Red Cross and Red Crescent can change their funding paradigm from one focused on short-term grant funding to one focused on medium to long term blended finance.

At the heart of the Facility is a trust fund where proceeds are pooled from four revenue streams. These revenue streams (or Loops) correspond to specific input actives, for example planting mangroves generates revenues from selling call options or warrants on associated carbon credits; or paying an annual insurance premium for the tropical typhoon catastrophe bond cover that protects the newly planted mangroves and related coastal communities.

Essentially how the structure works is as follows: Catalytic donor funding pre-seeds the mangrove trust fund, for example, this project has already mobilized more than USD 550,000 in catalytic funding.

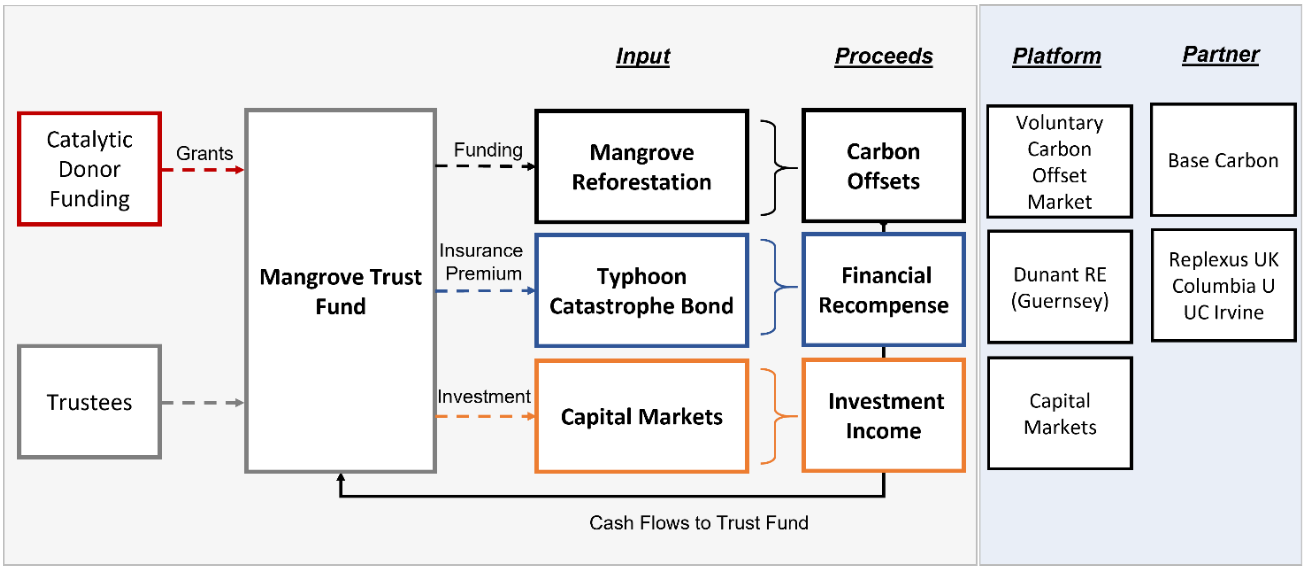
The trust fund bifurcates capital allocations to pay for (i) the restoration and reforestation program team embedded within the communities who plant mangroves; and (ii) to Dunant Re, an insurance company established by Danish Red Cross and Replexus, to pay for a parametric cat bond's insurance premium which insures against loss of or damage to the mangroves planted and to the surrounding communities.

Base Carbon anticipates providing up to USD 10mn in project financing, together with the Red Cross will create a Project Design Document. This Project will follow VERRA's methodologies for creating carbon credits from reforesting and protecting Mangrove habitats. The project financing will supplement the catalytic donor funding, and thus is expected to cover a good portion of the required Capex and Opex, such as operations, growing and planting, logistical support, design work, and the monitoring and verification required for Carbon Credits.

The Funds required for Capex and Opex and a normal IRR are considered in the cost of the project finance. The carbon offset credits will derive a certain market price and at the time of designing the project Base Carbon and the Red Cross will consider this market price and use it to model the project and determine an IRR. Returns to the Project are from the sale of carbon credits. Some of these sales agreements will be long term offtake agreements and a portion will be sold "merchant" (i.e., floating with the market price) to capture extra value.

Once Base Carbon and the Red Cross and Red Crescent are returned their initial finance subject to IRR calculations, the rest of the upside is to be shared between Base Carbon, Red Cross, and the partner communities. For example, assuming a conservative offset price of USD 10/ton covering 2,500 hectares of mangrove reforestation, the possible revenue from carbon credits would be between USD 7.5mn and USD 10mn. The cost of planting 2,500 hectares would likely come in under USD 1mn assuming it costs USD 180,000 per 500 hectares to restore and reforest.

Figure 39 Mangrove Trust Fund and Associated Structures



Source: Danish Red Cross

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

Gregor Vulturius, PhD
Advisor
Climate & Sustainable Finance
gregor.vulturius@seb.se

Tine Vist
Senior Quantitative Strategist
Equity Strategy Research
tine.vist@seb.dk

Filip Carlsson
Junior Quantitative Strategist
Macro & FICC Research
filip.carlsson@seb.se

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

Contacts at SEB

Hans Beyer
Chief Sustainability Officer of SEB
hans.beyer@seb.se

Christopher Flensborg
Head Climate & Sustainable Finance
christopher.flensborg@seb.se

The Climate & Sustainable Finance Team
greenbonds@seb.se

SEB Norway:
Ben Powell
Head Climate & Sustainable Finance in Norway
benjamin.powell@seb.no

SEB Finland:
Anssi Kiviniemi
Head of Sustainability in Finland
anssi.kiviniemi@seb.fi

SEB Germany:
Alexandra Themistocli
Head of Sustainable Banking in Germany
alexandra.themistocli@seb.de

SEB UK:
Renato Beltran
Client Executive, LC&FI
renato.beltran@seb.co.uk

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

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

SEB USA:
John Arne Wang
General Manager
john.wang@sebny.com

SEB Baltics:
Aušra Šamšonienė
Sustainability Officer, Baltics
ausra.samsoniene@seb.lt

Viktors Toropovs
Sustainability Officer in Latvia
viktors.toropovs@seb.lv

Audrius Rutkauskas
Sustainability Officer in Lithuania
audrius.rutkauskas@seb.lt

Evelin Allas
Sustainability Officer in Estonia
evelin.allas@seb.ee

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