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Marketing Communication

SustainaWeekly

The economic impact of extreme weather events

- **Economist: The economic impact of extreme weather events is different from chronic climate shocks. Chronic physical risk is gradual and deterministic. Extreme weather events are random and abrupt. Economic activity suffers in the immediate aftermath of an extreme weather event. The longer-term consequences on the economy depend on the capacity of the state to repair and rebuild and the prevalence of insurance contracts.**

- **Strategist: We summarise the results of our ESG Investor Survey. Compared to last years' survey, respondents place lower relevance to the EU Taxonomy compared to ICMA principles. More investors are allowed to invest in Sustainability-Linked Bonds, though many find points for improvement in this market. When evaluating ESG instruments, investors have a holistic approach, and more respondents now focus now on decarbonization strategies.**

- **Sector: Solar power is a key renewable source for the energy transition. But it has three major challenges: efficiency, intermittency and materials use. The emerging solar technologies aim to tackle these challenges but they are not commercially ready. The emerging technologies that could be game changers are: perovskites, quantum dots, thermochromic photovoltaic glass and night solar. We take a closer look into these.**

- **ESG in figures: In a regular section of our weekly, we present a chart book on some of the key indicators for ESG financing and the energy transition.**

Extreme weather events, such as heatwaves, fires, droughts, flooding and tropical storms, are more commonplace and more intense. In this edition of the SustainaWeekly, we first start by setting out the channels through which extreme weather events have an impact on the economy. We then go on to summarise the highlights of our ESG Investor Survey, which were covered in much more extensive detail in an earlier publication. Finally, we focus on the emerging solar technologies, which could be game changers but are not yet commercially ready.

Enjoy the read and, as always, let us know if you have any feedback!

Nick Kounis, Head Financial Markets and Sustainability Research | nick.kounis@nl.abnamro.com

How to think of the economics of extreme weather events

Amit Kara – Senior Climate Economist | amit.kara@nl.abnamro.com

- **The economic impact of extreme weather events is different from chronic climate shocks**
- **Chronic physical risk is gradual and deterministic. Extreme weather events are random and abrupt.**
- **Economic activity suffers in the immediate aftermath of an extreme weather event. The longer-term consequences on the economy depend on the capacity of the state to repair and rebuild and the prevalence of insurance contracts.**

Introduction

The science is compelling – extreme weather events, such as heatwaves, fires, droughts, flooding and tropical storms, are more commonplace and more intense. These events are chaotic and disruptive and in important ways different from chronic physical shocks which tend to be gradual and to some extent also more predictable. We focus on extreme weather events in this note, and more specifically, on the channels through which these types of events have an impact on the economy.

The timing of extreme weather events

The link between anthropogenic activities and atmospheric CO2 concentration and temperature is unequivocal, as is the link between the earth's temperature and the frequency and intensity of extreme weather events. It should come as no surprise that the number of extreme weather events has risen in response to higher CO2 concentration levels and temperatures. In the EU, for example, the number of extreme events has doubled from just under 20 per year in 1980 to around 40 in 2021 according to analysis by the ECB.

Although research that links the *frequency* of extreme events with anthropogenic activity is well-established, scientists have only very recently started to establish a compelling link between any particular extreme weather event and anthropogenic activity. A good analogy to illustrate the difference in the causal link between anthropogenic activity and the frequency of extreme weather events on the one side, and anthropogenic activity and its link to a particular event is a coin toss. In a fair coin toss there is an equal chance of heads and tails. One side is more likely in an unfair coin toss, but we cannot say for sure that a particular outcome in an unfair coin toss is entirely the result of tampering with the coin. In the same way, we cannot say with certainty that a particular extreme weather event would not have occurred without climate change.

One important difference between physical chronic and acute therefore, relates to attribution. There is a clear and deterministic link between the emissions, GHG concentration, temperature and sea levels. That link is better established for the *frequency* and *intensity* of acute events than for any *specific event*.
Another difference relates to the occurrence of the event. Acute events will turn more frequent but they will remain random. By contrast, the chronic physical effects of climate change will emerge on a deterministic and gradual path. The difference is illustrated in the graphic on the next page.

Transmission channel of extreme weather events

Having occurred, how does an extreme weather event impact the economy? A climate shock can have an impact on the demand and supply sides of the economy and in the case of an acute shock, the impact could vary over time. The table below lists a few demand and supply channels as examples and splits the impact into three distinct phases – short-term, medium-term and longer-term.

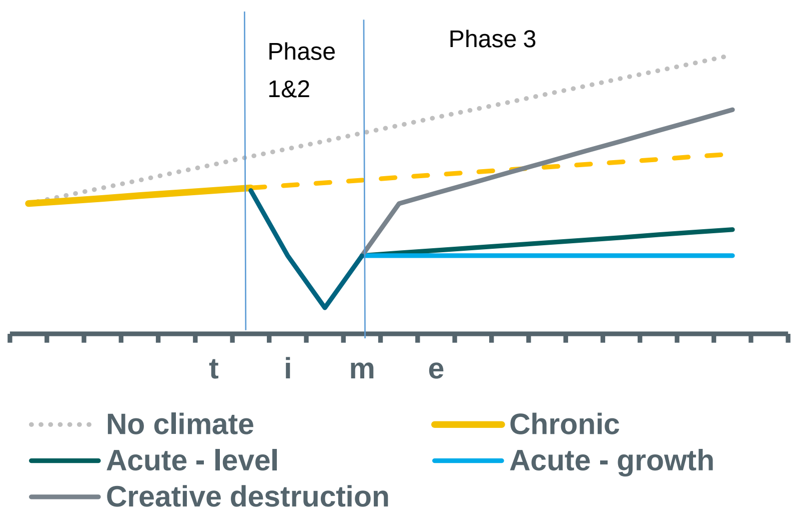
Extreme weather events: transmission channel

	Phase 1 (during the event)	Phase 2 (soon after)	Phase 3 (further out)
Demand			
Investment	Lower	Repair and reconstruction	Repair and reconstruction/adaptation
Consumption	Lower	Partial recovery	Full/partial recovery
Trade	Lower	Partial recovery	Full/partial recovery
Supply			
Labour supply	Mortality and morbidity		Partial recovery
Capital stock	Destroyed	Partial recovery	Full/partial recovery
Energy, food and other supplies	Disrupted	Partial recovery	Full/partial recovery
Technology			Diverted towards repair

Source: Batten, Sandra. "Climate change and the macro-economy: a critical review." (2018), ABN Amro Bank

There is little disagreement that the short-term impact (Phase 1) of a climate event is negative for economic activity. The loss in household and business income and the destruction to wealth has a negative impact on consumption, investment and trade. Activity tends to recover in the period immediately after the event (Phase 2) as households and businesses look to repair and rebuild. The extent of the rebuild will depend on the (financial) resources available to the public and the private sector and the availability of labour and material. The economic impact further out is more diverse and will in large part depend on the extent of insurance coverage and public finances.

GDP impact of physical climate shocks



Source: ABN Amro Group Economics

The chart above presents examples of possible outcomes. One possibility is that the economy is not able to recover to the pre-shock level of GDP in the foreseeable future. This could be because the credit conditions tighten and the government is unable to step-in with an effective reconstruction plan. The climate event would then have a scarring effect on economic growth (marked 'Acute – growth').

Another possibility is that the economy stages a partial recovery in the period immediately following the acute event (Phase 2) and economic growth recovers to its earlier trend. The climate event results a level shock to GDP (marked 'Acute – level').

A third possibility is where the damage from the climate event presents itself as an opportunity to replace existing capital stock with new and more productive capital stock. The recovery is not only immediate, but the improved capital stock results in faster economic growth (marked 'Creative destruction'). While there is little evidence that shows that economic growth improves after an acute climate events, there are occurrences where income levels more than fully recover and this positive outcome is largely because of state intervention. [1]

There are other possibilities as well. For example, there may be sufficient resources in the near term for the economy to fully recover but trend growth could be lower as a result of increased indebtedness or tighter credit conditions and higher uncertainty.

[1] Deryugina, T., Kawano, L. and Levitt, S., 2018. The economic impact of Hurricane Katrina on its victims: Evidence from individual tax returns. *American Economic Journal: Applied Economics*, *10*(2), pp.202-233.

ABN AMRO ESG Investor Survey: Key highlights

Larissa de Barros Fritz – ESG & Corporates Strategist | larissa.de.barros.fritz@nl.abnamro.com
Marta Ferro Teixeira – Financials Strategist | marta.ferro.teixeira@nl.abnamro.com

- **55 investors participated in the second edition of the ABN AMRO ESG Investor Survey. Most respondents are portfolio managers from asset management firms located in North Western Europe.**
- **Compared to last years' survey, respondents seem to place lower relevance to the EU Taxonomy compared to ICMA principles.**
- **Also compared to last years' survey, more investors are allowed to invest in Sustainability-Linked Bonds (SLBs). However, there are still points for improvement in this market, as investors perceive the standard step-up coupon to not be material enough and find it hard to evaluate the ambitiousness of SLB KPIs.**
- **When evaluating ESG instruments, investors have a holistic approach, and more respondents focus now on decarbonization strategies compared to last years' results**
- **Data comparability remains the biggest challenge when it comes to SFDR reporting requirements**

On the 25th July, we published the second edition of our ESG Investor Survey results (see here). The survey had a total of 39 questions in which 55 investors participated. The majority of the respondents are portfolio managers from asset management firms located in North-Western Europe. And most respondents either have an Article 8 or 9 fund (as per the Sustainable Finance Disclosure Regulation – or SFDR). From the investors that do have an Article 9 fund, the majority also focuses on the issuer ESG profile rather than the label of the bond.

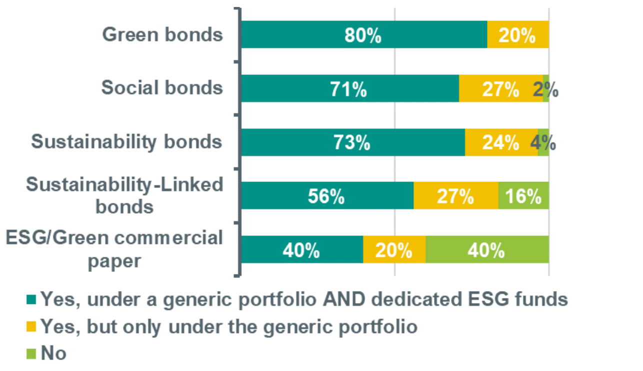
Below, we highlight the main takeaways from the ESG Investor Survey.

More investors can now invest in SLBs

Green bonds continue to be the preferred flavour among ESG investors, followed by social and sustainability bonds. Nevertheless, the share of funds allowed to invest in sustainability-linked bonds (SLBs) has increased since last year. While in 2022, 21% of investors indicated that they were not allowed to invest in SLBs, this number decreased to 16% this year (see chart below on the left).

Investors still prefer traditional "use of proceeds" bonds

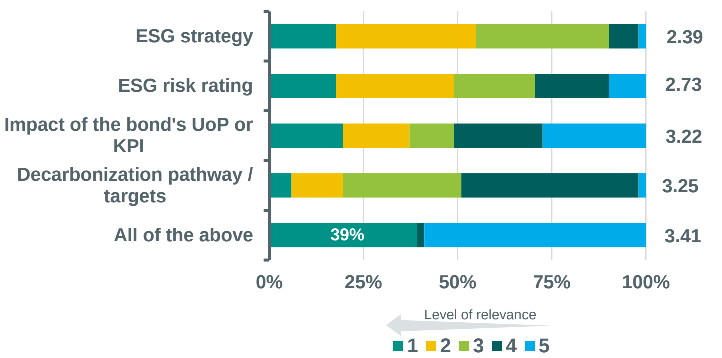
Question: Does your institution mandate allow for investments in any of the following ESG instruments?



Source: ABN AMRO Group Economics

40% of investors considers all criteria equally relevant when analysing ESG instruments

Question: When analysing ESG instruments, which of the following criteria would you judge as most relevant? (1= most relevant; 5= not relevant at all)



Source: ABN AMRO Group Economics. Note: Figures on the right hand side of the chart indicate the weighted average

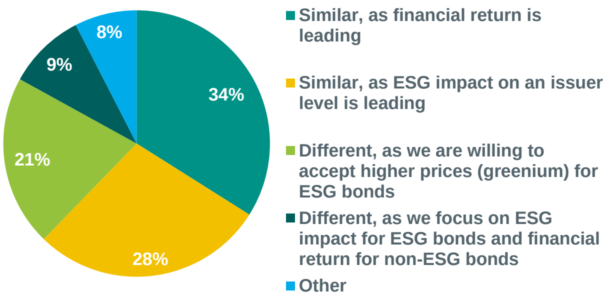
Furthermore, when looking at the criteria that investors judge most relevant when analysing ESG bonds, nearly 40% of the respondents said that they find all criteria (ESG strategy, ESG risk rating, impact of the bond's use of proceeds/KPI and decarbonization pathway) to be equally relevant (see chart above on the right hand side). For the respondents that put more weight on one, there seems to be a slightly higher preference for the impact of bond's use of proceeds (UoP) or KPIs. However, while the largest share of investors have selected this option as the most relevant, from a weighted average point of view, investors still seem mostly focused on the issuer's ESG strategy and/or ESG rating. This is aligned with results of last year's survey.

Furthermore, with regards the external standards used when assessing ESG instruments, the ICMA Green Bond Principles seem to be the most relevant for investors. This contrasts with last years' top choice, the EU Taxonomy, which now ranks second as preferred external standard. The lower relevance of the EU Taxonomy could be due to the fact that investors became more aware of the challenges that issuers face in aligning with this standard.

Most investors apply some sort of preferential treatment towards ESG when conducting investment decisions
More than 60% of respondents do not differentiate between ESG-labelled bonds and non-ESG labelled bonds in their general (non-dedicated ESG) portfolio (see chart below, left). Within these, 28% of investors indicate that the ESG impact of the issuer is leading, rather than the ESG label of the bond. Overall, only 34% of investors seem to solely focus on the financial returns , while the remainder applying some sort of preferential treatment towards ESG.

Most investors apply preferential treatment to ESG

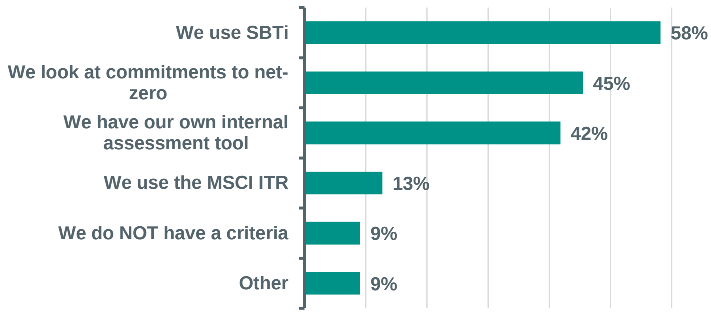
Question: How do you treat ESG vs non-ESG bonds in your general (non-dedicated ESG) portfolios?



Source: ABN AMRO Group Economics

More investors have criteria for decarbonization pathways

Question: Please specify your institution's criteria to evaluate decarbonization pathways / targets of issuers, if you have one. (Multiple answers allowed)



Source: ABN AMRO Group Economics.

When asked about the criteria they use to evaluate decarbonization pathways / targets of issuers, only 9% indicated that they do not have any criteria (see graph below on the right). This is a clear improvement since last year, when around 70% indicated they did not have criteria. These results are very encouraging because they signal that investors' are increasingly more focused on a long-term analysis of issuers' ESG credentials. Furthermore, the Science-Based Targets initiative (SBTi) is the most widely used criteria to evaluate issuers' decarbonization pathways (58% of respondents). Nevertheless, nearly 40% of the investors indicated that they make use of the SBTi along with other criteria, such as issuer net zero commitments or their own internal assessment model.

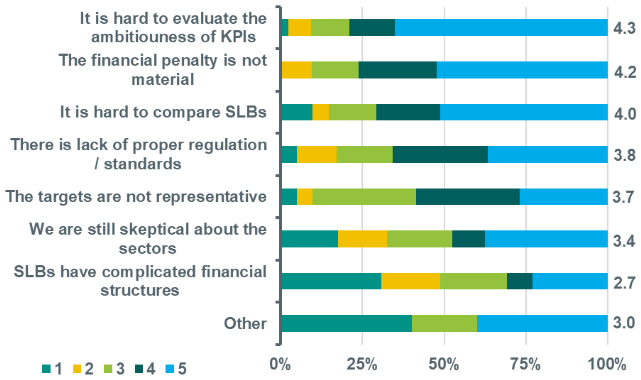
Opaqueness and lack of comparability are the biggest challenges for the SLB market
Regarding the barriers to the SLB market, investors mention that it is still very hard to evaluate the ambitiousness of the SLB KPIs, which makes it hard for them to judge whether issuers are as strongly committed to ESG as they claim (see chart on the next page on the left hand side). The second most relevant barrier is the size of the financial penalty – investors believe that the step-up amount is not material enough. This corroborates with the responses to another question in the survey, which enquires whether the standard 25bp coupon step-up is still deemed as financially material – almost 50% of the investors considers that the size of the step-up should be higher. Nevertheless, investors are still not clear about what this amount should be, given that more than 50% of respondents does not have a preference when questioned about the preferred amount of coupon step-up.

On a side note, the ESG survey also shows that almost 40% of respondents considers the inclusion of scope 3 GHG emissions in the SLB Framework as being very important, and another 30% considers it important if scope 3 emissions represent at least 50% of total emissions. However, our analysis indicates that while around 80% of all euro IG SLBs are tied to carbon emission targets, only 18% of the issuers have included scope 3 emissions in their Framework. This indicates a clear mismatch between what investors are looking for and what issuers are delivering at the moment. Nevertheless, almost 30% of investors does not consider scope 3 emissions to be that relevant, given the lack of reliability of this measure. In line with the latter, almost 70% of respondents considers the inclusion of scope 3 emissions in the SLBs KPIs important. Of these, 33% considers it relevant only if scope 3 emissions represent at least 50% of total emissions.

Finally, as shown on the chart below on the right hand side, data comparability remains the biggest challenge when it comes to SFDR reporting requirements. 64% of the investors flagged that the data currently being provided by issuers is not very standardised and that does not allow the investor to properly compare the information across issuers. Also, 25% indicates that issuers are not providing data verified by a reliable third party, and 36% considers that there is still a significant lack of data availability, which requires investors to rely on internal assumptions. This suggests that more clarity from regulators could help both issuers and investors to apply the SFDR efficiently.

Barriers for the SLB market

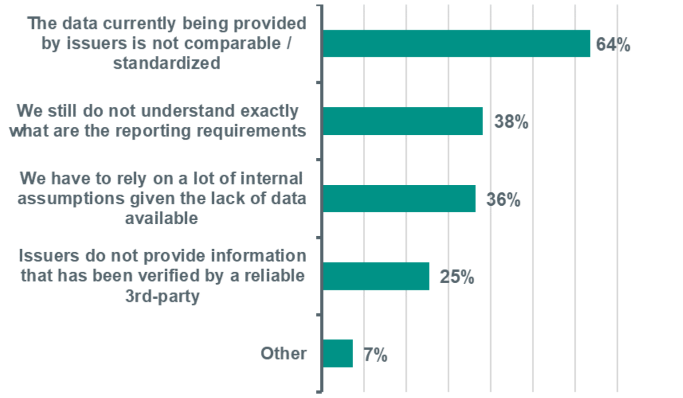
Question: What are for you still the biggest barriers for the growth of the Sustainability-Linked Bond (SLB) market? (5 stars = very important barrier, to 1 star = not a barrier at all)



Source: ABN AMRO Group Economics. Note: Figures on the right hand side of the chart indicate the weighted average

Data quality is the biggest issue around SFDR reporting

Question: What is your institutions' biggest challenge when it comes to regulatory transparency requirements (as per the SFDR)? (Multiple answers are allowed)



Source: ABN AMRO Group Economics.

Emerging solar technologies could be game changers

Georgette Boele – Senior Economist Sustainability | georgette.boele@nl.abnamro.com

- **Solar power is a key renewable source for the energy transition**
- **But it has three major challenges: efficiency, intermittency and materials use**
- **The emerging solar technologies aim to tackle these challenges but they are not commercially ready**
- **The emerging technologies that could be game changers are: perovskites, quantum dots, thermochromic photovoltaic glass and night solar**

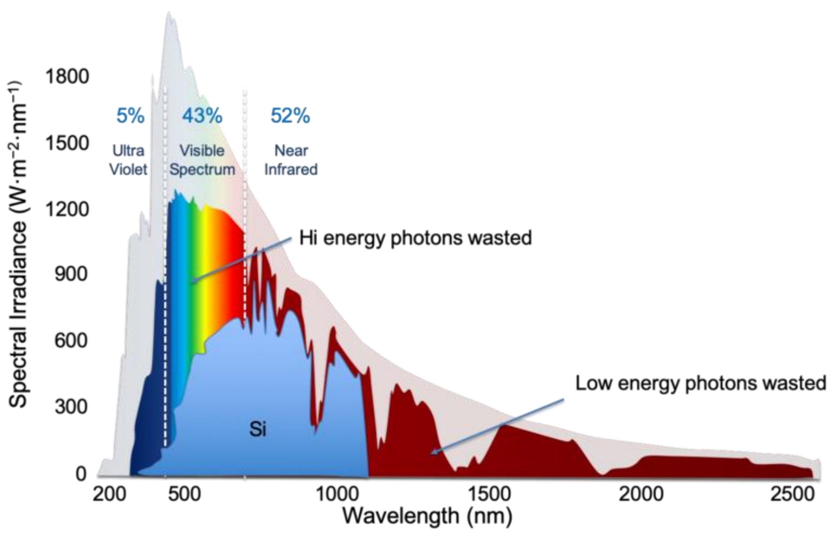
Introduction:

Solar power is a key renewable source for the energy transition. Globally, solar power has been the fastest growing clean technology. In 2022 solar capacity stood at 224 GW or 13% of the total renewable capacity globally. There are currently three major challenges to solve: efficiency, intermittency and materials use. Rooftop solar panels have on average 19-21% efficiency. Scientists are working on improving solar efficiency, reducing the costs and developing new technologies. In an ideal world, solar cells are integrated in buildings and the windows darken on sunny days and also generate electricity. Moreover, solar panels would work when the sun sets so there is no longer the challenge of intermittency. In this report we focus on the current and emerging technologies and how far are we from an ideal world. We first start with some basics about solar technology. We continue afterwards with the different solar technologies, other emerging technologies and applications.

How does photovoltaics work?

Solar energy reaches Earth as electromagnetic radiation that travels through space at the speed of light. It takes about 8.33 minutes to move from the Sun to the Earth. Some of this radiation is reflected off the clouds or absorbed by the atmosphere, while some passes through to the Earth's surface. The amount of energy depends on the angle of the sun's ray and the local weather. As light falls on the source of a solar cell, the energy moves electrons. Connected to a circuit, the solar cell becomes a source of electric current. This is called the photoelectric effect. So solar cells are devices that convert incident light energy to electric energy. Most solar panels are built with materials (mainly silicon) that physically interact with certain wavelengths of solar energy. The graph below shows the part of solar radiation that silicon (Si) captures.

Solar spectrum



Source: QD Solar

Almost 50% of solar spectrum is not captured by the majority of solar panels. This is because of the materials used (mainly silicon). Long wave infrared light lacks the energy to move the electrons, while the shortwave ultraviolet light has too much energy. If different materials are used then another part of the light could be captured. However there are two other challenges. First around 25% of the light energy is lost because of how electrons behave. Second about 14% is lost via resistance to current flow (**see here**). So of the total light energy 50% is used and of that 39% is lost (25%+14%) meaning the theoretical maximum efficiency of the solar panels that use silicon (majority) is about 32%. Most home solar panels have efficiency ratings between 19% and 21%. This may be low, but this is relatively high compared to the theoretical maximum efficiency of 32%.

What solar technologies are there?

There are four generations of solar cells. Moreover, there are also two other technologies that we focus on: thermochromic photovoltaic glass and night solar. These technologies are explained below.

First generation

First generation are crystalline silicon solar cells. This can be monocrystalline or polycrystalline solar cells. Monocrystalline silicon is a single crystal silicon meaning it is a homogeneous material. It has a higher efficiency compared to polycrystalline but the production is less efficient and creates material waste. Polycrystalline silicon is compiled of several small crystallites. It is non-homogeneous. Monocrystalline silicon has an efficiency in production of around 20-22% and polycrystalline 18-20%. The majority of the solar cells on the market are first generation crystalline silicon solar cells.

Second generation

The second generation solar cells are newer photovoltaic technology and consist of one or more thin films of photovoltaic materials on a substrate. These cells are thinner, flexible, cheaper, and have a wider use. The thickness of the film is in nanometres. These films can be used in Building Integrated PV (BIPV) such as solar tiles, solar windows, solar walls, roof-integrates panels, solar panel blinds and PV solar noise barriers. These thin-film cells absorb a different part of solar radiation than crystalline silicon because the materials used interact differently with light. Their major disadvantage is that on a commercial scale they are inefficient. Another drawback is that some of the materials are toxic (Cadmium) and other are scarce (Tellurium). On a commercial scale they have an efficiency of around 12-16% (**see here**).

Third generation

Third generation solar cells are emerging technologies. They are much cheaper and easy to produce on the roll-to-roll method. However, none of them has shown commercial efficiency similar to crystalline silicon cells. Examples are: dye-sensitized solar cells, organic solar cells, copper sinc tin sulfide (CZTS) solar cells, perovskite solar cells, quantum dot solar cells. The latter two get the most attention and we explain them below.

A perovskite is any compound whose crystal structure resembles that of calcium titanium oxide. They are thin film devices built with layers of materials. The costs of raw materials are lower compared to other solar technologies. Perovskites can be tuned to respond to different colours in the solar spectrum by changing the material composition. So they can be combined with another differently tuned absorber material to deliver more power from the same device. This is called tandem device architecture (**see here**). By doing this the efficiency percentage will increase considerably. But the major challenge is the stability of the material. They can degrade quickly when exposed to heat, moisture and snow.

Another promising emerging solar technology is quantum dots. They are considered to be artificial atoms. Their energy levels are adjustable by altering their size. So the size of the quantum dot defines what part of the spectrum of sunlight can be absorbed. Some of the materials are toxic though. Moreover, degradation increases in aqueous and UV conditions.

Fourth generation

Fourth generation solar cells aim to capture a wider spectrum by using different materials with different absorption such as perovskite and quantum dots. Then 50% of the spectrum light is no longer lost. As a result the theoretical maximum efficiency will increase. These are called multi junction solar cells.

Other technologies

In this section we focus on two other technologies: thermochromic photovoltaic glass and night solar. Thermochromic glass is a window that darkens when the heat from direct sun is on the window. A photovoltaic window is a window that have solar cells embedded that generate electricity. Thermochromic photovoltaic technology allows the window to change colour to block glare and reduce unwanted solar heating when the glass gets warm on a hot and sunny day. This colour change also leads to the formation of a functioning solar cell that generates power. The perovskites embedded within the material generate the electricity (**see here**). This is also called Switch Glaze. So it is combination of thermochromatic and photovoltaics. It is not commercially available yet as researchers are working on improving the technology.

In most emerging technologies, scientists aim to increase efficiency by using materials or a combination of different materials that absorb a larger proportion of the solar spectrum. These solar cells only work when the sun is up. Are there also panels that work when it is dark? Indeed there are! These solar cells are called night solar. Last year, there was a major breakthrough. Night-time solar can deliver power in the dark. They work like solar panels in reverse. They consist of a thermoradiative diode also found in night-vision googles. This diode works like the inverse of a solar cell accepting thermal energy radiated upward from the Earth into a colder area and turning the flow of energy across the energy differential into electrical potential. So night solar can tap the heat or infrared light falling on the panel’s surface to generate electricity. But currently night solar is only able to produce a fraction of what solar panels produce (around 0.04%). If the efficiency of this technology would increase substantially, battery storage in most cases would no longer be necessary.

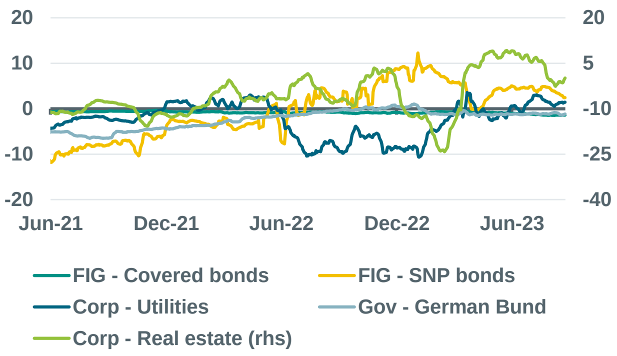
Conclusion

To reach net-zero by 2050 photovoltaics energy plays a crucial role. But there are three challenges to photovoltaics energy. First, current solar panels only absorb part of the solar spectrum and therefore the maximum theoretical efficiency is 32%. Second, solar panels don’t work when the sun is set. Third, several types and a lot of materials are used for the production of solar cells. The next generation solar technologies (especially third generation and higher) aim to overcome these challenges. Some of the technologies could have a major impact if they become commercially available such as perovskite, quantum dots, thermochromic photovoltaic glass and night solar. But none of these emerging technologies have shown commercial efficiency similar to crystalline silicon cells, some of them are not stable and others use toxic and or rare materials.

ESG in figures

ABN AMRO Secondary Greenium Indicator

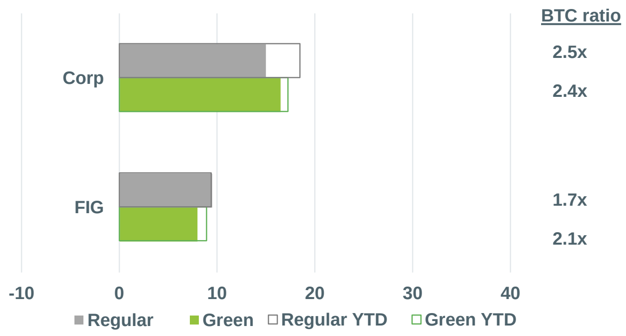
Delta (green I-spread – regular I-spread)



Note: Secondary Greenium indicator for Corp and FIG considers at least five pairs of bonds from the same issuer and same maturity year (except for Corp real estate, where only 3 pairs were identified). German Bund takes into account the 2030s and 2031s green and regular bonds. Delta refers to the 5-day moving average between green and regular I-spread. Source: Bloomberg, ABN AMRO Group Economics

ABN AMRO Weekly Primary Greenium Indicator

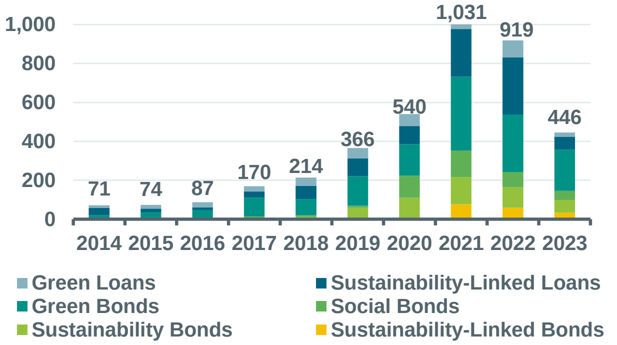
NIP in bps



Note: Data until 25-08-23. BTC = Bid-to-cover orderbook ratio. Source: Bloomberg, ABN AMRO Group Economics

Sustainable debt market overview

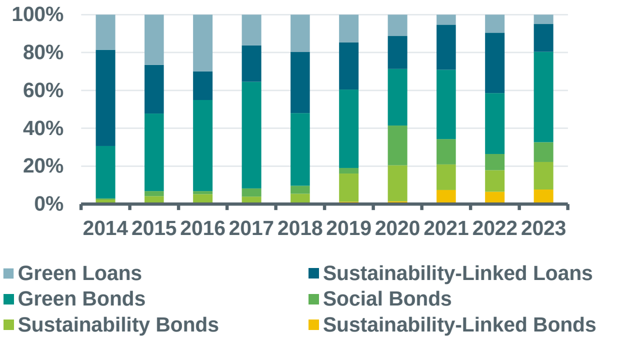
EUR bn



Source: Bloomberg, ABN AMRO Group Economics

Breakdown of sustainable debt by type

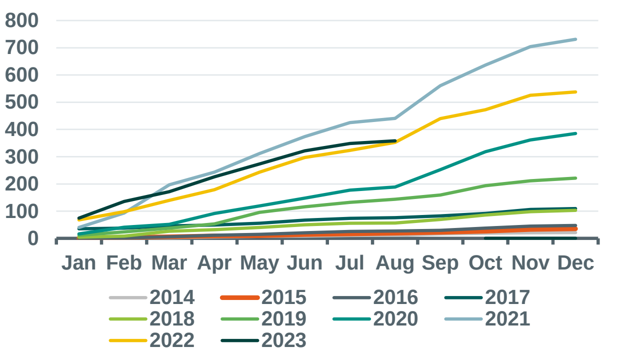
% of total



Source: Bloomberg, ABN AMRO Group Economics

YTD ESG bond issuance

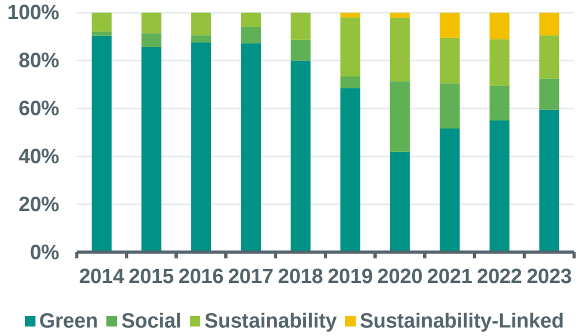
EUR bn (cumulative)



Source: Bloomberg, ABN AMRO Group Economics

Breakdown of ESG bond issuance by type

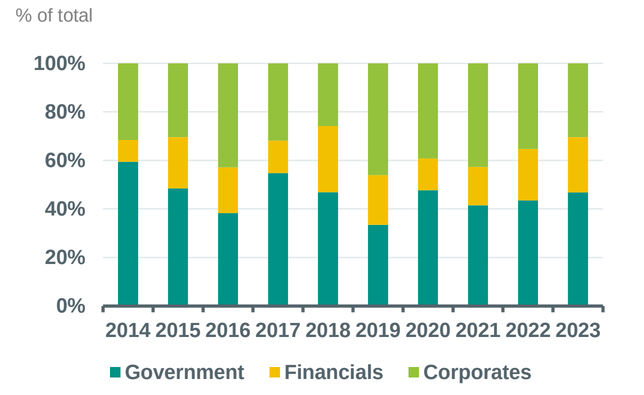
% of total



Source: Bloomberg, ABN AMRO Group Economics

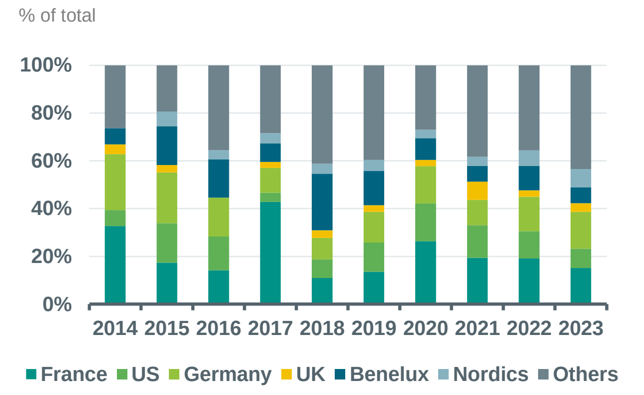
Figures hereby presented take into account only issuances larger than EUR 250m and in the following currencies: EUR, USD and GBP.

Breakdown of ESG bond issuance by sector



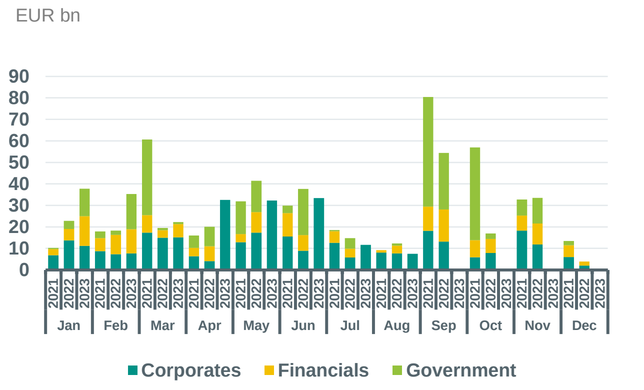
Source: Bloomberg, ABN AMRO Group Economics

Breakdown of ESG bond issuance by country



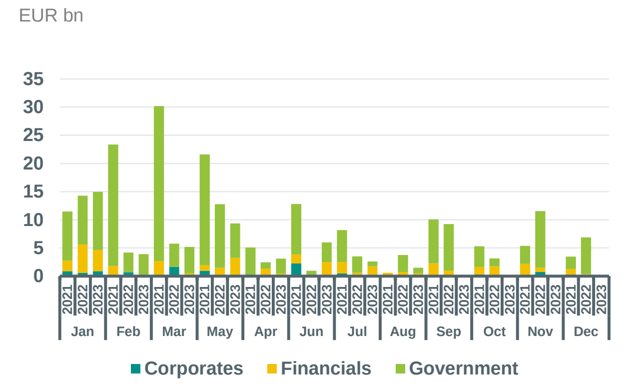
Source: Bloomberg, ABN AMRO Group Economics

Monthly Green Bonds issuance by sector



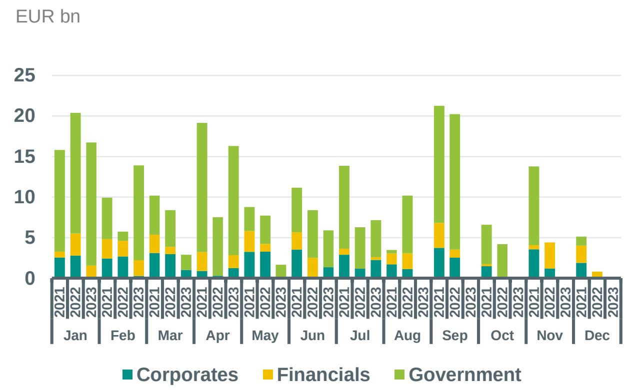
Source: Bloomberg, ABN AMRO Group Economics

Monthly Social Bonds issuance by sector



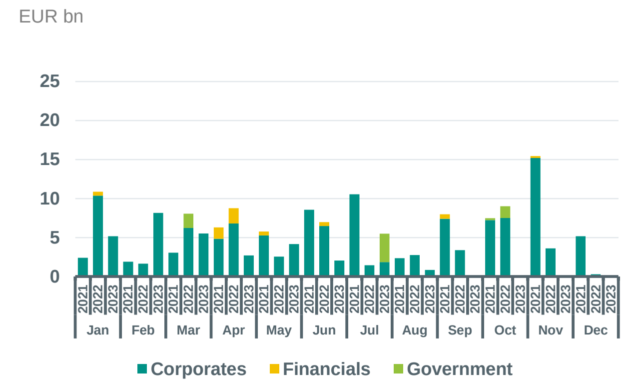
Source: Bloomberg, ABN AMRO Group Economics

Monthly Sustainability Bonds issuance by sector



Source: Bloomberg, ABN AMRO Group Economics

Monthly Sust.-Linked Bonds issuance by sector



Source: Bloomberg, ABN AMRO Group Economics

Figures hereby presented take into account only issuances larger than EUR 250m and in the following currencies: EUR, USD and GBP.

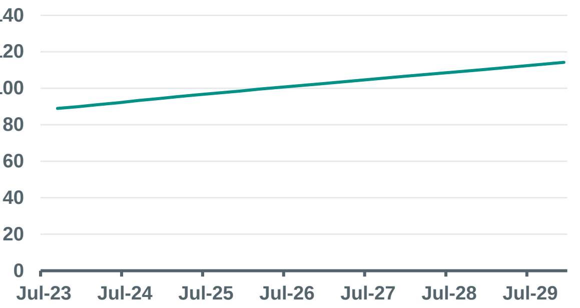
Carbon contract current prices (EU Allowance)

EUR/MT

Source: Bloomberg, ABN AMRO Group Economics

Carbon contract futures curve (EU Allowance)

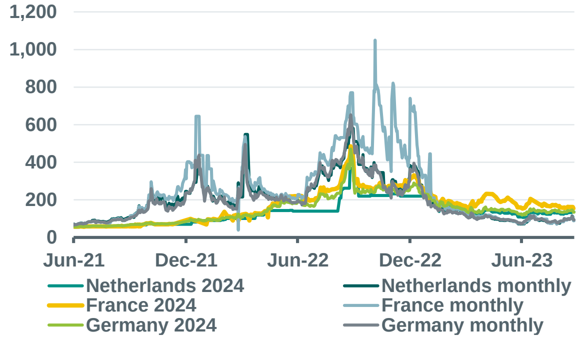
EUR/MT



Source: Bloomberg, ABN AMRO Group Economics

Electricity power prices (monthly & cal+1 contracts)

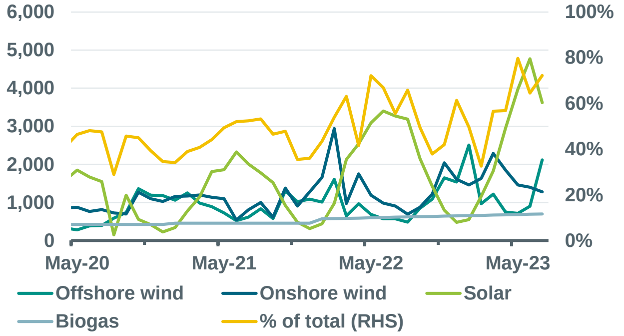
EUR/MWh



Source: Bloomberg, ABN AMRO Group Economics. Note: 2024 contracts refer to cal+1

Electricity generation from renewable sources (NL)

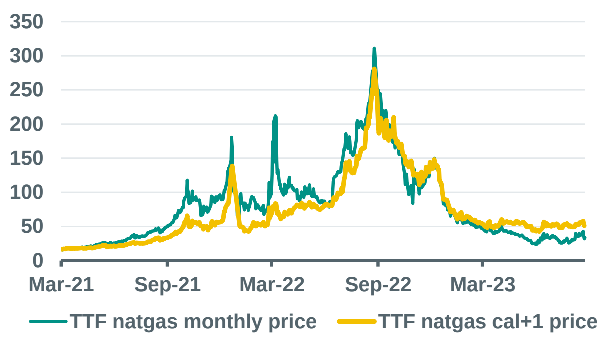
GW % of total



Source: Energieopwek (Klimaat-akkoord), ABN AMRO Group Economics

TTF Natgas prices

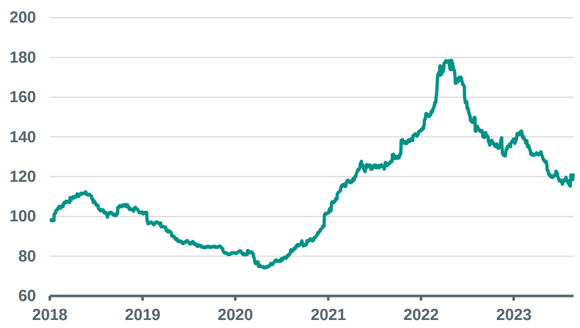
EUR/MWh



Source: Bloomberg, ABN AMRO Group Economics

Transition Commodities Price Index

Index (Jan. 2018=100)



Note: Average price trend of 'transition' commodities, such as: corn, sugar, aluminium, copper, nickel, zinc, cobalt, lead, lithium, manganese, gallium, indium, tellurium, steel, steel scrap, chromium, vanadium, molybdenum, silver and titanium. Source: Refinitiv, ABN AMRO Group Economics

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ABN AMRO Bank
Gustav Mahlerlaan 10 (visiting address)
P.O. Box 283
1000 EA Amsterdam
The Netherlands

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