Petrochemicals: Major credits, carbon risks, green bonds

Bauer, Fredric; Tilsted, Joachim Peter; Nielsen, Tobias; Anastasiya, Ostrovnaya; Erlandsson, Ulf

2021

Document Version:
Publisher's PDF, also known as Version of record

Petrochemicals: Major credits, carbon risks, green bonds

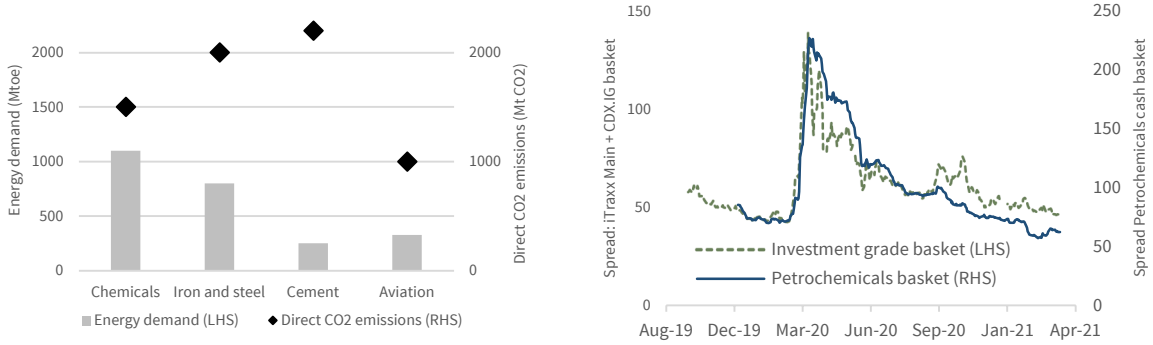
Bauer, F.,[1] Tilsted,[1] J., and Nielsen, T.,[2] and Ostrovnaya, A.[3] and Erlandsson, U.[4]

We review the petrochemical industry from a joint macro, credit specialist and climate mitigation perspective. The sector carries clear relevance for bond investors, with many of the biggest petrochemical producers also being large debt issuers and being actively traded in credit portfolios. **Out of the top 30 global petrochemical producers, 20 are actively traded in hard currency bond markets, and 13 in the liquid CDS indices.**

Despite this and the sector's importance in the global economy, it has enjoyed a fairly low-profile role in terms of climate change discussions. This is somewhat surprising given that it is the industrial sector with the highest energy demand and the third largest direct CO2 emitter**. This article takes a combined approach to understanding the activities in the sector, the associated greenhouse gas emissions, corporate structures and how the sector is funded through the bond markets, with relevant practical information for portfolio managers and asset allocators.**

The first green bonds out of the sector came in 2020. **We analyse a BASF green bond with relatively lacklustre performance and hypothesize that investors do not seem to be overwhelmed by the petrochemical sector's attempts to declare environmental alignment.** It does appear, however, that BASF's recently announced increases ambitions gave support to the green bond valuation.

Figure 1. Petrochemical sector CO2 emissions (left) and recent credit spread dynamics (right).



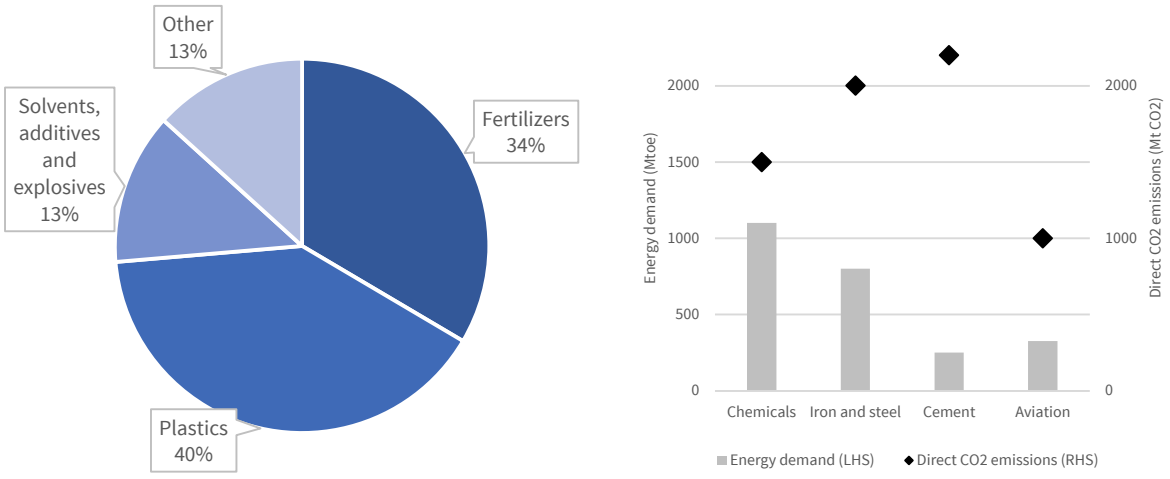
[1] Environmental and Energy Systems Studies, Lund University.
[2] IVL Swedish Environmental Research Institute.
[3] Centre for Climate Finance and Investment, Imperial College London.
[4] Anthropocene Fixed Income Institute. Editor and corresponding author: uge@anthropocenefii.org.

Overview of the sector

The chemical industry and all its sub-sectors, accounting for 8.3% of global manufacturing GDP or 1.4% of global total GDP[5], has been an important industry for economic growth in developed economies since the mid-20th century. Its products are cornerstones of modern economies and lifestyles in many ways. Plastics, rubbers, and synthetic fibres are used extensively for packaging, as textiles, in cars, and in modern buildings. Nitrogen fertilizers enable high yields in modern agriculture, feeding a growing global population. These are the two largest product categories from the industry, but also the rest of its products are omnipresent today – from explosives used in mining, to paints and lacquers in our homes, and pharmaceuticals used in modern healthcare.

The industry is intricately linked to climate change through its dependence on fossil fuels. While the industry emerged during the coal based industrial revolution and remains completely dependent on fossil resources. It is today the single largest industrial energy consumer with a demand for about 14% of primary oil and 8% of primary gas globally – and the single largest domain for growth in petroleum demand until 2030 according to projections by the IEA.[6]

Figure 2. Petrochemical output division in key product markets.[7] Right: The Industrial sectors with the largest energy demand and CO2 emissions in the world are Chemicals, Iron and steel, and Cement. Aviation added as cross-reference. Mtoe refers to million tonnes of oil equivalent.

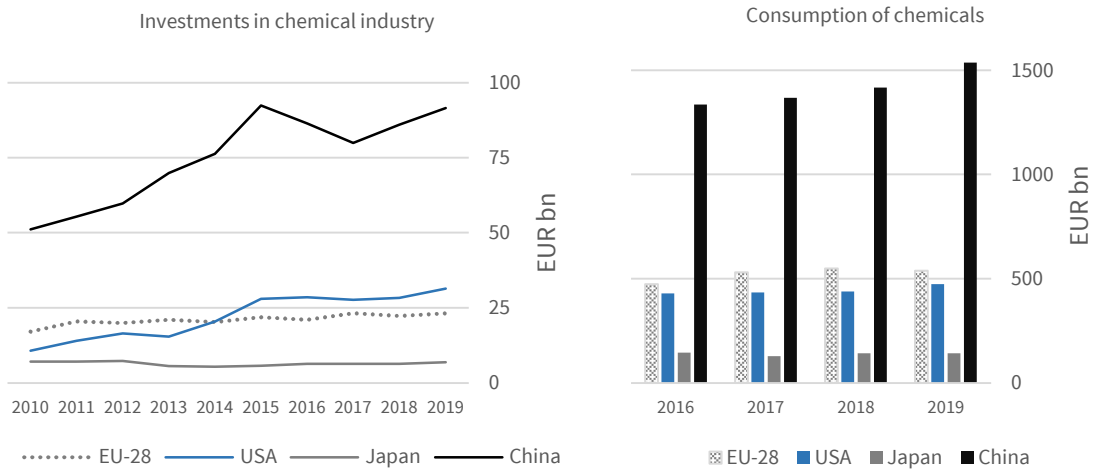


[5] "The Global Chemical Industry: Catalyzing Growth and Addressing Our World's Sustainability Challenges.", Oxford Economics, 2019.

[6] "The Future of Petrochemicals: Towards more sustainable plastics and fertilisers", International Energy Agency (IEA), Oct 2018.

[7] "Mapping Global Flows of Chemicals: From Fossil Fuel Feedstocks to Chemical Products", Levi and Cullen, Environmental Science and Technology, 52(4): 1725-1734, 2018.

Figure 3. Investments in the chemical industry (left) and consumption of chemicals (right) have over the past decade primarily executed in China, as the country's large manufacturing industry has the largest demand for chemicals in the world. The US has also seen a wave of investments driven by the rapidly expanding shale gas production leading to growing exports. Data from VCI, Chemiewirtschaft in Zahlen 2020.



As illustrated in the right-hand panel of Figure 2, this leads the (petro)chemical sector to be the third largest direct industrial GHG emitter, with total emissions north of 1.5 gigatonnes.[8] The sector emits about 50% more direct CO2 than aviation. This does not include emissions occurring when using or discarding products from the chemical industry. For example, when incinerating plastic waste as much CO2 is emitted as the emissions from the rest of the value chain.[9]

The sector was important for driving and supporting economic growth in industrialised economies in the post-war era and has continued to see a high growth in demand for its products. China and the rest of Asia has seen enormous growth of demand and investments in the industry over the past two decades and today, China is the single largest producer, consumer, and importer of chemicals.

Awareness of the negative externalities of petrochemical sector has grown considerably in recent years, yet its climate impact is still largely neglected. For example, it is largely exempt from carbon pricing instruments such as the EU ETS. In line with this, the petrochemical industry has effectively stayed out of the limelight of contemporary sustainability debates.[10] Recent debates around plastics have focused more on the environmental effects of littering rather than its impact on climate change.

---

[8] For reference, total global emissions are around 50 gigatonnes CO2e per annum, of which the industrial sector accounts for about 9 gigatonnes in direct emissions and another 7 gigatonnes in indirect emissions according to the IEA "Energy Technology Perspectives", Sep 2020.

[9] For an overview, see "Plastics and sustainable investments: An information brief for investors", Nielsen and Bauer, 2019, as well as "Industrial Transformation 2050 - Pathways to Net-Zero Emissions from EU Heavy Industry", Material Economics, 2019.

[10] In the public eye, the biggest debate may have come through its pesticide production which was implicated already in one of the first modern environmental scandals, described in Rachel Carson's *Silent spring.* Recent focus around plastic pollution appears to focus more on the clean-up and recycling than the production of the raw material, e.g. see "The world's plastic pollution crisis explained," National Geographic, 7 Jun 2019. A recent example around plastics production controversy, also around further ESG investment parameters: "Huge plastics plant faces calls for environmental justice, stiff economic headwinds", Washington Post, 19 Apr 2021.

Nonetheless, pressure on the petrochemical sector is slowly gathering pace. Plastic is becoming a contentious topic and public policies have emerged around the globe: on single use plastics (e.g. EU, India, Costa Rica) and circular plastic economy measures (e.g. EU and China).[11] Negative consumer attitudes and legislative pressure on plastics are sending shock waves further upstream to the petrochemical sector.

The industry is responding with plans to contribute further to circularity and greening production methods (e.g. electrification). This, however, is happening at a very slow pace and needs to be scaled up massively - indeed the industry needs to undergo a substantial restructuring.

The current norm for the petrochemical sector of self-governance has been criticized for being weak on environmental and climate considerations for a long time. National policies vary across regions and there are only a few categories of products being regulated internationally through conventions such as the Vienna, Rotterdam, and Stockholm conventions.[12] There are also some clear signs of industry groups arguing the opposite case: e.g. the association of plastic manufacturers PlasticsEurope view on EU Climate Neutrality from November 2010 refers to a report estimating 1.5-2 gigatonnes CO2e *savings* ("carbon balance") through the use of plastics[13] which seems like a less constructive way to create real incentives for a transformation of the sector.

While it is true that petrochemical products are important in the transition to renewable energy, e.g. for the production of solar PV cells, this industry must also find and navigate a path towards zero emissions. And unlike other energy intensive natural resource-based sectors like iron and steel, the road to decarbonization remains unexplored. We depend on the petrochemical sector today and we will depend on it in a greener tomorrow. Given the relative lack of climate-based industry regulation and the capital intensity of petrochemical sector – investors have a potential key role to play in facilitating change.

[11] "Politics and the plastic crisis: A review throughout the plastic life cycle", Nielsen et al., WIREs Energy and Environment 9(1):e360, 2020.

[12] The Vienna Convention for the Protection of the Ozone Layer and its Montreal protocol restrict the use of ozone depleting chemicals and are managed by UNEP: https://ozone.unep.org/
The Stockholm Convention on Persistent Organic Pollutants and the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade share a secretariat: http://www.brsmeas.org/.

[13] "The impact of plastics on life-cycle energy consumption and GHG emissions in Europe", Pilz, Brand and Fehringer, June 2010. The report is written under the umbrella of the denkstatt institute, commissioned by PlasticsEurope. A later report "Plastics and Climate in Perspective", denskstatt Vienna, 30 Sep 2020, makes the same case. Among other things, we believe it is entertaining reading for anyone looking to redefine the notion of "peer-reviewed" research and/or self-referencing argumentation.

Key companies

The four type of firms mainly dominating the global petrochemical industry are 1) long-standing (petro-)chemical firms, 2) international oil companies, 3) national oil companies and 4) emerging market firms.[14] These, in turn, are characterised by varying ownership structures. Accordingly, the top companies measured in chemical sales include both private, state-owned, and publicly quoted enterprises. Table 1 provides an overview of the biggest players, their chemical sales and assets as well as direct emissions (Scope 1) and emissions from electricity usage (Scope 2).[15]

Note that companies with broader activities than chemicals have their non-chemical CO2 emissions included in the numbers and that substantial scope 3 emissions from e.g. plastic incineration are not included. In general, drawing sector boundaries is notoriously difficult for the chemical industry with no clear-cut answers. The stated numbers should therefore not be considered precise estimates of relative carbon intensity. Since estimates are subject to a host of assumptions and firm-specific factors, direct comparison of relative carbon intensity requires taking these into account. The CDP score column is an indication of the transparency of the issuer to disclosing data.

Table 1. Overview of top-30 petrochemical companies ranked by chemical sales in 2019. Key names relevant for credit portfolios marked in "Cr" column. Notes: PQ=Publicly quoted, PV=Private, PM=Private majority, SO=State-owned, SM=State majority. Source: Authors' own calculations, Chemical & Engineering News, Bloomberg, CDP.

Rank	Cr	Company	ISO	Ownr	Equity ticker	Chem sales USDbn (% of total sales)	Chem assets, USDbn (% of total assets)	CDP score	GHG / Revenue (USD)	Scope 1 (MT CO2e)	Scope 2 (MT CO2e)
1	=>	BASF SE	DE	PQ	BAS GR	66.4 (100%)	97.3 (100%)	A-	303	17	4
2	=>	Sinopec	CN	PQ	386 HK	61.6 (15%)	25.5 (12%)	F	406	171	45
3	=>	Dow Inc.	US	PQ	DOW US	43.0 (100%)	60.5 (100%)	B	784	28	5
4	=>	SABIC	SA	SO	SABIC AB	34.4 (92%)	78.1 (94%)	B	1524	37	18
5		Ineos Ltd.	UK	PV	Private	32.0 (100%)	n/a	n/a	n/a	n/a	n/a
6		Formosa Plastics	TW	PQ	1301 TT	31.4 (67%)	n/a	A	n/a	3.7	5.0
7	=>	ExxonMobil	US	PQ	XOM US	27.4 (11%)	36.9 (10%)	F	481	n/a	n/a
8	=>	Mitsubishi Chemical	JP	PQ	4188 JP	27.4 (83%)	37.8 (80%)	B	505	8	8
9		LyondellBasell	US	PQ	LYB US	27.1 (78%)	n/a	B-	657	15	9
10	=>	Linde	UK	PQ	LIN GY	25.4 (90%)	n/a	n/a	1442	16	20
11	=>	LG Chem	KR	PQ	051910 KS	24.6 (100%)	29.2 (100%)	B	451	5	4
12	=>	Air Liquide	FR	PQ	AI FP	24.2 (99%)	45.9 (97%)	A-	1135	16	12
13	=>	PetroChina	CN	SO	601857 CG	22.7 (6%)	n/a	D-	478	132	42
14	=>	DuPont	US	PQ	DD US	21.5 (100%)	69.4 (100%)	A-	250	3	2
15	=>	Reliance Industries	IN	PQ	RIL IN	20.6 (22%)	18.6 (11%)	F	375	n/a	n/a
16	=>	Toray Industries	JP	PQ	3402 JT	17.3 (85%)	n/a	B	283	3.3	2.4
17	=>	Sumitomo Chemical	JP	PQ	4005 JT	15.2 (76%)	19. (61%)	A	353	6.2	1.1
18	=>	Evonik Industries	DE	PQ	EVK GY	14.7 (100%)	24.7 (100%)	A-	490	4.9	2.7
19		Shin-Etsu Chemical	JP	PQ	4063 JP	14.2 (100%)	29.6 (100%)	B-	381	1.8	4.5
20		Covestro	DE	PQ	1COV GR	13.9 (100%)	12.9 (100%)	F	428	n/a	n/a
21		Braskem	BR	PQ	BRKM5 BZ	13.3 (100%)	17.3 (100%)	A-	802	9.8	0.9
22		Lotte Chemical	KR	PQ	011170 KS	13.0 (100%)	17.2 (100%)	F	n/a	n/a	n/a
23		Yara	NO	SM	YAR NO	12.9 (100%)	16.7 (100%)	B	1400	17.1	0.9
24	=>	Solvay	BE	PQ	SOLB BB	12.6 (100%)	23.9 (100%)	B	962	10.6	1.5
25	=>	Mitsui Chemicals	JP	PQ	4183 JT	12.3 (100%)	13.6 (100%)	B	412	3.8	1.3
26		Hengli Petrochemical	CN	PM	600346 CH	11.8 (81%)	n/a	F	n/a	n/a	n/a
27	=>	Bayer	DE	PQ	BAYN GY	11.5 (24%)	n/a	A	80	2.0	1.8
28		Indorama	TH	PV	IVL TB	11.4 (100%)	12.3 (100%)	B	624	4.7	2.3
29	=>	Syngenta	CH	SO	n/a	10.6 (78%)	n/a	n/a	n/a	0.6	0.4
30	=>	DSM	NL	PQ	DSM NA	10.1 (100%)	15.0 (100%)	A	126	0.6	0.7

[14] "Petrochemicals 2030: Reinventing the way to win in a changing industry", McKinsey, 2018.

[15] To add to the table, at the time of publication Aramco/SABIC (#4) announced that it might acquire a 20% stake in Reliance (#15), see Financial Times, 28 April 2021.

Looking beyond the top 30 further illustrates the widespread state involvement in the sector. States hold direct majority ownership (with widespread indirect ownership as well) in least seven of the top 50 companies and the general presence of petroleum producing states through the aforementioned national oil companies is strong. [16]

The presence of national and international oil companies in the sector is no coincidence, the historical relationship between energy and chemicals dating back to the formation of the modern chemical industry[17]. The vertical integration, however, runs further downstream with high degrees of inter-sectoral integration. Indeed, petrochemical producers engage in not only fossil fuel extraction and refining but are also heavily invested in plastics and fertilizer manufacturing.

Considering ownership and petrochemical industry shareholders, institutional investors and asset managers figure prominently and have large exposures not only directly to fossil fuels but also indirectly through petrochemicals. Most prominently, Blackrock and Vanguard hold direct or indirect ownership in 18 of the 20 of the top 20 firms while ownership data also show that hundreds of their competitors are taking similar positions.[18]

Table 2. Key relevant (for credit investors) petrochemical issuers. "CDS Index" refers to the relevant CDS index (if any) each issuer belongs to. Credit ratings are inferred from public data and our own rating averaging algorithm. "Benchmark ISIN" refers to a relevant comparison bond around the 5yr maturity point, vanilla structure and benchmark size (>=500Mn USD or equivalent). "Crncy" refers to the currency of that benchmark bond, which may differ from the currency of the CDS spread. Source: AFII, Bloomberg, Chemical and Engineering News.

C&EN rank	Company	Equity ticker	Bond ticker	CDS index	Credit rating	Debt (USDbn)	Benchmark ISIN	Crncy	Benchmark z-spread	Benchmark maturity (yrs)	5y CDS spread or equiv.
1	BASF SE	BAS GR	BASGR	Main	A	28.0	DE000A188WW1	EUR	13	5.6	28
2	Sinopec	386 HK	SINOPE	Asia ex-Japan	A+	40.5	USG82016AR01	USD	78	4.8	43
3	Dow Inc.	DOW US	DOW	CDX. IG	BBB	16.4	US260543CX94	USD	63	5.2	61
4	SABIC	SABIC AB	SABIC		A	64.2	XS1890684761	USD	97	7.6	82
7	ExxonMobil	XOM US	XOM		AA	45.3	US30231GAT94	USD	41	4.9	35
8	Mitsubishi Chemical	4188 JP	MITCHM	Japan	n/a (BBB+)	6.7	JP389770BG61	JPY	20	5.2	20
10	Linde	LIN GY	LIN	Main	A	12.6	XS1143916465	EUR	23	4.7	21
11	*LG Chem*	*051910 KS*	*LGCHM*		*BBB+*	*7.8*	*USY52758AD47*	*USD*	*102*	*8.1*	*63*
12	Air Liquide	AI FP	AIFP	Main	A-	12.6	FR0013241346	EUR	18	6.0	38
13	PetroChina	601857 CG	CNPCCH		A+	59.5	XS2179917906	USD	92	4.3	71
14	DuPont	DD US	DD	CDX.IG	BBB+	18.7	US26078JAC45	USD	65	4.7	26
15	Reliance Industries	RIL IN	RILIN	Asia ex-Japan	BBB	55.4	USY72570AN72	USD	93	6.7	75
16	Toray Industries	3402 JT	TORAY		n/a (BBB)	3.2	JP362100AJ75	JPY	17	4.3	29
17	Sumitomo Chemical	4005 JT	SUMICH	Japan	n/a (BB+)	6.7	JP340140BG91	JPY	25	5.4	27
18	*Evonik Industries*	*EVK GY*	*EVKGR*		*BBB+*	*3.6*	*DE000A289NX4*	*EUR*	*39*	*4.5*	*81*
24	Solvay	SOLB BB	SOLVAY	Europe	BBB	5.5	USU8344PAB59	USD	73	4.7	49
25	Mitsui Chemicals	4183 JT	MITTOA	Japan		1.6	JP388830ALC9	JPY	15	4.7	27
27	Bayer	BAYN GY	BAYNGR	Main	BBB+	48.6	XS2281343686	EUR (15y)	116	14.8	55
29	Syngenta /ChemChina	CHNCCZ CH	HAHOHUA /SYNNVX	Xover ->S34	BBB	48.6	XS1199954691	EUR	184	6.5	182
30	DSM	DSM NA	DSM	Main	A-	4.8	XS1495373505	EUR	23	5.5	25

[16] Source: Orbis, MarketScreener.

[17] "Chemistry's special relationship", Bennett, S.J., *Chemistry World*. Vol. 4(10): 66-69, 2007.

[18] MarketScreener; Orbis. A full description of the investor base across equities and bonds is beyond the scope of this article, please contact the authors for such analysis.

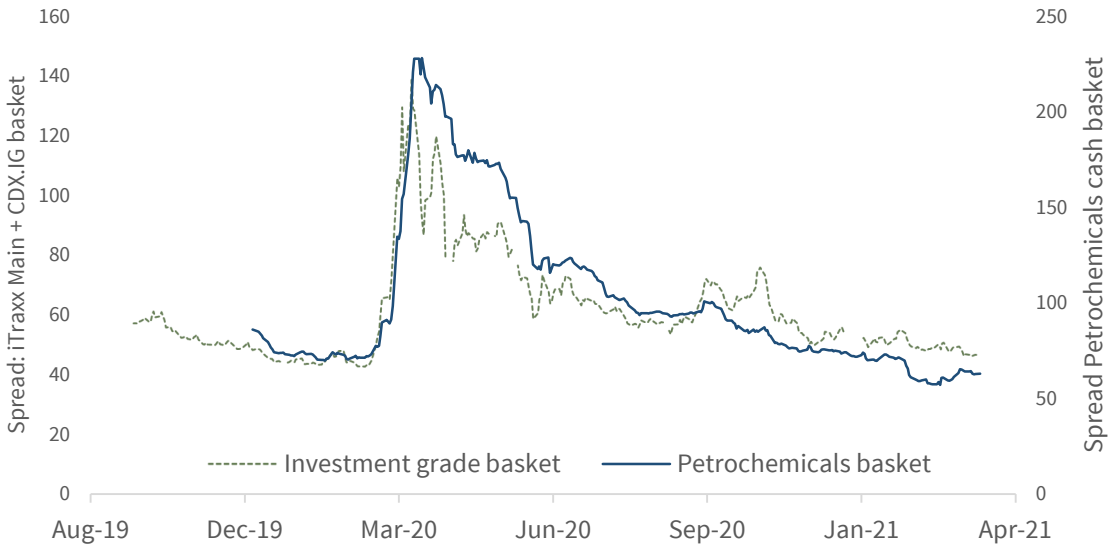
Sector credit dynamics

The key relevant companies in the sector from a credit investor perspective are presented in Table 2.[19] The total debt issued among these companies amount to USD490bn, which should be put in relationship to a total corporate bond market of around USD40trn.[20] However, the size of the non-financials is 21.5trn, effectively making the list reflects around 2% of the total issuance. Out of the 20 issuers in the list, 13 are represented in the current liquid traded CDS indices, highlighting the relevance the sector should have for global credit mandates.

The average 5yr equivalent spread for the sector is currently 52bp (over swaps) with credit ratings mainly in the A-BBB range and no official speculative grade ratings.

We illustrate the historical spread movements for the benchmark cash basket of these names in Figure 4.[21] As can be seen in the graph – and to be expected – the correlation with other credit indices is high and spread-beta adjusted volatilities do also appear to be equivalent. This suggests that credit investors looking to reduce their carbon exposure through rotating out of the sector completely, this is likely to be possible without major portfolio efficiency losses.[22] Having said that, we would refer to a forthcoming AFII longer time-series analysis of these dynamics for a more robust analysis of portfolio dynamics.

Figure 4. Credit spreads of a select petrochemical cash bond basket and a 50/50 mix of CDX.IG S33 and iTraxx Main S32. Source: AFII, Bloomberg.



[20] See ICMA report on bond market size (August 2020), accessed 20 March 2021.
[21] This is a fairly short time-series with rolling down maturities on cash bonds. Please contact the authors for a longer time-series analysis of the sector relationships, including constant-maturity type of calculations and data.
[22] See "Your AMs/PMs want to buy new Saudi Aramco bonds? Have them consider the alternatives", Anthropocene Fixed Income Institute, 17 Nov 2020.

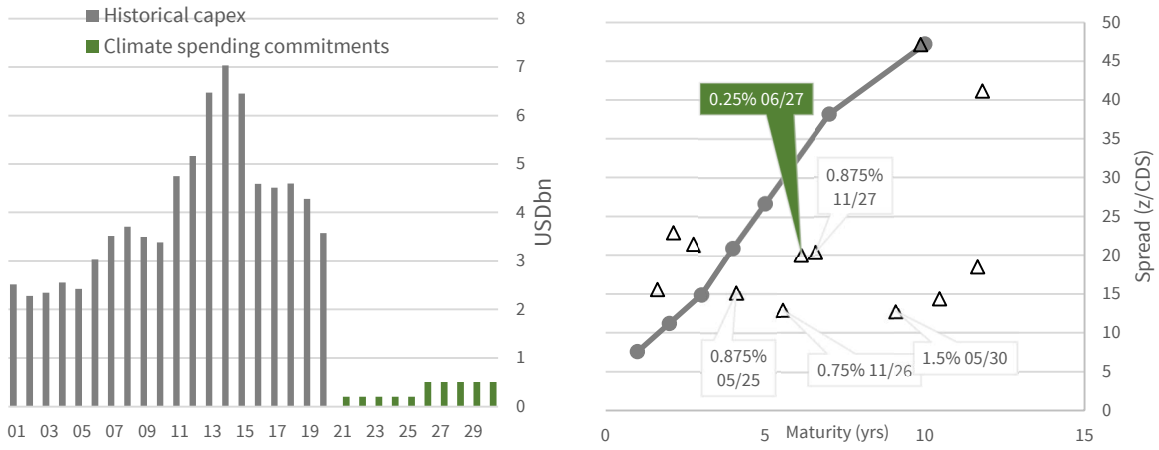
Petrochem green bond issuance: A case study on BASF

BASF is a leading company within the sector and has been spending on average USD4bn per annum in capital expenditure over the past two decades (Figure 5, left). Thus it seems a natural candidate for the sector in terms of testing the grounds in the green bond market.[23]

Green bonds are based on the use of proceeds concept, which means that the funding raised through such a bond is spent on environmentally aligned projects and causes (usually outlined in a Green Finance Framework). This however carries no guarantee that the company as a whole is aligned with any environmental targets. In the specific case of the BASF bond, the company provides a green bond framework[24] with an external second opinion provided by ISS.[25] The opinion expresses an alignment of the BASF green bond framework in line with general market standards, as well as a leading relative position of the company within the sector.[26]

In May 2020, BASF issued its inaugural green bond. The €1.0 billion 7-year bond, BASF €0.25 06/27, priced with a coupon of 0.25%, or 50 basis points (bps) over mid swaps at issue. The yield was 0.29%. While 50bps over the risk-free rate does not seem like an expensive financing, on the basis of credit spread it came more expensive for the issuer than the company's conventional bonds – a so called negative greenium.[27] Comparing the green 0.25 06/27 at ms+50 to the slightly longer €0.875 11/27, the latter traded at around ms+45 on the day of green issuance.[28]

Figure 5. BASF capital expenditure and climate investment commitments (left), and credit curve in EUR (right). Note the flat/almost inverted cash curve. Pricing date 19 April 2021. Source: BASF, Bloomberg, author's own calculations.



[23] Note that LG Chem actually was the first company out of the sector to issue green bonds (a 5 and 10yr USD500mn multi-tranche deal in March 2019). The company also recently issued several ESG bonds (not flagged as green on Bloomberg) in KRW on 5 Feb 2021.
[24] "Green Finance Framework", BASF homepage, accessed March 2021.
[25] "Second party opinion BASF SE", ISS, 19 May 2020.
[26] These are the views of the second opinion provider and necessarily not those of the authors.
[27] For clarity, we refer to greenium as the spread of a standard bond vs a twin-bond equivalent green bond. If the green bond, ceteris paribus, has a lower spread/yield than the standard bond, the greenium is positive. In the referred case, the green bond had a higher spread than the standard bond => a negative greenium.
[28] Having said that, this was still in in the market recovery from the covid/oil shocks of March, 2020. The deal had an initial price talk of MS+90bp and attracted a book of €4.2bn at IPT (>4x oversubscribed). For completeness sake, the company offered and priced a 3yr €1bn non-green bond at the same time, with an IPT of ms+75bp which was cut back to ms+40bp and attracted €3bn of demand. That 3yr (BASF 0.101 07/23) transaction is estimated to have been priced close to fair value.

We illustrate the spread dynamics of the green bond in Figure 6 with some end-date metrics in Table 3. The green bond has outperformed the closest peer (the 11/27 bond) by roughly 5bp so that the green bond now trades slightly inside (0.3bp) it slightly longer peer. This means essentially a flat green bond premium. But when comparing the green bond with its shorter peer 0.75% 11/26, the difference in spreads is 7bp which is exactly what it was at the original pricing of the green. Finally, even though the green 06/27 was priced 15bp inside the longer 2030s issue (BASF 1.5% 05/30), it has quite significantly underperformed that bond. The spread is currently (minus) -9bp, meaning a total underperformance of 24bp. Indeed, the 05/30 is trading flat to the 2026 bond.

The above pattern of the green bond trading cheaper or flat to the traditional bonds becomes even more striking given that the traditional bonds all were priced with significantly higher cash prices (higher coupons) which normally would results in a slightly higher/wider spread compared to the lower price/lower coupon bond.[29] Only remaining factor could be the bigger sizes of the two 27s bonds, €1bn vs €500-€750mn for the other bonds, especially with the two maturities so close on the curve. We argue that the size differential in benchmark space would not normally give arise to such substantial differences.

It should at this point be noted that the relative performance of the green bond has improved over the past two months: it was trading outside also the 11/27s up until the end of March-21. BASF released a new climate framework by the end of March, which is further commented below. What still holds, however, is that the green bond is not expensive to the traditional bonds on the curve.

There is an extensive literature seeking to document the amount of this greenium in the market, and it tends to suggest that green bonds should trade at a premium as they have a broader investor base than traditional bonds, and in line with general high demand for ESG products.[30] So why are investors demanding a higher spread for the BASF 0.25% 06/27 green bond than what the literature – if we assume it is correct - would suggest?

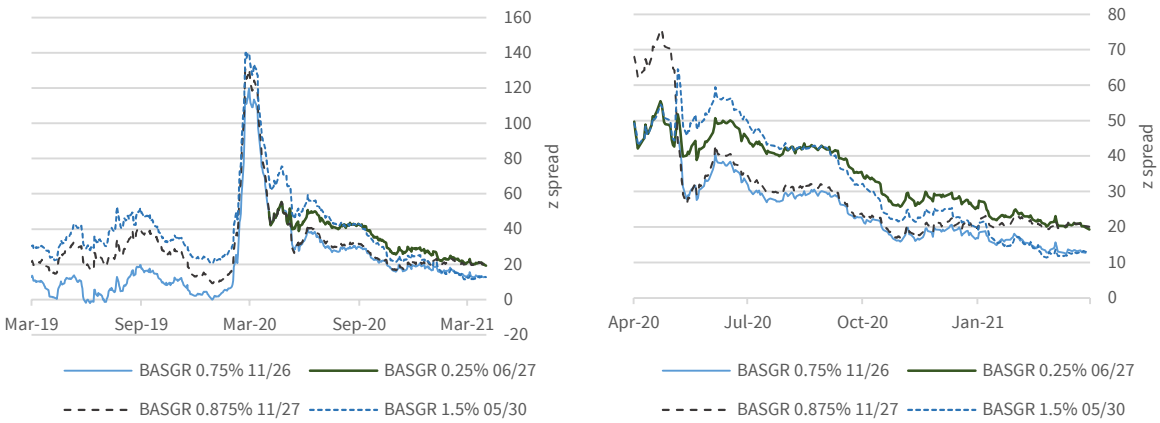
Table 3. BASF bond selection (EUR) around the green 2027 bond. Pricing date 22 Apr 2021. Source: Bloomberg.

Bond name	ISIN	Coupon	Maturity	Outstanding	Issued	z spread	Price	Yield
BASGR 0.875% 05/25	XS1823502650	0.875	05/11/2025	750	05/15/2018	15.1	104.44	-0.21%
BASGR 0.75% 11/26	DE000A188WW1	0.75	11/10/2026	500	11/03/2016	12.9	104.71	-0.13%
BASGR 0.25% 06/27	DE000A289DC9	0.25	06/05/2027	1,000	05/28/2020	20.1	101.56	-0.02%
BASGR 0.875% 11/27	XS1718418103	0.875	11/25/2027	1,000	11/08/2017	20.4	105.39	0.02%
BASGR 1.5% 05/30	XS1823502577	1.5	05/22/2030	500	05/15/2018	12.7	112.02	0.13%

[29] This is a result, among other things, the effect that the investor has more capital at risk when buying a higher cash price bond. In case of default there is a bigger initial investment at stake.

[30] We note that a lot of literature confuses this argument with investors paying a premium for 'virtue signaling'. For a discussion on how stable investor base could drive down volatility and thus result in a quite rational lower spread for green bonds, see "Green Bond Risk Premiums: A Twin-Bond ULFP Approach", Erlandsson, Jul 2020. The study was conducted at a time when there was little data available for the BASF green bond. For a study looking at primary market dynamics, see "Green bond pricing in the primary market 2020H2", Climate Bonds Initiative, 11 Mar 2021.

Figure 6. BASF Bonds z-spread around the 5-10yr points. Left panel shows the longer time-series for the non-green 26, 27 and 30s, and the right-hand panel shows spread performance since issuance of the green 2027 bond.



We believe that one of the most plausible explanation for the BASF green weak performance is that the reputational risk associated with green bond issues from carbon intensive companies is too high and investors simply have required a compensation for that. A number of similar cases have sprung up over the years in the green bond market, where the 2017 green bond issuance by oil company Repsol may be the best known.[31]

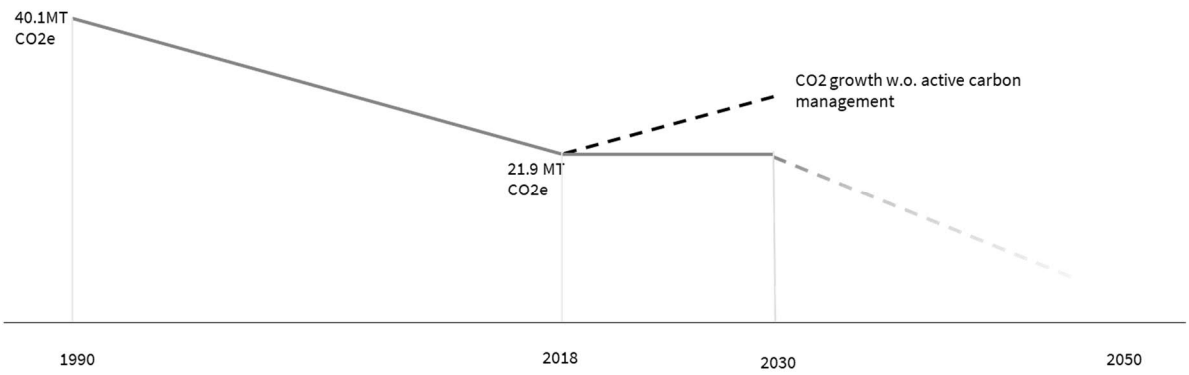
Our conversations with fund managers investing in green bonds indicate a dual approach to evaluating a green bond. First, the use of proceeds needs to be aligned with the investors' preferences and properly verifiable as such. Second, the intentionality of the issuer needs to be in alignment with the managers' own climate preferences. To put it simply: the issuer needs to convince the investor that they are climate aligned (or transitioning properly).

Figure 7. SBI green bond relative performance.

The intentionality is important as the reputational risk on the issuer rather than the bond specifically can be rather material for investors. One recent example was the protests by large asset managers around the green bond of State Bank of India (SBI).[32] SBI had issued a green bond in 2018 and was reported in late 2020 to be considering giving a USD670mn loan to Adani Enterprises, for financing of the Carmichael coal mine build in Australia. While the green bond was not in breach the commitments in the green bond marketing, the bank's funding of coal project alongside did not satisfy the investors that the issuer was dedicated to green commitments that the green bond should signal. The protests eventually led to SBI reportedly halting the loan. Still, it appears that there was a spread compression between the green and comparable bond (green underperformance), as illustrated by the arrows in Figure 7.

[31] E.g. see "Investors divided by green bond from Spanish oil company Repsol", Responsible Investor, 2017.
[32] See "How green bonds are (not) supposed to work", Anthropocene Fixed Income Institute, 25 Nov 2020. The key green bond investor in State Bank of India sold off their positions in late 2020: "Amundi is latest investor to ditch SBI green bonds", Environmental Finance, 5 Jan 2021.

Figure 8. BASF Group's 2018 projected CO2 emissions and carbon reduction strategy and trajectory. Source: BASF.



Coming back to the BASF green bond specifically, it may carry a risk premium for such intentionality risk. Chemical sector emissions need to reach their maximum in the next few years and decline to about 10% below 2018 level by 2030[33] to stay on track with the IEA's Sustainable Development Scenario (SDS).[34] As a European company BASF is facing further pressure to deliver on decarbonisation on the back of the EU Green Deal and Europe's ambition to become climate-neutral by 2050. This will require a deep transformation of the industry within one or two investment cycles.

In this context, we believe that investors may have opined that BASF's climate ambitions published in 2018 did not go far enough.[35, 36] We illustrate the magnitude of those ambitions in Figure 8. The company's goal was to achieve "CO2-neutral growth until 2030", which means the target is to maintain emissions at the 2018 level, at around 22MT CO2e. No target was then set beyond 2030. Indeed, one can argue that Figure 8 reflects an intention on behalf of BASF to effectively stop the process of decarbonization that it has been following over the past 30 years.

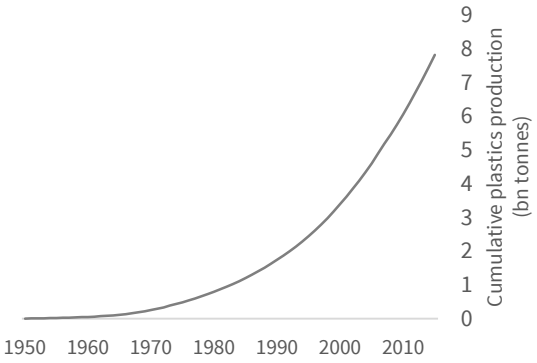
Such low climate ambitions are unlikely to have flown well with green bond investors, we believe. Analogously to BASF, the other green bond issuer in the sector, LG Chem, approaches the issue of greenhouse gas emissions by keeping the actual amount constant and projecting a growth of its business.[37] The data on LG Chem's green bonds is too sparse to make a robust inference from. Another example, Sumitomo Chemical, is not a green bond issuer but provides an example of baselining exercises that are quite commonplace in the climate space. In its 2020 plans, the issuer puts forward a 30% GHG emissions reduction by 2030 but has notably already achieved 24% of

[33] "Chemichals. More efforts needed.", IEA, 2020.
[34] The SDS is fully aligned with the Paris Agreement and holds the temperature rise to below 1.8 °C with a 66% probability without reliance on global net-negative CO2 emissions; this is equivalent to limiting the temperature rise to 1.65 °C with a 50% probability. Source: IEA.
[35] The BASF 2018 "Energy and Climate Protection" report sets the "CO2 neutral growth until 2030" target. The report also highlights the company's own estimated avoided emissions from the company's products, 640MT CO2e, or equivalent to 1.7% of the total global carbon emissions that year, which should be put in relationship to the company's own emissions of 21.9MT. One could extrapolate this into saying that for every tonne the company emits to produce products, it actually saves 30 tonnes. We would advise against making that argument though.
[36] BASF published a revised framework in March 2021. As noted in the text, the green bond was underperforming even the 11/27 peer bond up until March but has then improved somewhat. Even in the updated framework, we opine – although the market to some extent seems to disagree - that some of the targets are underwhelming, for example the carbon reduction capex spending laid out in Figure 5.
[37] E.g. see "South Korean Chemical Giant LG Chem Sells Record ESG Bond", Bloomberg, 15 Feb 2021.

that in 2020, giving the company a fairly modest 6% reduction target over the next decade.[38] Having said that, the 57% reduction target for 2050 is more in line strong ambitions on climate but from a credit standpoint might only be relevant for investors in the SUMICH 1.3 and 0.84 perpetual bonds (in yen). Everything else matures before the execution of those commitments can be fully controlled.[39]

Adding to this general potential investor skepticism around the sector's greenness, one should also not forget the other parts of Environmental factors, where plastic pollution would likely increase from the sector's "planned production growth" even if direct CO2 emissions from the production process are reduced on a relative basis. If plastics production and consumption continue along the historical exponential growth paths (see Figure 9), the pollution factor may come even more into focus of investors' minds.

Figure 9. Cumulative global plastics production. Source: Our world in data.



For avoidance of doubt, the above analysis indicates some tentative signs that the credibility of a green bond has effects on its actual spread relative to the standard curve, and how that may change as the credibility changes. Consider the evidence anecdotally: the above examples should inspire a further, more thorough quantitative investigation.

Endnote

The chemical industry relies on international credit markets to fund their large investments. The industry has one of the largest climate imp-acts of all industries and it continues to grow. With its capital intensive, longer-tem investment planning, we believe the industry can be a good bellwether on whether recent climate commitments and transition plans are credible or not. Credible efforts of the industry to align with Paris targets should allow it to access the green bond market – it provides critical products for the climate transition. However, investors should scrutinize promises made by key firms carefully, as – not surprisingly - the devil will be in the details, and the industry still exhibits clear signs of having a fossil-positive culture.

[38] "Environmental Activity Goals and Results", Sumitomo Chemical, 2020.

[39] Note that the bonds have (much) shorter call dates, making it likely that they will actually be outstanding in 2050. ISINs: JP340140AKC2 has a call in 2029 and JP340140BKC0 in 2024 respectively.

IMPORTANT DISCLAIMER:

This report is for information and educational purposes only. The Anthropocene Fixed Income Institute ('AFII') does not provide tax, legal, investment or accounting advice. This report is not intended to provide, and should not be relied on for, tax, legal, investment or accounting advice. Nothing in this report is intended as investment advice, as an offer or solicitation of an offer to buy or sell, or as a recommendation, endorsement, or sponsorship of any security, company, or fund. AFII is not responsible for any investment decision made by you. You are responsible for your own investment research and investment decisions. This report is not meant as a general guide to investing, nor as a source of any specific investment recommendation. Unless attributed to others, any opinions expressed are our current opinions only. Certain information presented may have been provided by third parties. AFII believes that such third-party information is reliable, and has checked public records to verify it wherever possible, but does not guarantee its accuracy, timeliness or completeness; and it is subject to change without notice. Information attributed to others are for informational purposes only and does not constitute endorsements.

The Anthropocene Fixed Income Institute is a non-profit organization "to monitor, advocate for and influence the impact of the fixed income and bond markets in the age of human induced climate change." For more information about the Institute, please visit wwww.anthropocenefii.org or follow us at @FixedInstitute (Twitter). Sign up to our e-mail distribution at info@anthropocenefii.org