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Banks, bonds and petrochemicals

Greening the path from the Copenhagen Agreement, through Covid and Beyond

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Abstract

The petrochemical sector is a high-emitting industry that is a crucial middle-ground between multiple sectors and is often touted as the producers of the ‘building blocks of life’ because of its omnipresence in everyday life. Despite this, however, petrochemicals slip under the radar in discussions on alleviating the impacts of climate change and the necessity for rapid decarbonisation, where focal points often centre on energy production, transport, and food. This paper maps the finance flows in the petrochemical industry since 2009 with the aim of identifying potential leverage points in the world of public and private finance that could help hasten the rate of decarbonisation for a sector that is hard-to-abate, given its dependency on the fossil fuel industry and the necessity for high-levels of heat and energy in its production processes. The findings aim to help contribute to debate given the growing number of governments and industries that have pledged to low-carbon or even zero-carbon strategies.

Chemical and plastics production, although inextricably connected with the extractivist fossil fuel industry at our current standpoint, do not have to be solely derived from fossil fuel feedstocks. Bioplastics and bio-based chemical innovations are hitting the market, but they continue to account for a negligible fraction of the overall output of the industry. This paper assesses the state-of-play in the financing of these niche-level innovations and identifies potential manners in which the re-direction of existing capital flows connected to the industry could harness the momentum of a green transition and realise an equitable pathway for decarbonisation.

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Introduction

This paper reports recent trends in finance to the fossil fuel, petrochemical and plastics economy, with a particular focus on public and so-called “green” sources of finance. It tracks the gradual decline in financial flows over the last decades against a surprising counter-trend increase in financing in the last Covid period, which is at odds with the commitments from governments, industry and civil society to reduce CO₂ emissions and plastics pollution to meet the climate-sensitive needs of the 21st century. Public finance in particular has been on a squarely downward trend and the latest rise is due to private financial flows, but none the less the continued State support for this sector is significant. Not all government support is necessarily a clash if it is helping the industry transform to more sustainable processes and products or if it is guiding a just transition, and there needs to be room for this in the debate; however, support to the status quo will not help this aim. Equally complex is the world of green finance, which appeared to offer enormous potential and is already measured in the trillions of dollars; however, it is also associated with claims of greenwashing amid other issues (Fancy, 2021; *TDR 2021*:Ch V). Much needs to be done to improve transparency and better align these new financial instruments with the growing concern about the environment on the part of the investment community and civil society.

More positively, the challenge is not insurmountable. Firstly, sustainability goals are not limited to governance and public institutions, as private sectors and civil society are joining the push for decarbonisation with net-zero pledges and emissions reductions from energy and industry to the world of finance (Ciplet & Roberts, 2017; Ampersand Partners & NZE, 2020). There is also strong investment interest in the search for new and less problematic alternatives to fossil fuel, petrochemicals and conventional forms of plastics. Secondly, some governments are already, even if in a small way, starting to promote alternative pathways and much more could be done if they resumed their catalytic and developmental roles of the past (*TDR 2016*; Mazzucato 2011). Third, a lot can be achieved by governments simply reappraising their financial support of the sector, even without taking the next step to turn it around, and if the new and emerging “green bond” universe joined in too. This third more modest element is where this paper is focused.

Why it matters: Petrochemicals, pollution, and climate change

While most attention in the climate debate typically goes to the fossil fuels sector, in fact petrochemicals and plastics have long been considered extremely problematic for their impact on pollution and now their contribution to global warming. CO₂ emissions are set to rise by 50% if the world continues to use plastic at current trends (CIEL 2019, WWF, 2019). Plastic also absorbs a surprisingly large proportion of the total carbon budget – it is forecast to account for 20% of total oil consumption and 15% of the annual carbon budget by 2050 (Barra et al., 2018; WEF, 2017; CIEL, 2017). Plastic-related emissions are estimated to reach 1.34 gigatons per year, equivalent to emissions released by more than 295 new 500-megawatt coal-fired power plants. By 2050, estimates are that plastic’s emissions could account for over 56 gigatons (CIEL, 2019). While plastic raises attention because it is the single largest component of petrochemicals financing, the global production of chemicals is also predicted to double in the next decade, with subsequent concerns for human and environmental health. There are therefore very high opportunity costs associated with the current practices.

One challenge is that the petrochemicals and plastics sector is huge, deeply rooted, employing large numbers of people and powerful. It will not be easy for governments to transform their economies away from the excessive reliance that has arisen over decades, and to do it in a way that is just and sustainable. This

must however be done if countries are to meet their commitments and pledges to the Paris Agreement and the Agenda 2030 (Atteridge & Strambo, 2020; Jenkins et al, 2020) Sustainable Development Goals (SDGs).

Another challenge is that petrochemicals are so ubiquitous in daily existence. Sometimes described as the “building blocks of life”, given their use in an incredibly diverse range of products from fertilisers and pharmaceuticals to plastic carpets, pipes, fishing lines and synthetic clothes. Their production and use have created jobs and income generating opportunities through economic diversification and trade that raised living standards across the globe through the latter half of the 20th century. Plastics are at the heart of much light manufacturing; exports of food products; and the synthetic clothing business, for example. However, given petrochemicals’ dependency on fossil fuels as a primary feedstock, their use is under greater scrutiny as the world looks to decouple economic growth from the nagging increase in GHG emissions.

Despite growing recognition of the problem, things are going in the wrong direction. A significant increase in petrochemical production is expected over the next decade (IEA, 2018).¹ Via efficiency improvements in energy production, decarbonising areas of transport and energy, and a projected increase in demand for petrochemical-derived products given an increase in global population and living standards (S&P Global Platts, 2021), the percentage of petrochemical driven oil demand is projected to rise to more than a third by 2030, and nearly half by 2050 (ibid). If the absolute global emissions are falling, one may argue that the proportional increase in petrochemical demand is not a problem in itself. However, if petrochemicals continue to be dependent on fossil fuel derived feedstocks – this will contribute to a carbon lock-in scenario (Janipour et al., 2020). There are ongoing improvements in recycling and successes in phasing out of products like single-use plastics, but these incremental reductions will be far outstripped by sharp increases in demand and consumption for petrochemical products in emerging economies, where demand is still at a low level compared to the advanced economies but is expected to rise. The petrochemical industry is renowned for being a hard-to-abate sector (Åhman, 2020), similar to the production of steel and cement, given its carbon-intensive lifecycle. If it is unable to decarbonise in a timely manner, it will continue to guarantee future emissions, hindering any meaningful attempt to achieve net-zero commitments by 2050.

1.5Gt of CO₂ stems from the chemical industry on an annual basis, accounting for 18% of all industry related emissions (IEA, 2018). These emissions are primarily related to the production of energy when fuel is combusted for the generation of heat, this accounts for 85% of the emissions (1.3Gt) (ibid). There are already significant advances being made in the research and development of electrifying heat generation and other means of zero-emissions heat (Thiel & Stark, 2021), which will have a large impact on reducing the overall emissions of the industry, providing that integrated electricity grids are also decarbonised along a similar timeline. Dow, Shell, Sabic, and BASF, for example, are developing ethylene crackers that run on renewable electricity. Heavy quantities of emissions are sadly not the only negative externality linked with petrochemicals; there are also multiple causes of concern linked to pollution, environmental racism, and climate justice issues.

Steps Towards Transition? – Corporate and Public Pledges

As with other sectors across the world economy, actors in the petrochemical and plastics sector have made pledges to shift to lower-carbon processes and product. This is of course one of the hardest to abate sectors and it is not at all clear what such a transition would mean in practical terms – whether it means fundamental changes in terms of core activities or on the periphery, for example. Nonetheless, at present at least 19 of the world’s top 50 petrochemical actors by sales have already made public pledges to reach net-zero carbon emissions. These 19 firms’ tally up to \$728.84bn in total capitalisation value (author’s calculations on

¹ International Energy Agency.

MarketScreener data, 2021). They include the firms shown in Section 4 below². Some of these firms still have a significant state involvement (such as China's Sinopec, or Saudi Arabia's SABIC, or the government of Austria's joint venture with the UAE in Borealis) (see Section 2) while in others direct state involvement is now either rather small, or through private sector investment funds or financial institutions including pension funds.

Some of these companies are attempting to partially reach their climate goals through the construction or procurement of renewable energy infrastructure to lessen the emissions intensity of their overall operations, BASF and Braskem for example. There are also examples of companies issuing green bonds to raise capital for innovations in low-carbon chemical production, renewable energy, and areas of conservation that can be used for offsetting purposes, Asahi Kasei, BASF, and SK Innovation have all issued green bonds (Bloomberg, 2021) in their bid to decarbonise across the value chain.

Since making their bold climate pledges, some companies have made investments in new oil and gas facilities (such as Sinopec or Reliance Industries) which may be adding directly to the level of absolute emissions or, if new and more efficient processes are envisaged, there could be significant improvements in emissions intensity when compared to old facilities. However, at least ten of these companies maintain stakes in projects that are either already existing or under-development such as fossil fuel power stations, exploitation of oil and gas fields, and distribution pipelines (Authors' research based on IJ Global data, 2021).

The remaining 31 firms in the top 50 either had no official pledge beyond 2030, or their sustainability commitment was for a lesser quantity than 50% reduction in carbon emissions.³

There have also been bold climate pledges made in the public sphere, including some of the world's main public and development banks. For some of these banks, financing the investments needed for climate change has been central to their mandate since inception, such as the new Southern-led banks that emerged in the last decade, the Asian Infrastructure Investment Bank (AIIB) and former BRICs bank; the New Development Bank (NDB). Other banks with a longer history that began before climate awareness have evolved to include climate adaptation and sustainability in their mandates to varying degrees – such as the European Central Bank, which recently announced it would include climate change considerations in its strategies, or the Asian Development Bank, which pledged that 75% of its projects will address climate change mitigation and adaptation by 2030. The World Bank pledged not to finance any new fossil fuel facilities.

On the other hand, some of the world's largest and most high profile banks have not adopted any quantitative climate goals or commitments that they could be held accountable to, including the US Federal Reserve (the Chair stated that the Fed did not seek to set climate policy for the USA); the Bank of England (which has for many years raised climate awareness but without setting quantitative targets for bank practices); and Korea's KEXIM bank (which issued green bonds but holds no official stance on climate). The continued support for the petrochemical industry from these Public Finance Institutions (PFIs) is mapped and assessed in Section 2 of this paper, and broader issues discussed in Section 4.

² BASF, Sinopec, Dow Inc, LG Chem, Reliance Industries, Evonik Industries, Braskem, Lotte Chemical, Bayer, DSM, Asahi Kasei, Eastman Chemical, Borealis, Ecolab, Johnson Matthey, Umicore, SK Innovation, Lanxess, DIC.

³ These included SABIC, INEOS, Formosa, Exxon Mobil, Mitsubishi Chemicals, Linde, PetroChina, DuPont, Toray Industries, Sumitomo Chemical, Shin-Etsu Chemical, Covestro, YARA, Solvay, Mitsui Chemicals, Hengli Petrochemical, Indorama, Syngenta, Wanhua Industrial, Arkema, Chevron Phillips, Air Products, Mosaic, Hanwha Chemicals, Westlake Chemical, Sasol, Nutrien, PTT Global Chemical, and Tosoh.

Structure of the paper

Section 1 describes recent trends in the geographical dispersal of petrochemical finance, and its purposes, showing the predominance of plastics production and fertiliser feedstocks. The scale of the petrochemical industry will become even more significant as the world starts transitioning away from fossil fuels for energy production and transport. *Section 2* digs deeper into the recent finance flows to the petrochemical industry, tracing the declining path from the Copenhagen Agreement, through the Paris Accord and then the shock to the global economy caused by Covid-19. It teases out the different contributions of public and private financial flows, including the role of equity holdings and loans by development banks and public institutions. It shows that private finance is now taking the lion's share when it comes to financial flows such as bonds and loans; although public funds are still significant and potentially with symbolic value that belies the monetary value. Finally, it shows the state is still significantly involved in equity holdings, specifically in countries with generous fossil fuel reserves.

Because the sector will still need massive investment in order to transition and transform itself, *Section 3* pivots to the rapidly growing “green bonds” market. This promises a kind of middle ground between traditional publicly oriented financing from governments or development banks, and the short-term profit-maximising imperative of the private sector. Can this new and rapidly growing category of finance meet the industry's transition needs, for example through low-cost loans, venture capital or equity positions that give the industry breathing space and the tools with which to change its path? Our findings are not very encouraging.

Section 4 concludes the paper by calling for governments and public financial institutions to take more seriously the contribution of this sector to global warming, carbon emissions and pollution. By continuing to fund and buttress the status quo, it delivers the message that change is not needed. On the other hand, public financial institutions such as central banks and development banks can help to finance the transition and transformation of this sector – hence it is not necessarily a question of stopping all financial flows to this both useful and problematic sector, but rather in helping guide it.

Methodological approach - significant moments in the path from Copenhagen to Covid-19

The paper uses three broad time frames based around major international agreements on global climate governance as the lens through which to examine the trends in financing and production. The starting point is the Copenhagen Accord of December 2009, which was an important landmark for environmental regulation. It marked the closing of the UNFCCC climate negotiations, widely regarded as a failure to achieve meaningful progress on climate governance. The second frame comes six years later, with the Paris Agreement signing in December 2015. By comparison commended as a breakthrough moment for climate ambition and breaking down of political boundaries on the issue of common but differentiated responsibility (Pauw et al., 2019). The third phase begins in February 2020, an approximate timing of the start of global social, economic and financial measures undertaken to curb the economic impact of Covid-19, and the “build back better” debate linking Covid recovery with a greener future.

These governance landmarks act as timeframe bookmarks in which we have detailed the trends of finance flows being funnelled into the petrochemical industry via the financing or refinancing of major infrastructural projects. The transactions mapped as part of our analysis were provided through collaborative research with Lund University and the data was sourced from IJ Global, the largest database of project finance data in the global infrastructure market. We tracked the transactions connected to IJ Global's categorisation of the

petrochemical industry where primary financing, refinancing, or additional facility had been confirmed in relation to greenfield or brownfield infrastructural projects. Although this dataset is not indicative of the entirety of the finance flows into the industry during these timeframes, as it is only connected to specific infrastructural projects that have mostly tendered debt to achieve their realisation, it highlights the importance of external financing necessary to get petrochemical plants and complexes off the ground. For the period Copenhagen to Paris (15.12.2009 to 12.15.2015) we tracked more than 140 separate financial transactions with a total value of \$129 billion, covering 100 individual projects. For the period from Paris to Covid (12.12.2015 to 01.02.2021) we tracked more than 750 separate financial transactions, over 100 individual projects and companies. For the period Covid to present (01.02.20-15.06.2021) we tracked transactions with a total value of over \$84 billion related to 48 projects or companies). The methodology for Figure 6 on 'Active Flows' in the petrochemical industry expanded upon the IJ Global data and incorporated additional data on the commercial bond market gathered from Bloomberg, covering over 3000 bond issuances linked to the petrochemical industry. Further specific data was gathered from the websites of assorted PFIs such as Central Banks, MDBs, ECAs, and EXIMs. The amalgamation of these data allowed us to map a rough estimation of finance flows that were active at the time of analysis, mid-June 2021. The exact valuations of these flows are dynamic due to variances in reporting transparency and changeable currency exchange rates.

Our analysis of equity holdings in C&EN's list of 50 largest petrochemical companies by sales in 2020 is derived from data supplied by Orbis and MarketScreener, as well as individual company annual reports when necessary. The figures are accurate as of 19th November 2021.

Section 1: Geographical and product trends

Where does the money go in the petrochemicals sector, and for what purpose? This section uses three Sankey (inspired by Drewniok, Cullen, Cabrera Serrenho, 2020) diagrams to tease out the flows in terms of geographical trend and product space.

Copenhagen to Paris

More than 140 separate financial transactions (debt instruments relating to primary financing, additional financing and re-financing) with a total value of \$129 billion USD were instigated during the six years from signing the Copenhagen Accord and up until the Paris Agreement. These covered at least 100 individual projects and facilities (IJ Global) and were primarily destined for making plastics (accounting for the largest degree of financing flows, at 72.28%); with fertiliser related production coming in second with 14.10% of the flows. Both of these uses are problematic for the green transition. The remaining ~14% is evenly distributed across a range of petrochemical outputs used for mostly industrial purposes.

Figure 1.

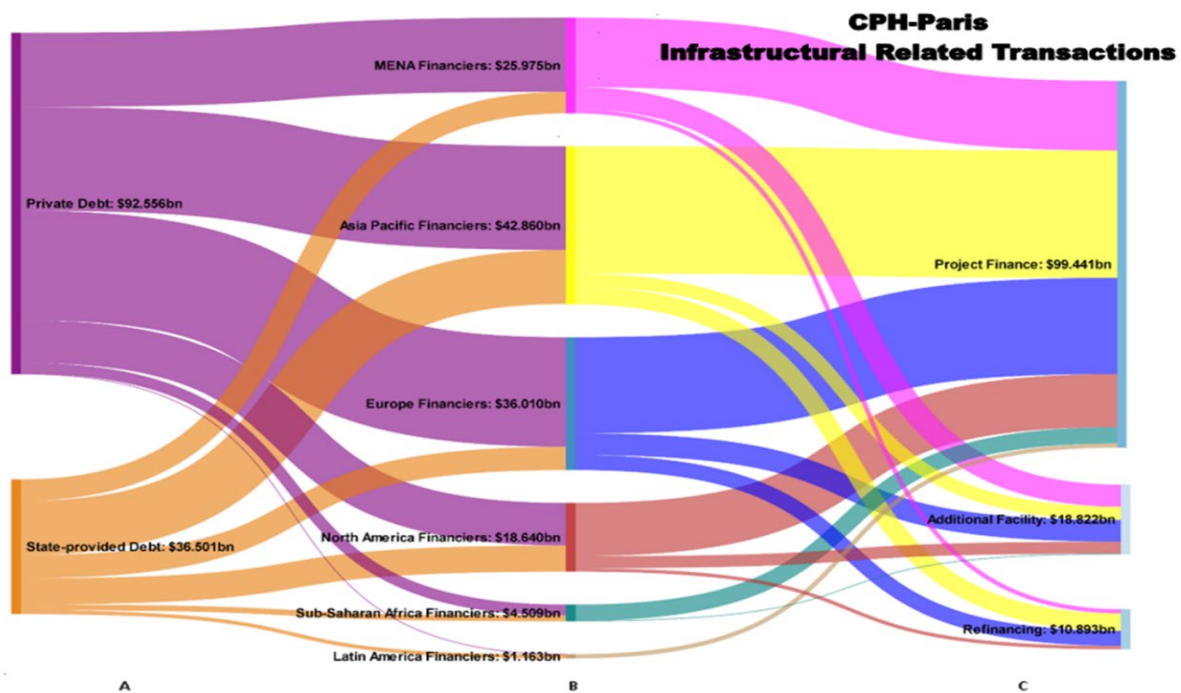


Figure 1 – CPH-Paris Infrastructural Related Transactions. Sankey diagram detailing the flows of state and private debt into financing the infrastructural related operations of the petrochemical since the Copenhagen Accord to the signing of the Paris Agreement. 15/12/09-12/12/15. Finance flows from left to right with values equating to the convergence of flows into each solid node. Column A displays the division between the start-points of financing, from either state or private interests. Column B shows the geographical distribution of financing based on the company/institutions' HQs. Column C depicts the purposes for which the financing is used, all related to either new or existing infrastructural projects. All terms can be found in the figure glossary.

Note: Data derived from IJ Global.

In geographical terms, the Middle East and North Africa and Asia Pacific regions dominate, much of the new and existing production during the era, reflecting growing consumer demand in these areas from a low baseline (IVL / LU, 2022 (forthcoming); IJ Global, 2021). New project finance dominates the flows of financing before the Paris Agreement, with a myriad of PFIs providing almost 30% of the overall funding. This flow from the state paved the way for mass investment from the private sector with state-backed support already assured, both within individual projects and across the industry as a whole. This is exemplified by direct state-involvement via assorted PFIs in over 20% of the 140+ transactions assessed within this timeframe. The Asia Pacific region is the largest source of financing in the CPH-Paris timeframe, coinciding with the comparable strength of the Asian markets in the post-GFC⁴ era (Burgess & Connell, 2013) and the significant role of their state-backed development banks and commercial banks lending both within their borders and across developing nations (Basu Das, 2015; Anthony & Ruppert, 2020; Chen et al, 2021). The principal drivers of new petrochemical projects are connected to the plastics industry with over \$135 billion going into the production of plastics or the principal feedstocks required for their production, and this plastics trend to continue in the coming years (Vanaerschot & Plaisier, 2021).

⁴ Global Financial Crash

Figure 2.

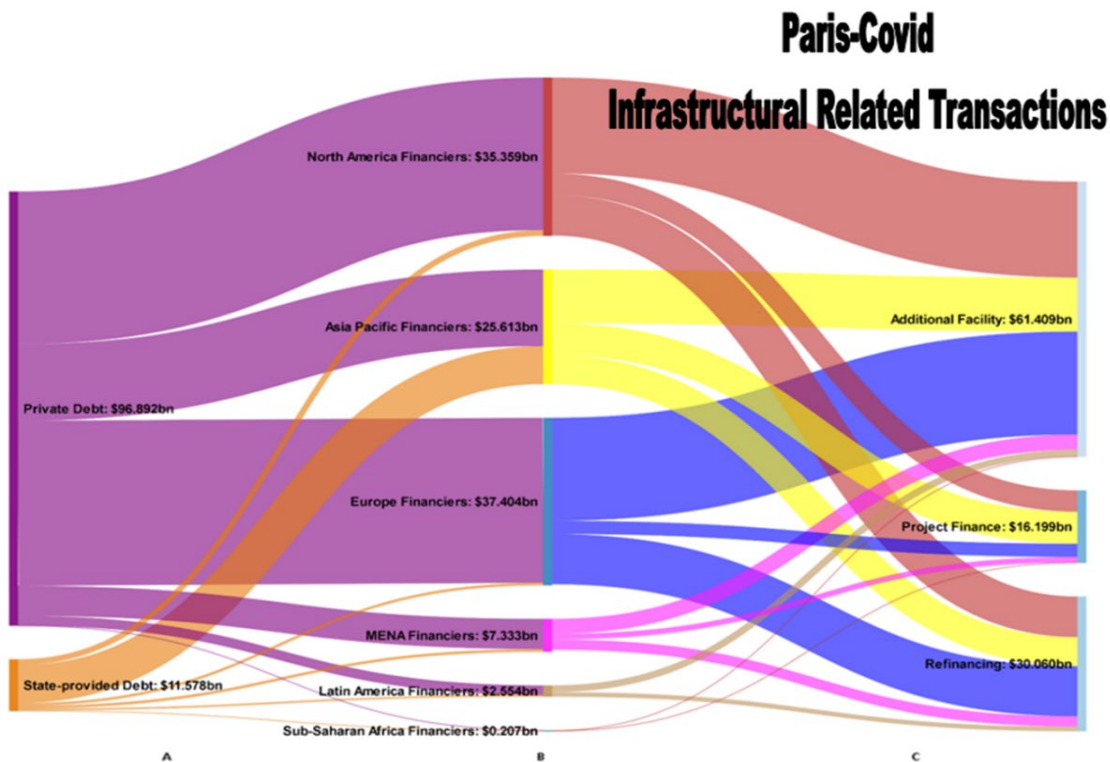


Figure 2 – Paris-Covid Infrastructural Related Transactions. Sankey diagram detailing the flows of state and private debt into financing the infrastructural related operations of the petrochemical since the Paris Agreement and the beginning of the Covid global impact. 12/12/15-01/02/21. Same structure as Figure 1. All terms can be found in the figure glossary.

Note: Data derived from IJ Global.

From Paris to Covid

Following the Paris accord, changes are apparent, both in the total amount of financing, and where it is headed. More than 160 separate financial transactions were recorded in this era, with additional facility and refinancing far outstripping fresh project financing, suggesting a general slowdown of greenfield operations getting the go ahead but the industry was able to easily raise capital to continue the funding of their ongoing projects and facilities. This often occurred through the re-issuance of bonds on existing prospectuses (Bloomberg, 2021). The geographical trends change, and North America overtakes the MENA region in regards to total petrochemical output – although this continues again to be mostly driven by the plastics industry (IJ Global, 2021). Asia Pacific remains a dominant collector of financing – including two new petrochemical complexes that had not confirmed their disaggregation of output at the time of writing. Europe and North America are the two largest sources of financing. An almost negligible quantity of new production capacity staying within Europe's borders, 3.57% of new global output compared to 34.48% of global financing (IVL / LU, 2022 (forthcoming); IJ Global, 2021). This showcases the "exporting emissions" nature of modern-day industry and manufacturing (Kanemoto et al, 2012; Liddle, 2018), where high-income countries can lower their territorial emissions by boosting production capacity in emerging economies, and then importing back the end-use products, leaving the associated emissions exported to the countries of production (Scott & Barrett, 2015; Jiborn et al., 2018).

The Covid Era (to June 2021)

What happened during Covid? As the world reeled under the economic and health shocks of coronavirus, there seem to have been contradictory trends – albeit this is the shortest time period that was assessed for the purpose of this report and is not standard on any measures. Starting from February 2020 as the approximate beginning of global lockdown restrictions due to the Covid-19 pandemic, the data show that despite many promises and pledges to ensure a green transition as part of the economic recovery, however this governmental issued ambition has not been mirrored across global industry (e.g., Oil Change International 2021) – and the petrochemicals sector is no exception.

Figure 3.

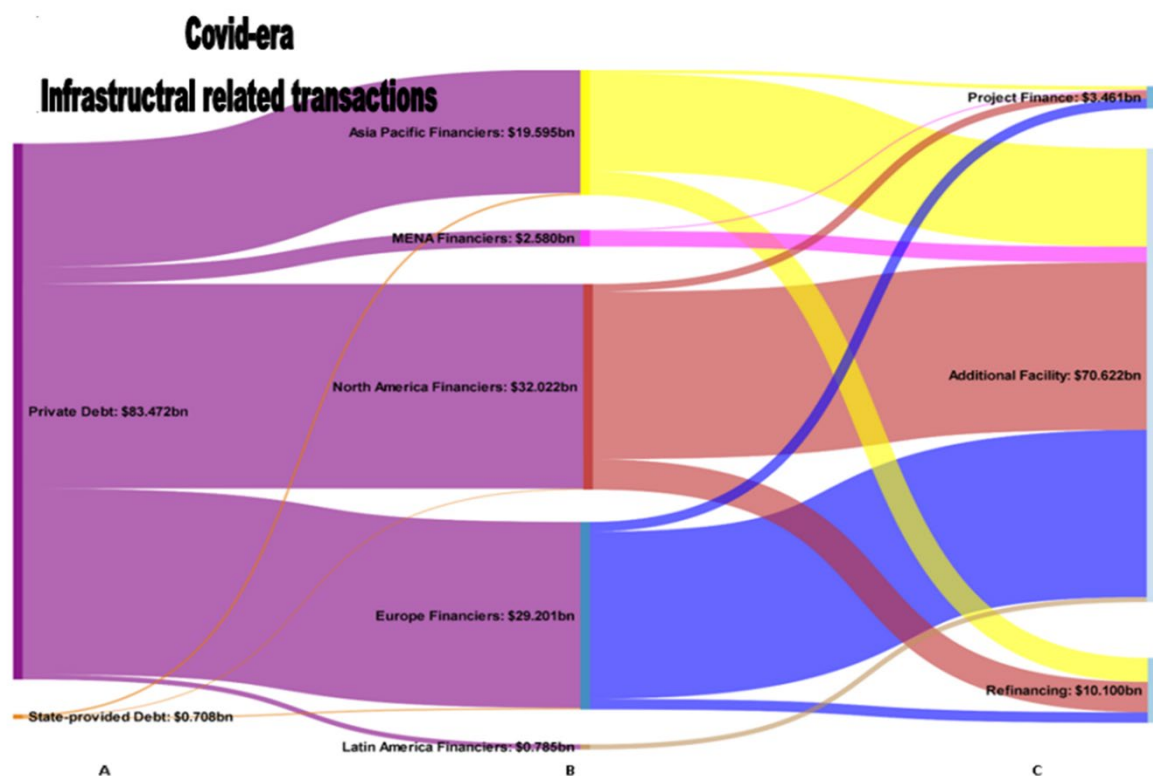


Figure 3 – Covid-era Infrastructural Related Transactions. Sankey diagram detailing the flows of state and private debt into financing the infrastructural related operations of the petrochemical industry since the start of the Covid-pandemic to present day. 01/02/20-15/06/21. Same structure as Figure 1. All terms can be found in the figure glossary. Note: Data derived from IJ Global.

Despite the small timeframe, the private flow of financing into the petrochemical industry shows no sign of slowing down, \$83.472 billion in less than 18 months, with over 80% of that being used for additional facility purposes, extending the longevity of pre-existing debt financing to accommodate the industry's need to bounce back from the economic downturn and to meet expected future demand (Mullin, 2021). New plastics production looks set to dominate global output, accounting for over 84% of new financing, the majority in the MENA region but also significant production taking place across North America and the Asia Pacific region (IVL / LU, 2022 (forthcoming); IJ Global, 2021). Financing once again originating from Europe (34.69%) and North America (38.04%) but also a marked proportional increase coming from the Asia Pacific region (23.28%) as the region bounces back from the global economic slowdown.

Summing up from Copenhagen to Covid

Looking at the three periods in terms of financing totals, rather than the granular view of the Sankey diagrams above, it seems initially that funding to the petrochemical industry is falling, especially in terms of finance from governments or government institutions. As shown in Figure 4, in the years between Copenhagen and before the Paris Agreement in 2015, financial flows totalled some \$129 billion, falling to \$108 billion after Paris and to \$83 billion since the economic lockdown of Covid-19. The fall is marked in State finance flows; in the years after Copenhagen signalled the start of a new perspective but before Paris sealed the deal, governments from 28 countries had provided funding of around \$36.5bn new and existing petrochemical projects around the world. This was around 28% of the total finance to the sector – so relatively small but still significant. After Paris, the State share dropped quickly both in absolute terms to \$11.578 billion and in relative share to just below 11%, because the share of the private sector fell at a slower rate (to \$96.892 billion). In the year and a half since the Covid-19 outbreak, the public sector share fell to \$1 billion and less than 1% of the total. It is so negligible by comparison with private financial flows that it does not even show in the Figures below.

Figure 4. Financial flows 2009–2021 (\$bn)

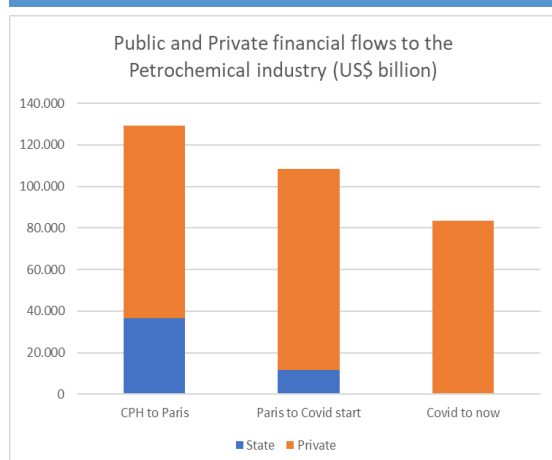
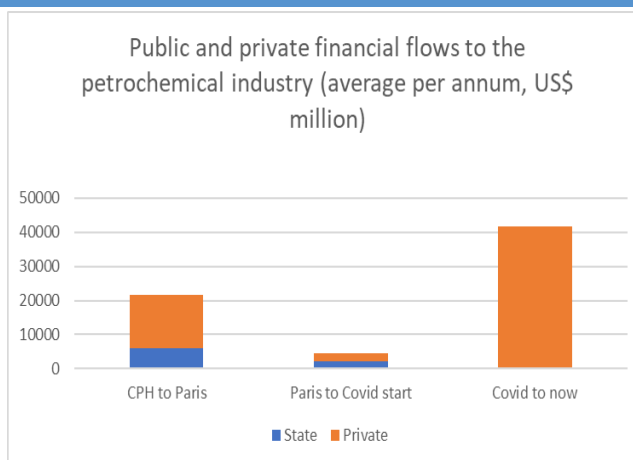


Figure 5. Ave. annual flows 2009–2021 (\$bn)



However, these encouraging trends disappear when looking at annual averages of financial flows without the framing lenses of political support as reflected in signed multilateral environmental agreements. The signs of a definite fall after Copenhagen and Paris may encourage environmentalists and others concerned about the climate impacts of the petrochemical sector, but Covid-19 provoked a different story. As shown in Figure 5, the annual average investment in the Covid period has leapt above pre-Paris levels. This is due to a surge of investment by the private sector and may be the consequence of rapidly falling interest rates and the subsequent search for yield on the part of fund managers and other financial market institutions. It may also reflect the impact of privileged corporate bond purchases implemented by central banks around the world as part of the Covid-19 Response and Recovery packages put in place by many governments. By tradition, central bank bond purchases are not specifically quantified per bond purchase but central banks' intentions to make "market neutral" purchases mean they likely choose the largest and longest-standing firms, which include high-carbon and often include companies involved in petrochemicals and fossil fuels.⁵

⁵ The central bank holdings were estimated by cross-referencing Bloomberg bond data with the Central Bank published data, making it possible to attribute the quantities coming from the public sector. It may not be the full figure because if petrochemical companies are borrowing in secondary markets from commercial banks, investment firms and others

This is not to say the State financial flows are negligible – as will be shown in subsequent parts of this paper – but the driving force of the post covid investment surge is coming from private funds.

Section 2: Financial flows and their sources

This section digs deeper into the types of funders and financial instruments, the following Figure 6, which depicts the current situation of all financial flows in the sector, currently active as of the 15th of June 2021. This could for example include loans taken out in the Copenhagen or Paris periods which have still not yet matured, as well as new loans taken out in the first half of 2021. Whereas the previous graphs focused just on project and infrastructural asset financing, this now includes all flows of finance – i.e., including those for general operations, general corporate purposes as well as the refinancing, additional finance and primary financing purposes found in the previous graphs. The following pages discuss in more detail the break-down between public and private financing.

Public finance to the petrochemical sector

As shown in Figure 6, total state financial flows to the petrochemical sector in the period currently stands at some \$38 billion, with the lion's share coming from central bank activities (\$25.9 billion), direct government finance of \$4.9 billion (directly funnelled to greenfield projects), then \$6.5 billion through export and multilateral development banks, and another \$1.6 billion through Sovereign Wealth Funds. Most of the funds given were directed to what are described as “general corporate” activities and only a small proportion for “brownfield” activities; greenfield projects are financed by the export credit agencies (ECAs) and Export-Import Banks (EXIMs).

While state finance is a small proportion of the total current financial flows to the petrochemical industry, it can be significant beyond its weight because, in addition to the actual capital it provides, government involvement may give confidence to the private sector whether implicitly or explicitly (as in the case of a guarantee). Many projects might not get off the ground were it not for the involvement of government investment, loans and guarantees, and other expertise. These can be provided through multiple sources including direct payment from the budget or indirectly through government-owned development banks (NDBs and MDBs), EXIMs, and ECAs, and Overseas Development Assistance (ODA), especially when projects are in emerging economies that lack integrated infrastructure. In some cases, technical expertise and management skills come as well as money, especially through development and public banks.

that have benefited from central bank support, this would not show up as public financed flows but rather as private ones. Unfortunately, it was not possible to disaggregate this further.

Notable in the diagram above is that State funding delivered via central banks is the lion's share at \$26 billion (67%) and that development or other public banks are quite a small proportion at around \$6.5 billion (17% of the state total). Sovereign Wealth Funds are also only lightly involved, providing some 3% of the total state share via their stakes in the commercial bond market.

Figure 6.

Active finance flows - Entire Petrochemical Industry

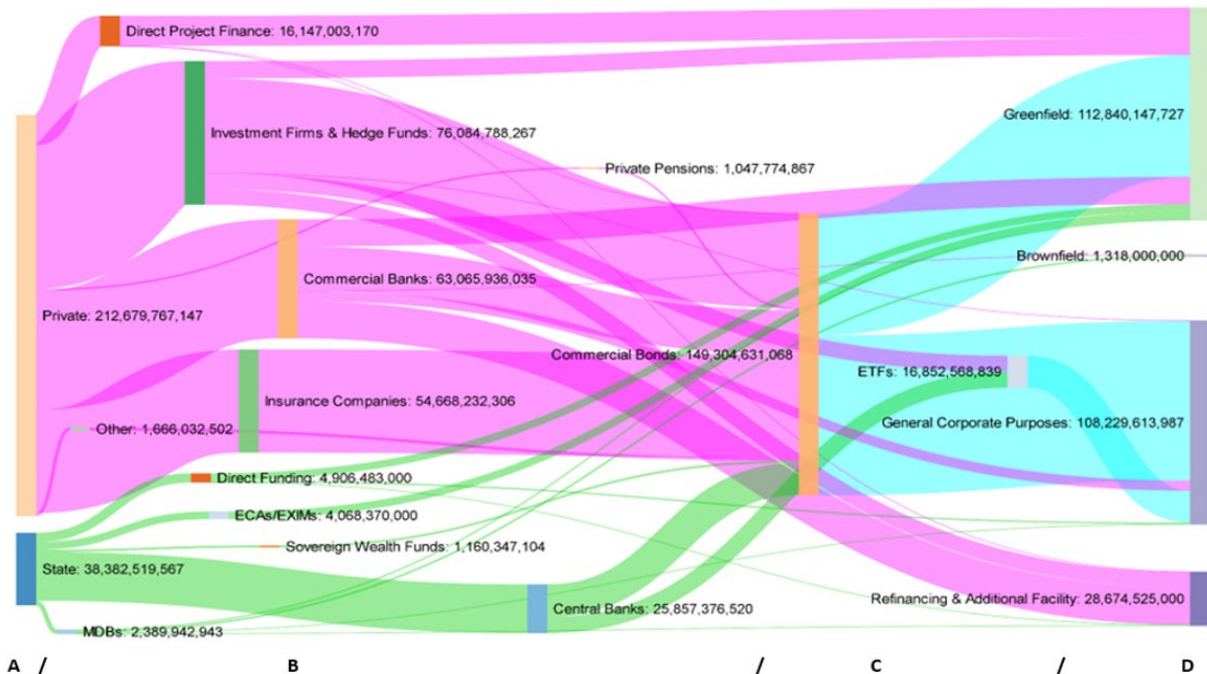


Figure 6 – Sankey diagram detailing current flows of state and private financing the petrochemical industry as of 15/06/21. Finance flows from left to right with values equating to the convergence of flows into each solid node. Column A displays the division between the start-points of financing, from either state or private interests. Column B disaggregates this into various forms of financial institution. Column C depicts the forms of corporate issued bonds flowing into the petrochemical industry. Column D shows the end-use of finances within the petrochemical industry. All terms can be found in the figure glossary.

Note:

- 1) Data derived from IJ Global, Bloomberg, Orbis, independent websites of financial institutions.
- 2) The refinancing and additional facility in this overview are not limited to asset projects but all of the petrochemical industry.
- 3) State finance flows highlighted in green, private in purple. When mixed they become turquoise.
- 4) The figures are relatively dynamic due to changeable exchange rates.

Central Banks

Central Banks account for a high proportion of current public flows into the sector through their open market operations, where they buy bonds from (i.e., lend money to) commercial companies; or because they lend to development banks and government ministries. In the period immediately after the Covid-19 lockdown, central banks throughout the world increased liquidity and lending through quantitative easing and corporate sector purchase schemes (CSPP) on an unprecedented scale in their efforts to stabilise the economy and stop things coming to a grinding halt. Across the world central banks initiated emergency pandemic purchase programmes (PEPP) on a massive scale. Such corporate purchases are based on principles of market neutrality, but whether this is possible, let alone desirable given the needs of climate change, is increasingly

being questioned by writers who argue that this as a missed opportunity to encourage new directions and continues to privilege large firms that are strongly incumbent in the wrong direction (Bank of England 2021; Dafermos et al, 2020; Dikau et al, 2021; *TDR 2019* and 2021 among others).

Given the large size and scale of petrochemicals corporations in the financial markets it is not surprising that a market neutral philosophy means that central banks' operations would include these companies, despite broader goals of transitioning to net zero. They included the European Central Bank, which bought around 131 corporate bonds in companies active in the petrochemicals industry, out of total purchases worth €281bn (ECB, 2020) through the conventional CSPP and another €33.68bn via the pandemic emergency purchase programmes (PEPP). Like most central banks, ECB do not provide exact figures of the percentages of individual bonds purchased, arguing this would affect market behaviour. However, the sectoral breakdown of procurement scheme is public record, and it indicates that 4% of the €281.73bn resides in the chemicals sector (ECB, 2020 and 2021) at the time of writing, i.e. around €12.6 billion.⁶ A conservative estimate at prevailing exchange rates put ECB's holdings in the petrochemical industry via the combined programmes at around \$14.8bn.

The US Fed does not hold the same quantity as the ECB of bonds in the petrochemical industry in a direct fashion, with only \$147m across 30 bonds issued by 12 petrochemical companies. However, it has significant holdings in 16 high-performing exchange-traded-funds (ETFs). These commonly high-yielding ETFs are comprised of thousands of separate bondholdings and indices that provide daily updates on the performance of their portfolios, unlike mutual funds that provide quarterly updates. The Fed has holdings in ETFs valued at just under \$3.4bn (US FED, 2021) which in turn have 0.91-4.86% of their funds invested in bonds issued by the petrochemical industry (Bloomberg data, 2021). Some of these funds are also linked to other forms of unsustainable investments that, while it is not clear if they involve petrochemicals, they are linked with other concerns that may clash with green ambitions⁷ (Popescu, Hitaj, Benetto, 2021).

The Bank of England (BoE) also instituted a very large-scale corporate bond purchase scheme (CBPS) as part of the covid-recovery programme, which offered liquidity at extremely low costs to borrowing firms. At its special meeting on 19 March 2020 the MPC voted unanimously to increase the Bank's holdings of UK government bonds and sterling non-financial investment-grade corporate bonds by £200 billion to a total of £645 billion, financed by the issuance of central bank reserves (Bank of England, 2020). At the time of writing, it had increased to £870 billion (Bank of England 2021). This includes an unspecified amount in Total SA and BASF (Bank of England, 2020; Cbonds, 2021), two dominant actors in the petrochemical industry. This is not to say the Bank is unaware of the inconsistencies, especially since it was one of the early central banks in the world to raise concerns about financial risks associated with global warming and climate change (Carney 2009; 2015). It noted in 2021 that only 40% of the firms currently eligible for the scheme have an emissions reduction target based on either SBTi or a 'transition pathways initiative' methodology" (Bank of England, 2021; TPI, 2021).

⁶ Although this figure may include chemicals that are not petroleum-based, it is also likely that it does not include procurements made into companies manufacturing plastics and artificial fertilisers that rely on petrochemicals as primary feedstocks.

⁷ These FED-invested ETFs has proportions of funds residing in company-issued bonds and indices that are recognised by the MSCI as UN Global Compact violators – disappointing those who hope to see responsible investment principles in place for a fund that is receiving significant investment from a Central Bank. One could go further and argue that such beneficiaries should adhere to a higher threshold of ESG principles.

Whether the Bank will lend less to petrochemical or fossil fuel companies in the future is unclear. In May 2021, BoE released a discussion paper titled “Options for greening the Bank of England’s Corporate Bond Purchase Scheme” (Bank of England, 2021), which listed three principles for greening their CBPS: 1) Incentivise companies to take decisive action to achieve net zero; 2) Lead by example, learn from others; 3) Ratchet up requirements over time. How far the Bank is prepared to go in terms of incentives is one issue; another is the use of disincentives. For example, the bank notes that it may be unlikely to divest from high-emitting companies, arguing this would mean losing the influence a key investor can have over the operations and portfolio allocation decisions of a company. The Bank states that as the data for transition pathways becomes more accurate and firm-level emissions improve, it will become progressively more demanding in expectations and qualifying parameters.

Critics may argue that this rationale legitimises continued financial support for already well-established companies that may or may not be financially viable and which are paying lip-service to strategies of decarbonisation and renewables rollout, whilst continuing high-carbon and polluting practices. It also enables companies to use green activities as a kind of Trojan Horse, where they profile desirable activities whilst continuing with undesirable ones. E.g., BP’s mass-purchasing of solar fields (Ambrose, 2021) in the US has been called a chance for the company to clean up a small portion of its portfolio while continuing to invest in new methods of extraction and exploitation (Christophers, 2021) that will outweigh the relative reductions in their portfolio’s emissions from the solar fields procurement.

The question of whether market neutrality was possible or not, or desirable, has long been debated but it has an extra bite today in tension between goals to ‘build back better’ after Covid-19 and the reappraisal taking place of the appropriate role of central banks (Matikainen, Campiglio, Zenghelis, 2017; Lepers, 2018; Dikau, Robins, Volz, 2021; *TDR 2019* and 2021). An emerging problem with trying to be market neutral is that it supports the status quo of well-established companies, including those that have been reliantly profitable through practices that are inherently unsustainable, exploitative, and polluting (Dikau, Robins, Volz, 2021) while simultaneously freezing out niche-level monetary policies and responsible investing that look to transform these practices and radically boost climate ambition (ibid). Please refer to Section 5 for our policy recommendations on how to overcome this.

In June 2021, the ECB hinted at a gradual move away from the market neutrality principle towards a model of market efficiency (ECB, 2021). This recognises “that a supposedly neutral market allocation may be suboptimal in the presence of externalities ... the CSPP currently exhibits an inherent bias towards large firms in carbon-intensive industries” (ibid). While this could be encouraging for the move towards financing alternative and more sustainable activities, it is not fast. The ECB’s tilting strategy of gradually making incremental adjustments to monetary policy operations to align with sustainability considerations is being criticised for moving slowly, while at the same time considering the hurdles to overcome with changes to risk exposure. These findings therefore support the argument made by Tearfund (2021) and others that Covid response programmes largely missed the opportunity to link emergency finance with a green recovery (O’Callaghan, 2021).

ECAs – Export Credit Agencies

Government-owned Export Credit Agencies (ECAs) play important roles in many countries, helping firms cover financial risks associated with importing and exporting, including delays in payment due to transport or exchange rate problems, or as most recently due to complete economic lockdown. They may be particularly important in multi-lateral infrastructural projects involving petrochemicals and fossil fuels that

have private and state actors from a range of companies, banks, financial institutions, and development funds. ECA's offer direct financing and underwriting loans and can therefore also give legitimacy and credibility to projects or private companies that would be otherwise considered as a risky venture (Hopewell, 2019). Recent research findings have found that ECAs have directly financed petrochemical projects to the tune of \$31.191bn since 2000 until mid-June 2021, while offering loan guarantees worth \$23.270bn during the same period (authors' research). Since the start of the Covid-19 Pandemic, ECAs have continued to buttress petrochemical projects (ibid) at the same time as their owner governments and multi-lateral institutions pledged to support the principles of a green economic recovery.

Multilateral Development Banks

Much like ECAs, Multilateral Development Banks (MDBs) provide essential financial support and legitimacy for large-scale infrastructural projects, especially in developing or emerging economies (Humphrey, 2018). Via an analysis of the MDBs listed in Table 3 of Section 4⁸ it has been found that these state-funded institutions have directly financed projects in the petrochemical industry totalling at least \$6.978bn since 2000 until mid-June 2021; with \$2.4bn of that still being used as of June 2021, as shown in the Figure 6. They could however play a more significant role in the transition and transformation of this sector, because their public oriented mandate should give the space to offer loan finance at lower interest rates and for the longer-time periods needed for this kind of change; however at the same time as many MDBs have significant pledges to follow climate change needs as a guiding principle, many petrochemical investments would be out of bounds and their support could only be given to the 'green' aspects. Further discussion on the role of MDBs in this sector is described in Section 4 below.

Equity Holdings

Much of this report has focused on recent finance flows and transactions within the petrochemical industry but it is important to remember that much of the financial clout of the petrochemical industry within its ongoing operations comes from the equity held in each individual company. While the public involvement in annual flows may be declining, state ownership and equity of petrochemical companies remains significant. This has potentially important implications not only to the extent it clashes with the political ambitions expressed in the landmark Paris agreement; but there may also be further costs going forward. It means that governments, public pension funds or other PFIs⁹ continue to be directly exposed to "climate Minsky shocks" (Carney, 2016; Nikolaidi, 2017), as well as being indirectly exposed in the case of financial shock to private firms deemed "too big to fail" – meaning the state is expected to bail them out. There is also the opportunity cost of not deploying those resources elsewhere, in new "sunrise" industries for example (Horton et al., 2018). On the other hand, if public investors use their equities to insist companies change, this could be a positive thing.

Looking at the fifty largest petrochemical companies according to a 2020 C&EN report (Tullo, 2020; MarketScreener, 2021; ORBIS, 2020), there is major state involvement in only a handful of companies. Private equity owners rather are represented more evenly across all the companies.

⁸ They include the Inter American Development Bank (IADB), Asian Development Bank (ADB), European Investment Bank (EIB), European Bank for Reconstruction and Development (ECRD), African Development Bank (ADB), Asian Infrastructure Investment Bank (AIIB), and New Development Bank (NDB).

⁹ Public Finance Institutions.

At the same time, there may be state investment via private sector funds or financial institutions. Three notable investing institutions that are particularly active are the private juggernauts BlackRock and Vanguard and also the Norwegian Sovereign Wealth Fund, operating under the investing name of Norges Bank Investment Management, but commonly known as the Norwegian Oil Fund or the Government Pension Fund. Table 1 below depicts a summary of the equity holdings in the 10 largest petrochemical companies, with an aggregation of companies 11-50. The full disaggregated table of 50 companies can be found in the annex.

Table 1. Equity holdings (USD billions) in the 10 largest petrochemical companies						
Company	Country Involved	State Quantity	Norges	BlackRock	Vanguard	Total value of Equity / Capitalization
BASF SE	NA	-	0.674	0.652	1.642	64.064
Sinopec	China	41.864	0.412	0.299	0.395	74.741
Dow Inc.	NA	-	0.458	0.897	3.435	42.883
SABIC	Saudi Arabia	70.000	-	0.796	0.739	100.00
Ineos Ltd.	Private Limited Company	-	-	-	-	32.900
Formosa Plastics	NA	-	-	-	0.561	23.689
ExxonMobil	NA	-	2.430	5.441	20.392	269.000
Mitsubishi Chemical	NA	-	-	0.321	0.272	11.859
LyondellBasell	NA	-	-	0.517	2.243	30.370
Companies 11-40	10 others	106.94	11.96	17.59	52.22	1,442.47

Table 1: This table shows free-floated equity holdings in the 10 largest petrochemical companies with the 40 next largest companies aggregated in the bottom row. All figures are represented in billions of US Dollars (USD). Data derived from C&EN, 2020; Orbis, 2020; MarketScreener, 2021.

State equity holdings are a small proportion of total equity, but the numbers are so large these could be significant if deployed elsewhere – for the top 50 petrochemical companies in the world, state holdings are worth some \$267 billion. To put this in context, this is around 60 times more than assessed PFIs have invested in or subsidised green infrastructure projects since making bold pledges towards ratcheting up climate finance. These funds could potentially be released and used to finance other greener activities – such as alternatives to plastics and petrochemicals. For some of the larger companies the State holding is directly through government as in the case of Sinopec, owned by the Peoples Republic of China, or SABIC, a subsidiary arm of Saudi Aramco, which is majority owned by the Kingdom of Saudi Arabia; and also in some smaller companies, such as the South African government's holding of Sasol, the Chinese government ownership in Syngenta or the government of Austria's joint venture with the UAE in Borealis.

Even when governments are not directly involved, the State may be indirectly involved through public pension funds with equity holdings, such as South Korea, which holds equity investments in several petrochemical companies. Sweden, Thailand, and most notably Norway all have a portion of their state pension funds tied up across a range of large-scale petrochemical companies.

BlackRock have recently made some moves towards cleaning up their portfolio, moving out of thermal coal related investments and joining the Climate100+ group (Farnworth, 2021). BlackRock, Vanguard, and other investment firm giants, many of which manage the assets of public pension funds (Aubry et al., 2020; Bloomberg, 2021), are under pressure (Friends of the Earth, 2018; Greenfield, 2021) to utilise their significant equity holdings in countless companies to ramp up climate ambition across their investment portfolio and move away from companies that do not possess strict methodologies on how to decarbonise in a reasonable timeframe. When it comes to petrochemicals, the future profitability of the industry is arguably debatable as alternatives come to the fore and once impartial investors begin to take more notice of ESG principles, petrochemicals appear to be no longer the safe bet that it has been for decades (Helm, 2017), as investors look to limit their portfolio risk exposure. At present, just three financial institutions – Vanguard, BlackRock and SSGA¹⁰ hold a total of \$151 billion of petrochemical equities in the top 50 companies. This is 7% of the total capitalization – a share that may not be so significant as to rock the entire sector but certainly a shock to these funds would have a major reverberation through the financial markets and subsequently to the rest of the economy (*TDR 2019; 143-156*).

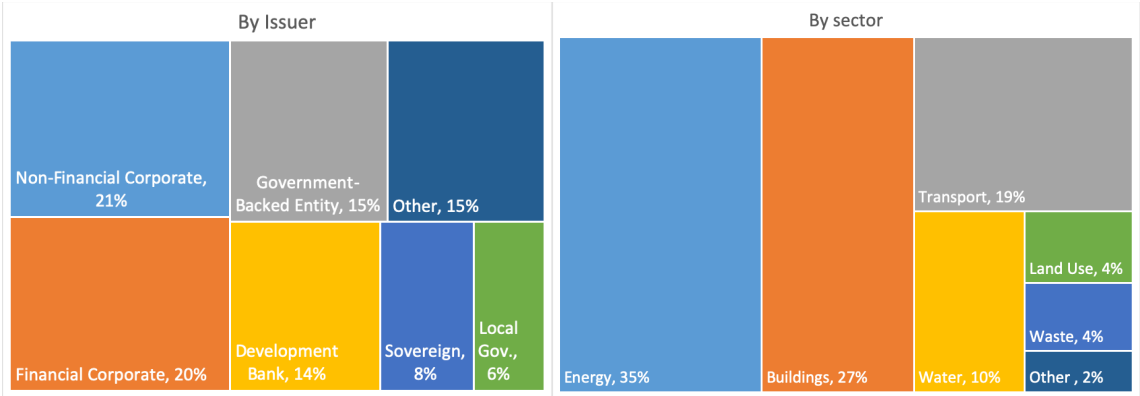
The State being vulnerable to the impacts caused by a Climate Minsky shock is not the only way that the State is exposed to the petrochemical sector. Governments are also expected to step in to help ensure the eventual process of transition into more sustainable alternatives is just and does not create further shocks throughout the broader economy (Galgóczy, 2018). This could include for example providing social and income support for “sunk workers” who are jolted into unemployment as the sector starts to change (Kizu et al., 2018). In this regard it could be possible that these employees would experience a double hit as pension funds that have invested in this sector would also be depleted.

Section 3: Slow Adoption of Green Bonds in Petrochemicals

As the financial sector races to decarbonise, there has been a surge of interest in greening asset and investment portfolios. In 2006, the UN-supported Principles for Responsible Investment (PRI) were developed by an international group of institutional investors with the goal of mainstreaming environmental, social and corporate governance (ESG) issues within investment practices (UNPRI, 2021). At present, the PRI have more than 1,400 signatories from over 50 countries representing \$59 trillion of assets. While the guiding principles for more responsible investment are relatively clear, there remains lacklustre definitions on what actually constitutes “responsible” or a “green” form of investment (OECD, 2016; Hansen et al., 2021; UNEP FI, 2021). There is also not a clear methodology on how the monitoring of progress should be measured. The OECD reports 400 sustainability disclosure schemes in use across both state and private institutions relating to climate alone, yet no single common definition of green finance exists (*ibid*). By some estimates, notably the Climate Bonds Initiative, certified green bonds were in the region of \$297 billion for 2020 (CBI, 2021), perhaps a more realistic estimation of the green bond market when compared with the vast asset portfolios represented by the PRI signatories.

¹⁰ State Street Global Advisors.

Figure 7. Green bonds issued 2014–2021



Source: UNCTAD TDR (2021 Ch V). Secretariat calculation based on Climate Bond Initiative database.

It is clear that the financial industry is not lacking in institutional actors that have the will, motivation, and capacity to facilitate a low-carbon transition. One of the primary financial tools at their disposal is the use of a green bond premium, commonly known as a ‘greenium’. Currently, there are just over 3,600 investable corporate green bonds available in the bond market, as well as around 460 green bonds issued by state-run banks or municipalities (Bloomberg data, 2021). The total value of these bonds tallies at over \$1.2tn with over \$250bn being issued in each of the last three years. Government issued green bonds are valued at \$280bn, 22.56% of the global total. European governments and public funds being the largest state issuers with just over \$200bn, 71.94% of the state-issued total. However, the bulk of the green bond market lies in the corporate world, with a total corporate issuance of \$961 bn (ibid).

These Green Bonds are not all uniform, in fact they can vary widely in their purpose, how the proceeds will be used and how this usage will be reported on, monitored and ultimately verified. Green has several shades in the bond market, which can make it tricky for investors to deduce where their money would be most responsibly invested. The label ‘green’ can apply somewhat conveniently to a wide range of bond types.

Bonds can be issued for general corporate purposes or refinancing with tranches linked to environmental social governance or sustainability behaviour until the maturity of the bond. These are often labelled as Sustainability Linked Bonds or SLBs, where the coupon rate of a tranche is often on a sliding scale that can drop or gain BPS depending on how a third-party organisation judges their progress on climate action. There are also green indices that work across a portfolio of green bonds that meet a pre-determined standard for inclusion. The progress of the companies can be monitored, and the bonds can fall from the indices if they fall below the adherence of the index sustainability framework. Brown-to-green (or transition) bonds are also of interest as they allow companies with traditionally high reliance on fossil fuels and high-emitting practices to enter the green bond market in order to stimulate financing that can be utilised for transitioning away from these increasingly obsolete practices.

Figure 8. Proportion of green bonds in petrochemicals, 2021, US\$ billion

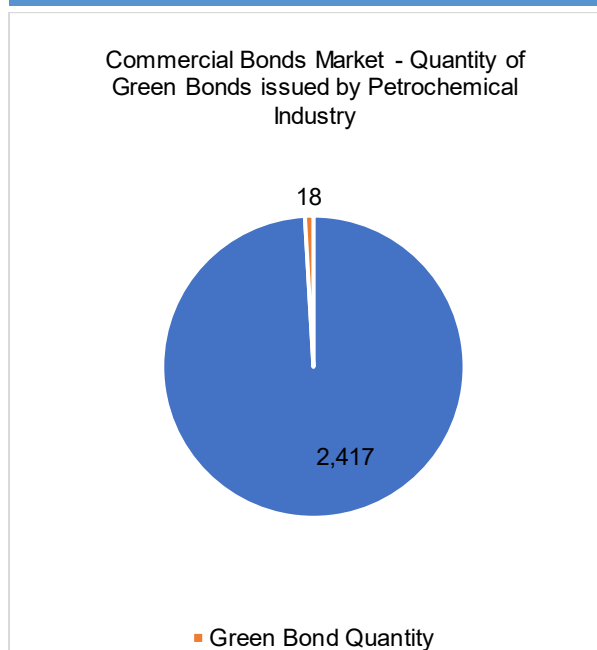
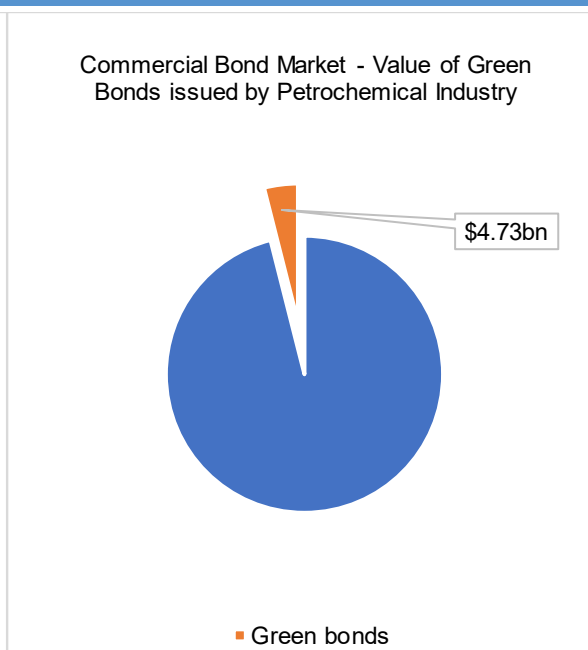


Figure 9. Proportion of green bonds in petrochemicals, by number of bonds



Note: As of 13/07/2021.

There is clearly a surge of green rhetoric and outlaying of climate commitments from the world of finance, despite this, a significant amount of public and private finance flows continues to be funnelled into the petrochemical industry via the commercial bond market, a carbon-intensive industry that is almost wholly dependent on fossil fuels for material feedstocks and production. Recent Bloomberg data (2021) shows that over \$150bn flows directly from the commercial bond market into the petrochemical industry. The magnitude of how much the commercial bond market buttresses the petrochemical industry is visible in the Sankey diagram shown in this paper (Fig. 6), detailing the current overview of finance flows in the industry, dwarfing most other types of direct financing.

18 of the active bonds (Bloomberg, 2021) issued by the petrochemical industry are currently listed as “green instruments”. The approximate value of these bonds, depending on exchange rates is \$4.73bn (Bloomberg, 2021; Bond Prospectuses & Cbonds, 2021). This is a very small fraction of the whole (Fig. 4 & 5), which is a concern if this sector is to be able to transition to low-carbon processes and eventually products. According to the prospectuses of these 18 green bonds, the use of proceeds met standards that were set in-house by the issuing companies or adhered to the frameworks in alignment with the Green Bond Principles published by the International Capital Markets Association. At least 5 of the 18 bonds were for the purposes of financing specific new-build projects or designs, such as Kaneka Corp’s research and development of Biodegradable Polymer PHBH (Kaneka Corporation, 2019) and Arkema’s world-scale plant in Singapore to be 100% dedicated to producing a bio-based amino 11 monomer and a Rilsan polyamide 11 from renewable and sustainable feedstocks. The others are spread across existing operations, unannounced projects, and general corporate purposes. The question is how to increase the green proportion of 2,439 investable bonds

issued by the petrochemical industry from a paltry 18 to a figure that will give significant impetus to transitioning the industry away from a fossil fuels reliance¹¹.

Section 4: Creating the path to net-zero: promises, pledges and lowering emissions.

Governments around the world and many actors in the petrochemical industry have pledged to transform their products and processes, in the goal to reach emissions reduction targets and even net-zero emissions. How is this to be financed? As shown above, the prospects for green finance do not yet look promising, and public sources of finance such as development banks and direct finance from government have been decreasing – leading to the question of how to pay for transition and transformation of the sector – putting aside the unlikely possibility of things simply grinding to a stop. The question is important not least because unless some mechanisms are found, the risks rise of the world experiencing the kind of reverberating shock through the financial sector and rest of the economy described as a “climate Minsky moment” (Carney, 2016; Matikainen, Campiglio, Zenghelis, 2017; *TDR 2019*:144-145). Some investors are looking to limit their investments and in turn their exposure to industries that are innately difficult to decarbonise while remaining profitable (Lazarus & van Asselt, 2018), therefore the petrochemical industry needs to display concrete steps towards greening their assets, operations, and eventual use of their output.

This section takes a brief look at some petrochemical industry pledges and ambitions for abating carbon emissions, alongside their actions. While there are areas with ‘low-hanging fruit’ that can contribute to improvements however, across the wider industry (Tullo, 2021), these relatively achievable decarbonisation measures remain a stumbling block that is yet to be overcome at scale (Chiappinelli et al., 2021; Sadorsky, 2020). These measures include switching to renewable energy wherever feasible and making efficiency improvements across the value chain.

Looking at the longer-term, the potential for CCU¹² for example, where CO₂ is captured from some operational processes, such as the separation of CO₂ out of raw feedstocks where it can then be redirected to other uses in construction materials and reconstituted plastics (IEA, 2018), is interesting yet still debatable as an effective manner of reducing emissions in the long-term (Carton, 2019; Friends of the Earth, 2021). There has been some progress in incentivising efforts to permanently store CO₂ such as the 45Q tax-credit and California Low Carbon Fuel Standard (LCFS) in the United States (Hirsch and Foust, 2020; Global CCS Institute, 2021) and calls for further incentivising monetary policies to boost CCS¹³ uptake (Rassool, 2021). These already existing policies to incentivise venture capitalists (Circular Carbon, 2020) and the petrochemical industry alike are being quickly embraced in both new builds and retrofitting existing high-emitting facilities (Tapia et al., 2018, Sinha and Chaturvedi 2019); but others also claim this is a legitimising technique (Carton 2019; Sapinski et al 2020) or a backdoor to writing off sunk-assets (Janipour et al., 2020). At present, although there is growing interest in CCS and CCU capacity, their uptake remains in the margins

¹¹ Issued after this paper was completed is the \$300 million sustainability-linked bond issued by Bangkok headquartered global chemical company Indorama Ventures, which included the target to increase recycling of PET bale inputs as well as increasing the use of renewable electricity. The issue was three-times oversubscribed, hinting at the demand from investors for these vehicles and prompting the company to increase the size of the bond.

¹² Carbon Capture and Utilisation.

¹³ Carbon Capture and Storage.

of the wider industry. Significant seed funding is required to reach a scale that is capable of tackling a significant proportion of the industry's recalcitrant emissions.

Other developments are aimed at the equally troubling problems of air pollution from the sector (IEA 2018; Sovacool et al 2021), including measures to alleviate the dispersal of air pollutants through technological adaptations of existing production plants (Hung and Carbonaro 2020; Sun et al 2020). There are parallels with regard to petrochemical and plastics waste and pollution, where public action including industry initiatives has already gone quite a long way, including bans on the trade of plastic waste, a move away from single-use plastics and efforts for a more circular economy; however while these well-intentioned initiatives are helping they are addressing only the tip of the iceberg, because the entire value life-cycle of plastic needs to be considered not just the final moment (Barrowclough and Deere Birkbeck, 2020). Plastic trade is worth at least \$1 trillion, and this does not account for the many plastic materials produced and consumed domestically, without being traded. Consumer goods firms are investing in less problematic packaging and other alternatives to plastics, but it is not at all clear how to finance transition and transformation in this sector.

Table 2 below traces out current pledges to reach net-zero carbon emissions of 19 of the world's top 50 petrochemical actors, alongside their actions on the ground by way of new deals, finance agreements and projects being greenlit in the petrochemical industry. It is not exhaustive and aims to be illustrative rather than the final word on this subject. These 19 firms' tally up to \$728.84bn in total capitalisation value (author's calculations on MarketScreener data, 2021), and ongoing research aims to trace out the value of the initiatives listed (Barrowclough and Finkill 2021 forthcoming), but broadly they are included in the commercial bond transactions shown in Figure 9. Further research is also needed to better understand the carbon implications of the purposes for which these companies raised finance. In some it seems reasonably clear – an investment in a windfarm as shown by BASF and Braskem or hydro-electric and biomass investments linked to the green bond issuance by Ashai Kasei, for example and hence is marked in the table in green. However other investments in new oil and gas facilities (such as Sinopec or Reliance) may be adding directly to emissions or, if new and more efficient processes are envisaged, they could be slight improvements. There are multiple methods of decarbonisation at the disposal of these companies, from reducing emissions intensity via efficiency improvements to mass carbon removal schemes but more information and granular analysis is needed to properly judge the impact of these, if adopted.

The remaining 30 firms in the top 50 either had no official pledge beyond 2030, or their sustainability commitment was for less than 50% reduction in carbon emissions.¹⁴

¹⁵ Greenfield projects listed include new infrastructural builds that have been greenlit or started construction across the range of eras covered in the infrastructural Sankeys in the background section, hence the large value of approximately USD 125bn.

Table 2. Carbon pledges by the world's Top 50 Petrochemical companies

Company	Pledge / Commitment / Aim	Date of Pledge	Subsequent / Ongoing Actions Percentage of Stake / Primary date of Financing
BASF	Net zero by 2050	16/03/21	Acquired a 49.5% stake in the 1.5GW Hollandse Kust Zuid (HKZ) offshore wind farm. BASF will pay around \$358m for its stake in the project and has agreed to commit around \$1.898bn more. 13/07/21
			Planning a \$4.9bn 2GW offshore wind farm to power the Ludwigshafen chemical site. 100% 01/06/21
			Continuing development of Zhanjian City Petrochemical Plant. Est. value \$10bn. 100% 05/12/19
			Continued stake in European Gas Pipeline Link (EUGAL). 25.25% 27/12/17
			Continued stake in Nord Stream 2 Gas Pipeline. 10% 19/08/16
			Continued stake in RusVinyl Petrochemicals Project. 25% 15/07/13
Sinopec	Net zero by 2050	29/03/21	Issuance of green bond, proceeds used for renewable energy procurement. 07/04/21
			Continued stake in Ironbark LNG Facility. 25% 20/12/19
			Construction of Coal-to-Gas Facility in Zhundong, China. 100% 21/07/17
			Exploiting new oil and gas fields in Sakhalin Island, Russia. 33.33% 30/09/16
			Development of Kaombo Ultra-Deep Offshore Project, Angola. 20% 24/08/17
			Development of PT West Point Terminal, Indonesia. 95% 04/02/14
Dow Inc	Carbon neutrality by 2050	17/06/20	Ongoing construction of Project Cabana Cane-to-Polyethylene, Brazil. 100% 16/09/13
			Ongoing construction of Jubail Acrylates Complex. 33.33% 01/04/14
			Continuing development of Sadara Petrochemicals Complex, Saudi Arabia. 35% 14/04/21
LG Chem	Carbon neutral growth by 2050	06/07/2020	Ongoing construction of Kazakhstan Petrochemical Complex, Saudi Arabia. 50% 25/07/17
Reliance Industries	Net zero by 2035	04/06/21	Development of Meghnaghat Gas-Fired Power Plant Phase I (745MW), Bangladesh. 51% 05/10/20
			Continued exploitation of MJ Offshore Gas Field, India. 60% 24/07/19
Evonik Industries	50% emissions reduction by 2025 on 2008 baseline	10/02/21	Development of Lingen - Gelsenkirchen Hydrogen Network (130KM), Germany. 20% 11/02/21
			Development of Marl Combined-Cycle Gas-Fired Power Plant (180MW), Germany. 100% 10/10/19
Braskem	Net zero by 2050	11/10/20	Signs PPA to purchase wind-generated power from Casa dos Ventos. Brazil. 25/01/21
			Extending brownfield facility for Delta Polypropylene Plant. USA. 100% 30/07/20
Lotte Chemical	Carbon neutral growth by 2030	02/02/21	Continued stake in new Lake Charles Petrochemical Complex. 50% 02/02/17

Bayer	Net zero by 2050. Across entire value chain	21/07/21	Signatory to the UN Business Ambition for 1.5 C. 30/07/21
DSM	Aim to be net zero by 2050	09/06/21	Signatory to the UN Business Ambition for 1.5 C. 30/07/21
			Signed a PPA with Orsted, all North American electricity needs will be met with renewables.
			Acquisition of Midoria USA, a eubiotics provider that helps to lower the environmental impact of livestock and their food.
Asahi Kasei	Aim to be carbon neutral by 2050	25/05/21	Issuing a \$93m green bond for financing hydroelectric power. 18/06/20
			Cancelled project for coal-fired Akita Thermal Power Station. 61% Probable biomass plant being constructed instead.
Eastman Chemical	Carbon neutral by 2050	01/12/20	Divesting from tire additives. More chemical recycling of polyethylene terephthalate, \$250m investment. 26/07/21
Borealis	Climate neutral by 2050	2020	Chemically recycled feedstock supplied by Renasci to be used to manufacture circular polyolefins and circular base chemicals. Belgium. 16/06/21
			Continued stake in gas-fired Kilpilahti CHP Plant (450MW). Finland. 20% 15/03/18
Ecolab	Net zero by 2050	05/12/19	Signed PPA for 100MW of electricity from Mesquite Star Wind Farm. USA. 26/06/19
			Currently, 99.4% of Ecolab's electricity in Europe comes from renewable sources.
Johnson Matthey	Net zero by 2040	18/06/21	Partnership with BP, Cardiff and Manchester Universities to convert CO ₂ waste and biomass into other fuels and products. 22/07/21
			Acquired Oxis Energy battery company as part of green hydrogen production. 29/07/21
Umicore	Net zero Scopes 1+2 by 2035	02/06/21	Rechargeable Battery Materials cathode manufacturing plant in Poland will be carbon neutral as of start of production in 2021.
SK Innovation	Net zero by 2050	29/07/21	Continued stakes in 2 operating gas block reserves in Peru. 18%.
			Recent acquisition of 49% stake in Mekong Petrochem. 13/04/20
Lanxess	Climate neutral by 2040	13/11/19	Divestment of 40% stake in Currenta, Germany. Currenta now responsible for prior management and co-ownership of gas-fired power plants. 06/01/21
DIC	Carbon neutrality by 2050	18/06/21	Acquired pigment business from BASF for \$1.4bn. 26/07/21
			DIC's Sun Chemical subsidiary launched a manganese-based curing agent for alkyd coatings and inks. It's meant to replace toxic cobalt compounds. 26/07/21

Source: Bloomberg, IJ Global and company websites and reports.

Table 3 below shows the carbon pledges made by some of the world's main public and development banks, as listed on official websites and publications and also their current actions and financial transactions (as included in Figure 9). For some of these banks, financing the investments needed for climate change has been central to their mandate since inception, such as the new Southern-led banks that emerged in the last decade, the Asian Infrastructure Investment Bank (AIIB) and former BRICs bank; the New Development Bank (NDB). Other banks with a longer history that began before climate awareness have evolved to include climate adaptation and sustainability in their mandates to varying degrees – such as the European Central Bank, which recently announced it would include climate change considerations in its strategies, or the Asian Development Bank, which pledged that 75% of its projects will address climate change mitigation and adaptation by 2030. The World Bank pledged not to finance any new fossil fuel facilities. On the other hand, some of the world's largest and most high profile banks have not adopted any climate goals or commitments that they could be held accountable to, including the US Federal Reserve (the Chair stated that the Fed did not seek to set climate policy for the USA); the Bank of England (which has for many years raised climate awareness but without setting quantitative targets for bank practices); and Korea's KEXIM bank (which issued green bonds but holds no official stance on climate.) As with the previous table, we have shaded in green those activities that seem broadly to correspond to green ambitions but note that this information is not perfect, and this is another area where more transparency is needed to help guide investors and others.

Table 3. Public and development banks pledges for climate action and current actions		
Public Finance Institution & Date of Pledge	Pledge / Commitment	Subsequent / Ongoing Actions
European Central Bank 08/07/21	Released action plan to include climate change considerations in its monetary policy strategy	Accept certain sustainability-linked bonds as collateral and for our asset purchases.
		Develop and adapt the CSPP framework to include climate change considerations.
		Continuing to finance 22 petrochemical companies across 131 bonds. With another 35 fossil fuel energy companies also benefitting from their quantitative easing monetary policy in response to the Covid-19 pandemic.
Bank of England 17/06/21	Net-zero by 2050 To 'Play a leading role, through our policies and operations, in ensuring the financial system, the macroeconomy, and the Bank are resilient to the risks from climate change and supportive of the transition to a net-zero economy.'	Increasing the quantity of green bonds being classified as eligible for the corporate bond procurement scheme.
		Continuing to finance 2 petrochemical companies across 8 bonds via quantitative easing in response to the Covid-19 pandemic.
BRICS New Development Bank 13/12/17	The purpose of the Bank shall be to mobilize resources for infrastructure and sustainable development projects in BRICS and other emerging market economies and developing countries to complement the existing efforts of multilateral and regional financial institutions for global growth and development.	Financing Renewable Energy Sector Development Project in India. \$300m
		Partial financing of Campo Largo Wind Complex (326.7MW). \$61m
		Financing Carbon Holdings to develop petrochemical projects in Egypt. \$110m
		Partial financing of Plastic Ampoules Production Facility, Uzbekistan. \$11.18m
		Partial financing of Grupa Azoty Polyolefins Facilities, Poland. \$152m
		Partial financing of Kokand Superphosphate Plant modernisation, Uzbekistan. \$12.5m
		Loan support for gas-derived Egyptian Fertilizers Company. \$60m

Asian Infrastructure Development Bank (AIIB) Sep 2020	AIIB will aim at reaching or surpassing by 2025 a 50 percent share of climate finance in its actual financing approvals.	Partial financing of Enel Green 300 MW Solar Project – Rajasthan, India. €50m
		Partial financing of Balakot Hydropower Development Project, Pakistan. 45.45% \$250m
		Partial financing of Solar Power Development and Energy Storage, Maldives. \$20m
		Partial financing of Ayana Anantapuramu NTPC Solar Project, India. \$35m
		Partial financing of Sirdarya 1,500MW CCGT Power Project, Uzbekistan. \$100m
African Development Bank & Africa Finance Corporation 24/06/21	Allocating 40 percent of project approvals to climate finance by 2021, with equal proportions for adaptation and mitigation. Mainstreaming climate change and green growth into all Bank investments by 2021. Securing significantly increased access to climate finance for low-income African countries with a target of \$25 billion by 2025 and positioning Africa's financial sector at the forefront of financing innovations.	Financing of Kandadji Hydro Power Plant (130MW), Niger. \$79.1m
		Partial financing of Singrobo Hydropower Plant (44MW), Ivory Coast. 53.9% \$83.14m
		Partial financing of Kinguele Aval Hydro Power Plant (35MW), Gabon. 19.43% \$29.95m
		Financing of Essor Hybrid Solar Mini-Grids, Democratic Republic of Congo. \$20m
		Partial financing of Malagarasi Hydro Power Plant (50MW), Tanzania. 85.71% \$120m
		Partial financing of Kom Ombo Solar PV Plant (200MW), Egypt. 15.27% \$17.8m
		Partial financing of Mozambique LNG mass-infrastructure project. \$400m
Asian Development Bank (ADB) 05/02/21	75% of its projects will address climate change mitigation and adaptation by 2030	ADB's cumulative climate finance commitment stands to reach \$80 billion by 2030.
		ADB recorded \$5,326 million in climate finance in 2020.
		Partial financing of new Nenskra Hydro Power Plant (280MW). 12.84% \$94.40m
		Partial financing of Balakot Hydropower Development Project, Pakistan. 54.55% \$300m
		Partial financing of Deedoke Hydro Power Plant (56MW), Myanmar. Unknown quantity.
		Partial financing of Lien Lap (48MW), Phong Huy (48MW) and Phong Nguyen (48MW) Wind Portfolio, Vietnam. 20.33% \$35.17m
		Partial financing of Dau Tieng Solar PV Plant Phase 2 (240MW), Vietnam. 95.02% \$152.5m
		Partial financing of Henan Tian Lun Gas Henan Province Facility, China. 15.2% \$50m
European for Reconstruction and Development 01/07/21	From end-2022, all EBRD activities must be aligned with the goals of the Paris Agreement. Decarbonisation support intensifies for regions where fossil fuel reliance remains heavy. EBRD to scale up policy work countries to develop low-carbon, climate-resilient transition	Ownership of new Tufail Solar PV Plant (400MW), Lebanon. 100%
		Partial financing of new Nenskra Hydro Power Plant (280MW). 29.12% \$214m
		Partial financing of Energix Wind Farm Portfolio (125.4MW), Poland. 50% \$71.68m
		Partial financing of Kom Ombo Solar PV Plant (200MW), Egypt. 40.1% \$36m
		Partial financing of Tutly Solar PV Plant (100MW), Uzbekistan. 24.97% \$26.49m
		Partial financing of Polimery Police Petrochemical Complex, Poland. 9.13%

European Investment Bank Nov 2020	Lending must consist of “finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development”	Partial financing of Tutly Solar PV Plant (100MW), Uzbekistan. 50.06% \$53.10m
		Full financing of Eolo Wind Portfolio Phase 2 (127MW), Spain. \$106.71
		Partial financing of Solaria Energia Solar PV Portfolio (261.05MW), Spain. 4.26% \$2.73m
		Full financing of Ouagadougou Solar PV Plant Expansion (13MW), Burkina Faso. \$45.74m
		Partial financing of Arcadis Ost 1 Offshore Wind Farm (257MW), Germany. 11.38% \$78.65m
		Financing of Lestijarvi Wind Farm (400MW), Finland. Quantity unknown
		Partial financing of Nuru Mini-Grid Solar PV Plant, Democratic Republic of Congo. 34.29% \$12m
		Partial financing of new Nenskra Hydro Power Plant (280MW). 20.41% \$150m
		Partial financing of Covestro’s development of circular economy program. \$270.92m
		Partial financing of Pcc Rokita Chemical Upgrade Programme, Poland. \$81.3m
Inter-American Development Bank Nov 2020	Working together with public and private financial institutions as well as with ministries of finance and planning to implement climate governance systems, develop innovative schemes and instruments to promote investment in emissions reductions projects and programs, as well increase resilience to the impacts of climate change.	Financing of Chile Decarbonization & Green Hydrogen. \$50m
		Financing of Bosques Solares de los Llanos 1-3 Solar Portfolio (81.7MW), Colombia. \$31m
		Partial financing of Casablanca Solar PV Plant (359MW), Brazil. 53.3% \$80m
		Partial financing of Ituango Hydropower Plant (2400MW), Colombia. 26.99% \$300m
		Partial financing of Calama Wind Farm (151.2MW), Chile. 59.2% \$74m
		Partial financing of La Pimienta Solar PV Plant (444MW), Mexico. 17.3% \$68.95m
		Financing of Jilamito Hydroelectric Plant (14.8MW), Honduras. \$20.25m
		Partial contribution to refinancing of Gunvor, an upstream oil & gas firm. Switzerland. 2.94% \$20m
Export Development Canada (EDC) 22/07/21	Net-zero by 2050	Partial financing of Azure Power Rajasthan Solar PV Plant (300MW), India. 33.33% \$54.64m
		Partial financing of West Wyalong and Woolooga Solar PV Portfolio (321MW), Australia. 25% \$63.86m
		Partial refinancing of Moron (50MW) and Olivenza (50MW) Thermal Solar Plants Refinancing, Spain. 32.47% \$154.04m
		Partial refinancing of Deutsche Bucht Offshore Wind Farm (252MW), Germany. 5.35% \$59.35m
		Partial financing of T-Solar development (100MWp), Spain. 12.5% \$29.41m
France AFD 01/10/19	Commitment to funding is entirely consistent with resilient, low-carbon development as defined by the Paris Agreement.	Financing of Shinyanga Solar PV Plant Phase 1 (50MW), Tanzania. \$157.36m
		Partial financing of Bois Rouge Biomass Power Plant (108MW) Conversion, France. 12.5% \$30.27m
		Full procurement of DBSA Green Bond 2021 - to on-lend projects that offer climate mitigation or climate adaptation, South Africa. \$240.39m
		Financing of Ancuabe Solar PV Plant (41MW), Mozambique. \$40m

		Financing of Se San 4 Solar PV Plant (49MW), Vietnam. \$27.03m
Hermes & KFW – Germany 28/01/20	Include ESG indicators for all ESG-related issues into its rating methodology.	Partial contribution to refinancing of Gunvor, an upstream oil & gas firm. Switzerland. 7.35% \$50m
World Bank - International Finance Corporation (IFC) & Multilateral Investment Guarantee Agency (MIGA) 22/06/21	Ramp up climate finance in ways that make the greatest impact, addressing client countries and private sector clients' short-term and long-term needs. That means helping the largest emitters flatten the GHG emissions curve and accelerate the downtrend, while also ramping up financing on adaptation to help countries build resilience to climate change.	50% Ownership of Mpatamanga Hydro Power Plant (258MW), Malawi. Under construction.
		15% Ownership of Kohala Hydropower Plant (1.124GW), Pakistan. Under construction.
		15% Ownership of Upper Trishuli Hydro Power 1 (216MW), Nepal. Under construction.
		Partial financing of Kinguele Aval Hydro Power Plant (35MW), Gabon. 41.70% \$64.28m
		Partial financing of Mazar-e-Sharif Gas-Fired Power Plant (58.6MW) IPP Phase 1, Afghanistan. 33.95% \$21.5m
		Partial financing of Temane Gas-Fired Plant (400MW), Mozambique. \$141m
Norway - Nordic Development Fund & NORAD April 2020	At least 50% directed towards climate adaptation projects.	Partial financing of Rucanzogera Small Hydro Power Plant (1.9MW), Rwanda. \$0.56m
USA – Development Finance Corporation 22/04/21	Net-Zero by 2040	Financing of Amreli Paryapt Solar PV Plant (70MW), India. \$27.3m
		Partial financing of Sitara Solar PV Plant (140MW) IPP, India. \$50m
		Partial financing of Temane Gas-Fired Plant (400MW), Mozambique. \$200m
		Financing of Freetown CCGT Gas-fired Plant (83MW) IPP, Sierra Leone. \$217m
Italy – SACE 2020	Intention to finance projects that aim to facilitate the transition to an economy with a lower environmental impact, integrate production cycles with low-emission technologies for the production of goods and services and promote mobility with lower polluting emissions.	Partial financing of new Nenskra Hydro Power Plant (280MW). 12.86% \$94.50m
		Partial financing of Fratelli Cosulich LNG Gas Carrier. 24.99% \$9.65m

Section 5: Conclusions and new directions

This paper has shown the gradual decrease in financial flows to the petrochemical industry in recent decades, especially since the Paris Agreement; only to be turned sharply around in the Covid-era. The increase in financing is almost entirely due to the private sector as public finance had fallen so much it was almost negligible, even in the Covid period. The total flow of currently active finance in terms of debt and bond instruments is just a touch over \$251bn, with private financing dominating with almost 85% of the current flows, coming mostly from investment firms and hedge funds, insurance companies, and commercial banks. However the public sector still has a small but significant holding in terms of equities, and in covid relief and recovery efforts also. There are concerns the clock has

turned backwards after more than a decade of political ambitions expressed in not just one but two international climate agreements. What now, for an industry that will need to transform if governments are to meet their net-zero pledges? Some firms and operations have also made similar pledges, as have many actors in the financial sector that support them. Some changes are already starting to be technologically possible, although difficult to achieve at scale; others may prove impossible, and it is difficult to predict what will happen to the sector then. Will they continue to find profitable markets without making the adjustments to product and process that today's consumers are starting to demand? Will the pension funds and hedge funds that currently support the industry continue to hold tight, or will there be a race to avoid being the last left in the sector? The possibility also exists for a large-scale coordination for investors and asset managers to push the petrochemical sector towards a rapid transition. If firms want to transition and change of their own accord, it is still unclear if they be able to get the finance needed for this – given that it may be an unprofitable or risky in the short-term and maybe also the long. There are more questions raised than answers and it is to be hoped that the topic will capture much more attention from policymakers, industry and the 'green' financial market regulators.

Based on experience in other contexts, the profound change that is needed will only occur with the support of the public sector, because the costs and risk involved and the need to balance competing interests (TDR 2016) are beyond the capacities of private finance. The growing green bond market may offer some potential, if there can be more transparency about the purposes for which funds are being used, and the returns offered; but at present, it is not looking promising as only 18 petrochemical bonds out of more than 2,000 qualify as being 'green', and experience in other easier-to-abate sectors is also disappointing (TDR 2021). On the other hand, this is the smallest fraction of a massive bond market worth tens of trillions of dollars – it is a great indictment of the current financial system if more cannot be directed to something so worthwhile.

The role of public funding in the sector will also need to be reappraised. As shown across the pages above, only 15% of financial flows in this sector are coming from the state, through a mix of state-managed financial instruments. Major central banks are currently dominating – in part due to the emergency corporate bond purchase schemes brought into action via quantitative easing as part of the global economic recovery to the ravaging Covid-19 Pandemic¹⁵. With such a relatively small proportion of ownership in the total, do governments and public finance have much of a voice in this sector? One response is that although the state-based funding only makes up a small fraction of the overall value of current finance flows, the involvement of central banks, MDBs, ECAs and EXIMs lends a degree of legitimacy and credibility from their mere presence as financiers. With strong government leadership, more could be done to guide this sector to push for most sustainable alternatives; and vice-versa, without strong cross-government leadership, it remains difficult to imagine that the private market will push for more sustainable alternatives as long as governments continue to play even a small role propping up this high-emitting and polluting industry. Hence the corporate, national and international pledges and agreements emerging today are hugely important. Aside from smart moves being made from the world of finance; the governance and regulation of the petrochemical industry remains a crucial component for the necessary push towards decarbonising the sector. See Bauer et al, 2018; Bulkeley, 2020; Hildingsson, Kronsell, Khan., 2018; Verbeek & Mah, 2020; Mah, 2021 for further reading.

In conclusion, the findings shown in this paper reinforce calls for governments and public financial institutions to take more seriously the contribution of this sector to global warming, carbon emissions and pollution, and their potential role in supporting it. By continuing to fund the status quo, it delivers the message that change can be avoided or is not needed. On the other hand, public financial institutions such as central banks and development banks can help to finance the transition and transformation of this sector – hence it is not necessarily a question of stopping all financial flows to this both useful and problematic sector, but rather in helping to better guide it.

¹⁵ Greenfield projects listed include new infrastructural builds that have been greenlit or started construction across the range of eras covered in the infrastructural Sankeys in the background section, hence the large value of approximately USD 125bn.

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Glossary

Additional Facility – A type of finance that extends a lending limit on an existing finance

Brownfield – A retrofitted or expanded infrastructural project

bn - billion

CAPEX – Capital Expenditure

CE – Cash Equity

ECAs – Export Credit Agencies

ETFs – Exchange-Traded Funds

EXIMs – Export/Import Banks

General Corporate Purposes – In respect of working capital, capital expenditures, acquisitions, stock repurchases or any other general corporate purpose

Greenfield – A new infrastructural project

m – Million

MENA – Middle East and North Africa

MDBs – Multilateral Development Banks

Refinancing – Replacement of an existing debt obligation with another debt obligation under different terms

tn – trillion