



The Green Giant: New Industrial Strategy for Norway

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Savings from the point of view of an individual and from the point of view of society as a whole are two entirely different concepts. They ought to be distinguished by using two different labels, not the same as now. This just causes confusion. Society as a whole can only save through productive investments.

Ragnar Frisch, *Noen Trekk av Konjunkturlæren*, 1947.

Summary

The value of petroleum-related assets, technologies and capabilities will diminish in the years to come, threatening jobs, export revenues and industrial innovation. With an advanced industrial base in sectors such as energy, maritime industries, offshore engineering and process industries fueled by green hydropower, the Norwegian economy might seem ready for a green industrial transition. But Norway faces a wicked policy paradox. On the one hand, reduced demand for petroleum, as a result of global climate policies, will mean that the country's main engine of growth must be replaced. On the other hand, several of Norway's foremost technological advantages are developed by the petroleum industry.

The carbon lock-in of the economy is exacerbated by path-dependent technological development and a tendency towards Dutch disease. Petroleum investments dwarf investments in other industries, attracting advanced skills to the sector. Yet investments in the nation's most important export industry are set to dwindle rapidly over the next decade. This implies that the capacity to absorb tens of billions of NOK in annual investments in green industrial development will be freed up in the real economy, at a time when international markets for green industrial technology are set to grow at record pace. Furthermore, Norway possesses enormous financial resources held in the world's largest sovereign wealth fund, the Government Pension Fund Global, created out of the petroleum of the continental shelf. Yet today the fund plays almost no role in either domestic or global green transitions. The oil wealth can serve as an insurance for the current and future wellbeing of Norwegians only if it is invested into funding the productive assets of the future, not of the past.

The lessons of Norway's historic approach to industrial development may prove valuable. Norway has shown before its ability to adapt to a changing context. At defining points in history, the Norwegian state has taken on an entrepreneurial role and set a new direction of growth, through the development of hydropower 100 years ago and a petroleum industry 50 years ago. At both of these turning points the state fostered inclusive growth by watershed decisions, such as placing conditionalities on investors regarding resource ownership and local industrial development, attaining technological sovereignty by investing in science and innovation, supplying industries with patient capital and utilising state ownership to confront the grand challenges of that day and age. Today, the green transition could be Norway's third industrial turning point, defining the country's prospects for inclusive growth and sustainable prosperity for decades to come.

A turn from the export of fossil fuels to the export of green technologies would be a sea change in Norway's role in the global climate effort. Putting its industrial capacity and financial strength to use in the green transition could turn the 'Fossil Ogre' of Western Europe into the 'Green Giant'.

In this report we outline a green industrial strategy for Norway where the state takes on an active role in investing and coordinating the shift from a fossil-driven to a green engine in the Norwegian economy. We argue that through well-defined goals, or 'missions' focused on the various aspects of the green transformation, Norwegian policymakers have the opportunity to determine the *direction* of growth by making strategic investments, coordinating actions across many different sectors, and nurturing new industrial landscapes that the private sector can develop further.

The UCL Institute for Innovation and Public Purpose

The mission of the UCL Institute for Innovation and Public Purpose (IIPP) is to change how public value is imagined, practised and evaluated to tackle societal challenges — delivering economic growth that is innovation-led, sustainable and inclusive.

Growth has not only a rate but also a direction: IIPP confronts this directionality head on. Finding solutions to global challenges requires purposeful organisations to collaborate in fundamentally new ways — across the state, businesses and civil society. Together, they can help reshape markets to produce growth that delivers public value. Building symbiotic eco-systems requires new tools and new forms of collaboration.

IIPP rethinks the role of the state in these collaborations. Rather than just a market-fixer, it can be an active co-creator of value. A mission-oriented approach can be used to set inspirational goals, with dynamic tools — from procurement to prize schemes — to nurture bottom-up experimentation and exploration across different sectors. IIPP's research and teaching help create new economic thinking and practical tools to make this a reality.

IIPP is a department within University College London (UCL) — founded in 1826 to solve grand challenges — and part of The Bartlett faculty, known internationally for its radical thinking about space, design and sustainability.

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PART I:

INTRODUCTION AND MAIN RECOMMENDATIONS

1. Introduction and main recommendations

The 21st century is increasingly being defined by the need to respond to major social, environmental and economic challenges. Sometimes referred to as 'grand challenges', these include climate change, demographic challenges, and the promotion of health and wellbeing. Behind these challenges lie the difficulties of generating sustainable and inclusive growth.¹

The global green shift represents a major challenge for every nation and only more so for petroleum-dominated economies. The value of petroleum-related assets, technologies and capabilities will diminish in the years to come, threatening jobs, export revenues and industrial innovation. Norway is the world's third largest exporter of gas, with total exports of petroleum reaching a value of NOK 424 billion² and 36% of the country's total exports in 2019.³ In the face of the climate crisis and the global green transition, this economy needs new sources and a new direction of growth. In this report we argue that the engineering and manufacturing of green technologies is an obvious candidate. If the world demands a green transition, why not produce it?

With an advanced industrial base in sectors such as energy, maritime industries, offshore engineering and process industries fuelled by green hydropower, the Norwegian economy might seem ready for a green industrial transition. But Norway faces a wicked policy paradox. On the one hand, reduced demand for petroleum, as a result of the global green transition, will mean that the country's main engine of growth must be replaced. On the other hand, several of Norway's foremost technological advantages are developed by the petroleum industry.

The carbon lock-in of this economy is exacerbated by path-dependent technological development and a tendency towards Dutch disease. Petroleum investments dwarf investments in other industries, attracting advanced skills to the sector. The innovation system is tied to incumbent industries, with little room for transformative innovations. The extraordinary profitability and export revenues of the oil and gas sector have inflated prices and wage growth in the rest of the economy, in turn creating challenges for other Norwegian exporters. Norway has been one of the biggest losers of international market shares in the OECD since the late 1990s and the non-oil trade deficit has been growing consistently over the last decade.⁴ Manufacturing's share of value-added is only half of what it is in the other Nordic countries.⁵ As for ambitious strategies and investments towards the green industrial transition, Norway is trailing other nations with more proactive approaches.

And the road ahead looks rocky. Investments in the nation's most important export industry are set to dwindle rapidly over the next decade. Over the previous decade, annual investments in the petroleum sector amounted to more than NOK 170 billion (about USD 17 billion) on average. Even without more restrictive petroleum policies, this level is estimated to fall by 60 billion NOK for the years 2025–2034, according to a recent report by Statistics Norway. In a scenario with restrictive extraction policies, the annual investment level in this sector could even fall to NOK 40 billion in 2029 (see Figure 1).

¹ Mariana Mazzucato. (2016). From market fixing to market-creating: A new framework for innovation policy. *Industry and Innovation*, 23(2) pp. 140–56. DOI: <https://doi.org/10.1080/13662716.2016.1146124>.

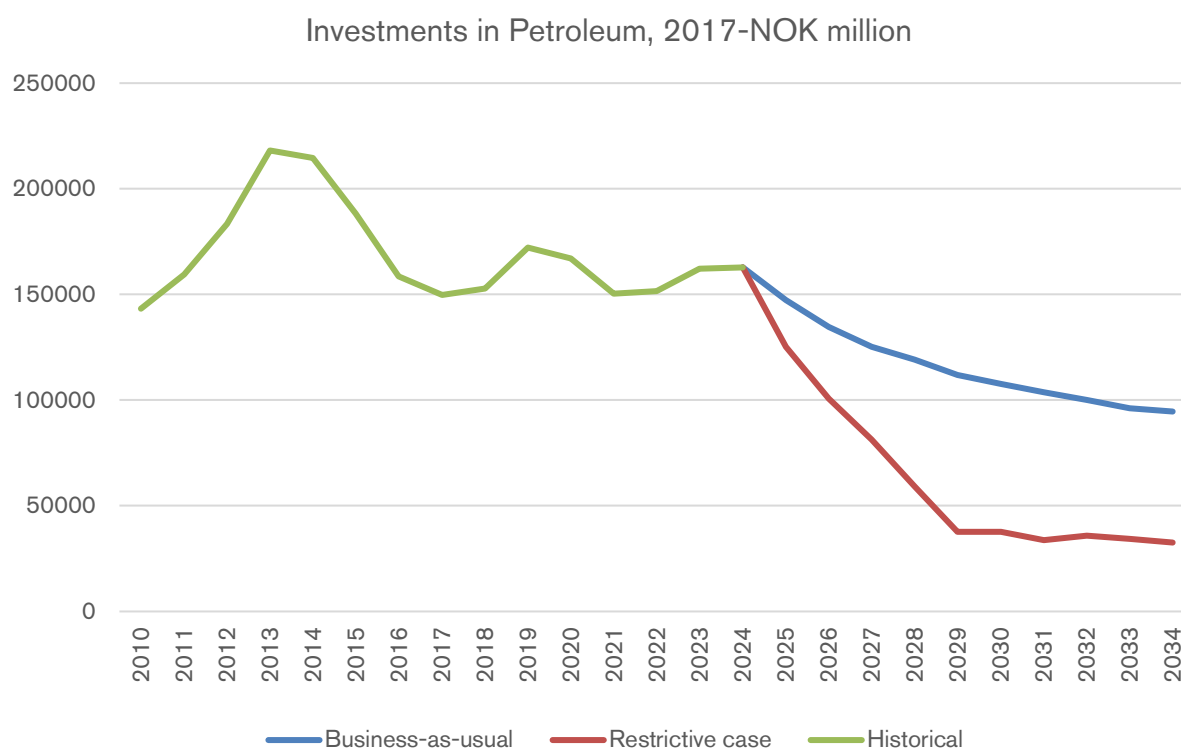
² Norsk Petroleum. Exports of Oil and Gas. Available at: <https://www.norskpetroleum.no/en/production-and-exports/exports-of-oil-and-gas/> (accessed: 2 December 2020).

³ Norsk Petroleum. The Government's Revenues. Available at: <https://www.norskpetroleum.no/en/economy/governments-revenues/> (accessed: 2 December 2020).

⁴ Sveinung Fjose et al. (2020). Kan Norge tette eksportgapet? Menon Economics. Available at: <https://www.menon.no/wp-content/uploads/2020/85-Kan-Norge-tette-eksportgapet.pdf>.

⁵ OECD. Value added by activity. Available at: <https://data.oecd.org/natincome/value-added-by-activity.htm> (accessed 2 December 2020).

Figure 1. Investment in petroleum in 2017 NOK (million)⁶



The dramatic scenario illustrated in this chart is double-edged. On the one hand, many jobs and prospects for industrial innovation may be lost. On the other hand, the engineers and workers involved in constructing offshore platforms for petroleum today could be constructing offshore wind power plants tomorrow. The same chart therefore implies that the capacity to absorb tens of billions of NOK in annual investments in green industrial development will be freed up in the real economy, at a time when international markets for green industrial technology are set to grow at record pace.

As Semieniuk and Mazzucato have shown, various predictions 'emphasise the need for investments to double or even triple over the next 15 to 25 years' in order to enable green transformation of the global economy.⁷ The increase implies compound annual growth rates that are several percentage points higher than recent historical rates. In order to produce 100% of electricity from renewables, the global economy needs investments in the amount of USD 5.5 trillion; low income and lower middle-income countries alone need investments in the range of USD 784 billion. Simply put, current green investment trends are insufficient. At the same time the global demand for green technologies offers opportunities for industrial development. Combining increased investment in the green shift with domestic industrial development provides a chance for a new path for the Norwegian economy.

Norway has significant capabilities at its disposal for action on this double challenge to the economy and the climate. Enormous financial resources held in the world's largest sovereign wealth fund, the Government Pension Fund Global, have been created out of the petroleum of the continental shelf. Yet today the fund plays almost no role in either domestic or global green transitions. In fact, quite to the contrary, a recent report has

⁶ Finn Roar Aune, Ådne Cappelen and Ståle Mæland. (2020). Konsekvenser av redusert petroleumsvirksomhet – Makroøkonomiske effekter av politiske tiltak for å redusere norsk produksjon av olje og gass. Statistics Norway. Available at: <https://www.ssb.no/nasjonalregnskap-og-konjunkturer/artikler-og-publikasjoner/konsekvenser-av-reduert-petroleumsvirksomhet>.

⁷ Gregor Semieniuk and Mariana Mazzucato. (2018). Financing Green Growth. UCL Institute for Innovation and Public Purpose Working Paper Series.

shown that 12 of the most devastating fossil fuel projects that are currently being planned or under development would use up three-quarters of the total remaining carbon budget if we are to have a 66% probability of limiting global warming to 1.5° Celsius. One of the most important funders of these projects is the Government Pension Fund Global.⁸ The fund can serve as an insurance for the current and future wellbeing of Norwegians only if it's invested into funding the productive assets of the future, not of the past.

The lessons of Norway's historic approach to industrial development may prove valuable. Norway has shown before its ability to adapt to a changing context. At defining points in history, the Norwegian state has taken on an entrepreneurial role and set a new direction of growth, through the development of hydropower 100 years ago and a petroleum industry 50 years ago. At both of these turning points the state fostered inclusive growth by watershed decisions, such as placing conditionalities on investors regarding resource ownership and local industrial development, attaining technological sovereignty by investing in science and innovation, supplying industries with patient capital and utilising the tools of state ownership to confront the grand challenges of that day and age.

Today, the green transition could be Norway's third industrial turning point, defining the country's prospects for inclusive growth and sustainable prosperity for decades to come. A turn from the export of fossil fuels to the export of green technologies would be a sea change in Norway's role in the global climate effort. Putting its industrial capacity and financial strength to use in the green transition could turn the country from a 'Fossil Ogre' to a 'Green Giant'.

In this report we outline a green industrial strategy for Norway, where the state takes on an active role in investing and coordinating the shift from a fossil-driven to a green engine in the Norwegian economy.

We argue that through well-defined goals or 'missions' focused on the various aspects of the green transformation, Norwegian policymakers have the opportunity to determine the *direction* of growth by making strategic investments, coordinating actions across many different sectors and nurturing new industrial landscapes that the private sector can develop further.⁹ Such a market-shaping approach is not about top-down planning by an overbearing state; it is about providing a direction for growth, increasing business expectations about future growth areas and catalysing activity that otherwise would not happen. It is not about de-risking and levelling the playing field, nor about supporting more competitive sectors over less, since the market does not always know best, but about tilting the playing field in the direction of the desired societal goals, such as the just green transition.

Norway should develop a mission-oriented green investment strategy that may require several new policies and institutions:

A Green Industrial Investment Bank. The Norwegian government should establish a Green Industrial Investment Bank which will channel public investments into green industries and in the process mobilise private capital. The bank will identify investment opportunities along the entire innovation/production chain that can spur green industrial development and promote competitiveness, as well as experimentation, from below. The bank should have a strong regional presence and mandate, and place necessary conditionalities on investments to safeguard labour standards and environmental considerations.

A Norwegian Bank for Sustainable International Cooperation. With a mandate to multiply and develop green investments abroad, a Norwegian Bank for Sustainable International Cooperation (NBSIC) should be established. The NBSIC could be a fully owned subsidiary of the Green Industrial Investment Bank. It will have a double mandate: to invest internationally in technologies that bring down greenhouse gas emissions at the

⁸ Urgewald. (2020). Five Years Lost. How Finance is Blowing the Paris Carbon Budget. Available at: <https://urgewald.org/sites/default/files/media-files/FiveYearsLostReport.pdf>.

⁹ Mariana Mazzucato and Caetano C. R. Penna. (2016). Beyond market failures: The market creating and shaping roles of state investment banks. *Journal of Economic Policy Reform*, 19(4) pp. 305–26 DOI: <https://doi.org/10.1080/17487870.2016.1216416>.

global level, and contribute to the success of Norwegian exporters who foster sustainable, green industrial jobs at the local and national level. Conditionalities will be important to ensure that economic development and international cooperation considers labour and environmental conditions, and the distribution of risks and rewards.

A revised fiscal rule for the green industrial transition. To finance large public investments in the green industrial transition and, rather than merely capitalising the Oil Fund further, the cash flow could be directed towards capitalising the Green Investment Bank and other relevant institutions. The current fiscal rule – developed with the purpose of shielding the public finances from the volatilities of the petroleum revenue – should not be a blockage for the policy development needed to deal with the economic challenges of today. To cover the need for investment, a number of financing routes could be considered so that public investments are adapted to the needs of the economy rather than the economy is adapted to the needs of the fiscal rule. **The fiscal rule has served the purpose of economic stability, but might need revision now that Norway's economy needs dynamic change.**

A mission-oriented policy for state-owned enterprises. So that these firms may contribute towards green industrial development, a mission-oriented policy for state-owned enterprises should be introduced. The Norwegian state has successfully used state-owned enterprises (SOEs) to promote industrial policy and innovation in several historical phases. To enable the green transition, the state should be ready to establish new renewable energy companies, as it did with Statoil in the petroleum industry. SOEs engaged in industries that are relevant for the green transition should be given new mission-oriented mandates.

Make Equinor a mission-oriented state-owned company. We recommend taking Equinor off the stock market. It should be evaluated whether it is necessary to move Norway's most important company into the state ownership category 3, which stipulates that the public ownership is used for achieving key policy goals. Companies such as Petoro, Gassnova, Nye Veier and Norfund are already in this category. This would enable a reorientation of the company away from value extraction and towards green value creation.

A Green Industrial State Holding Company. Norway's state ownership needs to be more efficient and coordinated if it is to help navigate the difficult green industrial transition. In order to facilitate coordination between the relevant companies and resources, and find cross-sectoral synergies, the government could establish a Green Industrial State Holding Company. The company should not be a passive financial actor, but an active player in strategic industrial coordination and development.

PART II:

ECONOMIC CONTEXT AND POLICY FRAMEWORK

2. The Norwegian context

As the economist Carlota Perez has shown, capitalism evolves through periodic technological revolutions that reshape the economy.¹⁰ Finance and technology are key ingredients in this process, co-shaped by public policy: "While each revolution brings a paradigm shift in the direction of innovation and the general criteria for competitiveness, it is ultimately the social forces and their institutions that define what part of that new opportunity space will be deployed and how."¹¹

Norway's industrialisation is a case in point, in particular the turn towards electrification following independence. Here public institutional innovations enabled the private investment boom: the concession laws of 1909 ruled that private developers of hydropower and related industrial production had to purchase licenses for access to the resources. Through the *hjemfallsretten* clause, these installations would fall into public ownership after the end of the licensing period, without remuneration for the investors.¹² An important motivation was the desire for the public control of the natural resources, as Norway became an independent country after the end of the Swedish-Norwegian Union in 1905.¹³ After WWII, the expansion of hydropower installations was the centrepiece of the Labour Party's industrialisation drive.

The current approach to innovation and industrial development in Norway is characterised by strong path dependence originating in the developmentalist petroleum policy of previous decades. During the initial phase of oil adventure, the government was keen to ensure domestic industrial development based on the petroleum reserves. In recent decades, policy development has focused more on reducing the state's direction-setting capabilities while investments in the petroleum sector have been allowed to grow; Norway has become focused on the status quo.¹⁴ The current institutional landscape is heavily petroleum-oriented and the private sector is not capable of delivering the green transition alone. While the Norwegian oil and gas industry has had several so-called 'green flings' in offshore wind, this has been a viable alternative when the price of oil has fallen, only to be reversed when the oil price rose again.¹⁵

2.1 The Oil Fund and the fiscal rule

The fiscal rule (*handlingsregelen*) established in 2001 has been an important policy innovation for managing the large and volatile petroleum revenue. The fiscal rule states that the revenue from petroleum activities must be transferred into an oil fund, invested abroad.¹⁶ The oil revenue is then phased into the economy as the fund is tapped at an annual rate that should average 3% of the fund's worth. With a 3% expected rate of return for the fund, it can be tapped at this rate without ever being depleted. This policy invention has helped balance a high tempo in petroleum extraction with limited inflationary pressure, enabled a gradual phasing in of the oil revenue into the Norwegian economy, and gives the state an extra source of revenue for its budget.

¹⁰ Carlota Perez. (2002). *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*. Cheltenham: Edward Elgar Publishing Ltd; Carlota Perez and Tamsin Murray Leach. (2018). *A Smart Green 'European Way of Life': The Path for Growth, Jobs and Wellbeing*. *Beyond the Technological Revolution Working Papers*. Available at: <http://beyondthetechrevolution.com/workingpaper/>.

¹¹ Perez and Murray Leach. (2018). *A Smart Green 'European Way of Life': The Path for Growth, Jobs and Wellbeing*.

¹² Per Einar Faugli. (2020). «Elektrisitetens forvaltningshistorie 1877-1921», Norges vassdrags- og energidirektorat.

¹³ Einar Lie. (2012). *Norsk økonomisk politikk etter 1905*. Oslo: Universitetsforlaget, pp. 23-24.

¹⁴ Erik S. Reinert. (2001). *Norway between King Midas and King Status Quo*. In: *Something Rotten in the State of Norway*. UKS Forum for Contemporary Art, 1-2, pp. 114–23.

¹⁵ Tuukka Mäkitie et al. (2019). *The green flings: Norwegian oil and gas industry's engagement in offshore wind power*. *Energy Policy* 127, pp. 269-279. DOI: <https://doi.org/10.1016/j.enpol.2018.12.015>.

¹⁶ Sashi Sivramkrishna. (2019). *Paradox of plenty: Norway's macroeconomic policy dilemmas during the oil price crash, 2014-15*. *Journal of Post Keynesian Economics*, 42:2, pp. 191-214. DOI: 10.1080/01603477.2018.1533413.

While the Oil Fund and the fiscal rule have enjoyed broad political support in Norway, concerns have been raised that the system has allowed a petroleum bubble to go unnoticed.¹⁷ Another concern is that elements of the fiscal rule may be outdated. This rule was made to safeguard stability, whereas what the Norwegian economy needs now is patient long-term finance for large-scale dynamic change to increase the economic diversity. The fiscal rule enables large public gross investments in the petroleum industry to be kept outside the normal government budget. This system fuels the current petroleum-determined path dependence. As a petroleum-dominated Norwegian economy stands on the brink of the green transition, it may be wise to rethink rules and regulations that were put in place to preserve the status quo. As the context changes, so should policy.

There is an emerging consensus that Norway needs to increase its efforts in the green industrial transition. Several evaluations and reports commissioned by the government as well as other institutions have found that Norway needs to both improve competitiveness and green the economy.¹⁸ Neighbouring countries such as Denmark and Sweden have turned towards more activist industrial policies and green export promotion activities while Norway pursues a more passive approach.¹⁹ Norway also needs to reduce its dependence on petroleum and improve the measures by which the state supports green industrial development. It is less clear whether such a break with the current path is possible within the current fiscal framework.

2.2 Future green industrial base

A number of sectors have been identified as potential high-growth green sectors by the Confederation of Norwegian Enterprise (CNE). These are offshore wind, hydrogen (which is related to carbon capture and storage), emission-free shipping and batteries.²⁰ Of course, other sectors have the potential for a shift into green production processes and technologies, but in this section we will outline the potential of the sectors highlighted by the CNE.

Offshore wind

Technologically, Norway has been an early mover within the floating offshore wind energy sector,²¹ which has the potential to unlock vast areas for renewable energy generation unavailable for bottom-fixed offshore wind. Norway is also well positioned geographically with a floating offshore wind potential among the largest in the

¹⁷ Knut Anton Mork. Etter oljen: utfordringer for norsk økonomi. Centre for Monetary Economics BI Business School Working Paper Series 2/13. Available at: <http://home.bi.no/fag87025/pdf/2013%2002%20WP%20Etter%20oljen.pdf> (accessed: 16 November 2020).

¹⁸ Ekspertutvalg for grønn konkurransekraft. (2016). Grønn konkurransekraft. Available at: <https://www.regjeringen.no/contentassets/02d09ccf18654070bc52e3773b9edbe1/t-1557b.pdf> (accessed: 25 October 2020); Deloitte. (2019). Områdesgjennomgang av det næringsrettede virkemiddelapparatet. Available at: <https://www.regjeringen.no/contentassets/0f8355831ed346c38fba23362eaa59be/helhetlig-anbefaling-om-innretning-og-organisering-av-det-naringsrettede-virkemiddelapparatet.pdf> (accessed: 25 October 2020); Regjeringen.no. (2019). Deloitte skal gå gjennom virkemidlene. Available at: <https://www.regjeringen.no/no/aktuelt/deloitte-skal-ga-gjennom-virkemidlene/id2624195/> (accessed: 2 November 2020).

Klimaomstillingsutvalget. (2020). Raskere klimaomstilling – Redusert risiko. Available at: <https://www.klimaomstillingsutvalget.no/wp-content/uploads/2020/09/Klimaomstillingsutvalgsrapport-2020.pdf> (accessed: 10 October 2020).

¹⁹ Sveinung Fjose et al. (2020). Kan Norge tette eksportgapet? Menon Economics. Available at: <https://www.menon.no/wp-content/uploads/2020-85-Kan-Norge-tette-eksportgapet.pdf>.

²⁰ Ivar Valstad, Mari Grooss Viddal, Kristian Blindheim, Halvor Hoen Hersleth, Kjell Øren and Therese Bakke Lossius. (2020). Norske muligheter i grønne elektriske verdikjedjer. Styringskomiteen for Grønne Elektriske Verdikjedjer, 52. https://www.nho.no/siteassets/veikart/rapporter/gronne-elektriske-verdikjedjer_final.pdf.

²¹ Equinor. Hywind Tampen - verdens første fornybare kraftkilde for olje- og gassvirksomhet til havs. Available at: <https://www.equinor.com/no/what-we-do/hywind-tampen.html> (accessed: 2 December 2020).

world.²² In 2017, Sintef estimated that Norwegian offshore wind (floating and bottom-fixed) has an export potential of NOK 50 billion and 24 000 jobs by 2030, and double that by 2050.²³

The UK has set a goal of 30 GW offshore wind generation by 2030.²⁴ Denmark, already well ahead of Norway, has already approved a €37 billion package for development of an extra 12 GW.²⁵ A leaked draft EU strategy shows that the EU aims to develop 60 GW by 2030 and 300 GW by 2050.²⁶ At the time of writing, Norway has yet to set goals for offshore wind development. Nor has a financing scheme or necessary regulations for offshore wind been established.

While industrial companies and climate activists are impatient, the government has been slow to act. In 2019, Norwegian researchers pointed out that, “What has happened in the industry so far has been ‘bottom-up’. There haven’t been any publicly led initiatives.”²⁷ Political authorities have not established a domestic market that could facilitate the demonstration and industrialisation of technologies developed by Norwegian companies. This hesitation only serves to exacerbate Norway’s petroleum lock-in and industrial path dependency.²⁸

Rapid offshore wind development requires active state involvement along the whole value chain, including target-setting, investment and credit direction, as well as financing of R&D. Such directionality is currently missing.²⁹

Hydrogen

The global market for hydrogen as an energy carrier for industrial processes and transportation is expected to increase dramatically as fossil-based technologies are phased out. Norway has optimal conditions for both the major methods for producing hydrogen: through electrolysis, which requires huge amounts of (renewable) energy, and by applying carbon capture and storage (CCS – more on this below) to fossil gas.

This sector is ripe with potential synergies. Large-scale production of green hydrogen would expand the market for electricity from offshore wind power plants, while the commissioning of emission-free sea vessels could provide a burgeoning market for hydrogen. McKinsey estimates that the Norwegian market share for hydrogen can reach €1 billion by 2030 and between €4 and €20 billion by 2050.³⁰ A number of firms currently developing hydrogen technology estimate that more than 10 000 jobs can be created in the sector with the right policies in place.³¹

²² Jonathan Bosch, Iain Staffell and Adam D. Hawkes. (2018). Temporally explicit and spatially resolved global offshore wind energy potentials. *Energy*, 163, pp. 766-781. DOI: <https://doi.org/10.1016/j.energy.2018.08.153>.

²³ Petter Støa et al. (2019). Energi og Industri: Mulighetsrom verdikjeder - NHO Veikart for fremtidens næringsliv. Sintef (2019): 57. Available at: https://www.nho.no/contentassets/998441bd312b471e964a6d9ea022afe8/sintef-rapport-2019_01139_energi-og-industri.pdf.

²⁴ Department for Business, Energy and Industrial Strategy. (2020). Offshore wind Sector Deal. Policy paper. Available at: <https://www.gov.uk/government/publications/offshore-wind-sector-deal/offshore-wind-sector-deal>.

²⁵ Leslie Hook. (2020). Denmark reinforces green commitment with ‘energy islands’ plan. *Financial Times*. Available at: <https://www.ft.com/content/8a44c322-b9ae-4deb-ba59-3d1068363143>.

²⁶ Daniel Boffey. (2020). EU plans to increase offshore windfarm capacity 25-fold. *Guardian*. Available at: <https://www.theguardian.com/environment/2020/nov/16/eu-plans-increase-offshore-windfarm-capacity>.

²⁷ Erik Martiniussen (2019). Bare 13 norske selskaper satser dedikert på havvind. *Teknisk Ukeblad*. Available at: <https://www.tu.no/artikler/bare-13-norske-selskaper-satser-dedikert-pa-havvind/465173>

²⁸ Ibid.

²⁹ Jens Hanson and Hakon Endresen Normann (eds.). (2019). Conditions for growth in the Norwegian offshore wind industry. Centre for Sustainable Energy Studies. Available at: <https://www.ntnu.no/documents/7414984/0/CenSES-Offshore-wind-report-v9-digital.pdf/749a6503-d342-46f2-973e-eb9714572931>.

³⁰ Ivar Valstad, Mari Grooss Viddal, Kristian Blindheim, Halvor Hoen Hersleth, Kjell Øren and Therese Bakke Lossius. (2020). Norske muligheter i grønne elektriske verdikjeder. Styringskomiteen for Grønne Elektriske Verdikjeder, 58. Available at: https://www.nho.no/siteassets/veikart/rapporter/gronne-elektriske-verdikjeder_final.pdf

³¹ Christian Rynning-Tønnesen, Tove Andersen, Karl-Petter Løken, Jon Erik Engeset, Vegard Frihammer and Jon André Løkke. (2020). Hydrogen kan bli Norges neste industrieventyr. *Finansavisen*. Available at: <https://finansavisen.no/nyheter/debattinnlegg/2020/04/20/7519088/hydrogen-kan-bli-norges-neste-industrieventyr>.

Several European countries have already launched green hydrogen strategies. Germany is to spend €9 billion, Spain €8.9 billion³² and France €7 billion³³ over the next years on their respective plans, which include R&D, technology development and market creation. The rapid development of a hydrogen-related sector in Norway will require a holistic approach to directional market shaping and the coordination of different industrial sectors. As of yet, no such strategy is in place. The foremost measure, at the time of writing, is probably the government's plan to demand low-emission technology in procurement processes for domestic ferries from 2023,³⁴ following a motion passed by Parliament in 2015.

Symptomatically, Norway's development of the hydrogen sector suffers from what the industry itself calls a chicken-and-egg problem: neither consumers nor producers dare make the investments necessary for a shift to hydrogen due to a lack of a long-term predictability. According to the Federation of Norwegian Industries, "Necessary long-term predictability can only be solved through active public participation."³⁵ This could include measures such as the patient and committed financing of technological innovation and industrial development, as well as public procurement, regulation, taxation and the promotion of exports. An effective strategy would also need to coordinate policies across sectors, to reap potential synergies. This points towards the need for a broad, mission-oriented policy for the green industrial transition, in which hydrogen could be an important component.

Carbon capture and storage

Several industrial processes, such as the production of cement and waste management, may not become emission-free without technologies of carbon capture and storage (CCS). CCS can also be used to produce so-called 'blue hydrogen' from fossil gas, although this entails risks related to methane leaks. Sintef estimates that carbon capture "will strengthen the competitiveness" of 80-90 000 jobs in Norway and can create up to 70 000 new jobs by 2050, including blue hydrogen production and ripple effects.³⁶ These numbers are highly uncertain, especially as it is yet unclear whether there will be much of a market for blue hydrogen in the EU.

In 2020, the Norwegian government moved to support the development of carbon capture and storage, investing NOK 16.8 billion in the "Longship" programme which will capture emissions at a cement plant and eventually at a waste management facility, and transport it to be stored in the North Sea.³⁷ This should be the first step towards a long-term strategy.

Public procurement will be an important tool for creating a market for CCS. The state purchases large quantities of cement and concrete for buildings and could use this channel for market creation, as well as taxes and regulations. Technology costs will have to be brought down through innovation and economies of scale,

³² Isla Binnie. (2020). Spain approves hydrogen strategy to spur low-carbon economy. Reuters. Available at: <https://www.reuters.com/article/us-spain-energy-hydrogen-idUSKBN26R2AF>.

³³ Ministère de l'économie, des finances et de la relance. (2020). Recovery Plan. Available at: <https://www.gouvernement.fr/sites/default/files/locale/piece-jointe/2020/09/french-recovery-plan-press-kit.pdf>.

³⁴ Hallvard Norum and Eivind Molde. (2020). "tiller krav om lav- eller nullutslippsferger innen 2023. NRK. Available at: <https://www.nrk.no/norge/stiller-krav-om-lav-eller-nullutslippsferger-innen-2023-1.15261914>.

³⁵ Jørn Kristian Lindtvedt et al. (2020). Hydrogen. Norsk Industri Olje og Gass: 9. Available at: <https://www.norskindustri.no/siteassets/dokumenter/rapporter-og-brosjyrer/2020-10-14-hydrogen.pdf>

³⁶ Sigmund Ø. Størset, Grethe Tangen, Ove Wolfgang and Gunnar Sand. (2018). Industrielle muligheter og arbeidsplasser ved CO₂-håndtering i Norge. Sintef: 4. <https://www.nho.no/contentassets/e41282b08ceb49f18b63d0f4cc9c5270/industrielle-muligheter-og-arbeidsplasser-ved-storskala-co2-handtering-i-norge.pdf>.

³⁷ Norwegian Government. (2020). The Government launches 'Longship' for carbon capture and storage in Norway. Available at: <https://www.regjeringen.no/en/aktuelt/the-government-launches-longship-for-carbon-capture-and-storage-in-norway/id2765288/>.

and transport costs through greater deployment.³⁸ CCS development will require coordination and cooperation between a number of actors and investment support.

Maritime industry

Shipping could be emission free. Batteries, hydrogen and ammonia have the potential to be energy carriers for different segments of seaborne transport. Norway is a significant player in the global shipping market, with a large number of ferries in domestic transport and Norwegian firms owning 7% of the world's vessels. McKinsey estimates that the Norwegian market for low-emission and emission-free maritime industry can reach €5 billion by 2030 and between €17 and 53 billion in 2050. Mostly, this will not be new jobs, but preserving the existing ship-building industry.³⁹

Requirements for low emissions in ferry transport by 2023, as announced by the government, could be an important first step towards an ambitious green industrial policy for the maritime sector. But the current approach is more focused on reducing domestic emissions than shifting productive capacity towards green technology. The public agency Enova has provided NOK 119 million in support for two autonomous electric ferries which will sail the Oslo fjord, but these Norwegian constructions are being built at an Indian shipyard.⁴⁰

The development of Norway's maritime industry would benefit from a better integration of climate policy and industrial policy, including an active procurement process supporting green technologies retrofitting and fleet renewal schemes, and investments in research and development, but also greater access to capital and more active export promotion. Today, 30% of revenue in the green maritime industry is based on exports, compared to 50% for the maritime industry as a whole.⁴¹

Batteries

The global demand for batteries is expected to grow significantly in the coming years as energy storage enables smoothening of renewable energy supply and electrification of transportation. Norway is well positioned to capture a large share of this growing market. Raw materials used in lithium batteries can be sourced in Norway or in the other Nordic countries, and hydropower provides Norwegian producers with access to reliable and renewable energy.⁴²

According to McKinsey, Norway can capture a market share within battery production of €9 billion by 2030 and €13 to 36 billion by 2050.⁴³ Sintef estimates that battery production in Norway is currently valued at NOK 800 million, but can reach NOK 10 billion and support 7 000 jobs by 2030, and NOK 50 billion by 2050 and 15 000 jobs.⁴⁴

³⁸ Ofélia de Queiroz Fernandes Araújo and José Luiz de Medeiros. (2017). Carbon capture and storage technologies: present scenario and drivers of innovation. *Current Opinion in Chemical Engineering*, Vol. 17, pp. 22-34. DOI: <https://doi.org/10.1016/j.coche.2017.05.004>.

³⁹ Ivar Valstad, Mari Grooss Viddal, Kristian Blindheim, Halvor Hoen Hersleth, Kjell Øren and Therese Bakke Lossius. (2020). Norske muligheter i grønne elektriske verdikjedjer. Styringskomiteen for Grønne Elektriske Verdikjedjer, 64. https://www.nho.no/siteassets/veikart/rapporter/gronne-elektriske-verdikjedjer_final.pdf.

⁴⁰ Tore Stensvold. (2020). Asko bygger autonome og elektriske sjødroner i India. *Teknisk Ukeblad*. Available at: <https://www.tu.no/artikler/asko-bygger-autonome-og-elektriske-sjodroner-i-india/497807?key=d29RR1aM>.

⁴¹ Kirsten Ånestad Øystese. (2020). Grønn skipsfart: Utslippene må i null i 2050. *Norsk Klimastiftelse*, 43. Available at: https://klimastiftelsen.no/wp-content/uploads/2020/01/NK1_2020_gronn_skipsfart.pdf.

⁴² Karl A. Almås, Maria Barrio, Vincent Wego Fleischer, Petter Haugan and Gunnar Sand (eds.). (2019). Nye muligheter for verdiskaping i Norge. Sintef, 32-33. Available at: <https://www.sintef.no/contentassets/5818f12cfe5a477e96221b99cf154500/rapport-nye-muligheter-for-verdiskaping-i-norge.pdf/>.

⁴³ Ivar Valstad, Mari Grooss Viddal, Kristian Blindheim, Halvor Hoen Hersleth, Kjell Øren and Therese Bakke Lossius. (2020). Norske muligheter i grønne elektriske verdikjedjer. Styringskomiteen for Grønne Elektriske Verdikjedjer, 52. https://www.nho.no/siteassets/veikart/rapporter/gronne-elektriske-verdikjedjer_final.pdf.

⁴⁴ Karl A. Almås, Maria Barrio, Vincent Wego Fleischer, Petter Haugan and Gunnar Sand (eds.). (2019). Nye muligheter for verdiskaping i Norge. Sintef, 32. Available at: <https://www.sintef.no/contentassets/5818f12cfe5a477e96221b99cf154500/rapport-nye-muligheter-for-verdiskaping-i-norge.pdf/>.

The growing market for batteries will create a number of relevant segments for Norwegian industries, from production to recycling. Panasonic is eyeing investments in a new plant in Norway, in collaboration with Equinor and Norsk Hydro,⁴⁵ and Swedish Northvolt has established a joint venture with Norsk Hydro for a car battery recycling plant.⁴⁶ The Norwegian firm Freyr is planning a battery plant in Mo i Rana, and will collaborate with Sintef and the Norwegian University of Science and Technology for related research and training.⁴⁷ Such developments show the potential of a green industrial strategy.

For Norway to develop its battery sector and take significant market shares, this sector needs research and development, and related training, as well as long-term and patient capital. Development of new plants will require more renewable energy for industrial processes. In their scenario for 2050, Sintef estimate that four-fifths of Norwegian battery production will be related to exports,⁴⁸ which highlights the need for export orientation and export promotion.

In order to take advantage of the new emerging green industrial opportunities, we argue Norway needs to build a new industrial policy focussed on a proactive approach on both the supply side and the demand side, and investment along the entire innovation chain, from basic research to full deployment of new technologies.

⁴⁵ Kana Inagaki and Richard Milne. (2020). Tesla supplier Panasonic to make big battery bet in Europe. Financial Times. Available at: <https://www.ft.com/content/91ad24ec-87f7-4228-99a5-cc99e78adbaa>.

⁴⁶ Richard Milne. (2020). Northvolt and Norsk Hydro to build car battery recycling plant. Financial Times. Available at: <https://www.ft.com/content/4bf84bbd-c4e2-48bb-920a-172805b9e594>.

⁴⁷ Freyr AS. (2019). Freyr AS announces plans to build a 32 GWh battery cell production facility in Mo i Rana in Norway and partners with SINTEF and NTNU. Available at: <https://news.cision.com/freyr/r/freyr-as-announces-plans-to-build-a-32-gwh-battery-cell-production-facility-in-mo-i-rana-in-norway-a.c2779883>.

⁴⁸ Karl A. Almås, Maria Barrio, Vincent Wego Fleischer, Petter Haugan and Gunnar Sand (eds.) (2019). Nye muligheter for verdiskaping i Norge. Sintef, 32. Available at: <https://www.sintef.no/contentassets/5818f12cfe5a477e96221b99cf154500/rapport-nye-muligheter-for-verdiskaping-i-norge.pdf/>.

3. New industrial policy framework: the mission-oriented approach

Moving to a greener low carbon economy means redirecting all sectors and all actors – public, private and civil society – towards economic growth in a sustainable and inclusive direction. However, such challenge-led growth requires a new toolkit; one that is more based on market shaping and market co-creating.⁴⁹

Directing investment into green industrial development rather than petroleum will not be profitable from a static short-term perspective. Ground rent gives rise to a very high value-added per employee in the petroleum sector, making non-strategic sunset industries highly profitable in the short term. Therefore, green industrial development is not about maximising value-added in the short term. Instead, a green industrial strategy is about developing technology and innovation that can help solve the climate crisis while capturing shares in markets that will expand as the global green transition progresses. The plummeting costs of renewable energy have been driven by mission-oriented investment and innovation by countries such as China, Denmark and Germany.⁵⁰ By accelerating zero-emission technologies along their learning curves, Norway can utilise first-mover advantages within such key sectors and develop necessary technologies for the global green shift.

Markets will not find a green direction on their own. There is not yet a ready-made route that will make multi-directional, experimental, green innovation profitable. Business does not invest unless it sees an opportunity for growth, so turning mitigation into opportunities for investment and innovation is key. Governments cannot micromanage this process as that would stifle innovation, but they can set a clear direction, make the initial high-risk bold investments which crowd in private actors later on and reward those who are willing to invest and innovate. Through proactive policymaking that encourages innovation and learning, creates and expands markets and ensures long-term predictability, costs of green technologies can be reduced. Dynamic policy that over time pushes down costs in strategic green industries therefore lies at the heart of green industrial development.

3.1 The market-failure approach

The dominant approach to public policy is derived from neoclassical economic theory, in particular microeconomic theory and welfare economics.⁵¹ This approach emphasises the idea of 'market failures' that arise when there are information asymmetries, transaction costs and frictions to smooth exchange, non-competitive markets (e.g. monopolies) or externalities whereby an activity harms another agent not directly connected with the market transaction (e.g. pollution), or coordination and information failures hamper investment.⁵²

The market-failure perspective creates a particular orientation towards innovation, industrial policy and structural economic change, as is required for the green transition. While certain elements of innovation policy, in particular early-stage R&D, can be considered to be public goods and thus a case for public policy provision

⁴⁹ Mariana Mazzucato. (2017). Mission-Oriented Innovation Policy. UCL Institute for Innovation and Public Purpose (IIPP) Working Paper Series: IIPP WP 2017-01. Available at: <https://www.ucl.ac.uk/bartlett/public-purpose/publications/2017/sep/mission-oriented-innovation-policy-challenges-and-opportunities>.

⁵⁰ Tom Jennings, Helen Andrews Tipper, Jonathan Daghish, Michael Grubb and Paul Drummond. (2020). Policy, innovation and cost reduction in UK offshore wind. Carbon Brief. Available at: <https://prod-drupal-files.storage.googleapis.com/documents/resource/public/Policy-innovation-offshore-wind-report-2020.pdf>; John A. Mathews and Erik S. Reinert. (2014). Renewables, manufacturing and green growth: Energy strategies based on capturing increasing returns. *Futures*, 61, pp. 13-22. DOI: <https://doi.org/10.1016/j.futures.2014.04.011>.

⁵¹ Mariana Mazzucato and Josh Ryan-Collins. (2019). Putting Value Creation Back into 'Public Value': From Market-Fixing to Market-Shaping. UCL Institute for Innovation and Public Purpose, Working Paper Series. Available at: <https://www.ucl.ac.uk/bartlett/public-purpose/publications/2019/jun/putting-value-creation-back-public-value-market-fixing-market-shaping>.

⁵² Dani Rodrik. (1996). Coordination failures and government policy: A model with applications to East Asia and Eastern Europe. *Journal of International Economics*, 40(1), pp. 1–22. Available at: [https://doi.org/10.1016/0022-1996\(95\)01386-5](https://doi.org/10.1016/0022-1996(95)01386-5).

can be justified, in the main it is assumed that the private sector is the more efficient innovator, possessing greater entrepreneurial capacity and better able to take risks given the pressure created by competition. In contrast, the state is viewed as risk-averse and in danger of creating government failure if it becomes too involved in industrial policy by 'picking winners'. The perception is its role is to level the playing field for commercial actors—mostly through supply-side inputs such as better skills or the removal of market frictions—and then get out of the way. This has led to rather diverse debates and the development of policy practices aimed at finding ever more precise *policy targets* through better measurement of failures and of the impact of policies trying to fix those failures. Such a targeted approach has led to an intense focus on the effectiveness of single policies, rather than evaluating the impact of policy mixes and public investment portfolios.⁵³ Indeed, as argued by Reinert, Rodrik and others, policy discussions, in particular, should focus on 'heterodox' policy approaches that recognise both market and government imperfections and failures—as well as the fact that it is impossible or even undesirable to attempt to remove all of them at once—and the need for policies that support scale economies, dynamic learning effects and cross-sectoral spill-overs.⁵⁴

3.2 The mission-oriented approach

While President Kennedy's moonshot is the best-known example of a mission-oriented policy, governments across the world in the 1960s seem to have been open to such bold policies. The first-generation mission-oriented policies followed a 'big science meets big problems' maxim that worked spectacularly well in some instances (e.g. the space race and the internet), but in others created inertia or, worse, long-term problems (e.g. nuclear energy). Importantly, the success of mission-oriented policies relied on innovative institutional solutions (e.g. creating demand for new solutions through procurement, prize schemes or similar) and mission-oriented agencies (such as DARPA and related procurement programmes in the US).⁵⁵

In contrast to previous generations of mission-oriented policies, the current missions focus on increasing the social responsiveness of science and innovation, and economic policy in general.

Rather than concentrating on a specific sector (such as energy) or technology (such as nuclear), as was often the case in the previous generation, current attempts are characterised by a deliberate cross-sectoral focus.⁵⁶

The role of the state is key here since it is the only institution with the power to shape markets and direct economic activity in socially desirable directions—or 'missions'—to achieve publicly accepted outcomes. This is especially true in Norway, where the state has historically had a key role in industrial development in the two 'industrial adventures' of harnessing hydropower, and the extraction of oil and gas. The state also has a role in distributing risks and rewards associated with innovation and industrial development. While the innovation

⁵³ Jakob Edler et al. (2016). Handbook of Innovation Policy Impact.

⁵⁴ Dani Rodrik. (2009). One Economics, Many Recipes. Available at:

<https://press.princeton.edu/books/paperback/9780691141176/one-economics-many-recipes>; Erik Reinert. (2008). How Rich Countries Got Rich . . . and Why Poor Countries Stay Poor. New York: PublicAffairs.

⁵⁵ Mariana Mazzucato. (2013). The Entrepreneurial State. Anthem.

⁵⁶ Mariana Mazzucato. (2017). Mission-Oriented Innovation Policy. UCL Institute for Innovation and Public Purpose (IIPP) Working Paper Series: IIPP WP 2017-01. Available at: <https://www.ucl.ac.uk/bartlett/public-purpose/publications/2017/sep/mission-oriented-innovation-policy-challenges-and-opportunities>; Jan Fagerberg. (2018). Mission (Im)Possible? The Role of Innovation (and Innovation Policy) in Supporting Structural Change and Sustainability Transitions. Working Papers on Innovation Studies. Centre for Technology, Innovation and Culture, University of Oslo. Available at: <https://ideas.repec.org/p/tik/inowpp/20180216.html>; Susana Borrás and Jakob Edler. (2020). The roles of the state in the governance of socio-technical systems' transformation. Research Policy, 49(5)1: 03971. Available at: <https://doi.org/10.1016/j.respol.2020.103971>; Johan Schot and W. Edward Steinmueller. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. Research Policy, 47(9), pp. 1554–67. Available at: <https://doi.org/10.1016/j.respol.2018.08.011>; Marko P. Hekkert et al. (2020). Mission-oriented innovation systems. Environmental Innovation and Societal Transitions, 34, pp. 76–79. Available at: <https://doi.org/10.1016/j.eist.2019.11.011>.

process is cumulative, collective and uncertain, the rewards from such innovation is increasingly distributed in fewer hands based on an ideology of maximising shareholder value. As the state contributes capital and workers contribute labour to the innovation process, such stakeholders should also participate in sharing the rewards.⁵⁷ On the brink of the green industrial transition, which could be the third such turning point in Norway's economic history, the state needs to play an entrepreneurial role and pave the way for the transition of the economy.

We believe a mission-oriented approach to green transition offers Norwegian policy makers an opportunity to join up policies targeting efficiency increases in current petroleum industries, diversifying the Norwegian economy and innovation system towards de-carbonised economic activities. **The overarching mission of the new industrial strategy could be to make Norway a leading investor in the global green transition and, in the process, turn the country into an innovation-driven green industrial powerhouse – the Green Giant.**

In the following section we outline a mission-oriented industrial strategy that focuses on 'greening' its public investments via both creating new mission-oriented public coordination and investment institutions, and reframing existing public financial and fiscal institutions and regulations to serve the green mission.

⁵⁷ William Lazonick and Mariana Mazzucato. (2013). The risk-reward nexus in the innovation-inequality relationship: who takes the risks? Who gets the rewards? *Industrial and Corporate Change*, 22(4) pp. 1093–1128. DOI: <https://doi.org/10.1093/icc/dtt019>.

PART III:

STRATEGY AND POLICIES FOR THE GREEN GIANT

4. Mission-oriented market shaping

Policy recommendations:

- A Green Industrial Investment Bank
- Norwegian Bank for Sustainable International Cooperation
- An amended fiscal rule for the green industrial transition
- Innovative procurement for green economic development

4.1 The role of finance in directionality

Financial systems comprise a mix of private and public financial interests, which are intertwined through a variety of financial contracts that make up financial markets.⁵⁸ Categories such as 'asset' and 'collateral' are instilled by the legal norms, which are shaped through their interpretation and adaptation (to financial engineering and innovation, for example) by private actors and enforced by public regulatory authorities.⁵⁹ Financial regulation contains a set of incentives to favour or to assign priority to one type of asset or financing activity over the other, while financial markets are highly policy-elastic (that is, respond fast to even a minimal regulatory change).

The way 'rules of finance' are designed and enforced defines the workings of the financial system, its distributional effects between the types of assets, financial actors and social groups at large, duration of financial contracts and investment horizons (e.g. short- vs long-term) and the priority assigned to various types of wealth created by and within the financial system. In other words, the way financial systems are organised has far-reaching implications for societal structures (issues of inequality and distribution), types of policy interventions available (financialisation further decreases the fiscal space) and the types of economic activities prioritised by existing financing structures.

The finance and financial structure of an economy are not neutral; the type of finance received affects the types of investments made and the type of economic activity pursued. In particular, there is an important difference between types of finance that are conducive for investment in the real economy and speculative finance which prioritises low-risk, short-term capital gains through the trade of existing assets.⁶⁰

Transformation of economic structures implies re-orienting financial flows – through regulation, financial innovation, institution-building and deliberate policy coordination – towards investments in the economic activities that are essential for the structural change to occur. In sum, green transformation needs the financial ecosystem to support innovations in industrial production and services.

Figure 2 shows evidence that public funding is important for keeping options open in renewable energy technology innovation. As Semieniuk and Mazzucato argue, wind energy technologies are vastly more developed than marine technologies, where the latter have only deployed demonstration projects and are nowhere near being cost-competitive. It is striking that the pattern (with wind investments an order of magnitude larger) is exactly the opposite in both technologies – while the private sector finances the majority of less risky wind R&D, public funds dominate the riskier marine sector, suggesting that public funds are very important, especially in the early development of green energy.⁶¹

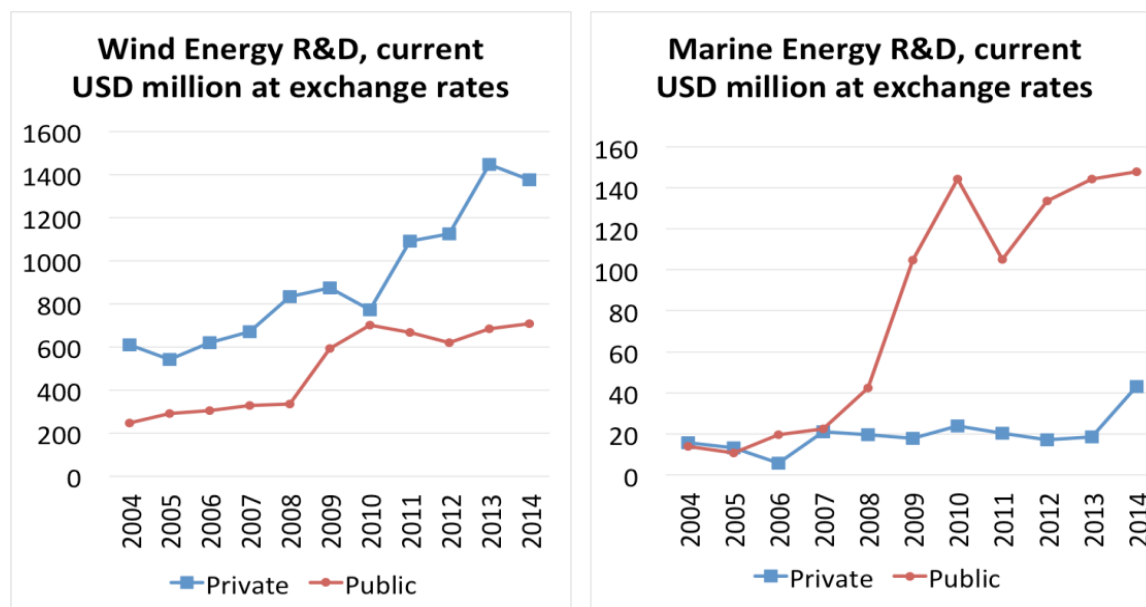
⁵⁸ Leonardo Burlamaqui and Jan Kregel. (2005) Innovation, competition and financial vulnerability in economic development. *Revista de Economía Política*, 25(2). DOI: <https://doi.org/10.1590/S0101-31572005000200002>.

⁵⁹ Pistor, K. (2019). *The Code of Capital*. Princeton University Press.

⁶⁰ William Lazonick and Mariana Mazzucato. (2013). The risk-reward nexus in the innovation-inequality relationship: Who takes the risks? Who gets the rewards?. *Industrial and Corporate Change*, 22(4), pp. 1093–1128, <https://doi.org/10.1093/icc/dtt019>.

⁶¹ Semieniuk and Mazzucato.

Figure 2. Global renewable energy investments in wind and marine energy R&D⁶²



This type of public direct investment has been found to *mobilise* private investment in renewable energy. According to Deleidi, Mazzucato and Semieniuk,⁶³ public investment does not only have a positive effect on private investment, but also has the *largest* positive effect compared to other traditional policy tools. While public investments are often misunderstood to crowd out private investment, these results point to the crucial role of public investments in developing technologies, taking on risk and pushing down unit costs in renewable energy generation.

4.2 The scale of investment needed for Norway’s green industrial transition

As we argue above, the investments in Norway’s most important economic sector are set to dwindle rapidly over the next decade. Over the previous decade, average annual investments in the petroleum sector amounted to more than NOK 170 billion (about USD 17 billion).⁶⁴ This has directed labour, capital and innovation towards petroleum extraction.

The level of annual investments in petroleum are in a business-as-usual scenario estimated to fall by 60 billion NOK for the years 2025–2034, according to one recent report by Statistics Norway. In a scenario with a more restrictive extraction policy, the annual investment level in this sector is estimated to fall below NOK 40 billion in 2029 (see Figure 1 above). On the one hand, the scenarios depicted in Figure 1 show that the fossil-driven engine of the Norwegian economy will be weakened. On the other hand, the same chart implies that real economic resources, such as engineers, technicians and productive facilities, will be available for a new economic direction. This double-sided nature of the transition from petroleum dependence, where the old must be phased out while the new is rapidly phased in, is the vantage point for our proposed Green Giant Strategy.

Whereas the dominating role of oil and gas investments over previous decades drove Norway down a petroleum-dependent path of economic development, where skills and technology are linked to that industry,

⁶² Semieniuk and Mazzucato.

⁶³ Matteo Deleidi, Mariana Mazzucato and Gregor Semieniuk. (2020). Neither crowding in nor out: Public direct investment mobilising private investment into renewable electricity projects. *Energy Policy*, 140. DOI: <https://doi.org/10.1016/j.enpol.2019.111195>.

⁶⁴ Finn Roar Aune, Ådne Cappelen and Ståle Mæland. (2020). Konsekvenser av redusert petroleumsvirksomhet - Makroøkonomiske effekter av politiske tiltak for å redusere norsk produksjon av olje og gass. Statistics Norway. Available at: <https://www.ssb.no/nasjonalregnskap-og-konjunkturer/artikler-og-publikasjoner/konsekvenser-av-reduisert-petroleumsvirksomhet>.

the green transition requires rapid development in the opposite direction: a massive mobilisation of skills and technologies to build green industries and break the economy away from petroleum dependency. This will require investments in green industrial development on a large scale. They should go hand-in-hand with a conscious policy of restricting petroleum expansion and scaling down investments in oil and gas, freeing up resources for rapid development of emerging green industries.

Through this double-sided policy approach, the green engine of growth can be accelerated, while the fossil-driven engine of growth is gradually phased out.

What is the scale of investments necessary to drive Norway's green industrial transition? One estimate using the Stockholm Environment Institute's Climate Equity Reference model finds that Norway's 'fair share' of international climate mitigation until 2030 requires annual investments of NOK 50 billion, plus an annual NOK 15 billion towards climate change adaptation in developing countries.⁶⁵

Such estimates are complicated. A different approach is to start from the reduction in annual investments following a decline in petroleum activities. The abovementioned scenarios published by Statistics Norway imply a reduction in annual petroleum investments of somewhere between 60 billion and 130 billion NOK per year, compared to the 2010–2019 decade. That gap will have to be closed with both direction-setting public investment as well as private investment.

Rather than waiting for the world to stop purchasing petroleum, the Green Giant Strategy is a proactive strategy for spurring on the green industrial revolution of the 21st century that utilises the resources – technical and financial – of existing petroleum industries and, simultaneously, phases out petroleum extraction. We therefore recommend a more restrictive petroleum policy, guiding markets towards a steeper decline in oil and gas investments. **Necessary investments in green industrial development could therefore be over 100 billion NOK per year, on average, over the coming decade.**

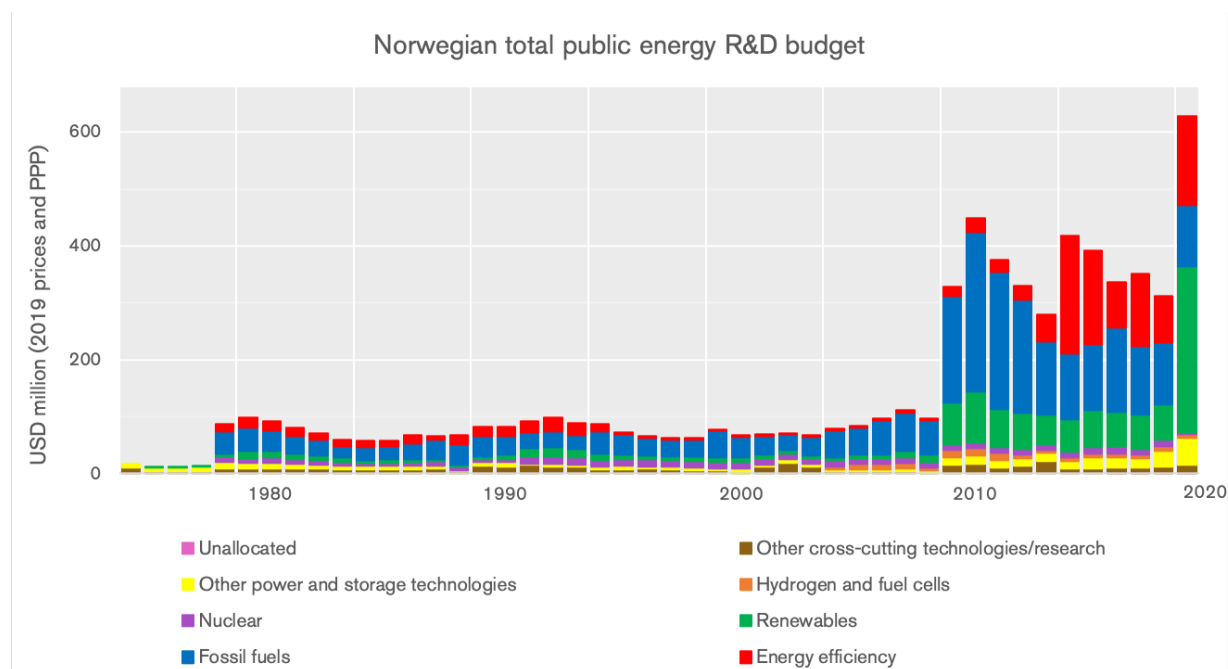
4.3 Norway's emerging green finance landscape

Various public agencies provide funding along the Norwegian green innovation chain. Innovation Norway, the Research Council, Investinor, Enova, Norfund, GIEK and Export Credit Norway are a number of the institutions that provide funding in various segments. The Environmental Technology Scheme (Miljøteknologiordningen) is a green technology programme targeted at firms that 'help solve environmental problems' and Nysnø Climate Investments is a new state-owned investment company with the mission of reducing emissions through profitable investments in partnership with the private sector. However, as mentioned above, there is a lack of coordination between these public institutions supporting green industries. Excessive fragmentation of institutional and financial support measures is a serious impediment to the successful implementation of a mission-oriented approach to innovation and green growth.

As can be seen in Figure 3, Norway's public funding R&D in renewables has been increasing since 2010.

⁶⁵ Sivan Kartha, Christian Holz and Tom Athanasiou. (2018). Norway's fair share of meeting the Paris Agreement. Norwegian Church Aid, Stockholm Environment Institute, Rainforest Foundation Norway, Friends of the Earth Norway (NNV) and the Norwegian Forum for Development and Environment (ForUM). DOI: <https://doi.org/10.5281/zenodo.2595491>.

Figure 3. Norwegian total public energy R&D budget⁶⁶



Expectations of the green industrial shift are high and there has been a wave of private investment in the green transition in the last year. Since the end of 2019, 'green' firms have doubled their share of value on the Oslo Stock Exchange. The value of green shares has increased by 84% in the same period and several green firms have been, or soon expect to be, listed on the Stock Exchange.⁶⁷ Some commentators argue that Norway is experiencing a green bubble similar to the dotcom bubble at the turn of the century.⁶⁸

Petroleum-related firms have started greening their activities and separating out their green activities into new firms to ride the green wave. The supplier firm Aker Solutions has separated its carbon capture and offshore wind activities into two new firms, and merged with the smaller Kvaerner, signalling a strategic shift towards capturing international energy markets and dissociating its renewable energy activities from petroleum supplies.⁶⁹

The Norwegian government has opened up blocs for offshore wind development and will open for tenders in January 2021.⁷⁰ Several private firms have since started showing interest in the Norwegian offshore wind market – the private equity firm HitecVision and Italian ENI have created a joint venture called Vårgrønn, which aims to invest NOK 20 billion and build 1 GW of offshore wind by 2030.⁷¹

The Norwegian trend is in line with an international shift. The price of petroleum has yet to recover to pre-Corona levels, while renewables are prioritised in electricity grids and renewable energy corporations have

⁶⁶ IEA website. (2018 prices). Energy technology RD&D budgets. Available at: <https://www.iea.org/data-and-statistics?country=NORWAY&fuel=Energy%20technology%20RD%26D%20budgets&indicator=RDDTechSplitNC> (accessed: 16 November 2020).

⁶⁷ Oslo Børs. (2020). Dobling for grønne aksjer. Available at: <https://www.nordnet.no/blogg/dobling-for-gronne-aksjer/>.

⁶⁸ Asgeir Aga Nilsen. (2020). Prigalopp på hete aksjer tross krisetid: - Ligner veldig på 1999. e24. Available at: <https://e24.no/boers-og-finans/i/bn5m3q/prigalopp-paa-hete-aksjer-tross-krisetid-ligner-veeldig-paa-1999>.

⁶⁹ Oslo Børs. (2020). Aker Solutions appoints new CEO and launches transformation to spin off offshore wind and CCUS businesses to shareholders and merge with Kvaerner. Available at: <https://newsweb.oslobors.no/message/510018>.

⁷⁰ Norwegian Government. (2020). Varsler veileder for vindkraft til havs til våren. Available at: <https://www.regjeringen.no/no/aktuelt/varsler-veileder-for-vindkraft-til-havs-til-varen/id2785322/>.

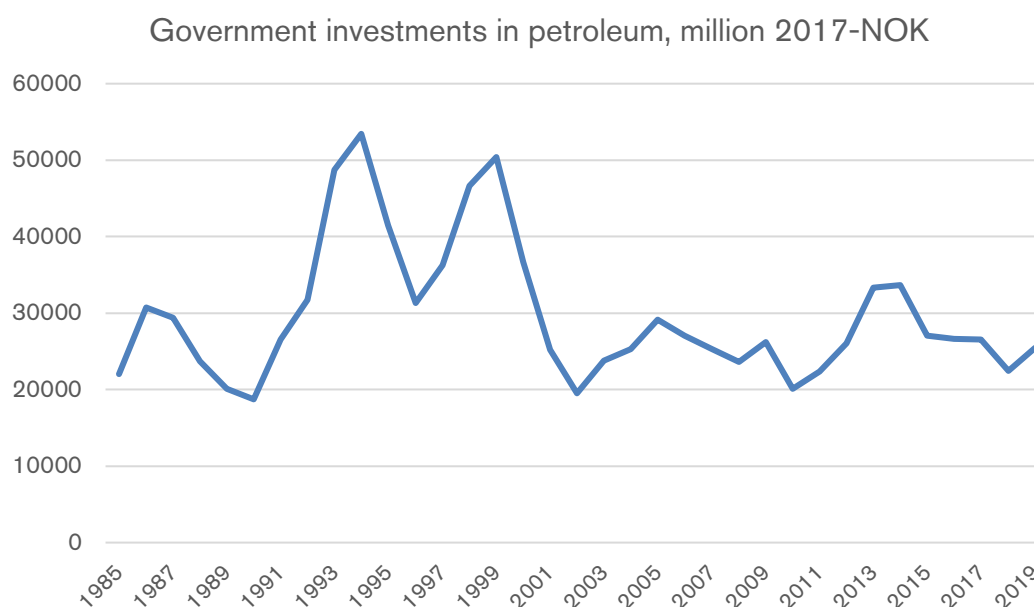
⁷¹ Adrijana Buljan. (2020). Eni ready for Norwegian offshore wind tenders with newly established company. [Offshorewind.biz](https://www.offshorewind.biz/2020/11/11/eni-ready-for-norwegian-offshore-wind-tenders-with-newly-established-company/). Available at: <https://www.offshorewind.biz/2020/11/11/eni-ready-for-norwegian-offshore-wind-tenders-with-newly-established-company/>.

therefore fared better than other sectors. The valuation of petroleum assets has been sharply reduced by a number of petroleum firms⁷² and investment in renewables has shot up.⁷³

It is not clear whether the shift in private investment towards renewables is a sign of a lasting and durable shift towards green energy development.⁷⁴ It is possible that the current trend is a new 'green fling';⁷⁵ a brief engagement within renewable energy which lasts while the price of oil is low, but is then reversed when profitability within fossil energy recovers. Norwegian policymakers should not let the financial trends produced by the Corona crisis lead to complacency. A durable and long-term green industrial transition is a major challenge which requires bold and strategic policy making. The speed and rapidity needed in the global green transition should not be underestimated. In a recent report from DNV GL,⁷⁶ Norway will only be halfway to the goals of domestic emission reductions for 2030 and at the same time the change in global energy demand will put pressure on Norwegian petroleum exports. If Norwegian lawmakers want to reach their own emission goals and avoid catastrophic climate change while developing new industries, they cannot wait for the private sector to fix the problem alone, but must be ready to take on a leadership role.

That will require coordinating public agencies towards the green industrial transition as well as investing accordingly. The state has been a major investor in petroleum. Since 1985, the state has directly invested from around NOK 20 billion annually, adjusted for inflation (Figure 4). As patient and long-term public investments have been a significant component of total investments in petroleum, public investments will probably have to be a significant component in green investments.

Figure 4. Norway's public investments in petroleum⁷⁷



⁷² Anjil Raval. (2020). Oil majors face up to plunging asset values. Financial Times. Available at: <https://www.ft.com/content/b7689fd1-5b06-42e9-bc9f-0a912c93924e>.

⁷³ David Sheppard, Neil Hume and Anjil Raval. (2020). Oil traders rush to invest billions into renewables. Financial Times. Available at: <https://www.ft.com/content/394bf3d1-95c9-45e9-ae81-6434d441e237>.

⁷⁴ Mariana Mazzucato. (2013). Financing innovation: creative destruction vs. destructive creation. *Industrial and Corporate Change*, 22(4), pp. 851–867. DOI: <https://doi.org/10.1093/icc/dtt025>.

⁷⁵ Tuukka Mäkitie, Håkon E. Normann, Taran M. Thune and Jakoba Sraml Gonzalez. (2019). The green flings: Norwegian oil and gas industry's engagement in offshore wind power. *Energy Policy*, 127, pp. 269-279. DOI: <https://doi.org/10.1016/j.enpol.2018.12.015>.

⁷⁶ DNV GL. (2020). Energy Transition Outlook Norway 2020. Available at:

<https://www.norskindustri.no/siteassets/dokumenter/rapporter-og-brosjyrer/energy-transition-norway-2020.pdf>.

⁷⁷ Aune, Cappelen, and Mæland.

4.4 Public procurement

Procurement is another highly influential public financing lever. Public procurement has played a critical role in the innovation chain. In pre-WWII periods public procurement was the key means of supporting the development of new technologies for public missions (especially military).⁷⁸ In post-WWII decades it also became an important policy tool for industry creation, protection and overall industrial upgrading.⁷⁹ The current wave of policy change allocates an even wider role for public procurement. As argued by Lember et al., “Public procurement is increasingly seen as a horizontal policy measure that should be applied across the public sector and regardless of the characteristics or missions of public agencies.”⁸⁰

In Norway, public procurement amounted to NOK 523 billion in 2017, or more than 16% of GDP.⁸¹ Despite legislative efforts over the last five years, few public sector organisations have implemented innovative procurement. On the other hand, recent research shows that public procurement of innovation in Norway clearly has a positive impact on business innovation.⁸² This suggests that procurement of innovation is a largely untapped public resource in the Norwegian innovation system and that there is a need to develop specific capabilities in public organisations.

4.5 The Oil Fund and national savings

Norway's Oil Fund (Government Pension Fund Global) is the largest sovereign wealth fund on the planet. Sovereign wealth funds (SWFs) can serve various purposes and have been one of the mechanisms for how governments can direct public spending to prioritised and high-impact sectors. Reorienting investment strategies of sovereign wealth funds towards the green sector would bring some USD 8.2 trillion into climate action finance. At the same time, the portfolios of SWFs are exposed to climate-related financial risks. Despite some important recent initiatives, their activity in low-carbon sectors remains ‘aspirational’ (less than 1% of all investments). Few sovereign funds assess climate risks in their portfolio companies systematically⁸³ and very few disclose information about their own climate policies and strategies.⁸⁴

In addition to the different types of objectives that sovereign wealth funds serve, often simultaneously (including short-term and *ad hoc* stabilisation or a more long-term return on investments), investment strategies can also vary in terms of internationalisation. For instance, Temasek Holdings, one of Singapore's sovereign wealth funds, is one of the least internationalised sovereign funds in the world. Temasek is a state-owned investment company, operating under the auspices of the Ministry of Finance, which holds equity amounting to some USD 200 billion (as of 2019).⁸⁵ Its history dates back to 1974, when Singapore needed to develop key infrastructure sectors, which required substantial capital, but private investment was scarce. Temasek was established as a holding company for key SOEs, including some 35 government-linked companies, in the aviation, shipping,

⁷⁸ David C. Mowery. (2012). Defense-related R&D as a model for ‘grand challenges’ technology policies. *Research Policy*, 41(10), pp. 1703–15. DOI: <https://doi.org/10.1016/j.respol.2012.03.027>.

⁷⁹ Rainer Kattel and Veiko Lember. (2010). Public procurement as an industrial policy tool: An option for developing countries? *Journal of Public Procurement*, 10(3), pp/ 368–404. DOI: <https://doi.org/10.1108/JOPP-10-03-2010-B003>.

⁸⁰ Veiko Lember, Rainer Kattel and Tarmo Kalvet. (2015). Quo vadis public procurement of innovation? *Innovation: The European Journal of Social Science Research*, 28(3) pp. 403–21.

⁸¹ Ministry of Trade, Industry and Fisheries. (2019). *Smartere innkjøp – effektive og professionelle offentlige anskaffelser*. Meld. St. 22 (2018-2019).

⁸² Marialuisa Divella and Alessandro Sterlacchini. (2020). Public procurement for innovation: Firm-level evidence from Italy and Norway. *Industrial and Corporate Change*. Available at: <https://doi.org/10.1093/icc/dtaa023> (accessed 9 October 2020).

⁸³ Norway's Government Pension Fund Global and the New Zealand's Superannuation Fund are among few examples.

⁸⁴ OECD. (2020). The role of sovereign and strategic investment funds in the low-carbon transition. Available at: https://www.oecd-ilibrary.org/sites/ddfd6a9f-en/index.html?itemId=/content/publication/ddfd6a9f-en&_csp_=7075e316988f49f0fe40465b1becdd08&itemGO=oecd&itemContentType=book.

⁸⁵ In addition, the Government of Singapore Investment Corporation (GIC) is a fund management company that manages a diverse portfolio of foreign assets amounting to some USD 100 billion.

telecommunications and banking sectors.⁸⁶ This institutional set-up allowed the government to pursue policy-oriented objectives and regulate the newly established sectors, while Temasek Holdings owned and managed the investments in the new sectors on a commercial basis.⁸⁷ On a risk-return continuum it is oriented towards long-term returns and acts as an active equity investor,⁸⁸ fulfilling both wealth management and development mandates.⁸⁹

Despite a major change in leadership, prioritisation of shareholder returns and a more dynamic take on internationalisation in early 2000s, Temasek remains strongly linked to the domestic economy and currency: 24% of total assets are held domestically and the Singapore Dollar accounts for 57% of assets' currency denomination.⁹⁰ Through its corporatisation strategy (a large share of SOEs associated with Temasek Holdings were incorporated and publicly listed in the 1990s), Temasek shifted towards a strategy of open growth, which included a rapid growth in international investments from the 2000s. This makes Temasek a corporation running its own portfolio of investments rather than acting as a vehicle to control SOEs.⁹¹ By pursuing an internationalisation strategy Temasek has contributed to Singapore's regionalisation strategy and, ultimately, economic diplomacy in Asia and beyond.⁹²

The Norwegian Oil Fund could be turned into a similarly important domestic mission-oriented actor and a powerful global driver of green economic development. Typically, SWFs do not have pension liabilities and usually serve macroeconomic purposes through long-term investment strategies, although funds with stronger stabilisation objectives can be more short-term oriented due to higher liquidity preferences in their portfolios.⁹³ Nevertheless, because SWFs represent a group of government-owned investors and do not have to focus strictly on shareholder financial returns (as private investors typically do), it is easier, relatively speaking, to include explicit sustainability and climate-oriented objectives in their mandates.⁹⁴ For instance, Singapore's Temasek announced its carbon neutrality in 2020 and has set two climate-related targets for its portfolio: to cut carbon equivalent in half by 2030 and achieve carbon neutrality for its entire investment portfolio by 2050.⁹⁵

Due to their global nature,⁹⁶ SWFs are managing a complex mix of assets (e.g. cash, public and private equities, real estate, infrastructure, venture capital and hedge funds) and therefore are 'learning organisations' managing large international complex portfolios. Combined with the systemic power they have in the global financial

⁸⁶ Cummine, A. (2014). How Temasek has driven Singapore's development. *East Asia Forum Quarterly*, 6(4), pp. 40-42. Available at: <https://search.informit.com.au/documentSummary;dn=348138453614661;res=IELIAC>.

⁸⁷ Menon, R. (2019). A speech given by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the National Asset-Liability Management Europe Conference on 13 March 2019. Available at: <https://www.mas.gov.sg/news/speeches/2019/how-singapore-manages-its-reserves>

⁸⁸ Menon, R. (2019) A speech given by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the National Asset-Liability Management Europe Conference on 13 March 2019. <https://www.mas.gov.sg/news/speeches/2019/how-singapore-manages-its-reserves>

⁸⁹ Cummine, A. (2014). How Temasek has driven Singapore's development. *East Asia Forum Quarterly*, 6(4), pp. 40-42. Available at: <https://search.informit.com.au/documentSummary;dn=348138453614661;res=IELIAC>.

⁹⁰ See: <https://www.temasek.com.sg/en/what-we-do/our-portfolio#geography>.

⁹¹ Chen, C. (2016). Solving the puzzle of corporate governance of state-owned enterprises: The path of Temasek model in Singapore and lessons for China. *Northwestern Journal of International Law and Business*, 36 (2), pp. 303-370. Available at: https://ink.library.smu.edu.sg/sol_research/1693

⁹² Yeung, H. (2011). From national development to economic diplomacy? Governing Singapore's sovereign wealth funds. *The Pacific Review*, 24 (5), pp. 625-652.

⁹³ UNEP. (2018). Financing the SDGs: the role of sovereign wealth funds for green investment. Policy brief. Available at: <https://sites.tufts.edu/sovereignet/files/2018/02/Policy-brief-Capapé-SWF-Green-Investments-2018-1.pdf>.

⁹⁴ Liang, H. and Renneboog, K. (2019). The global sustainability footprint of sovereign wealth funds. European Corporate Governance Institute – Finance working paper no 647. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3516985.

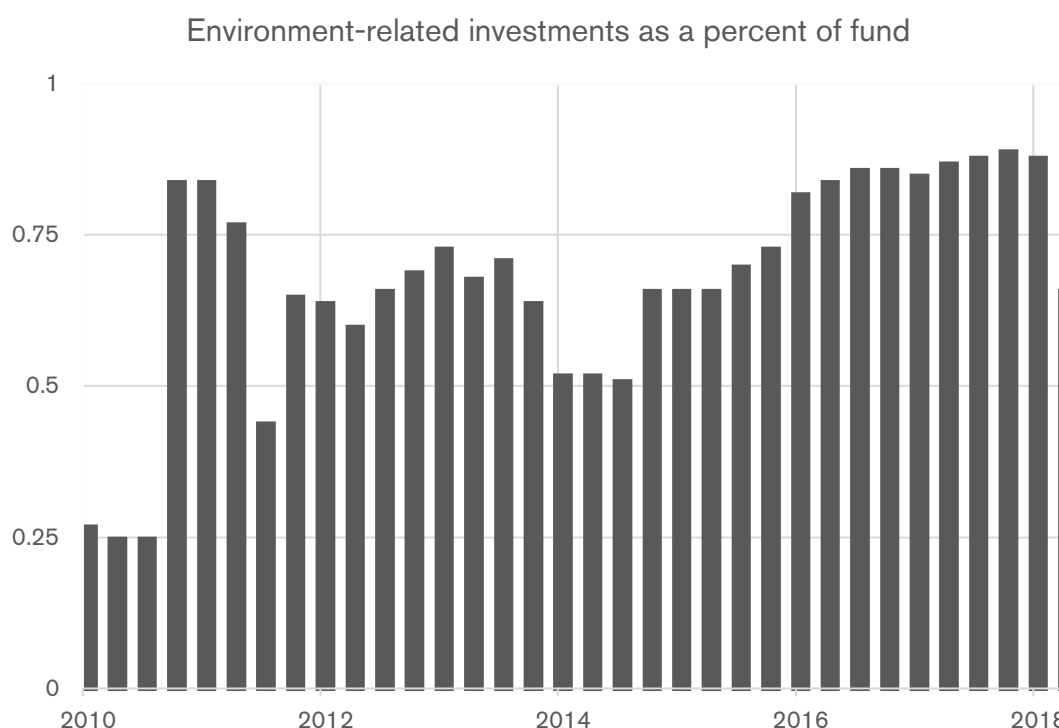
⁹⁵ Temasek Review 2020. Available at: <https://www.temasekreview.com.sg>.

⁹⁶ Most SWFs emerged due to the rapid accumulation of foreign reserves from commodities trading, especially in export-led developing countries.

system, this makes SWFs a unique type of public investor as they have the direct capacity to intervene in private firms, on a par with that of other institutional investors.⁹⁷ These factors make SWFs well positioned to assume a more active role in explicitly targeting green sectors.

Norway's Oil Fund has increased its environmental engagement over time. A section of the fund is included under the environment-related mandates, currently in the 30-120 billion NOK range. Since 2018, there is the possibility for investment in unlisted renewable energy infrastructure.⁹⁸ However, Norway's Oil Fund investment in green has remained constantly low during the last decade, as shown on Figure 5.

Figure 5. Environment-related investments as a % of the Oil Fund⁹⁹



Driving SWFs from being passive towards becoming more active green investors (either direct investors or through their asset management companies) will also require substantial capacity-building across these organisations (boards, management, staff), including the capacity to engage with portfolio companies on climate-related issues, to select and monitor asset managers based on their climate-related performance and the capacity to directly invest into low-carbon sectors.¹⁰⁰ In addition, developing a clearer understanding of investment opportunities in low-carbon and risks around high-carbon sectors is essential. Thus, Norway's Oil Fund could be gradually transformed into a tool of climate and industrial policy. A change of mandate would have to be wholesale, as the fund cannot be managed towards several diverging objectives at the same time, for example maximising return on capital versus climate policy objectives.

⁹⁷ Aguilera, R., Capaoe, J. and Santiso, J. (2016). Sovereign wealth funds: a strategic governance view. *Academy of Management Perspectives*, 30 (1), pp. 5-23.

⁹⁸ Norges Bank Investment Management. (2018). Investments in unlisted renewable energy infrastructure in the Government Pension Fund Global. Letter sent to the Ministry of Finance.

⁹⁹ Norges Bank Investment Management. (2018). Data adapted from the Government Pension Fund Global's environment-related investment mandates. Available at:

https://www.nbim.no/contentassets/c3fce99f4f424f839722093cd4109e29/20181030_spu-environmental-related-investment-mandates.pdf (accessed: 16 November 2020).

¹⁰⁰ OECD. (2020). The role of sovereign and strategic investment funds in the low-carbon transition. Available at:

https://www.oecd-ilibrary.org/sites/ddfd6a9f-en/index.html?itemId=/content/publication/ddfd6a9f-en&_csp_=7075e316988f49f0fe40465b1becdd08&itemIGO=oecd&itemContentType=book

In this discussion it is important to clarify the distinction between national saving and saving for a household. It seems to be a wide-spread public perception in Norway that the Oil Fund contains the nation's 'savings' for the future and that moving money out of the fund amounts to 'stealing' from future generations. This is not always true. For the economic wellbeing of future generations, what happens in terms of domestic innovation, industrial development and the employment of the country's labour force will be of far greater significance than what happens to the Oil Fund. If there is little innovation, scant industrial development and high unemployment in the future, 'savings' in foreign financial markets will be of limited use. Those dollars will allow for more foreign goods to be imported to Norway, but they will not mend a broken industrial base, make up for decades of little innovation or secure decent jobs for unemployed Norwegians.

As Ragnar Frisch, a Norwegian recipient of the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, put it, "Savings from the point of view of an individual and from the point of view of society as a whole are two entirely different concepts." The individual, Frisch pointed out, can save by not consuming those commodities and objects that are for sale in stores. This is not true for the national economy. He said, "Society as a whole cannot save simply by restraining consumption. Society's saving requires, in order to be effective, a change in production."¹⁰¹ Society cannot put money aside in the bank for retirement as an individual can, for societies do not retire. It is through increasing its efficiency in producing machinery, housing, roads and so on – "durable, useful objects" that society secures the economic wellbeing of future generations. According to Frisch, "Only by such productive measures can society as a whole achieve saving" for the future.¹⁰²

At present, Norway's predominant industry and main source of export revenue appears unsustainable and annual investments are set to diminish rapidly over the next decade. An unsuccessful shift away from petroleum would provide significant risks for employment, growth and the Norwegian welfare state. If saving abroad becomes an aim in itself and prohibits necessary productive investment at home, growth, innovation, employment and the economic security of future generations may be risked.

The present situation is quite different from the situation in 2001, when the fiscal rule was established. It has served the object of economic stability well. As the Norwegian economy enters a phase where the status quo is no longer an option, policy makers might need a revised fiscal rule to accommodate the green industrial transition.

Recommendations

Establish a Green Industrial Investment Bank

The Norwegian government could establish a Green Industrial Investment , which will channel public investments into green industries thereby also mobilising private capital. The aspiration of this institution should be to unify Norway's unique financial strength and its advanced industrial base by directing some of the wealth extracted from petroleum towards the investments now necessary for accomplishing the green industrial shift. Co-financing (which can be mandatory for certain types of projects, sectors or technologies) with commercial banks and potentially other private financial institutions can be an effective way of crowding in private finance to projects in which the private sector alone is unable or unwilling to invest.

¹⁰¹ Ragnar Frisch. (1947). Noen trekk av konjunkturlæren. Aschehoug.

¹⁰² Ibid. It is, of course, possible to invest in productive measures abroad, not just in the national economy. The Oil Fund does this when it invests in other nation's productive capacities through foreign companies around the world, but much of the fund is invested in less productive assets, such as real estate and state bonds. More importantly, as Frisch also stated, this way of strengthening the financial balance vis-à-vis other states is compatible with effective saving for future generations only insofar that it "is not to the detriment of the maintenance and renewal of the durable, useful objects" of the national economy – the domestic industrial base. (Ibid: 43.)

Strategic development banks tend to possess substantial analytical capacities in the form of technical competences and market intelligence that commercial banks or other types of financing agents do not have.¹⁰³ This allows public development banks to perform due diligence of projects, especially pre-appraisal (i.e. before financial appraisal), based on future-oriented projections and estimates (in terms of potential markets, technological readiness and risks, supply chains and regulatory bottlenecks).¹⁰⁴ Therefore, valuations performed by development banks are valued by private commercial lenders because future-oriented evaluation requires more extensive, in-house and specialised expertise as compared to evaluations based on firms' past performances. In this way public financial institutions can act as 'door openers' for companies with limited access to finance.¹⁰⁵

Loan syndication with other financial actors, particularly multilateral banks and international agencies, can be another mechanism for financing large-scale and megaprojects in Norway and especially abroad.¹⁰⁶ The Green Industrial Investment Bank would identify investment opportunities along the entire innovation/production chain which could spur green industrial development and promote competitiveness, as well as experimentation and innovation, in low-carbon sectors from below.

The mission for the bank would be to spur innovation, set the green direction of growth for the Norwegian economy and create new innovation landscapes by being an *investor of first resort*, rather than a lender of last resort. The green transition is a long-term challenge which requires long-term and patient finance. The Green Industrial Investment Bank therefore needs to have a long-term and patient perspective. The longer investment horizon is also related to profitability and operational targets. Public investment banks typically operate under lower profitability targets and have access to government guarantees, which enable them to raise cheaper capital on international markets, thereby reducing the costs of funding for the borrowers. For this reason, majority or full state ownership of the Green Industrial Investment Bank is essential for this institution to develop investment and leveraging functions (to leverage initially injected public capital by subsequent borrowing) in full. The White Paper on State Direct Ownership in Norway defines three categories of state ownership of companies, with the rationale for the third goal being "the most efficient possible attainment of public policy goal".¹⁰⁷ Similar to the rationale behind full ownership of Norfund, the state's goal as the owner of the Green Industrial Investment Bank would be to directly contribute to the green transition, and sustainable industrial and business development, in Norway and abroad.¹⁰⁸

¹⁰³ Mikheeva, O. (2019). Financing of innovation: national development banks in newly industrialized countries of East Asia. *Journal of Post Keynesian Economics*, 42 (4), pp. 590-619.

¹⁰⁴ Mazzucato, M. and Mikheeva, O. (2020). The EIB and the new EU missions framework: Opportunities and lessons learned from the EIB's advisory support to the circular economy. IIPP policy report. Available at: <https://www.ucl.ac.uk/bartlett/public-purpose/publications/2020/nov/eib-and-new-eu-missions-framework>.

¹⁰⁵ EIB. (2016). Access-to-finance conditions for KET companies. EIB report. Available at: <https://www.eib.org/en/publications/access-to-finance-conditions-for-kets-companies> (accessed: 5 November 2020).

¹⁰⁶ Some industries are essentially global – for example, shipping and cargo – which implies that certain financing facilities (in the form of financial contracts, types of financial instruments and their enforcement mechanisms) can dominate international practices. Early exposure of national financial institutions (e.g. development banks) to such practices and participation in, for example, syndicated financing arrangements, can contribute to learning from such experiences and can translate to building a competitive advantage among financial institutions. This is relevant in the context of the green transition, especially with many projects being financed by international donor organisations in emerging countries. This is equally relevant for helping domestic firms internationalise and concur international markets where certain financial players or arrangements can dominate.

¹⁰⁷ Norwegian Ministry of Trade, Industry and Fisheries. (2020). The state's direct ownership of companies: sustainable value creation 2019-2020. Report to the Storting (white paper), p. 31. Available at: <https://www.regjeringen.no/contentassets/44ee372146f44a3eb70fc0872a5e395c/en-gb/pdfs/stm201920200008000engpdfs.pdf> (accessed: 5 November 2020).

¹⁰⁸ Norwegian Ministry of Trade, Industry and Fisheries. (2020). The state's direct ownership of companies: sustainable value creation 2019-2020. Report to the Storting (white paper), p. 49.

The ability of development banks to develop in-house technical and appraisal expertise allows them to take a more informed approach to risks, which are significant across the spectrum of green technologies and sectors. They are more likely to engage in co-financing arrangements and on-lending schemes, whereby they provide financing either with or through commercial lenders. The discretion to evaluate and price the risks, and the ability to attract private lenders, makes them different from development or climate funds that invest in emerging countries by blending financial instruments that already exist or by being funded directly by donor governments, such as Norway's Norfund, Swedfund in Sweden or FMO¹⁰⁹ in the Netherlands.¹¹⁰ Despite being a visible element of climate action finance, climate funds have limited capacities in terms of technical knowledge that often ultimately define the types of finance available for green projects. They are also constrained by how they can raise funds and therefore operate with a limited number of financial instruments, thereby having little discretion in the types of projects or technologies they can finance and the risks they can take.

The Green Industrial Investment Bank is also a vehicle that ensures that the Norwegian 'entrepreneurial state' and its citizens are not only represented and participate in risk-taking, but also reap the rewards from such risk-taking. That implies, if necessary, putting conditionalities on labour conditions, the distribution of rewards and environmental impact.

Consolidate the green export effort under a Norwegian Bank for Sustainable International Cooperation linked to the Green Industrial Investment Bank

Exports will be a key pillar of Norway's green industrial strategy. The Norwegian government could establish a Norwegian Bank for Sustainable International Cooperation (NBSIC).

Norway is already a major exporter of capital through the Oil Fund. The question is whether all investment decisions should be made within a purely financial perspective aimed at maximising financial returns or if the strategy should be diversified. We believe the situation demands that some part of Norway's vast financial strength is put to work directly for emission reduction projects at the global level, and for safeguarding and further developing advanced domestic industries at the national level. This will be the mission of the NBSIC. This green development and exports vehicle should aspire to unify global obligations and local manufacturing jobs through matching the world's need for emission cuts with Norway's need for green industrial development. Such a policy can deal with the lack of green investments in parts of the world, while ensuring that such projects are developed in a socially sustainable and equitable way, and stimulating demand for Norwegian exports.

There are several examples of how this has been done in other countries. For example, the German Investment and Development Company (DEG) is a subsidiary of state-owned national development bank KfW, which has been one of the essential actors in helping finance renewable energy and energy efficiency programmes in Germany. In addition, KfW has been active in investing worldwide, especially in developing countries, thereby helping German companies establish operations or development assistance programmes abroad. Therefore, KfW represents a financial institution that pursues the financing of Germany's industrial policy goals both domestically and abroad. On the other hand, such an approach can seriously limit the abilities of developing countries to actualise industrial and financial policies conducive to green growth.¹¹¹ To avoid this, we suggest that a local co-financing requirement is required when investments are made abroad. This way, the Green Industrial Investment Bank will be co-financing green sectors with local financial institutions, thereby extending its own financial expertise to local financial actors (most typically banks) and contributing to learning-by-doing in developing countries. This takes time and therefore long-term financial commitments are essential. The

¹⁰⁹ The Netherlands Development Finance Company is the largest development fund among OECD countries.

¹¹⁰ See: <https://www.oecd.org/development/development-finance-institutions-private-sector-development.htm>.

¹¹¹ N. Naqvi, A. Henow and H-J. Chang. (2018). Kicking away the financial ladder? German development banking under economic globalisation. *Review of International Political Economy*, 5, pp. 672-698.

learning process within the banking sector was essential to the financing of industrial technologies in developed countries: economic development occurred when local industrial *firms* received financing for investments, not just projects.¹¹²

There are other already existing institutions that could be wholly or partially merged into the new Green Industrial Investment Bank. Norfund has been operating on behalf of the Norwegian government as a state investment company for private sector development in developing countries. Through equity and loans, Norfund invests in priority sectors, including green energy and infrastructure.¹¹³ It has accumulated significant expertise in developing regions, including in Africa, which can be further strengthened before the fund is turned into the subsidiary of the bank fully dedicated to international investments in green sectors abroad.

Other existing agencies, such as Eksportkreditt, GIEK, NORWEP and Innovation Norway, all have overlapping mandates when it comes to export promotion, export advising and investments abroad. Norfund invests a portfolio of NOK 25 billion and specifically targets renewable energy development in developing countries. Such competences and responsibilities related to green investments could be put under the NBSIC as export policy is integrated in the green industrial strategy.

NBSIC could be established as a fully owned subsidiary of the Green Industrial Investment Bank.

Amend the fiscal rule to accommodate the green industrial transition

The Norwegian state has no shortage of capital for making investments in green industrial development. The scale of the required investments imply that taxes are unlikely to be a sufficient source of funding.

Government borrowing for industrial investment is prohibited under the current fiscal rule, as is utilising the cash flow from oil and gas for that same purpose. But this rule could be amended. The current fiscal rule strengthens the current path for the Norwegian economy and could stand in the way of a green transition. The government's investments in petroleum are kept out of the normal budget, as both expenditure and revenue from the sector is kept out of the structural non-oil deficit.

The current fiscal regime ensures that gross petroleum investments – which since 1985 have ranged from 20 billion up to 50 billion NOK annually – are not subject to the same anti-inflationary discipline that the fiscal rule imposes on all other forms of government expenditure. Norway could amend the fiscal rule, if it stands in the way of a green industrial transition.

Let low carbon emissions and innovation be weighted higher in procurement processes

Through public procurement the government provides significant demand for the private sector. Construction is one area that is a large recipient of public procurement and also has high levels of emissions. Public procurement should be utilised to spur green industrial development and innovation, and therefore has to be weighted higher in procurement processes. Innovations such as carbon capture and storage technology require active public procurement to be profitable.

Norsk Industri has stated that at the time of purchase price is often weighted too highly and at the expense of quality, innovation and environment. It suggested that the environment should be weighted at least at 30% in procurement. Such a target should be a minimum level.

¹¹² C. Mayer. (1989). Myths of the West: Lessons from developed countries for development finance. Background paper for the 1989 World Development Report. World Bank Working Papers 301. <http://documents.worldbank.org/curated/en/453431468740700141/pdf/multi-page.pdf> (accessed: 5 November 2020).

¹¹³ See: <https://www.norfund.no/key-figures/>.

Establish a Ministry of Climate and Industry

To coordinate and implement the green industrial strategy, Norway could establish a new Ministry of Climate and Industry. It is important to coordinate the phasing out of petroleum and the phasing in of green industries, and to ensure that the burden of adjustment is not placed on Norwegian workers.

The development of the petroleum industry was a large transition for the Norwegian economy, which required strategic planning and coordination. The division of ministerial responsibilities and development of capabilities in Norwegian public institutions were adjusted to facilitate such a structural change. Both the Ministry of Oil and Energy, as well as the Oil Directorate, were established in the following years. The creation of a Ministry of Climate and Industry and other public institutions could be informed by these experiences from the petroleum sector.

The suggested ministry would take over responsibilities from the Ministry of Oil and Energy, and the Ministry of Trade, Industry and Fisheries, as well as the Ministry of Environment and Climate, with regard to green industrial development. These responsibilities include estimating climate-related risk, defining what are 'green', low-carbon industries, and investing and planning the deployment of renewable energy and low-carbon, as well as developing new partnerships with the private sector. The ministry would report annually on how effectively the government is managing the transition and whether it is reaching its targets. While the new ministry would take the main responsibility, the green industrial strategy and emission cuts have to be implemented across all departments and public agencies.

5. State-owned enterprises in the green industrial transformation

Policy recommendations:

- Give Equinor a mission-oriented mandate
- Establish a state holding company charged with strategic coordination across companies and sectors relevant to the green industrial transition
- Give relevant state-owned enterprises the mandate to green their activities

In modern economic history, state-owned enterprises (SOEs) played an important role in economic development, including during post-WWII nationalisation programmes when the public sector was significantly enlarged in France, the UK, Austria and the Netherlands.¹¹⁴

Despite being one of the key targets for liberal reforms during the 1980s to 1990s through privatisation programmes, SOEs continue to operate in developed and developing countries in more traditional sectors such as utilities and infrastructure, as well as more technology-intensive sectors. Even when their relative economic share is not large when compared to the national GDP, SOEs tend to account for large shares of market capitalisation, investment and employment.¹¹⁵

SOEs can serve as vehicles for more targeted policy interventions, such as directing resources to prioritised sectors, clusters of technologies or socially and environmentally important projects.¹¹⁶ SOEs can become national industrial 'champions' and effective vehicles for governments to face the economic and technological uncertainty of new economic sectors. Korean POSCO, Singapore Airlines and Brazilian EMBRAER are examples of success stories where respective governments decided to build competitive advantage in new economic/technological sectors.¹¹⁷

SOEs have not only played an important role in innovation policy in developing countries: in Finland, Sweden and particularly Italy SOEs were crucial vehicles for supporting innovation and development. Italy's IRI invested in machinery and electrical equipment, and also played the central role in the technological advancement of many industries, such as ICT, power generation, electronics and aerospace.¹¹⁸

Without necessarily following the industrial 'champions' model, SOEs can play the role of knowledge agents and change agents. For example, they can bring complementary technologies and companies operating cross-border together under one roof: the cases of joint Franco-Italian knowledge-intensive ventures (STMicroelectronics in the semiconductor industry and Thales Alenia Space in the space industry) provide successful examples.¹¹⁹ Indeed, by combining private sector and public sectors incentives, SOEs can provide a unique setting for combining risk-taking and long-term horizons.¹²⁰

The role(s) of SOEs in the green transition has been recently analysed in the energy and other sectors in terms of natural monopoly structures where governments typically maintain significant, if not full, ownership. SOEs account for larger shares in both renewable energy sectors and fossil fuel sectors, and keep investing into both. Between 2000 and 2014 SOEs in OECD and G20 countries increased the share of renewable energy in

¹¹⁴ P.A. Toninelli (ed.) (2000) *The Rise and Fall of State-owned Enterprise in the Western World*. Cambridge University Press.

¹¹⁵ S. Clò, M. Di Giulio, M. T. Galanti, and M. Sorrentino. (2016). Italian state-owned enterprises after decades of reforms: Still public? *Economia Pubblica*, 3, pp. 11-49.

¹¹⁶ OECD. (2015). *State-owned Enterprises in the Development Process*. OECD Publishing. Available at: <https://www.oecd.org/corporate/state-owned-enterprises-in-the-development-process-9789264229617-en.htm>.

¹¹⁷ H.J. Chang. (2007). *State-owned enterprise reform*. UNDESA.

¹¹⁸ M. Benassi and M. Landoni. (2018). State-owned enterprises as knowledge-explorer agents. *Industry and Innovation*, 26(2). Available at: <https://doi.org/10.1080/13662716.2018.1529554>.

¹¹⁹ *Ibid.*

¹²⁰ P. Tonurist and E. Karo. (2016). State owned enterprises as instruments of innovation policy. *Annals of Public and Cooperative Economics*, 87(4), pp. 623-648.

their electricity capacity portfolios from 9% to 23%.¹²¹ At the same time, some of the SOEs operating in the carbon-intensive sectors – coal, gas and fuel – are powerful multinational corporations (such as Petrobras, Gazprom and PetroChina) and therefore it is hard to imagine a managed green transition and the development of risk models to measure *dynamic* climate-related risks without taking into account global SOEs operating in the energy sector.¹²² Due to their proximity to economic and environmental priorities, and a typically large share in domestic markets, SOEs can become vehicles for accelerating and scaling up green projects.¹²³

Another benefit of utilising SOEs in an innovation-led industrial strategy is that they are not limited to profit-maximisation goals and have softer budget constraints (SBCs). While SBCs have been used to explain inefficiencies in state-controlled economies, Schumpeterian economists have argued that SBCs are essential in enabling the innovation and investment required for technological shifts. In an economy under competitive pressure, SBCs can, contrary to conventional wisdom, be essential for inducing sufficient entrepreneurialism.¹²⁴

Energy is a sector with significant state ownership.¹²⁵ Therefore, SOEs will be key agents in the transition away from fossil fuels and towards green industrial development. Norway is not an exception.

The Norwegian national innovation system is characterised by a significant share of public ownership. As in many Western countries, the capabilities of the state to engage in business activities has been reduced over the last few decades. However, the state still has a strong presence in Norwegian industry¹²⁶, owning around a third of total value at the Oslo Stock Exchange and partially owning five out of the seven largest companies in 2016.¹²⁷ Notably, the Norwegian state owns 67% of the petroleum giant Equinor (formerly Statoil), the flagship company in the Norwegian petroleum industry and by far the largest actor in the petroleum sector.¹²⁸ Hence the active use of SOEs will have to be one of the key tools for achieving a green transformation.

Historically there have been three distinct rationales for state ownership in Norway: the lack of private investors, protecting common interests and the aversion to foreign influence in the economy.¹²⁹ During the first half of the 20th century, the state had to function as an 'entrepreneur of last resort' due to the lack of private investors.¹³⁰ Later, when oil was found on the Norwegian continental shelf, the SOE Statoil was established

¹²¹ A. Prag, D. Röttgers and I. Scherrer. (2018). State-owned Enterprises and the Low-Carbon Transition. OECD Publishing. DOI: <http://dx.doi.org/10.1787/06ff826b-en>.

¹²² Po-Hsuan Hsu, Hao Liang and Pedro Matos (2020). Leviathan Inc. and Corporate Environmental Engagement. Darden Business School Working Paper No. 2960832, ECGI – Finance Working Paper No. 526/2017. DOI: <http://dx.doi.org/10.2139/ssrn.2960832>.

¹²³ A. Prag, D. Röttgers and I. Scherrer. (2018). State-owned Enterprises and the Low-Carbon Transition. OECD Publishing. DOI: <https://doi.org/10.1787/06ff826b-en>.

¹²⁴ Max Jerneck. (2020). When soft budget constraints promote innovation: Kornai meets Schumpeter in Japan. Industrial and Corporate Change, dtaa014. Available at: <https://doi.org/10.1093/icc/dtaa014>.

¹²⁵ A. Prag, D. Röttgers and I. Scherrer. (2018). State-owned Enterprises and the Low-Carbon Transition. OECD Publishing. DOI: <http://dx.doi.org/10.1787/06ff826b-en>.

¹²⁶ OECD. (2019). OECD Economic Surveys: Norway. Available at: <https://www.oecd.org/economy/surveys/Norway-2019-OECD-Economic%20Survey-Overview.pdf> (accessed: 10 May 2020); Hans Christiansen. (2011). The Size and Composition of the SOE Sector in OECD Countries. OECD Corporate Governance Working Papers No. 5. OECD Publishing. DOI: <http://dx.doi.org/10.1787/5kg54cwps0s3-en>.

¹²⁷ Einar Lie. (2016). Context and contingency: Explaining state ownership in Norway. *Enterprise & Society*, 17(4), pp. 904-930. doi:10.1017/eso.2016.18.

¹²⁸ PwC. (2020). E&P transactions on the NCS. Available at: <https://www.pwc.no/no/nyheter/e-and-p-transactions-on-the-ncs-2019.pdf> (accessed 30 October 2020).

¹²⁹ Einar Lie. (2016). Context and contingency: Explaining state ownership in Norway. *Enterprise & Society*, 17(4), p. 905. doi:10.1017/eso.2016.18.

¹³⁰ Ibid. p. 911.

explicitly to protect the state's and Norwegian interests.¹³¹ And more recently, when SOEs have become partially privatised, state majority control is considered important in order to block any outsourcing abroad.¹³²

The large share of state ownership in Norway implies that an innovation-led green industrial strategy has to utilise these operating capabilities of the Norwegian state, which can provide green investment opportunities for the financial sector. While increased financialisation risks leading to a *short-termist* tendency¹³³ within key sectors, the active use of SOEs can function as a vehicle for the state's capacity for *long-term* planning and risk-taking in the market. They can also function as coordinating and direction-setting agents within the broader national innovation system.¹³⁴

SOEs have historically had a significant impact on innovation and industrial development in Norway.¹³⁵ The active, innovative and entrepreneurial utilisation of SOEs was key in the development of the petroleum sector and related industries. In the 1980s, however, there was a turn away from active state involvement in enterprise towards trust in the efficiency of the private sector alone. State ownership stakes were sold to finance government budget expansions, which reflects a change in the view of SOEs from an entrepreneurial arm of government to a source of revenue.¹³⁶ Statoil was eventually publicly listed and partially privatised, and recently renamed Equinor.¹³⁷ The new model for state ownership was now the 'hydro model', where the state reduces its ownership but retains a share large enough to block 'unwanted' decisions.¹³⁸ Thus, state ownership was no longer based on the 'positive possibilities of governance', but instead on 'negative control'.¹³⁹

This process has implied a shift away from an entrepreneurial state towards a passive state that looks to fix market failures rather than shape markets.

There was a clear divergence in the approach towards renewable energy investment and incentives between China and the EU when the Great Financial Crisis struck. While EU countries turned towards austerity and reduced their public support towards renewable energy industries, China instead chose a green industrial strategy with large-scale investment in green technologies, mainly financed by the China Development Bank.¹⁴⁰ Before the Great Financial Crisis, the Norwegian solar PV manufacturing industry became significant, reaching a 10 to 20% world market share in various sections of the industry.¹⁴¹ While there was significant public support in the form of tax credits, R&D funding and collaboration between industry and research institutes, the Norwegian solar PV manufacturing industry to a large extent relied on the demand-side policies of other countries. In 2012 REC, originally a Norwegian company, closed down Norwegian production facilities

¹³¹ Industrikomiteén. Innst. S. nr. 294. (1970-1971). Innstilling fra den forsterkede industrikomite om undersøkelse etter og utvinning av undersjøiske naturforekomster på den norske kontinentalsokkel m.m.

¹³² Ministry of Trade, Industry and Fisheries, Meld. St. 8 (2019-2020). The state's direct ownership of companies, 18.

¹³³ Mariana Mazzucato and Carlota Perez. (2015). Innovation as growth policy: The challenge for Europe. In: Jan Fagerberg, Staffan Laestadius, and Ben R. Martin (eds.). The Triple Challenge for Europe: Economic Development, Climate Change, and Governance. Oxford: Oxford University Press. DOI: 10.1093/acprof:oso/9780198747413.003.0009.

¹³⁴ Piret Tõnurist and Erkki Karo. (2016). State-owned enterprises as instruments of innovation policy. *Annals of Public and Cooperative Economics*, 87, p. 624. DOI: <https://doi.org/10.1111/apce.12126>.

¹³⁵ Ole Andreas Engen. (2009). The development of the Norwegian petroleum innovation system: A historical overview. In: Jan Fagerberg, David Mowery and Bart Verspagen (eds.). *Innovation, Path Dependency, and Policy: The Norwegian Case*. Oxford: Oxford University Press DOI: 10.1093/acprof:oso/9780199551552.003.0007.

¹³⁶ Einar Lie. (2012). *Norsk økonomisk politikk etter 1905*. Oslo: Universitetsforlaget, p. 181.

¹³⁷ Tore Grønlie. (2001). Mellom politikk og marked - organisering av statlig næringsdrift. In: Tranøy Bent Sofus and Øyvind Østerud (eds.). *Den fragmenterte staten – Reform, makt og styring*. Oslo: Gyldendal Akademisk, pp. 322-323.

¹³⁸ *Ibid.*, p. 323.

¹³⁹ *Ibid.*, p. 330.

¹⁴⁰ Mariana Mazzucato. (2015). *The Green Entrepreneurial State*. SWPS 2015-28. DOI: <http://dx.doi.org/10.2139/ssrn.2744602>.

¹⁴¹ Antje Klitkou and Helge Godoe. (2013). The Norwegian PV manufacturing industry in a Triple Helix perspective. *Energy Policy*, 61, pp. 1586-1594. DOI: <https://doi.org/10.1016/j.enpol.2013.06.032>.1588.

while production continued in Singapore and the USA.¹⁴² In 2011 Elkem Solar, another Norwegian company, was taken over by China National BlueStar and new production facilities were built in Iceland instead of Norway. China National BlueStar is owned by ChemChina, a Chinese SOE. With a greater willingness to use state ownership in strategic sectors, the Norwegian solar sector may have fared better.

Governments tend to utilise SOEs to achieve policy goals beyond profit maximisation. There is evidence that suggests that the turn to renewables, a policy goal, has therefore been driven by SOEs. OECD found that the capacity share of SOE ownership in the electricity sector has a positive effect on renewable energy investment across OECD and G20 countries.¹⁴³ This is driven by two factors: that SOEs tend to be directly used by states to increase investment in renewables; and that it is easier for SOEs to finance investment in renewable energy projects. Therefore, it concludes that governments cannot be passive shareholders:

These results point to an opportunity for governments with SOE holdings to make use of their shareholder influence to accelerate the low-carbon transition while retaining public service obligations (such as universal electricity provision) and financial return requirements.¹⁴⁴

Recommendations

Utilise SOEs for the green industrial transition

The Norwegian state has historically used state ownership to promote industrial policy and innovation, a responsibility the state often had to shoulder due to the lack of private investors. To enable the green transition, the state could either establish new renewable energy companies as it did with Statoil in the petroleum industry, or direct existing SOEs towards renewable energy development. All SOEs engaged in industries that are relevant for the green transition should be given missions to spur green industrial development and enable the green transition.

Establish a Green Industrial State Holding Company

The Norwegian state has an inefficient and uncoordinated ownership in a variety of enterprises. To facilitate coordination between the different companies relevant for the green transition and find synergies, the government could establish a Green Industrial State Holding Company (GISHC). The GISHC should not be a passive financial actor which merely reaps a return on its equity shares in different firms, but actively and strategically coordinates activity across the different firms and plans for green industrial development. Exercise of ownership in a single entity such as a state holding company is also recommended by OECD. The GISHC should be fully state owned to avoid the pressure to distribute earnings among private shareholders and to ensure that investments are made based on industrial development and not on financial extraction.

Make Equinor a mission-oriented state-owned company

Making Equinor a fully state-owned company would enable the firm to focus on the big challenge facing the Norwegian economy today by removing the pressure on Equinor to distribute earnings among shareholders. The company could thereby be reoriented away from value extraction and towards green value creation. Extensive share buyback programmes in a time where significant investments in the green transformation are necessary would signal a need for a rethink in the orientation of the firm. The current arms-length distance between government and management makes it difficult to ensure political accountability for the activities of Norway's petroleum giant. Moving the firm to state ownership category 3 could be a necessary move.

¹⁴² Antje Klitkou and Helge Godoe. (2013). The Norwegian PV manufacturing industry in a Triple Helix perspective. *Energy Policy*, 61, p. 1592. DOI: <https://doi.org/10.1016/j.enpol.2013.06.032.1588>.

¹⁴³ Ibid., p. 34.

¹⁴⁴ Ibid., p. 38.

6. Mitigating climate risks through financial regulation

- Encourage 'green' and penalise 'brown' in financial regulation
- A green mandate for the Financial Supervisory Authority of Norway
- A green mandate for Norges Bank

The then Bank of England governor Mark Carney made the case that the common mainstream conceptualisation of environmental regulation as a “tragedy of the commons” is less suitable for climate change than as a “tragedy of the horizon”.¹⁴⁵ Where the horizon for monetary policy is over two to three years and financial stability regulation is for about a decade, the horizon for climate change is much longer: “In other words, once climate change becomes a defining issue for financial stability, it may already be too late.”¹⁴⁶ A green transition in Norway would require that climate-related risks are analysed thoroughly and that the financial sector not only reduces its exposure to such risks, but is mobilised to finance a green transition.

There are two main types of financial risk associated with climate change: physical risks and transition risks. Physical risks are based on the effects of climate change on insured and uninsured assets, either affecting insurers or the balance sheets of the affected households or firms. Transition risks originate in the transition away from fossil fuels, risking the stranding of fossil-based assets. The question is whether financial markets have correctly priced fossil-based assets if future climate policy requires that petroleum reserves remain in the ground and that petroleum platforms, machinery and equipment are decommissioned earlier than planned. If the transition away from fossil fuels is done rapidly and in an uncontrolled fashion, it is likely that there will be large financial losses that may have system-wide effects on the entire economy.

Climate change is more a threat to Norway via transition risks than physical risks. In the Notre Dame Global Adaptation Initiative (ND-GAIN), Norway has the highest rank (minimal vulnerability relative to maximal readiness) of all countries in the evaluation.¹⁴⁷ But the large share of GDP constituted by the petroleum industry and related sectors implies large transition risks. The share of GDP constituted by the petroleum sector alone has fluctuated between 10 and 24 per cent in the last 30 years.¹⁴⁸

The Financial Stability report of 2020¹⁴⁹ concludes that Norwegian banks have moderate lending to the sectors with the highest emissions: oil and gas, transport, manufacturing and international shipping. The falling demand for oil and gas will affect expected returns, according to the report, and such uncertainty should be included in capital requirement assessments. Norges Bank concludes that firms' reporting, regulation and supervision should be strengthened to improve assessments of climate-related risks.

The transition towards sustainable investments may require climate-aligned prudential regulation. The EU High-Level Expert Group on Sustainable Finance (HLEG) has suggested the use of capital requirements (lower for lending to the green sector) as a potential policy tool.¹⁵⁰ The suggestion has been supported by the banking community and is currently under consideration by the European Commission. It is important to note that climate-aligned financial regulations should include not only encouraging 'green', but also penalising

¹⁴⁵ Mark Carney. (2015). Breaking the tragedy of the horizon – climate change and financial stability. Available at: <https://www.bis.org/review/r151009a.pdf>.

¹⁴⁶ Ibid.

¹⁴⁷ Notre Dame Global Adaption Initiative Country Index. Available at: <https://gain.nd.edu/our-work/country-index/> (accessed: 10 October 2020); NOU 2018:17. (2018) Klimarisiko og norsk økonomi. Oslo: Finansdepartementet, p. 67.

¹⁴⁸ Norwegian Petroleum. The government's revenues. Available at: <https://www.norskpetroleum.no/okonomi/statens-inntekter/> (accessed: 20 October 2020).

¹⁴⁹ Norges Bank. (2020). Financial Stability 2020. Available at: https://static.norges-bank.no/contentassets/b3eb84932f954041899b357b19a5259c/fs_financial-stability-2020.pdf?v=11/11/2020142239&ft=.pdf (accessed: 16 November 2020).

¹⁵⁰ High-Level Expert Group on Sustainable Finance. (2018). Financing a sustainable economy.

'brown': there should be a mix of strictly defined taxonomy of green lending and clearly spelled out degrees of brown lending.¹⁵¹

Other macro prudential tools include liquidity ratios, reserve ratios, ceilings on credit growth, and restrictions on profit distribution, as well as capital adequacy ratios and incorporation of environmental, social and governance (ESG) criteria into asset risk assessment for risk-weighted capital requirements.¹⁵² Risk-weighting is important for effective correction of high-carbon bias: assigning relatively lower risk weights for low-carbon projects will help make commercial banks more willing to invest in these projects without fearing that their balance sheets look too risky and with less liquid assets.¹⁵³

Disclosure of non-financial information, such as exposure to carbon-intensive sectors, has been emphasised as an important measure for identifying and measuring the climate-related risks among financial market participants. The approach suggested by the Task Force on Climate-Related Financial Disclosure involves two main types of risk: physical (extreme climate events) and transition (devaluation of brown assets or 'stranded assets').¹⁵⁴ Yet risk disclosure goes hand in hand with accurate pricing of risks and hence substantial technical capacities for risk assessment.¹⁵⁵ Without proper risk assessment techniques, disclosed information will result in the mispricing of risks. Yet currently financial regulators are lacking the analytical tools to adequately capture the mechanisms through which transition risks may translate into financial stability risks.¹⁵⁶

The extent of knowledge and capacity building, especially among the central banks, has substantially grown and the Network for Greening the Financial System (NGFS) is a vivid example of how financial regulators have built a community of 'willing' central banks to promote actions to fight climate change, independently from political narratives.¹⁵⁷ Norges Bank became one of the members of the NGFS and announced that it will be focusing on two work streams within NGFS: macro-financial and scaling up green finance.¹⁵⁸

A recent survey by financial regulators of the types of activities supporting green finance suggests five broader groups: micro-prudential/supervisory, macro-prudential policy, monetary policy, research and capacity building, and scaling up green finance through, for example, credit guidance policies.¹⁵⁹ There are currently 390+ policy and regulatory measures adopted to facilitate green finance.¹⁶⁰ Financial regulatory and supervisory authorities worldwide have deployed various initiatives: from establishing task forces and expert groups to ESG criteria for assets to lending quotas to green QE. Appendix 1 lists various policy measures implemented by Central Banks worldwide.

Another type of monetary policy tool that can be used by central banks is the collateral framework that is applied to assets commercial banks hold and against which central banks lend cash to the commercial sector.

¹⁵¹ D. Gabor. (2020). Greening the European financial system: Three ideas for a progressive sustainable finance agenda. Policy Brief. Foundation for European Progressive Studies (FEPS). Available at: <https://www.feps-europe.eu/attachments/publications/feps%20paper%20three%20ideas%20gabor.pdf>.

¹⁵² E. Campiglio, A. Godin, E. Kemp-Benedict and S. Matikainen. (2017). The tightening links between financial systems and the low-carbon transition. In: M. Sawyer and P. Arestis (eds.). Economic Policies since the Global Financial Crisis. Palgrave Macmillan, pp. 313-356.

¹⁵³ Ibid.

¹⁵⁴ See: <https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-2017-TCFD-Report-11052018.pdf>.

¹⁵⁵ I. Monasterolo. (2020). Climate change and the financial system. DOI: <http://dx.doi.org/10.2139/ssrn.3479380>.

¹⁵⁶ D. Gabor. (2020). Greening the European financial system: Three ideas for a progressive sustainable finance agenda. Policy Brief. Foundation for European Progressive Studies (FEPS). Available at: <https://www.feps-europe.eu/attachments/publications/feps%20paper%20three%20ideas%20gabor.pdf>.

¹⁵⁷ S. Dikau, N. Robins and M. Täger. (2019). Building a sustainable financial system: The state of practice and future priorities. Banco de España. Revista de Estabilidad Financiera, 37, pp. 81-104. Available at:

https://www.bde.es/f/webbde/GAP/Secciones/Publicaciones/InformesBoletinesRevistas/RevistaEstabilidadFinanciera/19/noviembre/Building_sustainable_financial.pdf.

¹⁵⁸ See: <https://www.norges-bank.no/en/news-events/news-publications/News-items/2018/2018-12-12-ngsf/>.

¹⁵⁹ Ibid.

¹⁶⁰ See: <https://greenfinanceplatform.org/financial-measures/browse#>.

The collateral framework defined by financial regulators affects the types of assets private banks hold and therefore includes low-carbon projects in the list of eligible assets.¹⁶¹ Recently, the European Central bank announced that green bonds will be accepted as collateral from January 2021.¹⁶²

Climate-aligned financial regulation and green monetary policies put additional pressures on central banks to act as responsible portfolio managers. The principles of sustainable and responsible investments (SRI) suggested by the NGFS touch upon a broad range of sustainable investment strategies, including environmental, social and governance (ESG) criteria.¹⁶³

Norges Bank has two key missions: to promote economic stability by conducting monetary policy and monitoring the financial system; and to manage Norway's Oil Fund based on a separate mandate issued by the Ministry of Finance. In both areas of responsibility, the issue of understanding the risks and ensuring effective risk management is key.

Norges Bank carries out work on climate risk management within its mandate related to the management of the Oil Fund. The Oil Fund is focused on long-term financial returns and therefore Norges Bank, when assessing the companies in which it invests, takes into consideration sustainability risks from a long-term perspective. In 2019, the Bank divested from 42 companies (282 companies since 2012) based on assessments of ESG risks.¹⁶⁴

The mandate of Norges Bank related to the management of Norway's sovereign wealth fund reinforces the position of Norges Bank as a responsible and transparent investor. ESG guidelines for companies have been developed by Norges Bank (including the ESG database of companies since 2015) and since 2015 the bank has responsibility for decisions on the exclusion of companies, based on recommendations from the Council on Ethics.¹⁶⁵ The responsible investment mandate is included in Norges Bank's annual report and a separate Responsible Investment Report (with the detailed information on management of the Oil Fund) has been published since 2014.

Norges Bank has accumulated extensive expertise in developing and implementing ESG guidelines as part of its management of the Oil Fund, which can serve as the basis for building up the climate risks management inside the bank.¹⁶⁶

Norwegian banks have reduced their exposure to the oil sector in recent years, but they have also experienced a period of declining oil prices (2014) combined with higher risk weights due to banks' higher exposure to oil-related loans. This experience can be relevant for assessing the transition risks within climate-related risks, and Norges Bank's further analytical work on interdependencies between real economy, financial risks and macroeconomic stability.¹⁶⁷

¹⁶¹ E. Campiglio, A. Godin, E. Kemp-Benedict and S. Matikainen. (2017). The tightening links between financial systems and the low-carbon transition. In: M. Sawyer and P. Arestis (eds.), *Economic Policies since the Global Financial Crisis*. Palgrave Macmillan, pp. 313-356.

¹⁶² See: <https://www.ecb.europa.eu/press/pr/date/2020/html/ecb.pr200922~482e4a5a90.en.html>.

¹⁶³ See: <https://www.ngfs.net/sites/default/files/medias/documents/ngfs-a-sustainable-and-responsible-investment-guide.pdf>.

¹⁶⁴ See: https://www.nbim.no/contentassets/aaa1c4c4557e4619bd8345db022e981e/spu_responsible-investments-2019_web.pdf.

¹⁶⁵ The Council on Ethics was established by the Ministry of Finance as an independent body.

¹⁶⁶ See: <https://www.norges-bank.no/en/news-events/news-publications/Speeches/2019/2019-11-08-matsen/>.

¹⁶⁷ Norges Bank Financial Stability Report 2019. Available at: https://static.norges-bank.no/contentassets/62ef0b6e18674ebe9f26fe10944e2512/fs_2019_eng.pdf?v=11/05/2019092038&ft=.pdf.

Recommendations

- Encourage 'green' and penalise 'brown' in financial regulation

The financial sector should support the smooth transition to a post-petroleum economy. Therefore, financial regulation has to encourage 'green' and penalise 'brown' based on a taxonomy of clearly defined green lending and degrees of brown lending.

- A green mandate for the Financial Supervisory Authority of Norway

As suggested by Finance Norway, the Financial Supervisory Authority of Norway should be given a green mandate to ensure that climate-related risks are disclosed and monitored. Financial firms should be legally obliged to disclose non-financial information relevant for identifying and measuring climate-related risks among financial market participants. Competences relating to climate-related risks should be developed together with the financial sector.

- A green mandate for Norges Bank

Despite the significant Norwegian exposure to climate-related risk, other central banks are taking more drastic measures to climate-align their activities. Norges Bank's strategy for 2020-2022 mentions climate change, but does not outline any actions to deal with climate-related risks or to smooth the green transition. Therefore, the Norges Bank should be given a clear climate-related mandate.

The bank should also incorporate environmental considerations into prudential regulation such as liquidity ratios, reserve ratios, ceilings on credit growth, restrictions on profit distribution and capital adequacy ratios.

7. Conclusions

The Intergovernmental Panel on Climate Change states in its report *Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development*¹⁶⁸ that with a linear decrease in emissions starting in 2018, emissions will have to reach net zero in 2038 to have a two-thirds chance of keeping temperature increase below 1.5 degrees, or zero in 2048 to keep the temperature increase below 2 degrees. Every year without emission reductions brings that final year closer and budgeting for a longer timeline in hard-to-abate sectors will require steeper emission reductions in other sectors.

The climate crisis is an enormous global challenge and petroleum-dependent economies are in a particularly difficult position. Norway now needs an industrial transition comparable to the major shifts of the 'industrial adventures' of hydropower development and the emergence of the petroleum industry. Rather than just a managed phasing out of petroleum, Norway needs a managed transition whereby labour and technology are freed up in petroleum-related industries and instead utilised in green sectors. Such a transition will require an entrepreneurial state, spurring dynamism and industrial development rather than limiting itself to maintaining stability.

In this report we have outlined a number of recommendations which delineate a green industrial strategy for Norway. By mobilising investment towards innovation and green industrial development, Norway can set a green direction of growth and accelerate key green technologies along their learning curves. Profitability across sectors is likely to shift dramatically as green technologies mature and global energy demand shifts. Strategic industrial policy now will be needed to reap opportunities of such shifts in the future and to ensure a fair distribution of both risk and reward in the green transition.

It is unlikely that there will be immediate political majority support for all proposals in this report, which span fiscal, monetary and ownership policy. However, the dual challenge of Norway's carbon lock-in and the urgency of ambitious climate action requires a willingness to rethink established convention. We hope that our recommendations will contribute to the essential debate on how Norway could realistically transition its economy in line with the Paris Agreement, and also help other countries do the same. By learning from the historical lessons of hydro-powered and petroleum-powered industrialisation in the 20th century, Norway will be able to utilise its financial strength and productive capacity towards the grand challenge of the 21st century. Through reducing global greenhouse emissions by way of developing green industrial jobs, yesterday's Fossil Ogre could become the Green Giant of tomorrow.

¹⁶⁸ IPCC. (2018). *Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development*, 107. Available at: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter2_Low_Res.pdf.

8. Appendix 1. Environment and financial regulators

Type of intervention	Concept	Selected current applications
<i>Research</i>		
Assessment of climate-related financial risks	Develop and apply methodologies to identify and measure climate-related risks to financial institutions	DNB ¹⁶⁹ , Bank of England ¹⁷⁰ , French supervisory authority ¹⁷¹
Macroeconomic modelling of low-carbon transition	Develop modelling tools to assess the wider impact of climate risks and the transition	Only outside central banks and regulations (private sector and academia)
<i>Policy</i>		
Support to international activities on green finance	Enhance knowledge, cooperation and diffusion of good practices	G20 Green Finance Study Group ¹⁷² , Sustainable Insurance Forum ¹⁷³ , NGFS ¹⁷⁴ , ASEAN Sustainability Bond Standards ¹⁷⁵
Disclosure of climate-related financial risks, including classification systems	Enforce or encourage disclosure of climate-related financial risks by firms and investors	FSB Task Force on Climate-related Financial Disclosures ¹⁷⁶ , French Energy Transition Law ¹⁷⁷ , New Zealand's External Reporting Board ¹⁷⁸ , EU ¹⁷⁹
Environmental aligned prudential regulation policy	Incorporate environmental considerations into prudential regulation	Banque du Liban ¹⁸⁰ , Banco Central do Brasil ¹⁸¹

¹⁶⁹ G. Schotten, S. van Ewijk, M. Regelink, D. Dicou and J. Kakes. (2016). Time for Transition—An Exploratory Study of the Transition to a Carbon-Neutral Economy. Netherlands Central Bank.

¹⁷⁰ M. Scott, J. Van Hulzen and C. Jung. (2017). The Bank of England's Response to Climate Change 98–109. Bank of England.

¹⁷¹ ACPR – Banque de France. Climate Change: which risks for banks and insurers? Available at: https://acpr.banque-france.fr/sites/default/files/medias/documents/as_cover_note_en.pdf.

¹⁷² J. McDaniels, N. Robins and B. Bacani. (2017). Sustainable Insurance: The Emerging Agenda for Supervisors and Regulators. UN Environment Inquiry.

¹⁷³ Priority Sector Lending—Targets and Classification (2015). Reserve Bank of India.

¹⁷⁴ Central Bank and Supervisors Network for Greening the Financial System Joint Statement by the Founding Members of the Central Banks and Supervisors Network for Greening the Financial System. (2017). (Banco de México, Bank of England, Banque de France, De Nederlandsche Bank, Deutsche Bundesbank, Finansinspektionen, Monetary Authority of Singapore, The People's Bank of China).

¹⁷⁵ By ASEAN capital market forum (2018). Available at: <https://www.sc.com.my/api/documentms/download.ashx?id=3c4f768f-a290-4722-b9d1-ef55942fbfde>.

¹⁷⁶ S. Dietz et al. (2017). Management Quality and Carbon Performance of Cement Producers: A Commentary. Transition Pathway Initiative.

¹⁷⁷ C. Aspin. (2017). The Missing 55%. Voting Records for the 10 Largest Utility Investors Show Divergence on Climate Risk. Preventable Solutions.

¹⁷⁸ Ongoing – see: <https://www.mfe.govt.nz/climate-change/climate-change-and-government/mandatory-climate-related-financial-disclosures>.

¹⁷⁹ The Taxonomy Regulation. (2020). European Parliament. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R0852>.

¹⁸⁰ Intermediate Circular 236. (2010). Banque du Liban. Available at: <http://climatechange.moe.gov.lb/viewfile.aspx?id=216>.

¹⁸¹ Circular 3, 547 of 7 July 2011: Establishes Procedures and Parameters Related to the Internal Capital Adequacy Assessment Process (ICAAP). Banco Central do Brasil; China Monetary Policy Report—Quarter Four 2017 (2018). People's Bank of China.

Type of intervention	Concept	Selected current applications
Green central bank financing	Provide additional/subsidised liquidity to banks that lend to environment-friendly activities	Bangladesh Bank ¹⁸² , Bank of Japan ¹⁸³
Lending quotas	Impose a minimum proportion of bank lending to flow to environment-friendly sectors	Reserve Bank of India ¹⁸⁴ , Bangladesh Bank ¹⁸⁵
ESG factors in asset eligibility criteria, ESG integrated into own investment portfolio management	Include ESG criteria in the evaluation of the overall risk of an asset purchased or accepted as collateral	Only for own purchase, for example, DNB ¹⁸⁶ , Norges Bank ¹⁸⁷ , Banca d'Italia ¹⁸⁸ , Banque de France ¹⁸⁹ , DNB ¹⁹⁰ , Banco de Mexico ¹⁹¹ , People's Bank of China ¹⁹²
Green quantitative easing	Purchase green assets as part of quantitative easing programmes	Assets purchased only if they meet the central bank's eligibility criteria, such as EIB bonds ¹⁹³
Green bond portfolio/fund	Create a green bond portfolio (including within foreign exchange reserves)	Magyar Nemzeti Bank ¹⁹⁴

Source: adapted from Campiglio et al. (2018)¹⁹⁵; updated based on recent policy measures

¹⁸² A. Barkawi and P. Monnin. (2015). Monetary Policy and Sustainability—The Case of Bangladesh. UNEP Inquiry into the Design of a Sustainable Financial System.

¹⁸³ Principal Terms and Conditions for the Fund-Provisioning Measure to Support Strengthening the Foundations for Economic Growth Conducted Through the Loan Support Program. (2010). Bank of Japan.

¹⁸⁴ C. A. E. Goodhart. (2011). The changing role of central banks. *Financial History Review*, 18, pp. 135–154.

¹⁸⁵ Principal Terms and Conditions for the Fund-Provisioning Measure to Support Strengthening the Foundations for Economic Growth Conducted Through the Loan Support Program (2010). Bank of Japan.

¹⁸⁶ 2016 Annual Report. (2017). De Nederlandsche Bank.

¹⁸⁷ Observation and Exclusion of Companies. (2017). Norges Bank. Available at: <https://www.nbim.no/en/responsibility/exclusion-of-companies>.

¹⁸⁸ Information on new ESG criteria. (2019). Banca d'Italia. Available at: <https://www.bancaditalia.it/media/approfondimenti/2019/informativa-esg/index.html?com.dotmarketing.htmlpage.language=1>.

¹⁸⁹ Responsible Investment Charter. (2018). Banque de France. Available at: https://www.banque-france.fr/sites/default/files/media/2018/03/29/818080_-charte-invest_en_2018_03_28_12h12m41.pdf.

¹⁹⁰ Responsible Investment Charter. (2019). De Nederlandsche Bank. Available at: https://www.dnb.nl/en/binaries/DNB%20Responsible%20Investment%20Charter_tcm47-382883.pdf

¹⁹¹ Sustainable Responsible Investment practices were adopted within fixed-income holdings in Banco de Mexico's portfolio. Available at: <https://www.banxico.org.mx/publicaciones-y-prensa/discursos/%7BA975ABA4-4DB3-1CA3-64D7-88F1B494A964%7D.pdf>.

¹⁹² PBOC accepts loans with AA rating as collateral in medium-term loan facility. (2018). Available at: <http://vochina.org/show-3-178.html>.

¹⁹³ Bonds and Climate Change: The State of the Market in 2017. (2017). Climate Bonds Initiative.

¹⁹⁴ See: <https://www.mnb.hu/en/pressroom/press-releases/press-releases-2019/magyar-nemzeti-bank-among-the-first-central-banks-to-create-a-dedicated-green-bond-portfolio-within-foreign-exchange-reserves>.

¹⁹⁵ E. Campiglio, Y. Dafermos, P. Monnin, J. Ryan-Collins, G. Schotten and M. Tanaka, M. (2018). Climate change challenges for central banks and financial regulators. *Nature Climate Change*, 8 (6), pp. 462–468.

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