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CHINA'S GREEN INDUSTRIAL SHIFT

WHAT DOES IT MEAN FOR NORWEGIAN CLIMATE POLICY?

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ABSTRACT

CURRENTLY ENGAGED IN A DEEP DEBATE over its future economic course -- to green or not to green – Norway has many models on which to base its future course. With the world’s largest sovereign wealth fund built up from oil industry earnings, it has surprised many by the decision to divest itself of some fossil fuel investments around the world. This has been followed by announcement of a green investment package to kick-start green industries. This paper discusses how Norway could extend its current divestment program into a domestic industrial investment program, with clear focus on green targets that complement existing industrial trends around the world – moving from **divestment to green investment**. The prior example of China is discussed as an exemplar of state-led greening of a vast economy, where market-shaping strategies are pursued to complement state-directed policies. This (perhaps surprising) model of market governance and green growth has the effect of driving down costs for all and opening opportunities for Norwegian companies prepared to move in a new and profitable green direction. China has demonstrated that manufacturing of renewable energy devices generates energy security, and likewise Norway can utilize renewables such as offshore wind power to drive the construction of wind power platforms and the value chains that feed them.

INTRODUCTION

NORWAY IS ENGAGED IN A NATIONAL STRATEGIC DEBATE over the direction of its future industrial investments – to green or not to green. Norway has much of its GDP and exports tied up in fossil fuels, particularly oil from the North Sea. In 2019 the petroleum industry constituted 13 percent of Norway's GDP, 19 percent of government tax revenue, 19 percent of total investments and 36 percent of export revenue.¹ A total of 225 000 people were employed in the petroleum industry and related industries in 2017. These proportions represent a high degree of dependence for a country of just over five million people.

In recognition of the time limits imposed on this resource, Norway is moving ahead rapidly to promote green growth as an alternative to continued dependence on oil and gas. This is evident already in the recent decision to phase out investments in fossil fuel exploration by the country's sovereign wealth fund (largest in the world) – the Government Pension Fund Global (GPF). This was followed by the government's announcement in June 2020 of a NOK 3.6 billion emergency package to boost green investments – focused on hydrogen, hydro energy storage, offshore wind and green shipping. At the same time the oil industry received substantial tax breaks, meaning that the government feels constrained to back fossil fuels as well as pursue a green shift. Where are the models that Norway might follow in this endeavour?

Although China is an enormous country compared with Norway, there are nevertheless important (perhaps surprising) lessons to be learnt from the Asian giant. China has built its energy system (like all previous industrializers) on fossil fuels – but at enormous and growing scale. It has found to its cost that there are limits to the use of fossil fuels as engines of industrialization – not just the impoverishment of air quality in cities and burning of fossil fuels' contribution to global warming, but geopolitical limits as China's dependence on coal, gas and oil imports rises. Energy security is indeed the prime driver for China's green energy strategies. It has used its powerful state to intervene in the economy to begin a process of transition away from fossil fuels towards green power generation, green industry and green cities. How is it doing this and what are the implications for a small country like Norway?

THE CHINA EXAMPLE

THIRTY YEARS AGO Robert Wade examined the record of North East Asian industrialization, with a focus on Japan, then Korea and Taiwan, and coined the expression “governing the market” to capture the core features of these countries’ industrialization strategies. At that time he did not query that their strategies were based on fossil fuels. Now with China as the centre of attention, we find that “governing the market” is still an excellent characterization of the country’s green shift.² Against expectations, China has proven to be adept in harnessing market forces to drive its green shift. There are many examples in the rise of new green industries like solar PV cells and wind turbines, as well as shifts in power generation patterns. These shifts are backed by market-based schemes such as a national cap-and-trade scheme to phase out fossil fuels, not by government mandate so much as by strong influence on market forces.

Apart from conventional climate-related policies there is the outstanding example of China’s highly successful program to reforest sloping lands (e.g. on upper reaches of valleys) that had been dangerously put under cultivation. This outcome was achieved through the Sloping Lands Conversion Program, widely admired as the largest and most ambitious reforestation scheme in the world. The program began with smaller payments to farmers on gently sloping land to convert their farmland to forest, to larger payments to farmers on more steeply graded land – until the point where the state set a prohibition on continued farming on the steepest land (defined as land exceeding a slope of 25%) with all its attendant risks of landslides and flooding. This has been a highly successful Payment for Environmental Services (PES) program; it demonstrates an astute blend of graded market-based incentive combined with strong state involvement in setting the limits to a defined policy of market shaping.³

China’s building of its wind power industry over the course of three decades demonstrates powerful use of market shaping strategies, together with payment of extensive subsidies early on and strong tax incentives offered, particularly by provincial governments acting within overall national government guidelines. In the early years the focus was on attracting foreign investments qualified by Local Content Requirements (LCRs) designed to build local supply chains – a strategy emulated by India and other industrializing countries.⁴ The programs then evolved into renewable energy market expansion programs, combined with subsidies paid through Feed-in Tariffs and eventually to public auctions to award wind power concessions to the most cost-competitive players. These strategies have been backed by extensive credit provision, via the state investment banks (mainly the China Development Bank and the Export-Import Bank), enabling China firms to expand their scale of

operation rapidly and venture into international competition much faster than would otherwise be the case.

The effect of this green shift in China's energy strategies has been a stunning transformation of its electric power generation, with a clear shift to renewables in terms of generating capacity and in terms of electricity generated over the past decade. Figure 1 reveals that China has raised the proportion of electric generating capacity sourced from water, wind and sun (WWS) from 24% in 2009 to 38% in 2019 – or a 14% shift in a decade, in what is now the world's largest electric power system. The same Figure reveals that electricity actually generated from WWS sources has increased from 18% in 2009 to 27% in 2019 – or a 9% shift in a decade.⁵ These shifts are having dramatic effects worldwide, and they are making China the undisputed renewables superpower, as shown in Figure 2.

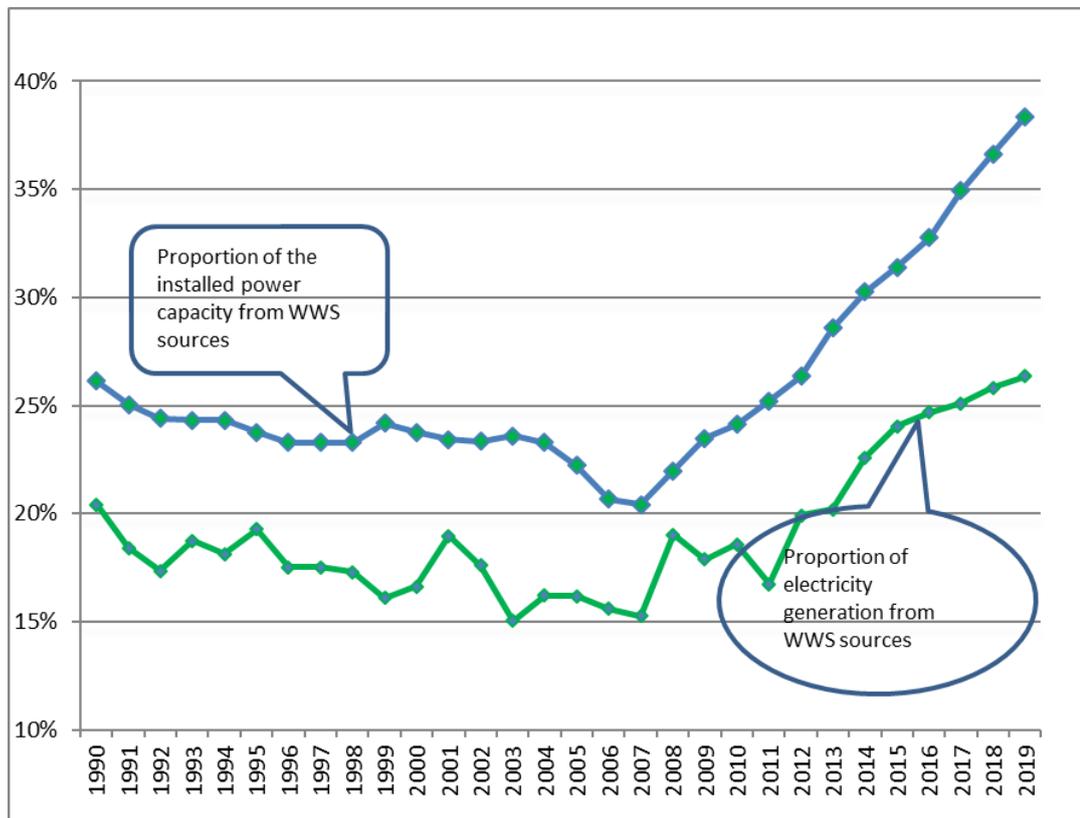


Figure 1 China: Proportion of electric power generation sourced from WWS, 1990 to 2019. Source: Mathews and Huang 2020

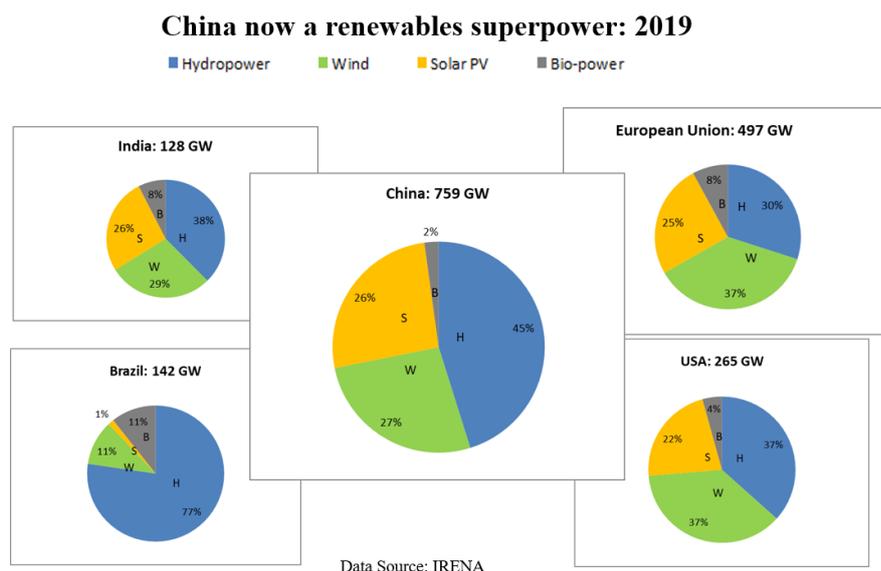


Figure 2. International electric generating capacity, by major countries, 2019. Source: Mathews and Huang 2020

These dramatic shifts in the generation of electric power, and the shift away from fossil fuels in transport, industry and domestic consumption that they imply, are turning China into the world's leading promoter of urbanization and electrification, with enormous implications for trade and manufacturing patterns around the world. These shifts provide the setting in which smaller but technologically sophisticated countries like Norway need to frame their energy strategies.

China has of course not left these shifts to market forces alone. Instead it has utilized its state power to intervene in the energy markets and drive them in a green direction, which favours China's manufacturing prowess and enhances its energy security, making it less and less dependent on fossil fuel imports. The full power of the Chinese state has been evident in the most recent series of industrial strategies, visible in the growing field of electric vehicles and associated -production of batteries to build up domestic supply chains. China recognized that its industrialization would be incomplete without a full-blown automotive industry, associated with vehicle production and full supply chains of component production feeding these production activities. As a late starter China recognized that it would need to focus not so much on internal combustion engine vehicles as on "new energy vehicles" involving electric motors and fuel cells (using green hydrogen as fuel). By 2019 it had already built the world's largest market for conventional vehicles and for NEVs (EVs and FCVs) and is now strongly focused on building supply chains for NEVs, particularly battery production.

To this end China flexed its industrial muscle and instigated in 2015 a state policy to pay subsidies to producers of NEVs in China, where the

subsidy was payable only if the batteries were supplied by a local Chinese producer. This so-called “whitelist” of approved domestic battery suppliers proved to be a powerful means of growing a battery supply industry rapidly, and while it triggered numerous foreign protests as being against WTO rules China was able to relax the policy by 2019, opening up the supply of batteries to foreign competitors.⁶ This is an example where China utilizes the full power of the state to intervene in an industrial market, but in a finely tuned way and only for as long as is called for to establish producers in a new industrial market.⁷

China pursues targets framed as business/industrial goals (such as rising proportion of EVs in automotive sales, or rising proportion of locally manufactured wind turbines in total turbine sales) rather than as explicitly framed carbon emissions reductions goals. Of course, the green industrial goals translate over time into carbon reduction outcomes – but these are implied outcomes, not explicit goals. In this way China’s “green growth” industrial targets are of a piece with its other industry promotion targets such as building national self-reliance in IT equipment and semiconductors. At the same time China has been prepared to use its large state-owned firms in driving a green shift, instructing SOEs to diversify where needed from fossil fuel dependence to green business practices, while also encouraging new firms to enter energy and transport industries. And of course the Chinese state adopts a “whole of government” perspective and ensures that one strategy links with another – as when provision of finance through state development banks is targeted at meeting targets for energy, transport and industry.

NORWEGIAN INITIATIVES

Norway would be able to draw from these examples as it seeks to accelerate a green shift in its existing industries and to create new green industries. There are several ways in which Norway could build on the precedents established by China, and utilizing measures that complement existing strengths, by:

- promoting diversification on the part of big oil and gas producers in the North Sea to use their capabilities and resources to become green energy producers;
- building industrial strength in sectors already targeted by the recent NOK 3.6 billion green transition package; and
- reinforcing the pattern of investments recently displayed on the part of the government-owned sovereign wealth fund, the Government Pension Fund Global (GPF), to encompass investment in green Norwegian domestic industry.

Let us consider these three pathways to a greener economy and the ways that they could be strengthened by drawing on Chinese precedents.

(i) DIVERSIFICATION AWAY FROM NORTH SEA OIL AND GAS OPERATIONS

The clearest example of a green shift in Norway's economy can be found in the strategies of Norway's state-owned energy firms, Equinor (formerly Statoil) in oil and gas, and Statkraft (former hydroelectric power generator). Equinor's move from building floating oil and gas platforms to generating power on floating offshore wind power platforms is a clear case where a former fossil fuel producer is able to transfer its resources and capabilities across to the generation of renewable power.

Equinor announced in late 2019 its intention of building the world's first floating windpower platform, utilizing its **Hywind** technology, to provide power to the Snorre and Gullfaks oil fields off the coast of Norway (for generation of power in late 2022). Equinor then let the first contracts, with (German-Spanish) **Siemens Gamesa Renewable Energy** winning the initial contract to provide 11 giant wind turbines, in total providing power at 88 MW.⁸ Contracts have also been let for services in the value chains leading to the building of these offshore floating windpower platforms.

The Hywind technology has been proven through three stages so far. First, the **Hywind Demo** (a decade ago, initiated in 2009), in Norway, rated at 2.3 MW. Next, the **Hywind Scotland** (a 30-MW floating windpower platform, launched in 2017) – currently the world's largest floating windpower farm. And now most recently the Norwegian **Hywind Tampen** floating system, involving 11 turbines and rated at 88 MW.

Thus over the course of the past decade the Norwegian national energy company Equinor has been diversifying from a pureplay oil and gas major to an energy company that is building a world-class leading position in offshore floating windpower technology. Equinor is demonstrating a capacity not just in shifting its own operations but in building the supply services needed, such as in enhancing fleets of supply vessels, or in building and operating wind power platforms, and in operating the wind farms themselves. In this it is showing other oil and gas companies how to adapt to the new green trends and make them their own.

The Norwegian state-owned power company, Statkraft, with its origins in hydropower, has embarked on an equally impressive diversification strategy with an emphasis on onshore windpower (leaving offshore windpower for its sister state-owned company Equinor). It announced this diversification in 2015, the same year as Statoil initiated its own

diversification strategy. Statkraft sold off its offshore windpower assets in 2018 in order to concentrate on onshore wind power as well as other renewables projects. It has publicly announced plans to invest more than \$1 billion per year in renewable energy over the years 2019 to 2025, with more than a third anticipated to be in Norway, and the majority within Europe. Statkraft aims to reach 6 GW in installed onshore wind capacity by 2025 (as well as 2 GW of solar PV power), with a business strategy to act as developer of the projects, aiming to sell them off to financial investors after completion. Consistent with this strategy, Statkraft renamed its onshore windpower business (which moved into the black in 2018) as European Wind and Solar on 1 January 2019.⁹

The cases of Equinor in offshore wind power and Statkraft in onshore wind power reveal clearly how companies with long and strong traditions in fossil fuel production (and hydro generation in the case of Statkraft) can transfer (diversify) these capabilities across to renewables generation and distribution. This is already a process under way with initiatives taken by Equinor in offshore wind power and by Statkraft in onshore wind power – and it is clearly a strategy that could be further pursued if there is sufficient government support for such diversification initiatives. The strategy is firmly based on industrial investment initiatives to transform public infrastructure, as has been pursued successfully by China.

These initiatives are not confined to the final energy producers Equinor and Statkraft. More to the point, they involve companies providing services along the value chain where again companies that have provided services in the oil and gas sector are now providing services to Equinor and Statkraft as they transition to renewable energy producers. For example, Kvaerner has grown to be a major supplier of offshore drilling equipment to the oil and gas sector (particularly to Statoil and subsequently Equinor) – and it has followed Equinor in its diversification across to the offshore wind power (OWP) sector. The steps being taken in Norway to become a key player in this OWP industry are economically sound, and promise great benefits – energy, jobs, exports – now and in the future.

(ii) GREENING OF NORWEGIAN INDUSTRY

The greening of Norwegian industry is to be accelerated by the government's announcement of a NOK 3.6 billion fund for investment in the economy's green shoots – encompassing hydroelectric power as green battery, generation of offshore wind power, hydrogen production and use as energy source in industry and transport, and low-emissions shipping. These initiatives have been designed to mesh with existing patterns of industry in Norway and to extend and reinforce green

tendencies that are already in train. Hydrogen initiatives could involve expanding the production and distribution of green hydrogen as a fuel, particularly in the shipping industry (e.g. in cargo vessels, ferries and tourist craft), as well as for export. Here the Norwegian government could emulate the Chinese example and pursue strong policies to drive the initiatives, working with rather than against market forces, and focusing on industrial hubs where the new firms can generate savings through complementary interaction.¹⁰ The prospects of green hydrogen as a low-carbon fuel are growing rapidly around the world, particularly as costs fall in essential equipment such as electrolysis units which can produce hydrogen from water. Again there is already evidence of movement in this green direction for Norwegian shipping, with strong government support (e.g. ban on diesel-powered tourist vessels and ferries in Norway's pristine fjords). Let us examine the individual schemes and their interconnections.¹¹

(a) GREEN BATTERY: PUMPED HYDRO STORAGE FOR EUROPE

Norway already has a strong network of 937 hydro power plants that provide 96% of the country's electricity – making its power grid one of the greenest in the world. But if the dream of using pumped hydro storage as a means of providing power to the rest of Europe is to become a reality, there needs to be substantial investment in the grid and in inter-grid connections that link the Norwegian power system to the wider EU system.¹² These have been widely discussed in Norway, and have become controversial because of the price effect in raising Norwegian on-shore wind power prices to the EU level.

(b) OFFSHORE WIND POWER

Partly because of its prior commitments to hydro power, Norway has not been an advanced generator of wind or solar power, nor has it produced advanced manufacturing companies like Vestas in Denmark with its extensive supply chains. But this now has the potential to change as the goal of 100% green power becomes realistic for Norway, and the potential of green manufacturing and associated supply chains becomes tangible. After the earlier global waves of renewables in the form of solar PV and wind power, offshore wind power now looms as an important third wave – and again Norway is well placed to catch this third wave through its access to the generating capacity of wind power in the North Sea. The issue is whether this prospect can be translated into creation of new manufacturing industries and new manufacturing industry jobs.

The potential for the offshore windpower market is huge. The International Renewable Energy Agency (IRENA) for example, estimates the global

potential for offshore windpower to be 100 GW by 2030.¹³ The International Energy Agency (IEA) estimates the market potential of offshore windpower by 2040 to be no less than \$1 trillion.¹⁴

Equinor is already a leader in generating offshore wind power, both on the Continental Shelf and on floating platforms that can supply power both to existing offshore oil and gas operations and to the mainland grid. At the same time it is bringing a supply chain of service and components suppliers with it – such as Kvaerner for supply vessels as well as marine service companies, insurance, service supply vessels, turbine construction and other aspects.¹⁵

(c) HYDROGEN

In June 2020 the Norwegian government outlined a strategy to build its national hydrogen industry, proposing hydrogen as an energy carrier that can eventually take over from fossil fuels in greening the economy. Hydrogen promises to provide the clean energy of the future, where it can be used to power fuel cells in transport as well as provide hydrogen direct to businesses and households and to industry as an alternative to fossil fuels like coal. In the steel industry for example, which in its traditional form burns a lot of coal and has high carbon emissions, there are now demonstrated cases where hydrogen can be introduced as a direct substitute for the fossil fuel.¹⁶

Norway can utilize its existing industrial parks to build hubs for these new green directions for the economy. A start has already been made, with the Norwegian power utility Statkraft and Norwegian steel manufacturer CELSA together with the Mo industrial park in Norway announcing their agreement to develop green hydrogen for industrial uses such as high-temperature metal production processes.¹⁷

(d) LOW-EMISSIONS SHIPPING

From producing ships that burn diesel and produce high carbon emissions, Norway and the Scandinavian countries now face the prospect of transitioning to clean carbon-free shipping, using fuel cell vessels utilizing liquid green hydrogen. If produced from electrolysis of water utilizing green electric power this provides the ultimate solution to decarbonizing the world's shipping – and creating a wholly new shipbuilding and shipping industry. And a start has already been made in creating this industry of the future. In February 2020 Norway announced the world's first fuel cell powered cruise ship to run on liquid hydrogen.¹⁸ In this project a consortium of Norwegian companies have joined forces, including system integrator Norwegian Electrical Systems (NES) which plans to incorporate a 3.2 MW fuel cell in a ship designed by Havyard Design for the shipowner Havila.

With their long shipping traditions, the Scandinavian countries are taking the lead in driving the HFC shipping clean transition, seizing first mover advantages. The world's first fuel cell-powered ocean-going ship, the service supply vessel for the North Sea oilfields *Viking Lady*, was launched a decade ago, and it has since proven itself to be an efficient and reliable performer. Many smaller passenger vessels and ferries, particularly in Norway, are now battery-powered, with some companies introducing their own floating recharging stations as part of the green shift. The *Ampere* launched by Norwegian *Fjord1* company provides an exemplary case. Larger vessels call for FCs with liquid hydrogen as fuel – because batteries take up too much room or are too heavy when scaled up to cargo vessel size. Some companies have tried out HFCs in practice, and a leading Nordic cruise line, *Viking Cruises*, has already commissioned a HFC-powered full cruise ship that is due to be launched by 2022.

In **Denmark** there are moves to build a marine FC and marine hydrogen cluster, covering as much of the international value chain as possible, in the port town of Hobro. This port city now boasts a Marine Center of Excellence housing the European HQ of FC producer Ballard as well as components suppliers.¹⁹ This is hub-based industrial strategy, which is world best practice. In **Norway**, there are several projects that date back to the launch of the FC-powered supply vessel, *Viking Lady*, just a decade ago. Norwegian pleasure craft now have several examples of electric traction, utilizing both batteries (for smaller vessels) and HFCs for larger vessels. The largest FC-powered cruise ship commissioned so far is that by Norway-based Viking Cruises, commissioned in 2017 and due for delivery by 2021. The details of this initiative are being tightly guarded.

Indeed in Norway there have been legislative requirements that shipping move to cleaner fuels, such as successive legislative initiatives from the Norwegian Parliament aimed at keeping the fjords as clean as possible. As early as 2015 the Norwegian Parliament adopted a world-first legislative requirement that new tenders for pleasure boats and ferries in the fjords specify that the boats run on clean fuels such as hydrogen. This was a successful initiative that was acted on by Norwegian shipping and cruising companies. It was followed in 2018 by a more general requirement that applies to existing shipping, requiring all vessels sailing in the fjords to be zero emissions by the year 2026 at the latest.

These regulatory requirements can clearly be expected to have knock-on effects, as companies that operate in the fjords as well as in wider waters will be looking to extend their HFC-powered operations from Norway to areas outside Scandinavia. Such companies will be looking to have

hydrogen refuelling stations installed in ports and harbours along the shipping routes. More fundamentally there is the prospect of building water electrolysis stations in ports and harbours in Scandinavia to produce green/clean hydrogen that can be stored in bunkers and used to re-fuel HFC-powered vessels.

It is in mandating such infrastructure, such as liquid hydrogen refuelling stations and hydrogen-producing electrolysis units placed in strategic locations around Norwegian waters, that the Norwegian government could provide a stimulus for this new green pathway for shipping, seeking to build on first mover competitive advantages. This would create the set of companies that would be in a position to enter joint ventures with Chinese and other NEAsian companies looking to enter the clean shipping industry. Big players like Hyundai in Korea and Toyota in Japan are committing to producing marine propulsion FCs for use in shipping, while Chinese companies will be looking for partners as they seek to enter this new industry.

Of course there are other sectors that would benefit from green initiatives such as these. We may view these as examples where the government has already identified opportunities and made available seed funds through the NOK 3.6 billion green package announced in 2019. Further possibilities exist for such seed funding, such as promotion of hydrogen-powered fuel cells for marine application or scoping of use of hydrogen in Norwegian industry. The key to the efficacy of such initiatives is to extend and deepen the prospects for manufacturing as key to a greening strategy. As Erik Reinert and I argued in 2014, renewables are superior to fossil fuels not so much because they lower carbon emissions as because of their common attribute as products of manufacturing, and hence as means of capturing the increasing returns that learning effects in manufacturing generate.²⁰ In Norway the shift to greener energy through onshore wind is not considered so beneficial given that the wind turbines and towers are imported; more beneficial in the Norwegian context would be initiatives such as offshore wind power where Norwegian firms would be involved in building both the fixed and floating platforms for wind power generation. Consistent with this view there need to be further announcements of seed funding, to redress the imbalance where fossil fuels have received disproportionate support hitherto.

(iii) NORWEGIAN ENERGY FUND: FROM DIVESTMENT TO INVESTMENT IN NORWEGIAN INDUSTRY

The third aspect of the Norwegian green shift involves the use of finance from the country's amply endowed sovereign wealth fund. As part of its cautious approach to building the financial benefits from the North Sea

oil bonanza, in the form of what has grown to be the world's largest sovereign wealth fund, Norway has abundant financial assets to invest in green enterprises around the world. Steps have already been taken in such a direction. This fund (the GPF), now with US\$1.1 trillion in accumulated funds extracted from North Sea oil operations, in 2019 was directed by the Finance Minister to steer investments away from fossil fuel exploration activities. This was followed by the launch of the green transition package of funds to be set aside for investments in green industrial projects (such as green shipping and hydrogen). While these are substantial steps their impact should not be over-stated. The GPF still has investments in fossil fuel companies, while the government has announced substantial tax breaks for oil and gas companies.

A clear and sensible extension of this third trend would involve the Norwegian parliament in lifting the ban on GPF investments in domestic Norwegian industries, to enable the fund to boost investment in green industries and in the greening of established fossil fuel industries in Norway itself. In this way Norway could extend its current divestment program into an industrial investment program, with clear focus on green targets that complement existing industrial trends around the world. The four areas identified by the government in its green support package – hydro battery development, hydrogen industrial initiatives, offshore wind power and low-emissions shipping – represent excellent candidates for such financial support, following the Chinese example in providing companies with extensive credit lines as they seek to accelerate their green initiatives.

If these three trends are pursued with political drive and determination, they would lead to a rapid greening of Norwegian industry, and create the foundations for a viable and expanding green industrial sector to provide jobs and exports for the future. Like the Chinese in their promotion of green growth, these initiatives can be taken through catalytic investments in public infrastructure and in state-owned companies like Equinor and Statkraft. In this way they can focus on the governance of market forces in encouraging private investment in greening initiatives.

CONCLUDING COMMENTS: PROSPECTS FOR GREENING IN NORWAY

Norway is poised to create major initiatives in shifting its economy towards green practices and goals. It starts with key advantages – its existing energy system is not burdened with past mistakes like building coal-fired power stations or nuclear power (as in Sweden and Finland). But its energy structure is still skewed strongly towards the petroleum sector – based on drilling for oil and gas in the North Sea, where the clock is ticking on existing gas and oil fields. Norway does not yet have anything like the integrated approach to energy and climate goals that Finland has succeeded in creating.²¹ Nor does Norway possess an institutional structure that would drive the transition to green energy and its industrial basis, such as a mechanism for inducing firms to negotiate long-term energy efficiency agreements and energy services agreements as in other countries such as Finland, Ireland and the UK.

In this paper the perspective is taken beyond the EU to examine the Northeast Asian countries and in particular China as they build their new energy industries for the 21st century, with renewables playing a central role as sources of energy security as well as foundations for employment and exports in the future. It would be a smart move for Norway to pursue strategies that emulate the Chinese greening experience while adapting this experience to Norwegian conditions. At the same time Norwegian firms stand to benefit by targeting the wider EU market for green products and services, as Brussels seeks to build an enormous green market oriented towards future prosperity.

China is industrializing at such awesome scale that it simply cannot afford to continue with its reliance on fossil fuels – which explains why it is greening its economy with such determination. China is taking heroic steps to green its industry and its financing of investment, while balancing direct state involvement with market-guided intervention. It does so in the clear perspective that green investments are good business investments; they promise to be profitable rather than cost burdens. In this way, China both offers an example to the rest of the world, and lowers costs in its targeted green sectors, making those sectors increasingly attractive for other countries such as Norway to enter on a competitive and future-oriented footing. Norway can emulate China in building green initiatives that complement and link with each other – as when hydrogen goals can link with goals to decarbonize ocean shipping.

Norway has long admired its Scandinavian neighbours Sweden, Finland and Denmark for their advanced manufacturing industries. With the

green shift being propelled by the NEAsian countries, as they build new green energy systems and green powered industries, Norway is faced with extraordinary opportunities to green its own industrial and energy sectors, and advance its manufacturing goals in doing so by linking with similar initiatives in NEAsia. There is no secret to the prowess of the NEAsian countries in manufacturing, and to their capacity to drive their manufacturing business goals through their focus on the greening of energy, industry and transport. These countries already recognize that the future belongs to green manufacturing as the foundation of new low emissions and energy-saving industries. Green investment should be seen as a way to build new and competitive industries, rather than as a cost burden on existing industries. Norway has the opportunity to extend its manufacturing prowess through taking green initiatives and become a leader in this historic global transition.

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NOTER OG REFERANSER

- ¹ See “The government’s revenues” at <https://www.norskpetroleum.no/en/economy/governments-revenues/>
- ² Dr Elizabeth Thurbon and Dr Sung-Young Kim have characterized this strategy involving the state in continuing a developmental tradition in Northeast Asia as one of “developmental environmentalism”; see Thurbon and Kim (2015).
- ³ Note that this Chinese program is targeted at agriculture, not forestry in the first instance. For an evaluation of the program, see Rodriguez et al (2016).
- ⁴ For discussion of the use of Local Content Requirements and their relation to climate policies, see Mathews (2017).
- ⁵ The proportion of electricity generated from WWS sources is lower than in the case of capacity because of different generating capacities for wind, solar and hydro. For further details see Mathews and Huang (2020).
- ⁶ “China scraps list of recommended auto battery suppliers: ministry”, *Reuters*, 24 June 2019, at: <https://uk.reuters.com/article/us-china-electric-batteries/china-scraps-list-of-recommended-auto-battery-suppliers-ministry-idUKKCN1TP0HY>
- ⁷ In China’s case the state needs to exercise its influence not just in creating new industries but in phasing out incumbent industries, particularly coal-fired power. On the strategies pursued, see Tan (2020).
- ⁸ The turbines are the SG 8.0-167 DD turbines, each rated at 8 MW. See “Construction starts on world’s largest floating offshore wind farm”, *Equinor*, 1 Oct 2020, at: <https://www.equinor.com/en/news/20201001-construction-start-hywind-tampen.html>
- ⁹ Note however that these Norwegian onshore wind power initiatives do not involve the manufacture of wind turbines and towers, which are imported. Hence the onshore wind initiatives do not generate as many jobs as those which involve manufacturing.
- ¹⁰ The Korean scholar Sung-Young Kim calls such industrial hubs housing supply chains “hybridized industrial ecosystems” (Kim 2019).
- ¹¹ The draft budget package included NOK 2 billion allocated to the state investment body Enova, and NOK 1 billion to green R&D – including NOK 120 million for hydrogen (via the ENERGIX program) and NOK 25 million to offshore wind power and associated supply chain development.
- ¹² Note that the export of green power from Norway to the EU is controversial because it will exert pressure on prices to raise those in Norway to European levels. See “Pumped hydropower The green battery”, 19 May 2019, *Industry Europe*, at: <https://industryeurope.com/pumped-hydropower-the-green-battery/#:~:text=Norway%20is%20one%20country%20that,power%20supplies%20across%20the%20continent>
- ¹³ “Future of Wind: Deployment, investment, technology, grid integration and socio-economic aspects”, IRENA, October 2019, available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Oct/IRENA_Future_of_wind_2019.pdf
- ¹⁴ See “Offshore wind energy outlook 2019”, International Energy Agency, Nov 2019, at: <https://www.iea.org/reports/offshore-wind-outlook-2019>
- ¹⁵ Note however that the scale of Equinor’s investments in offshore wind power are still well below those of comparable Scandinavian companies like Oersted in Denmark.

¹⁶ See the description of hydrogen-based green steel production at Thyssenkrupp, “Green hydrogen for steel production: RWE and Thyssenkrupp plan partnership”, *Fuel Cells Works*, 10 June 2020, at: <https://fuelcellsworks.com/news/green-hydrogen-for-steel-production-rwe-and-thyssenkrupp-plan-partnership/>

¹⁷ “Norwegian green steel project, hydrogen strategy launched,” 3 June 2020, *S&P Global*, at: <https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/060320-norwegian-green-steel-project-hydrogen-strategy-launched>

¹⁸ “World’s first liquid hydrogen fuel cell cruise ship planned for Norway’s fjords”, 3 Feb 2020, *Recharge*, at <https://www.rechargenews.com/transition/world-s-first-liquid-hydrogen-fuel-cell-cruise-ship-planned-for-norway-s-fjords/2-1-749070>

¹⁹ “Ballard Power to supply fuel cell modules in Norway”, *Nasdaq*, 10 April 2019, at: <https://www.nasdaq.com/articles/ballard-power-bldp-to-supply-fuel-cell-modules-in-norway-2019-04-10>

²⁰ See Mathews and Reinert (2014).

²¹ See Finland’s *Integrated Energy and Climate Plan*, issued by the Ministry of Economic Affairs and Employment, in December 2019, at: https://ec.europa.eu/energy/sites/ener/files/documents/fi_final_necp_main_en.pdf



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