WORLD ENERGY COUNCIL | THE NETHERLANDS

‘ABOUT BLACK SWANS AND GREEN FUTURES’

DECARBONISING NORTH WEST EUROPE AFTER COVID-19

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CONTEXT

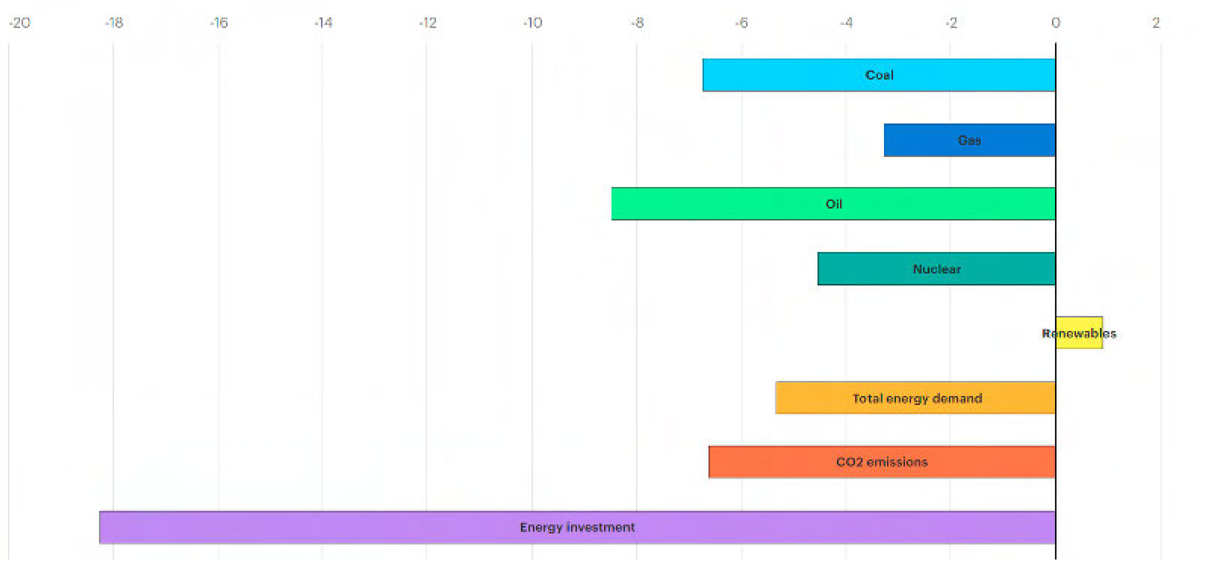
It is WEC Netherlands’ (WEC NL) mission to energize the debate around the 2030-2050 decarbonization objectives and strategies in Northwest Europe. To implement this objective WEC NL has started an annual series of publications in 2015. The choice of each annual topic has been driven by what was at the forefront of the debate at the times. Studies have been conducted into themes such as the merits of coordination, the rich opportunities of the North Sea, or the potential path towards green hydrogen. The focus of the studies has touched on the corresponding technological, political, economic, financial and legal dilemmas associated with the topic.

Each year a consortium of WEC NL members is brought together so that the analyses were fuelled by the latest insights from business, science and political perspectives, and to ensure that the collectively delivered outcomes and recommendations are impartial.

The latest report ‘Phasing Out Carbon’ (March, 2020) described and quantified a scenario towards 2030 and beyond, towards 2050, in which NW Europe would meet the Paris greenhouse gas emissions targets while at the same time also sustaining a prosperous society and a modern competitive industrialised economy.

Literally a few days after the publication of this relatively hopeful message, Europe entered the COVID-19 lockdowns, and in a matter of days the carefully crafted and detailed scenarios of Phasing Out Carbon looked irrelevant. IEA’s recent World Energy Outlook states that energy use in 2020 has dropped by several percentage points compared to the trend – see Diagram. With a notable exception for renewables use, which seems to have grown despite the drop in economic activity. CO_2 emissions will have dropped by more than 6%. This windfall effect appears not to be structural, as recent data on CO_2 emissions indicate that economies are recovering more and more to pre-Corona levels of activity. Other impacts seem to be more structural. Aggregate energy investments for instance have dropped by a staggering 18%, and part of that drop could be aborted investments in decarbonization.

Diagram: percentage year on year drop in 2020 (Source: IEA WEO 2020)



Although at the moment of writing this report we are still in the midst of the Global Corona crisis in terms of human suffering and ongoing societal lockdowns, thinking about what the SARS-COVID-19[1] pandemic means for the future of how societies operate is ongoing. One of the most important discussions revolves around the priority to be given to the acceleration of decarbonization.
The fundamental question on which economists and politicians alike disagree is whether the gigantic economic shock is a reason to moderate expensive decarbonization efforts to save funds to rescue business and protect income, or whether the crisis is just the right moment to nudge the economy 'from the ashes' on to a faster decarbonization track.

Underneath this relatively short-term discussion there is widespread realization that societies post-COVID-19 will look differently in many respects. Several of those structural changes will have implications for energy use and its carbon content mixture. How we work, how we move, how we use technologies and what types, how we think about our relationship with the planet, and with other regions in the world, and how we think societies should be run to keep us safe and reasonably prosperous, all get profound attention from politicians, scientists, and business leaders. Governments worldwide have spent trillions in rescue operations, and this crowding out by the governments have pressured the question of who should be held responsible for what part of the decarbonization agenda, public or private.

Corona no doubt was the dominant driver of events in 2020, but in its shadow the year has seen a number of other significant developments that are crucial for the achievability of NW Europe's Net Zero ambitions. China, USA and the European Union have each announced, introduced, or intensified their decarbonisation ambitions, indicating that climate change abatement is taken more seriously than ever. And for the first time in the history of the EU a large and energy-relevant member has left the Union.

At the moment of publication of our 2020 report 'Phasing Out Carbon', we could not have anticipated Corona itself, let alone the huge responses taken by governments or the massive implications on lives, society and economics. Added to these Black Swans a number of very consequential events have taken place, perhaps to some extent independently, like the outcome of elections, the path Brexit took, or the momentum that climate change policies have acquired.

All these Black Swan and cross-roads events have potentially kicked the development trajectories of NW Europe into new orbits. It is therefore clear that there is ample scope to rethink the Phasing Out Carbon scenario against these radically changed perspectives and potential new trends. For governments to adjust the Green Deal if and where appropriate, and for business to realign their strategies.

1 Throughout the report we refer to SARS-COVID-19 alternately as COVID-19 or Corona.

RESEARCH QUESTION

This brings us to the following research question for the WEC NL 2021 publication:

HAVE THE PIVOTAL EVENTS OF CORONA-YEAR 2020 AFFECTED THE ACHIEVABILITY OF THE 2050 PARIS GOALS?

Aspects that might affect the pre-COVID-19 pathway include:

- **Work** – 2020 has shown that up to 50% of workers can work from home in services-oriented and densely broadbanded NW Europe. Employers and employees are finding out what works well and what new work patterns are here to stay. This has direct consequences for energy demand in offices, at home, and on commuting. It does undoubtedly raise energy demand from internet nodes and data centres;

- **Mobility** – new and distant work patterns will alter mobility demand, by public and private transport, surface and air. This too affects energy demand;

- **Office space** – in the medium term, the need for office space will be fundamentally reconsidered with profound implications for the volume and composition of workspaces, with corresponding consequences for energy demand;

- **Cities** – cities as a magnet for business and smart, creative and entrepreneurial talent will see several attraction attributes change, notably everything that functions because of the proximity of other people: events, bars, theatres, etcetera. The question is whether the lockdown of cities will lead to a strong realisation that there are downsides to live in the crowdy centres or not. Cities are energy intensive structures, and less bustling cities will probably need less energy;

- **De-globalisation** – reconsiderations of the risks associated with international supply chains will most likely alter value chain location decisions, which will affect transport and trade flows, in size and composition;

- **Role of the State** – the State is carrying much of the crisis budget to keep the economy as alive as possible under hibernation lockdowns, and support the recovery. This drains their financial position, urges the state to borrow and ultimately raise taxes at some point in our 2050 timespan. It also urges them to think about how serious they should be with grander objectives, such as distribution of income, vitality of the economy, and safety and wellbeing of people and planet. This comes on top of and/or might need to be incorporated in all the government efforts needed to nudge the economies towards decarbonization, as outlined in our 2020 publication, and as underlined by the SDS scenario of the IEA;

- **Mood** – crises like this tend to change the general mood – vis-à-vis many things potentially, from health and well-being to the role of technology, and from the dependency on long and risky supply chains to the position of the state versus own responsibility to the relationship with society and the planet, and so on;

- **Sense of urgency and anticipation** – one notable consequence of the crisis might be the increased awareness of business that the climate change challenge is an acute challenge and that climate change policies are here to stay - and that business has an important role to play as part of the solution, for instance by embracing circularity and net-zero strategies, and formation of alliances;

- And perhaps most of all: the economic downturn and subsequent recovery itself has strong and so far unknown implications for long term economic activity, and for energy usage and the energy mix.

The effects of the kaleidoscope of potential changes have knock-on effects, through prices of energy carriers, adoption rates of certain technologies, behaviour of investors and consumers, and regulations by responding politicians.

For most of these trends it is 'too early to tell', and whether they will bring the decarbonization targets closer or more distant is unsure. In comes the merit of scenarios.

APPROACH

The approach taken in this report is the following.

ECONOMY

The first assumption we made was that the period until 2050 should, for the purpose of the 2020-impact, be split into a short term immediate impact period until 2022, and a long term 'aftermath' period to 2030 and 2050. A second assumption is that we choose to focus on 10 Northwest European countries, roughly located around the North Sea.

Despite the many unclarities still surrounding the shape and speeds of recovery paths from Corona, economists are beginning to agree on the general picture. We have simulated the 'wobbly' recovery paths from the steep drop of Spring 2020 towards the end of 2022, based on available statistics and consensus short term forecasts, assuming the Global economy will be back at pre-Corona levels by the end of 2022.

After 2022 we have chosen two 'aftermath' scenarios that reflect the consequences of the structural changes that the Corona crisis have brought about, what is now being called the New Normal. These two scenarios are matched – as we did for Phasing Out Carbon - with two scenarios from the suite of scenarios worked out by the European Commission. The two scenarios are chosen on the basis of a range of potential changes that we have identified and qualified - and the evidence for which are discussed in the report.

One scenario is equivalent to the one we suggested in Phasing Out Carbon, arguing that there is some evidence that we might essentially migrate back to pre-Corona behaviours and structures – the only difference between our 2020 perspective and this scenario would be a temporary dip in economic activity and corresponding carbon emissions

Scenario 2 is built on the assumption that the pivotal events in 2020 have indeed changed the structure of the economy and society, including the mood (the animal spirits of consumers, business and governments, as economists call it), and that the NW European economies are lifted to a higher growth path long term. A discussion of the early evidence for such structural changes is the main topic in this report.

The scenarios in this study are considered ‘not unlikely’ on that qualitative basis. The scenarios should not be regarded as accurate forecasts from either of the authors of the report.

ENERGY

The accumulated consequences of the short term Corona-related shock and the new normal aftermath for the energy intensity of sectors and the energy efficiency of production are clustered in five categories: structural effects through:

- Changes in demand patterns compared to the outcomes of Phasing Out Carbon, or our best pre-Corona assumptions
- Changes on the supply side of energy
- Changes in the energy mix
- Changes in intensities of innovation and technical change
- Changes in policy approaches

THE ACCUMULATED CHANGES TO ENERGY USE AND CARBON EMISSIONS ARE SUMMARISED IN THE TWO SCENARIOS

As we do with the economics, with regard to energy use and carbon emission, we assume in the first ‘modest growth’ scenario that the changes turn out to be small and we return to business as usual, which means we arrive at equivalent pathways as in Phasing Out Carbon. If however we assume the changes to occur and be sustained, then the cumulative effects translate into an optimistic scenario for decarbonisation. This assumption is compatible with the high-growth economic scenario. We call the scenario ‘High-Growth, High RES’. In the report we discuss the evidence why we think both scenarios are not inconceivable.

(POLICY) RESPONSE

The Corona pandemic has led to unprecedented resolve among governments. There is some evidence that the resolve has been the result of a more pronounced realisation of common threats, and stronger momentum to meet the Paris goals in particular. Governments worldwide have responded massively to the pandemic. Both to support the economy in crisis, but also to respond to the evolving preferences of society towards climate change abatement as reflected in voting behaviour. We have explored the assumption that the resolve will prove to be sustained long enough after Corona has ebbed, that the economy and the energy transition will both be pushed to a structurally higher level towards 2050.

SUMMARY

In summary, our answers to the research question are as follows:
History will tell. In a decade or two historians might come to the conclusion that 2020 has been an exceptionally eventful year, but that the longer-run undercurrents of society and the economy hasn't been affected fundamentally. In which case our Phasing Out Carbon scenario might still have proven to be valid. We will be returning to a long-term 1.5% growth rate of the NW European economy. The Paris objectives will be met under the assumptions around demographics, technological advancement, behavioural change, and policies.

But it does seem likely that Corona year 2020 has had a profound effect on the trajectories of the economy and of the energy system towards 2030 and 2050. Drivers for the change include the changes in the way North-west Europeans work, travel, commute and buy. Moreover the events of the year seem to have intensified the mood of the population, business, and politicians, who realise how vulnerable the planet and our societies on it are.

Reflections of the changed moods are visible in surveys into investment intentions, that are across the board greener than they were two years ago. They are observable in the louder voice of the investment community, that demands more genuine ESG objectives in public companies' strategies. And the mood is expressed in several election outcomes across Europe, and in the prepped-up plans of governments. Not just the European Commission's top-up of the European Green Deal in 2020 is evidence of the latter, but the recent announcements of massive plans for the development of hydrogen and carbon-capture-usage-and-storage (CCUS) facilities and infrastructure of several national governments also testify to an enhanced determination.

Since governments have taken the helm of the economic recovery on a scale not seen since WW-II, it seems that a certain rebalancing has taken place between governments and the private sector, in economic terms and in moral terms. Surveys show the beginning of the mutual realisation that both public and private sector have distinct but aligned roles to play. Now that the contours of the Green Deal are given more shape at the bureaus of the European Commission, private initiatives in large ad-hoc clusters are emerging at a rapid speed, filling the implementation gaps, in areas like off-shore wind, phasing through of natural gas, green hydrogen production and use, and CCUS.

There is some evidence emerging that the drivers have had an acceleration effect, meaning that rather than a revolution of new trends already existing, trends have intensified. For this reason we have felt comfortable to explore in this report the implications on the economy, energy use, and CO_2 emissions using a scenario for NW Europe that is both more optimistic about economic growth towards 2050, and at the same time more optimistic about the speed of the transition towards renewable energy. Average annual economic growth might be nudged up from 1.5% to 2%. At the same time, the region can become more energy efficient and more successful in shifting towards renewable sources as a collective consequence of the changes. We argue in this report that there is evidence that also under High-Growth-High RES scenario, NW Europe will meet the Paris targets. Just like it was for the scenario in Phasing Out Carbon in 2020.

Obviously this optimistic scenario is no done deal at all. For it to materialise, all the drivers need to continue to hold. The mood needs to stay on high decarbonisation alert, at the levels of the citizens, the private sector, the investors, and the governments. That would for instance mean that once the consumers start to consciously spend their massive savings (holds for about 80% of the population) in a greener way than before, thereby fuelling business cases for decarbonisation of industry.

It means that the bold European restructuring funds need to be directed towards projects which have a distinct green bias. It requires that the newly formed ambitious consortia and clusters of businesses acquire sufficient regulatory support or sometimes leeway to develop beyond the valley of death, and other tipping points will be passed before the momentum for speedy decarbonisation slips against the priorities for other pressing societal Corona-aftercare.

National Governments are indicating that they intend to accelerate their efforts towards achieving the Paris goals. 2020 has seen a number of examples supporting that view. Governments are fast-learning what works and what doesn’t in supporting and nudging business and households to reduce carbon emissions, and the optimistic scenario requires determined implementation. Clusters of high energy users need to be supported and incentivised to develop decarbonisation strategies and capture the – ultimately exportable – business cases. At the same time, the humanisation of the decarbonisation process needs to be inclusive: the overall aim is still to generate clean, reliable, but also affordable energy for all.

Financial innovation needs to continue so that risk profiles from a range of new risks can be covered. Think of the rising volatilities associated with renewable power production, or very long-term infrastructure projects of which the return is not yet very predictable.

And last but not least, the optimistic scenario needs a relatively manageable geopolitical climate in the world as a whole. Addressing the climate objectives collectively across the globe makes policies much more easy to implement and control than if addressed region for region. It makes a lot of sense to invest in the relationships with the future suppliers of green molecules and electrons, because in the most optimistic scenario NW Europe will still have to rely on imports for a large proportion.

Each of these drivers are necessary conditions for achieving the Paris objectives. If at work, they can create a virtuous circle. The pessimistic view needs to be taken seriously too, because switching off a number of the drivers can equally plausibly lead to a vicious circle. We have captured the consequences of that possibility in a second scenario. We consider this scenario to be not unlikely if the acceleration of the drivers is just temporary, and the effects of corona year 2020 turn out to be incidental and not structural. It would not be against human nature to quickly forget the good intentions when Corona has subsided to just a flue, in which case meeting the Paris goals will become as hard again as they looked a few years ago.

This underlines the importance of the mood of the population. Corona year 2020 has shown us what a mood swing towards dedication can deliver. It is tempting to be hopeful that this lesson can be sustained. ■

2

AN EXTRAORDINARY YEAR

The year 2020 turned out to be an extraordinary one in several respects, with COVID-19 being the most notable. What began as primarily a health crisis ended up shaking the global economy in a way that no economist could have predicted, taking the sharpest hit since World War II levels[2], presenting itself as a true Black Swan[3].

The response to the crisis has been unprecedented as well. Governments and economists worldwide have almost immediately come to the conclusion that the only way to respond to the accelerating spread of Corona was the immediate shutdown of the economy, to prevent human interactions to occur, while at the same time ensuring the continuation of essential parts of economic activity, as much as possible. That meant both imposing lockdowns and at the same time mobilizing massive financial support and rescue schemes, to support healthy businesses that saw their sales fall, and productive workers who saw their salaries at risk.

These huge transfers were largely funded by borrowing, blessed by the extremely low interest rate. This has led to trillions of dollars of additional debts on governments. The rise of debt hasn’t come to a halt yet, as governments are considering supporting the recovery of the economies out of the crisis.

There were also other events that made 2020 an unusual one[4]. Several of them involved the acceleration or culmination of already existing trends.

Among the ones that matter for our use of energy and our greenhouse gas emissions are the acceleration of a sense of conscience of the prevalence of low-likelihood-high-impact events more generally. Contrary to a sort of sentiment of Global safety in the first decade of the century, there is more realization that the World isn’t immune to sudden, supranational and impactful crises. Out of all the adverse events (for e.g. financial crisis and wars), natural disasters, often climate and weather-related, have started to occur more frequently since the 2000s[5,6] see figure 6.

One that is relevant to the NW European region is the heatwave, accompanied by lengthy spells of drought. In 2019, Europe featured in the top 3 regions to observe the most acute heat waves in the world; with Belgium, Netherlands, Germany and the UK recording all-time high temperatures[7] and ~86% of the total heat wave deaths[8]. In addition to loss of lives, the climate-related disasters have caused major economic losses. Between 1980 and 2019 alone, this totalled to an estimated EUR 446 billion in the EEA member countries[9].

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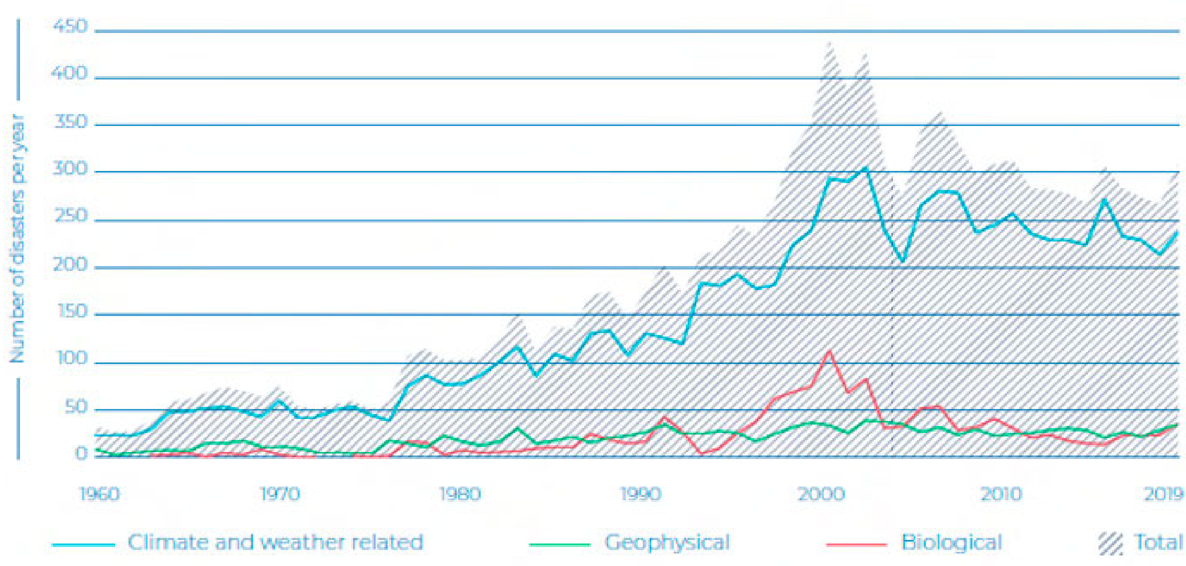
2 TIEA, Global annual change in real gross domestic product (GDP), 1900-2020, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-annual-change-in-real-gross-domestic-product-gdp-1900-2020
3 Taleb, Nassim Nicholas, 1960-. The Black Swan : the Impact of the Highly Improbable. New York :Random House, 2007.
4 Among others were orange skies and several times more bushfires, the US elections, Brexit, plummeting oil prices and Green Deals from various countries.
5 Human Cost of Disasters : An overview of the last 20 years 2000-2019, CRED, UNDRR, 2020.
6 World Disasters Report ‘Come Heat or High Water’, Geneva 2020, International Federation of Red Cross and Red Crescent Societies (IFRC), 2020.
7 Insider News, Insider, 2019. https://www.insider.com/europe-heat-wave-record-temperatures-deaths-uk-2019-7
8 World Disasters Report 2020, International Federation of Red Cross and Red Crescent Societies (IFRC), 2020.
9 Economic losses from climate-related extremes in Europe, European Environment Agency, 2020.

Figure 1: Comparison of different types of disasters triggered by natural hazards, 1960-2019



One of the consequences of the greater awareness of the vulnerability of the planet has been the announcement, and in the case of the EU intensification of Green Deals. With the election of Joe Biden to the White House, a Green Deal worth around 2 trillion has gained momentum, reflecting a huge one-eighty compared to the US stance under his predecessor. At the same time, China has announced an ambitious plan to curb greenhouse gas emissions. And Europe has stepped up its emission reduction ambitions levels for 2030 and 2050. What is more, entrepreneurs and investors seem to have bought in into the ambitions, as for instance witnessed by their responses to PwC's Annual Global CEO Survey, January 2021, where more than 60% not only indicate that climate change is one of their greatest concerns, but also that they recognise that they have a role to play by investing in R&D and implementation of technologies and behavioural measures. This is a distinct acceleration of a steady but somewhat slumbering trend in the earlier CEO Surveys.

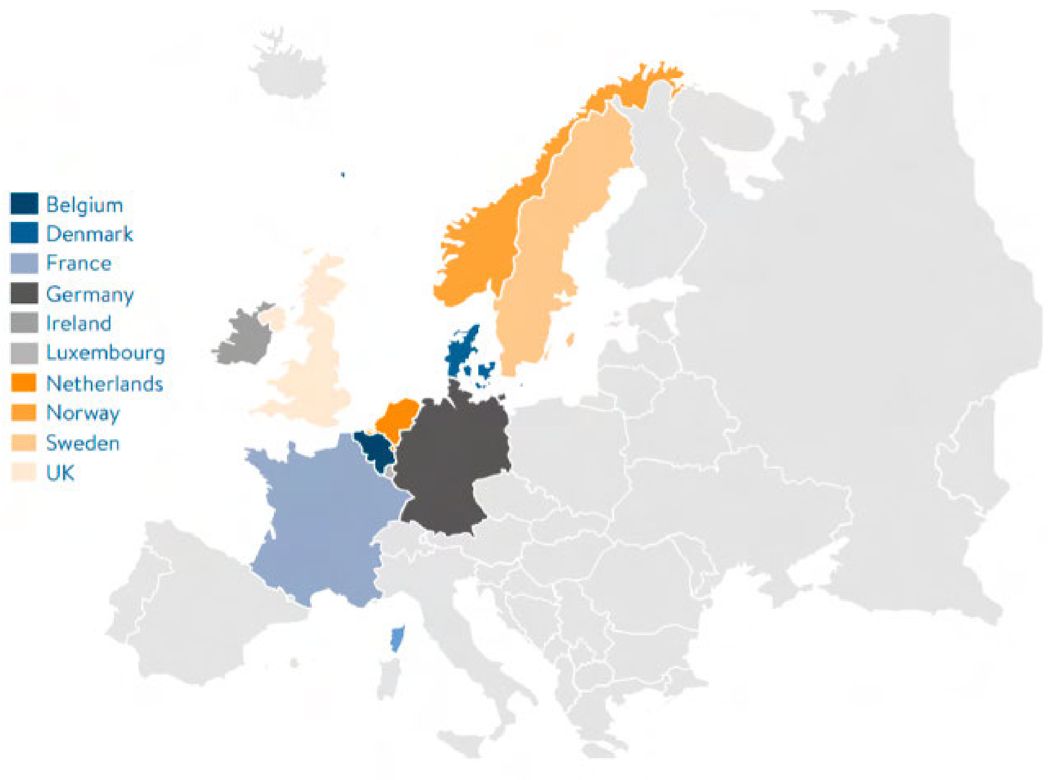
Politicians throughout the region have seen the moving sentiment, and have embraced climate change as one of the themes of choice. Fresh out of Brexit, the UK government has published an ambitious Environmental Bill. Polls for the upcoming German Bundestag elections suggest that the Green party may become a serious contender for leadership. The French and the German governments have announced a sizeable effort and billions of euros to support a hydrogen agenda. And these are just a few examples of the raised activity. Which is all the more remarkable given that politicians were also busy addressing the pandemic and all its facets.

Finally, worth mentioning here are some of the consequences of the pandemic for how we work, travel, and consume. Working from home turned out to be quite possible for large parts of our relatively service-focused economy, and given our on average well-developed broadband infrastructure. The fact that large parts of the economy and indeed society could almost resume its original intensity would have been unimaginable 15 years ago, when broadband wasn't as widespread as today. Vice versa, working from home has generated software innovations and has led to the awareness that daily commuting may not be the best way to make a productive day. Many consumers have in addition familiarised themselves with purchasing from the armchair. Specialised home deliveries are less travel-intensive than individual shopping trips. And many business trips have turned out in hindsight not to have been that indispensable.

The purpose of this study is to assess if these and other economic and energy shocks and trend shifts in 2020 have affected our ability to reach European climate targets of 2030 and 2050. And what this could mean for governments and business while they consider their strategies to recovery and the post-COVID-19 period.

For this report we analyzed the economic and energy trends and shocks in 10 North-Western European (NWE) countries[10]. Since we wanted to focus on the impact of 2020, we looked at the situation until the end of December 2020. Forecasting is not within the scope of this report, rather the report is based on scenario analyses based on EC data and discussions with subject matter experts representing the organisations participating in the study.

Figure 2: North West European countries covered in this study



10 Norway, Sweden, Denmark, The UK, Ireland, Germany, The Netherlands, Belgium, Luxembourg, France

In order to obtain the goal of this report, we carried out a mix of quantitative and qualitative analyses.

- A quantitative analysis was used to understand the macroeconomic shocks due to COVID-19 in the NW European region in the period from 2020 to 2022. We then looked at an OECD scenario for the same set of countries on the implications from the Covid-shock on productivity to form a quantitative view on the short-term recovery path. It was assumed that the NW European economy will rebound in 2021 to reach pre-Covid levels by 2022.

- For the long term, we have distinguished two scenario's, one a business as usual scenario, assuming that after the Corona crisis has calmed down, the economic structures turn out to have remained relatively unharmed, and pre-Corona economic activity is resumed after 2022. The numbers of longer-term economic growth, energy use, and carbon emissions are the same as those in Phasing Out Carbon.

- In a second long-term scenario we have assumed that the Covid-induced accelerated trends cumulatively contribute to a changed economic structure, and the path of growth will by higher. At the same time, several of those accelerated trends justify an assumption of faster decarbonisation, as will be argued in this report. Multiple trends, the loans and grants of the European Recovery and Resilience Facility (RRF) being the biggest one, indicate that NW Europe is expected to move towards a future with higher economic growth and a bigger share of renewable energy sources. In order to move into this direction certain policy recommendations have to be implemented to increase energy efficiency and a less carbon intensive energy mix. This second scenario is therefore a High-Growth-High- Renewables scenario.

- We have quantified the long-term scenario's using growth theory and productivity growth outlooks.

We have augmented the quantitative analysis of economic growth with a qualitative analysis of the drivers for decarbonisation: the product of energy use per gdp, efficiency, the energy mix, and the emission intensities. The question addressed was to what extent a case can be made for the assumption of the accelerated decarbonisation needed to compensate for the higher energy use that is the inevitable consequence of the high-growth scenario.

This report is structured as follows. In section 2 of the report we discuss the impact of 2020 on the economic trajectory. We first look at the short-term impact of the shocks and then consider how the recovery actions may result in a faster growing economy where renewable energy is a key driver. We also consider what this implies for the demand of energy, which may increase as a result of higher production levels. In section 3 we discuss how the rest of the energy sector will need to adapt to meet this demand in the high-growth scenario, taking into account energy supply, the energy mix and technology and innovation in the sector. In section 4 we discuss the major impacts on policy and finance instruments that occured in 2020. How these should evolve to support a future with high growth and renewable energy is discussed in section 5. In section 6 we conclude and provide our recommendations.

THE IMPACT OF THE YEAR 2020 ON ECONOMIC GROWTH

The economic pain caused by COVID-19 has woken us up to the awareness that Global Black Swans still exist. Several commentators have suggested that the shock events of the pivotal year and the massive response can serve as a dress rehearsal for the next big thing, tackling the threat of Global warming[11][12]. We seem to have come to realise that inaction and not adhering to mitigation or adaptation plans will increase the likelihood of putting economies in heaps of debt. To cultivate a resilient economy that at the same time moves to a path towards EU’s 2030-2050 targets and the Paris goals, the 2020 crisis should not be wasted. Capturing the momentum should be in alignment with the three dimensions that constitute the “Energy Trilemma” - affordability and access, energy security and environmental sustainability[13].

This chapter assesses to what extent the 2020 events might have affected economic growth of NW Europe since 2020 and onwards to 2050, as compared to the outlook we used for Phasing Out Carbon in March 2020. Given the nature of the sudden and severe shock of COVID-19 and the subsequent government responses in terms of strict lockdowns and simultaneous huge support packages, the responses of the macro-economies break down in two periods: (1) the immediate aftermath of the outbreak, with its high volatility, need of fast learning and adaptation, and sizeable knock-on effects between and within economic sectors; and (2) the episode after the very first initial effects have slowed down, and the economies resume a more stable development path into the long term.

2.1 SHORT-TERM: A WOBBLY W-SHAPED ECONOMIC RESPONSE

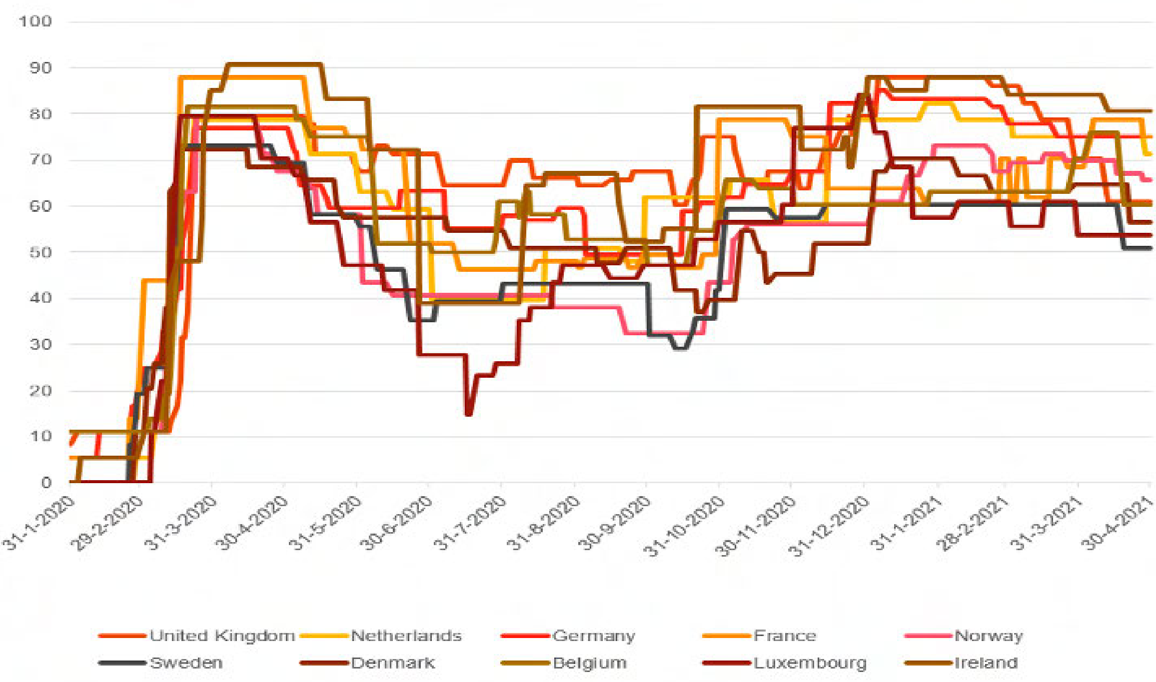
The immediate effects of the COVID-19 outbreak in March 2020 were simultaneous demand and supply shocks. That dual effect is a distinct characteristic of a pandemic outbreak. Other than for instance in the financial crisis of 2008, where economic activity dropped because of a credit crunch and downward economic consumer and investor sentiments, this time supply was restricted as well due to closing borders and workplace shutdowns. National government responses worldwide were a rapid implementation of vast and far reaching support schemes, in NW Europe mostly in the form of support schemes for businesses to cover expenses and sustain employment.

11 Klenert, D., Funke, F., Mattauch, L. et al. Five Lessons from COVID-19 for Advancing Climate Change Mitigation. Environ Resource Econ 76, 751–778 (2020). https://doi.org/10.1007/s10640-020-00453-w

12 Nikendei C, Cranz A, Bugaj TJ. Medical education and the COVID-19 pandemic - a dress rehearsal for the “climate pandemic”? GMS J Med Educ. 2021 Jan 28;38(1):Doc29. doi: 10.3205/zma001425. PMID: 33659634; PMCID: PMC7899110.

13 In order to build a strong basis for prosperity and competitiveness, individual countries must balance the three core dimensions of what Oliver Wyman and the World Energy Council have defined as the energy trilemma: affordability and access, energy security and environmental sustainability.

Figure 3: Government response stringency index, per country of NW Europe

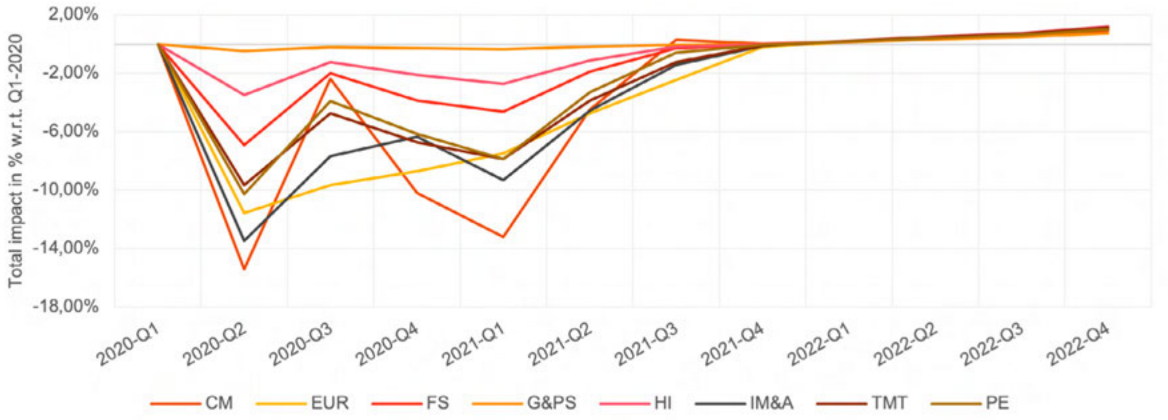


At the moment of writing, observed economic activity levels have roughly shown a W-shape, thus reflecting the two major waves of infections, the first in Spring of 2020, and a second one roughly since the Fall of 2020. The W-shape looks sharper and deeper in the first wave because the first responses were much more strict and complete than in the second wave, and compliance was stronger. The second half of the W looks less deep, largely because governments could benefit from what they learned in the first wave. Measures were much more focussed at the protection of specific sectors and activities, as can be seen in the graph of lockdown intensities over time. The second dip also looks more 'wobbly', as governments responded more adaptively to surges in infection rates and hospital occupancy rates, tightening and loosening as the situations required, as shown in Figure 3.

2.1.1 ZOOMING IN ON SHORT-TERM SECTORAL EFFECTS

Some parts of the economy have evidently been hit harder than others. And as some industries have higher energy intensities than others, assessing the economic effects of the pandemic per industry is insightful for understanding total energy and emission effects. In order to understand the effects of the lockdowns at a sectoral level, we have used an Input-Output analysis. Observed data were used for the period until end of December 2020. The further recovery numbers result from assumptions around the evolving intensities of the lockdowns, in combination with the evidence we have built on the relation between a lock down and economic activity.

Figure 4: Total shock in % to the GDP of the Dutch economy, keeping Q1 2020 as the baseline PwC’s input-output model, based on CBS data[14]

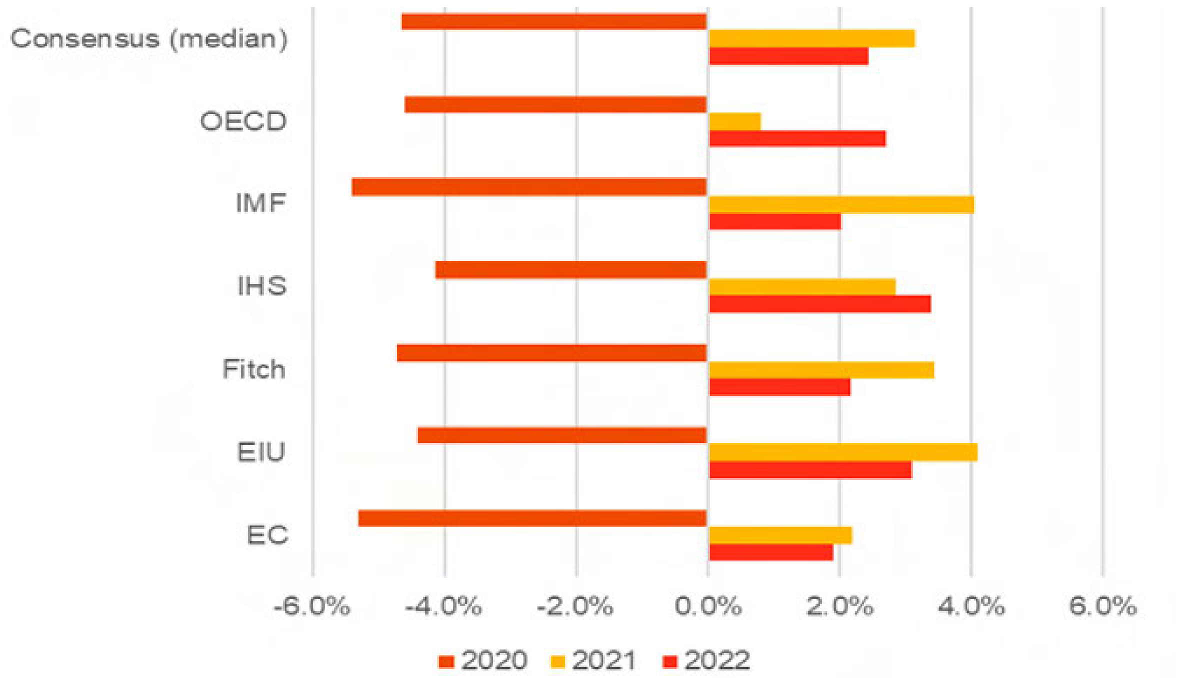


In response to the simultaneous supply and demand shock in the first lockdown, aggregate activity levels have dropped by as much as 11%. Figure 4 shows how certain sectors hits were even bigger than that. In the summer of 2020, COVID-19 infection rates fell enough for the European governments to lift lockdowns, and economic activity picked up right away. This very quick recovery is also a characteristic of a pandemic-induced crisis. As long as the underlying economic structures are not affected, lockdowns can be very quick and complete. In the Dutch economy for example, which is driven by domestic spending more than exports, household spending increased 9.4% in the third quarter, in comparison to the second quarter’s 11.3% contraction (Focus Economics, 2020)

Autumn of 2020 again saw an increase in COVID-19 infections in Europe, and new lockdowns were enforced. Governments - having learnt from the first wave - implemented finetuned restrictions, resulting in a smaller economic contraction than the first wave. The increased duration of these lockdowns, new variants of the virus and decreased public compliance has led to a slower recovery. The EU’s vaccination challenges are also a contributing factor to the swings around the upward trend. Again looking at the Netherlands’ economy as an example, Dutch real GDP’s year on year decline ended up at 3.8%. As vaccination programmes have gained momentum, lockdowns are expected to be gradually relieved, and most economy watchers’ forecast the Dutch economy to rebound back to pre-Corona levels at the end of 2021 – see Figure 4.

14 Data taken only until end of December 2020

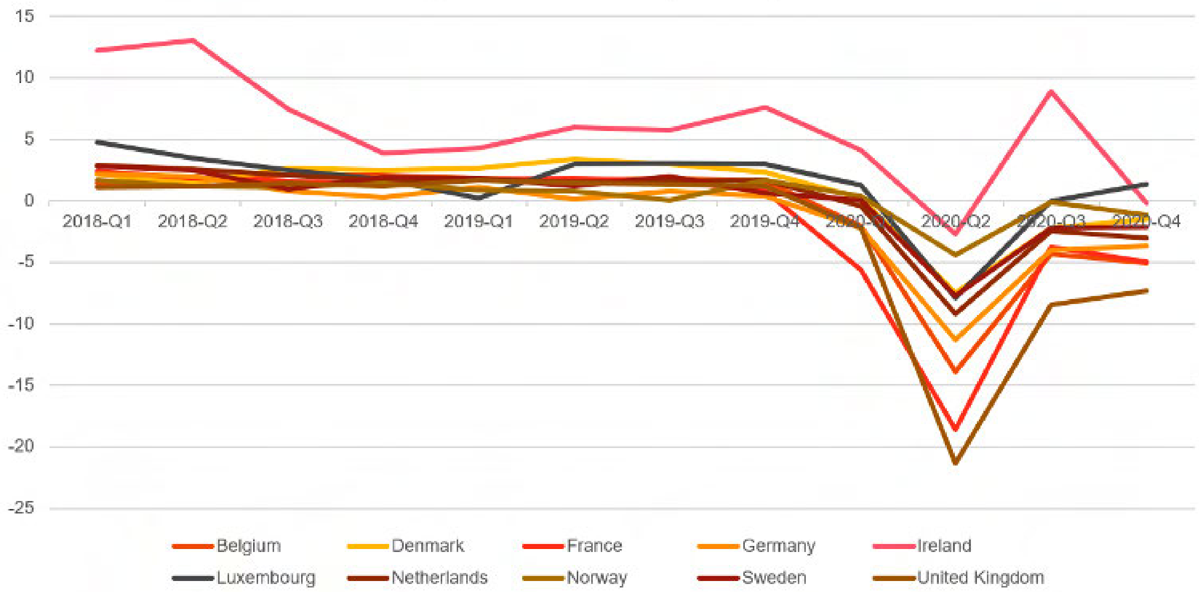
Figure 5: Expected Dutch GDP growth rates, 2020, 2021 and 2022, various institutes



2.1.2 ZOOMING OUT OF THE NETHERLANDS AND INTO THE NW EUROPEAN REGION: SUPERIMPOSING THE SHOCKS

We have used the Netherlands’ economic response paths as the basis for the relative response paths per industry in the other nine NW European economies. We think assumption is not unreasonable, because first of all the ten NW European economies are very intertwined, and secondly, they have broadly a comparable structure. The fact that the countries’ economies are intertwined is one of the great results of the European Union project, and the integration has been strengthened further by the common currency. As an illustration of the fact that the economies move up and down with the regions business cycle simultaneously, Figure 6[15] shows the GDP growth rates over time. All ten states have mature, rather services-oriented industry structures, and share the fact that they are among the most open economies in the World.

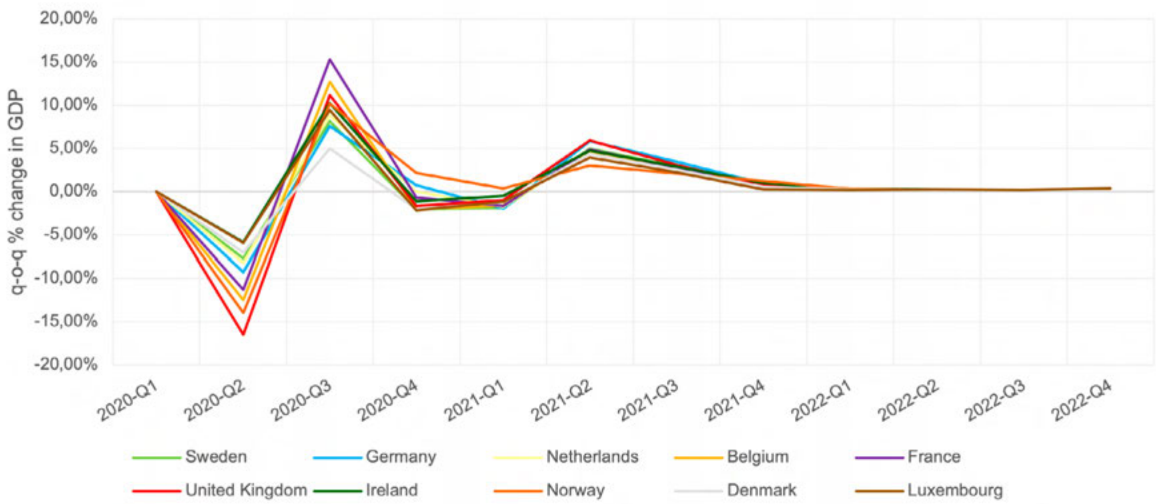
Figure 6: GDP growth of the NW European countries (% growth of real GDP year on year)



15 The World Bank IBRD-IDA, Section 4.2 World Development Indicators - Structure of Output

Applying the Netherlands' relative response rates per industry to the nine other countries' industrial structure, and then aggregated back into total GDP responses per country, leads to the patterns in Figure 7 below. The differences in absolute GDP response rates result from the fact that industry compositions do vary from one country to another, and that countries have been hit more or less severely by the pandemic.

Figure 7: Percentage change in GDP when compared to the previous quarter of the same period[16]



As an example, the UK suffered a deeper dip in 2020-Q2. It's dependence on the service sector and longer lockdowns (which were also stricter than its peers) in London and other metropolitan areas exacerbated the economic impact. The short-term GDP quarter-on-quarter growth scenario of this report is relatively more optimistic about the UK's performance in 2021-Q2 and 2021-Q3 due to a much faster nationwide vaccination roll-out, and despite the British variant. The outlook looks grimmer by 2022 with a downward structural effect on the economy. Among others, the assumptions behind this scenario include Brexit resulting in transaction costs going up, imports becoming more expensive (as the pound gets more expensive), some of the financial services shifting to the EU zone, weaker business investment and a heavily trodden services sector. Ireland, on the other hand, having a relatively bigger international corporate services sector dependence outperformed the average of NW Europe in 2020 despite suffering from successive lockdowns.

2.1.3 WHAT THESE IMMEDIATE EFFECTS OF CORONA MEAN FOR 2030 AND 2050

What effect might the immediate short-term effect of the Corona turbulent years have down the line in 2030 and 2050? Will the economic dip still be felt in the long run?

16 Reference data sources for the macroeconomic model - Eurostat, CBS and OECD

As argued, the immediate effect might end up being a dip in economic activity to the tune of 4 to 6% accumulated over 2020-2021. In 2022 for most NW European economies the pre-Corona level of economic activity will most likely be matched again. For the CO_2 emissions the crisis will have had a temporary effect as well. Estimates are that the lockdowns and lower travel intensities than the trend have led to 8% less greenhouse gas emissions in the European Union[17].

In the long run, all other things being equal, emissions will have resumed their trends after 2022, and the fact that the upward trend of emissions will have stopped for two years at the maximum will have a negligible effect in 2050. The effect of a two-year delay on the level of emissions 30 years later disappears against the confidence intervals around the outlooks.

What it does mean is that the accumulated emissions will be lower thanks to Corona, with around 0.3 giga tonnes for the European Union. Valued at today’s ETS carbon price of €44 per ton, this can be regarded as a benefit to the European society of €13 bn.

2.2 LONG TERM: PATH TO HIGHER AND GREEN ECONOMIC GROWTH

What will determine economic development after the Corona effect has subsumed depends on the longer-term underlying drivers. Economic theory states that long term growth of economies depends on growth of the economically active population and of its productivity. Most population growth forecasts for the region up and until 2050 are flat, which leaves productivity growth as the dominant driver for the long-term outlooks of NW Europe.

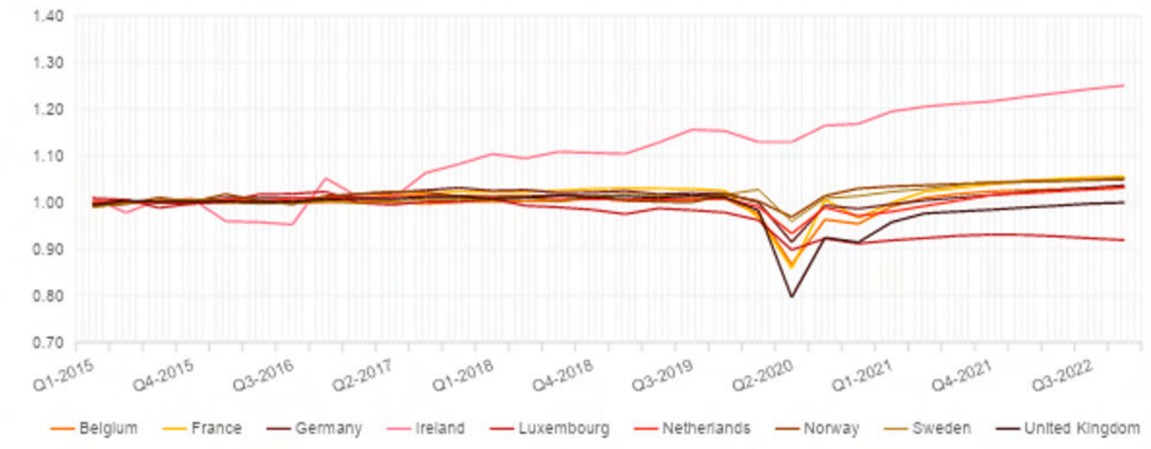
The baseline for the outlook after Corona for this study is taken from the OECD scenario of December 2020, as shown in Figure 8[18]. OECD defines labour productivity as output per unit of labour input[19]. Labour productivity in turns depends on factors such as the results of R&D, education, the quality of capital and equipment, and the functioning of the labour market. Relevant for this study is the question whether factors like these have been kicked up or down by the events of the Corona year, and, as a consequence, have redirected the trajectory of long-term economic growth.

There is evidence that pandemics in general indeed structurally affect drivers of productivity. A study on the pandemics of the last decades shows a substantial impact on productivity, from factors such as elevated uncertainties affecting investments, changing working conditions, and changed consumer demand[20]. In the 2000s, the major epidemics like SARS, Ebola and Zika led to a 4% cumulative decline in labour productivity after 3 years in the affected regions[21]. The OECD productivity scenario of December 2020 assumes this number to materialise for the Corona pandemic as well.

17 World Energy Outlook 2020, IEA, 2020
18 Economic Outlook No 108 - December 2020, OECD.Stat https://stats.oecd.org/index.aspx?queryid=51396
19 OECD.Stat Source metadata, OECD Glossary - https://stats.oecd.org/glossary/detail.asp?ID=4819
20 Global Productivity: trends, drivers and policies, The World Bank, 2020
21 Global Productivity: trends, drivers and policies, The World Bank, 2020

Figure 8 shows the effect of this productivity dip for the NW European economies, and puts the dips in a historical context. Again, NW European economies show very similar patterns. The outlier in this regard is Ireland. The Celtic Tiger has seen an unusually fast development of productivity. For one, the Irish economy has flourished from a relatively low base. Second, in its bridging the productivity gap with more mature economies, Ireland's economy has swung towards sectors with high productivity, mainly industry and headquartering multinational IT companies[22],[23].

Figure 8: Labour Productivity, OECD Scenario (Outlook 108), Indexed to 2015



If nothing else fundamentally has happened during the Corona pandemic, in economic and energy use terms, then economic development, energy use, and greenhouse gas emissions will return to their original trajectories as presented in our Phasing Out Carbon scenario. With the one exception that the economies will have lost two years of economic wealth accrual, and the swelling of the accumulated carbon bubble will have temporarily slowed down.

But the assumption of 'no-change' can be challenged. In all likelihood a number of events from the Corona period have in fact fundamentally affected economic growth, energy efficiency, and emissions per GDP. Clearly the governments' financial position has deteriorated by billions of Euros, but luckily most NW European governments were in a solid starting position. Company debt has risen in certain hard-hit industries, but at the same time the resilience of the banking sector was in a much better shape than in the previous financial crisis. So the downside risks seem to be manageable this time.

There have been some notable positive developments that drive labour productivity as a response to COVID-19. These range from enhanced efficiency from work-from-home arrangements, to accelerated digitalisation in various sectors. We did see a rise in employment[24]. On the policy front, we saw more ambitious climate targets. Not just in Europe, but also more globally.

22 Gandy, R., Mulhearn, C. Allowing for unemployment in productivity measurement. SN Bus Econ 1, 10 (2021). https://doi.org/10.1007/s43546-020-00008-7
23 OECD Jobs Strategy, OECD 2018
24 Eurostat Data Browser TIPSUN30 https://ec.europa.eu/eurostat/databrowser/product/view/UNE_RT_Q

2.2.1 EU POLICIES & EMERGING TRENDS ENABLING FASTER ECONOMIC GROWTH

No doubt one of the most eye-catching drivers of 2020 towards a higher growth path was the European Commission’s Recovery and Resilience Facility (RRF). The EC set up the RRF as a stimulus package in a determined attempt to emerge stronger from the current COVID-19 Crisis. The RRF consists of €672.5 billion[25] in loans and grants that European Member States can use to fund investments in one of six pillars:

1. Green transformation
2. Digital transformation
3. Smart, sustainable and inclusive growth and jobs
4. Social and territorial cohesion
5. Health and resilience
6. Next generation policies, including education and skills

The combination of the €672.5 billion short-term RRF and EU’s long-term 2021-2027 budget of €1,074 billion[26] will be the largest stimulus package ever financed through the EU budget. A big part of this overall package will be used to mitigate the social and economic effects of COVID-19 on the Member States. In other words: to de-hibernate the economies as quickly as possible, and have the economies return as quickly as possible to the status quo, so that structural damage is minimised. However, the RRF is also earmarked for a resilient and more productive future. In other words, to achieve structural improvements that generate a higher productivity. For example, 20% of the investments should be used to support digital transition and innovation while 37% should support the climate objectives[27]. In order to ensure that liquidity is not the issue when making plans for a better future, pre-financing of 13% of the total amount allocated to Member States will be made available once recovery and resilience plans are approved[28].

The increased public spending on digital transformation is aimed to stimulate innovation. Firstly, by turning up the efficiency of high productivity sectors. Secondly, by accelerating the innovation plans already put into motion. Also, the spending on education and new skills is to lead to a more skilled and therefore more productive workforce. If the investments to recover from the current crisis indeed trigger higher productivity, this would bring the NWE countries on a higher annual GDP growth path.

25 https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en
26 https://ec.europa.eu/info/strategy/eu-budget/long-term-eu-budget/2021-2027/whats-new_en
27 https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en
28 https://ec.europa.eu/commission/presscorner/detail/en/ip_21_423

Empirical estimates of multipliers of R&D in the EU range from 13% to 17% (https://ec.europa.eu/futurium/en/system/files/ged/60_-_rise-value_of_research-june15_1.pdf). If put on the RRF fund, the investments might add up to another €100 billion per year to European output, or -0.5%. This would come on top of the 1.5% growth rate that was the basis in the scenario in Phasing Out Carbon[29]. This annual additional 0.5%-point would accumulate to more than 13% higher GDP in 2050, as shown in the graph below.

Drawing conclusions from all the sources that we consulted as well as our expert views, we see some high-level trends emerging that are influenced by 2020. The probability of these trends staying or amplifying due to the multiple stimulus funds may substantiate the claim of how solid the likelihood is that the NW European economies are propelled to a higher economic growth path of the order of magnitude of 2% per year.

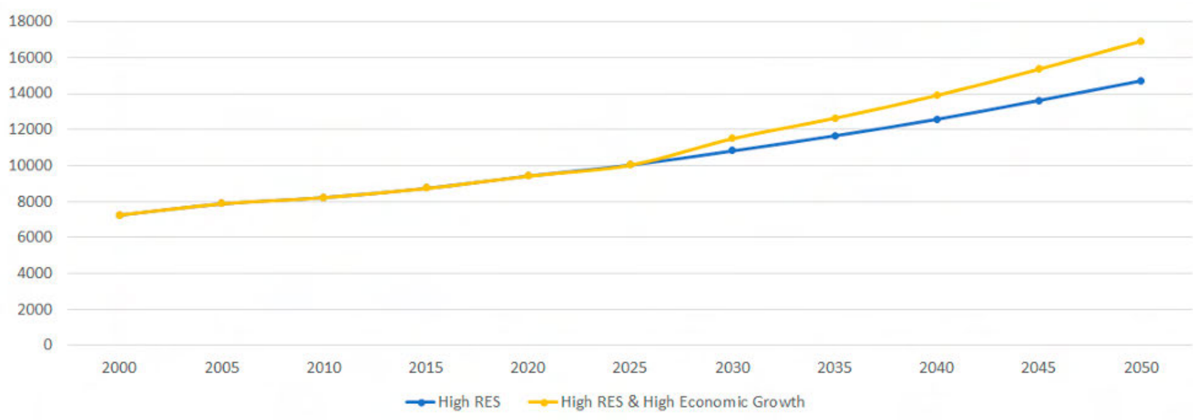
Some of the potential trends underscoring the possibility of a 2% economic growth path post-Corona include:

- **Socio-economic shifts** - raising productivity per hour worked:
  - Less efficient firms could perish and the labour from those firms will be reallocated to higher productivity sectors. Provided labour markets are flexible enough and member states invest in reskilling of their current workforce.
  - De-risking global supply chains (i.e. repatriating production back to Europe) in certain sectors could affect global trade, highly impacting maritime and air freight.
  - Pronounced effect on passenger travel might result from a reduction in travel for business and short-distance tourism due to social distancing measures/hassles.
  - Behavioural changes in consumers and producers alike - less likelihood of going back to their old habits in certain sectors, preference for local goods, healthier air, while producers might rethink business models.
  - 'Buy more local' obviously drives up prices, but that needs to be traded off against the opportunity costs of having to pay the price of the higher risk supply chains and delivery interruptions.

- **Acceleration in digitalization** - in various applications, across different industries:
  - Reliance on video conferencing and other virtual collaboration will in turn reduce pollution from traffic and less congestion in cities. Working from home as a concept and the flexibility it delivers are expected to improve productivity.
  - Better organised traffic over day and place might also reduce the need for new facilities, hampering the construction sector, also affecting energy intensive use of non-metallic minerals, cements and other inputs of the construction sector.
  - Increased digitization increases the need for data centres, which in turn increases the demand for electricity, but also tends to attract innovative data-heavy new business and employment.

29 In our report "Phasing out Carbon" from March 2020, we took a European GDP growth level of 1.5% per year into account in the applied energy scenario, in line with the underlying EC scenarios. These take into account a moderate economic growth. In EC scenarios assuming high economic growth, the GDP growth level applied amounts to 2.0%.

Figure 9: Scenario projections GDP NW Europe (in 000 M€13)



2.2.2 THE SAME EU POLICIES & EMERGING TRENDS MIGHT ENABLE FASTER DECARBONISATION

The question is whether RRF could drive not only a stronger economy but also a greener one. The WEC’s ‘World Energy Transition Radar’ suggests that to be a real possibility. WEC scanned and analyzed more than 3100 signals regarding how 85 countries will develop after the COVID-19 and what this implies for the energy transition[30]. The signals for the NW European countries increasingly indicated that there will not be a return to normal (less than 15% of all signals). Instead, 64% of the signals received indicated that countries are using this time of crisis as an opportunity to build back greener. The signals indicate three potential trends to be shaping the recovery plans, each of them gaining momentum during 2020:

- **Driver for carbon neutrality and system innovation:** Europe as a whole is striving for a better recovery from the impacts of the pandemic. EU-specific long-term strategy is focussed on a combination of the EU Green Deal and a strengthening of the EU Single Market[31]. It drives collective actions on various levers of change and includes policies to promote innovation, finance and citizen engagement. The UK is making ambitious pledges in advance of COP-26.

- **Hydrogen momentum:** The European energy community recognizes the role that hydrogen can play in decarbonising energy systems and hard-to-abate sectors like industry, shipping and heavy transport. The debate is no longer whether hydrogen will play a crucial role in 2030-2050, but more around how to generate demand and supply development and create a level playing field across different countries.

30 https://www.worldenergy.org/transition-toolkit/world-energy-scenarios/covid19-crisis-scenarios/world-energy-transition-radar
31 The single market refers to the EU as one territory without any internal borders or other regulatory obstacles to the free movement of goods and services.

- **Enabling greater consumer and worker engagement:** As a pathway for transformation, the region is taking an initiative to empower consumers to play an active role in the green and digital transitions. For instance, with the New Consumer Agenda the European Commission wants to empower consumers to become the driver of green transition by equipping them with better information on the sustainability of products[32]. Also, the Just Transition Fund and Skills Agenda for Europe aims to support re-skilling, helping businesses create new economic opportunities[33].

Next to the RRF and these World Energy Transition Radar signals we see some concrete NW European policy implementations as well to accelerate the transition of the energy mix in the EU towards a larger share of renewables and a stronger role of hydrogen. For example an EU Hydrogen strategy[34] was adopted in 2020 with an ambition to have 6GW of electrolyse capacity for the production of green hydrogen in 2030, to develop an European backbone for hydrogen transport in the EU and to have 2x40 GW of electrolyse capacity in 2040 in the EU and neighbouring countries. The EU offshore renewable energy strategy[35] has become more ambitious, with an acceleration of wind deployment towards 300 GW in 2050. As a result of this increased ambition, also member states increase their emission reduction targets or investment in renewable energy such as offshore wind and hydrogen and climate change mitigating technology such as CCS. Germany[36] is to invest €9 bln in a hydrogen economy, France[37] €7 bln. In the hydrogen strategy, billions are going into developing the hydrogen economy via the green deal and the recovery and resilience fund. Apart from electrolysers, a combined €11 bln is to be spent by the NW European countries on carbon capture and storage. In a number of North Sea countries this has been translated into several projects on CO_2 storage in the North Sea[38], notably UK, Netherlands, Denmark and Norway. This strong push in Europe towards investments in low carbon energy will result in a structural change in the energy mix with a lower CO_2 footprint.

One additional early indicator that busines is society is taking the ambition towards the 2030 and beyond objectives very seriously is perhaps the carbon price at the European emissions Trading market (ETS). As Figure 10 shows, during 2020 the carbon emissions price has really started to rise fast. Prices seem to be moving to levels that economists have argued would be needed to work as strong incentives, and for decarbonisation business cases to become more 'in the money'.

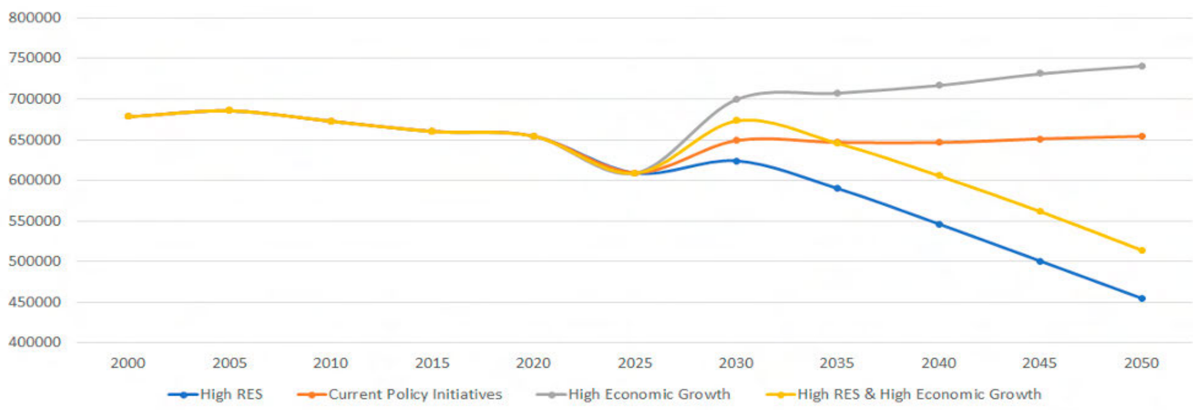
32 https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2069
33 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/just-transition-mechanism_en
34 https://www.waterstofnet.eu/_asset/_public/WIC/Hydrogen-Europe_2x40-GW-Green-H2-Initative-Paper-1.pdf
35 https://ec.europa.eu/energy/topics/renewable-energy/eu-strategy-offshore-renewable-energy_en
36 https://renewablesnow.com/news/germany-approves-national-hydrogen-strategy-with-eur-9bn-stimulus-package-702209/
37 https://fuelcellsworks.com/news/french-economic-recovery-package-to-include-7-billion-euros-for-hydrogen-industry/
38 https://www.oilandgaseurope.org/wp-content/uploads/2020/06/Map-of-EU-CCS-Projects.pdf

Figure 10: Daily EU ETS carbon market price (€).

2.2.3 LOWER CARBON ENERGY MIX & HIGHER ENERGY EFFICIENCY TO FUEL HIGH ECONOMIC GROWTH

These market and policy trends seem to indicate that Europe could be on a path in line with the ‘high economic growth - high renewable energy’ (High RES - high growth) scenario, focused at recovery policies that deliver on both economic and climate goals. This includes increased climate ambitions and policies and funds to support these, a large role for hydrogen in the decarbonisation of energy systems and hard-to-abate sectors, and re-skilling of the workforce to address unemployment on the one hand and job openings in growing sectors on the other. In Figure 11 below we visualize energy demand in different European Commission scenarios. The energy demand of the ‘High RES, High Economic Growth’ scenario was calculated by adding the percentage changes of the ‘High Economic Growth’ scenario in relation to the baseline to the ‘High RES’ scenario

Figure 11: Scenario projections total energy demand NW Europe (in ktoe).




OPEN
BUSINESS AS
NEW NORMAL

2.2.4 WHAT THESE LONG TERM EFFECTS OF CORONA MEAN FOR 2030 AND 2050

Greenhouse gas emissions in 2050 are the product of economic growth, energy use per GDP (energy efficiency), and the energy mix (including carbon capture like storage and natural sinks). Our position is that two economic growth scenarios are not inconceivable: 1.5% and 2%. The moderate scenario coincides with our Phasing Out carbon scenario, except for two changes: (1) the immediate effect of the halted emissions trend during Corona is that the period starts from a smaller carbon bubble - but as said the impact will be smaller than the noise; and (2) the EC has raised the bar with the higher targets for 2030[39].

To realize the ECs increased climate ambitions towards 2030 and climate neutrality in 2050, a combination of a higher share of renewable energy (including carbon capture) and higher energy efficiency is required to make up for the potentially higher economic growth trajectory. Otherwise, the higher economic growth levels would result in higher CO_2 emissions and adversely impact the Paris Agreement goal. The changes that would be necessary to get to a future with a higher share of renewable energy and higher energy efficiency are discussed in the following chapters of this report. In the subsequent chapters we will deal with the changing energy mix and which policies should be implemented to see an energy mix that is the least carbon intensive as possible.

As a result of the higher economic growth level in this scenario, the GDP will have grown with an additional 13% by 2050 as indicated before. In case there are no significant changes in the energy efficiency level, the cumulative additional energy demand may amount to approx. 7% over the period up to 2050, being about 1500 Mtoe for NW Europe. Taking the CO_2 intensity levels consistent with the scenario into account, this would sum up to 1.6 giga tonnes of additional CO_2 emissions. At the current ETS price of € 44/ton, this amounts to € 70 bln. Although being a very large number, this implies that only a limited portion of the EU recovery funds are needed to offset the additional CO_2 emissions resulting from the higher economic growth. In this simplified calculation the additional wealth created by the higher economic growth is even not taken into account. ■

39 The two scenarios used in this study coincide in essence with the Pause and the Fast-Forward scenarios from WEC Global’s 2020 scenario study: https://www.worldenergy.org/assets/downloads/World_Energy_Council_-_Covid_Scenarios_Summary_-_FINAL.pdf.

3

THE SPEED OF THE ENERGY TRANSITION AFTER COVID

The two long-term economic scenarios we argued could emerge from the Corona year events will, all other things being equal, lead to quite different energy use paths and by implication different greenhouse gas emissions outcomes in 2030 and 2050. If the NW European economies will resume their pre-Corona projected growth rate of 1.5% on average, the energy and greenhouse gas emissions performance will resume to our Phasing Out Carbon levels too. But if the Corona year events would have kicked the economies to the other scenario of 2% growth, additional efforts need to be taken to stay on course for the net zero emissions objectives of 2050. The additional efforts could be aimed at a combination of enhanced energy efficiency, and a more decarbonised energy mix.

In this chapter we take a closer look at the trends that were set off due to COVID-19 in the energy supply (and resulting mix) side and the subsequent effects on energy technologies and innovations. This cannot be seen in isolation and the other parts of the energy value chain will feel the reverberations as well. The energy infrastructure and energy-intensive sectors (like industries) will face the need to evolve together with changing energy mixes.

Secondly, this chapter also aims to explore whether these trends could help realise the necessary acceleration of the energy transition, in the event that the higher economic growth scenario would materialise. In order to substantiate the argument that not just economic growth but also the energy efficiency trajectory and the energy mix and its carbon content might have been affected structurally by the Corona-year events, we take a closer look through five lenses.

3.1 EMERGING TRENDS IN THE ENERGY MIX - PERSISTENT AND IRREVERSIBLE?

The events of 2020 have influenced the energy system drastically over the past year. From an energy mix perspective, oil experienced an unexpected decline in demand (https://www.iea.org/reports/oil-2021) and a possible forward shift in peak oil demand in some regions in the world. Coal has not only been faced with political and societal pressure, but also with tough competition against renewables; the latter proving to be a resilient energy source in 2020.

Natural gas became the new merit order favourite for electricity production in several regions (https://www.iea.org/reports/oil-2021). Finally, the attention for hydrogen gained unprecedented momentum - see Figure 15. There has been a higher push for CO_2 (from CCUS) to pick up in the coming years, driven by the approaching climate targets.

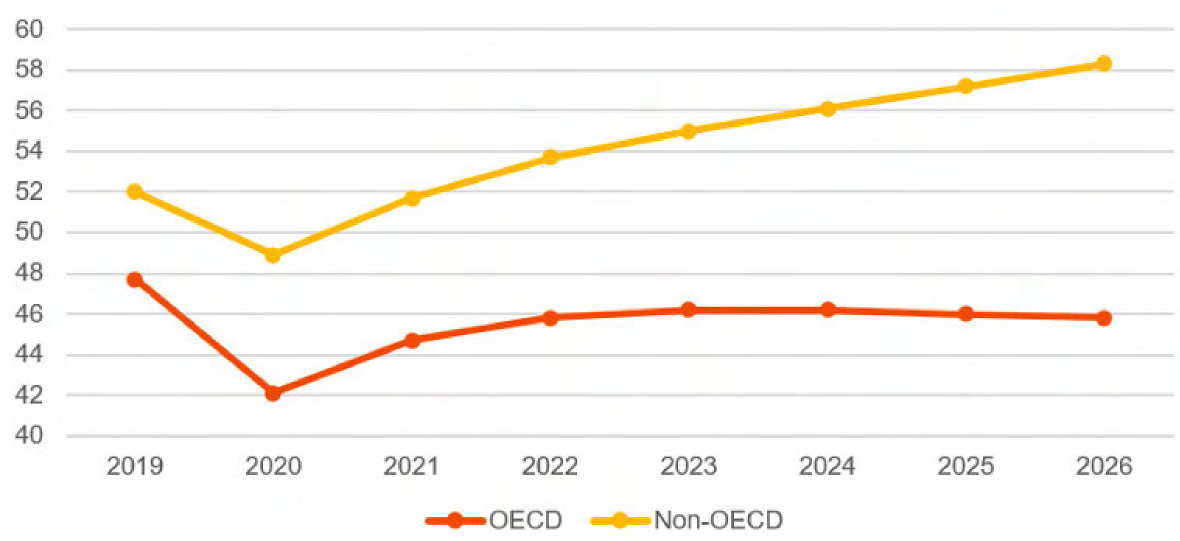
All these trends, if continued after Corona, could contribute to a cleaner energy mix long term, and help bridge the gap between the higher economic scenario’s emissions and the net-zero targets. It is a big if, and in this section we explore how strong the trend breaks might be, and how irreversible the trend breaks might turn out to be.

3.1.1 FOSSIL FUELS IN THE ENERGY MIX

A. PEAK OIL DEMAND MAY HAVE ALREADY BEEN REACHED IN SOME PARTS OF THE WORLD

In its initial stages, COVID-19 put pressure on oil with the speed and magnitude of market decline going beyond the market flexibility to adjust supply. Peak oil demand may possibly occur sooner than expected and might have been brought forward by a combination of the COVID-19 pandemic, the continued US-China trade war and Brexit, as IEA has suggested. However, the actual peak oil moment will vary greatly per region. The effect of the COVID-19 pandemic on the oil supply will vary across the globe. In the context of ageing NW European, even at the 2% growth path, oil demand could well have plateaued in 2020, with a possibility of a faster decline as more renewable energy sources will come to the market (ETO, 2020). In China on the other hand, economic activity has for instance recovered far more quickly to their high pre-Corona growth rate, and China remains a fossil fuels-intensive emerging economy. As a reference, without COVID-19 effects, oil was expected to peak in 2023 and decline more gently towards 2050 in Phasing Out Carbon.

Figure 12: Oil demand projections during and after COVID-19
(source IEA: https://www.iea.org/reports/oil-2021)



The pandemic will likely lead to a 13% reduction in global crude-oil demand in 2020 (IEA, 2020), mainly due to the impact on the transport sector. Especially fuel demand from the aviation sector will likely not return to pre-pandemic levels soon. Road fuel demand on the other hand recovered after easing of confinement measures and consumer preference for personal vehicles over virus-spread risky public transport. However, as some hybrid forms of working from home are here to stay, the demand for road fuel will probably not completely recover to the old levels.

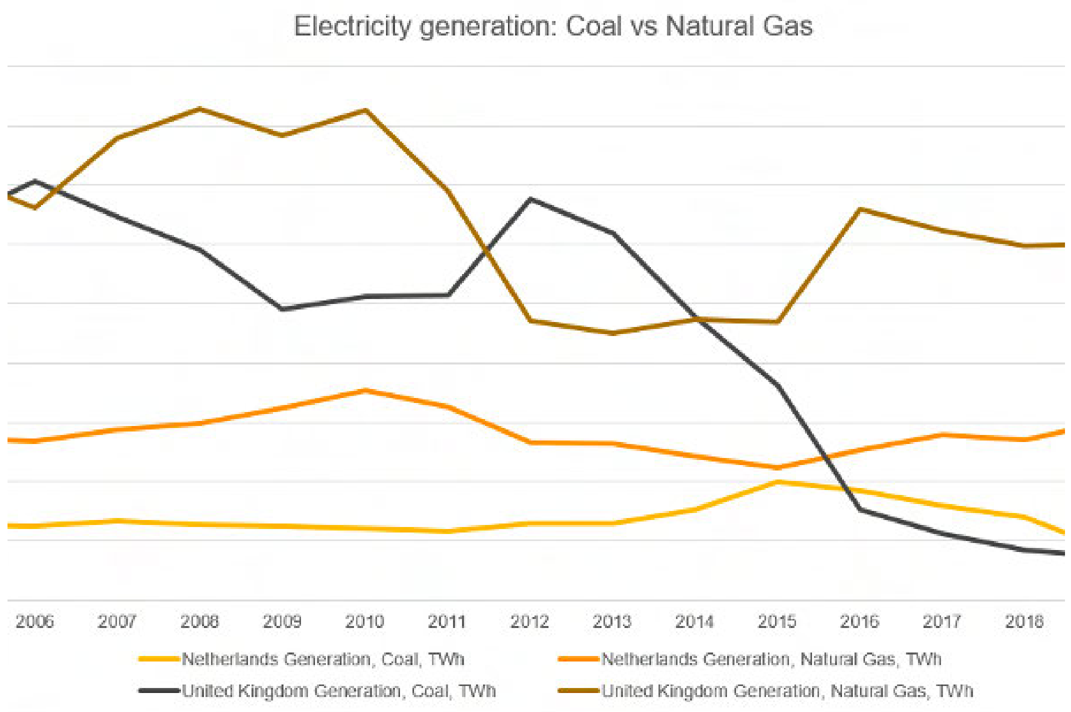
We conclude that it is not unreasonable to assume that peak oil demand in NW Europe may have been brought forward in time by Corona, and decline of oil demand may have been accelerated.

B. DECLINING ROLE OF COAL AS A POWER SOURCE BUT NOT IN THE STEEL INDUSTRY

From the perspective of its role as feedstock for power production, coal’s contribution has been declining in the past years in Europe. This was partly due to the increased availability of cheap gas (both pipeline and LNG), partly due to the availability of cheap renewables, and partly due to political choices concerning coal fired power plants. The Netherlands has decided that all coal fired power plants should be closed by 2030, with Germany following in 2038 (DNV-GL).

In the high growth scenario, the EU ETS could play a role in further pushing out coal. As using coal for power generation results in higher life-cycle emissions compared to using natural gas, a higher ETS price has a larger price impact for coal-fired power plants than for gas-fired power plants. These developments, combined with the increased introduction of cheap renewable energy sources, led to a declining role for coal as a power source and the increased use of natural gas (as depicted for the United Kingdom and Netherlands, Figure 13), and renewables (mainly wind and solar) for electricity supply in Northwest Europe. This process seems to be irreversible, politically and economically.

Figure 13: Electricity generation in UK and Netherlands, 2005-2020; coal-fired vs natural gas-fired (Sources: DECC/EIA/Fitch)



However, coal’s role is the most important as a feedstock in the steel industry in Europe (especially when the automotive sector picks up), and this could be expected to remain so for the coming years. Hydrogen could be a possible alternative[40] in a long-term scenario future that aligns with the high growth scenario.

40 https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/641552/EPRS_BRI(2020)641552_EN.pdf

C. NATURAL GAS COULD BE AN ATTRACTIVE LOWER CARBON BASELOAD ALTERNATIVE

The supply of natural gas in the early stages of the pandemic did not respond to the lower demand, leading to more gas in underground storages[41]. The short-term oversupply of gas led to extremely low gas prices, making gas an attractive lower carbon alternative to coal for electricity generation - provided, from a life-cycle perspective, methane emissions are managed properly over the cycle. Gas supply could remain strong and further increase in the coming years, remaining an important energy source for Europe – see again Figure 13.

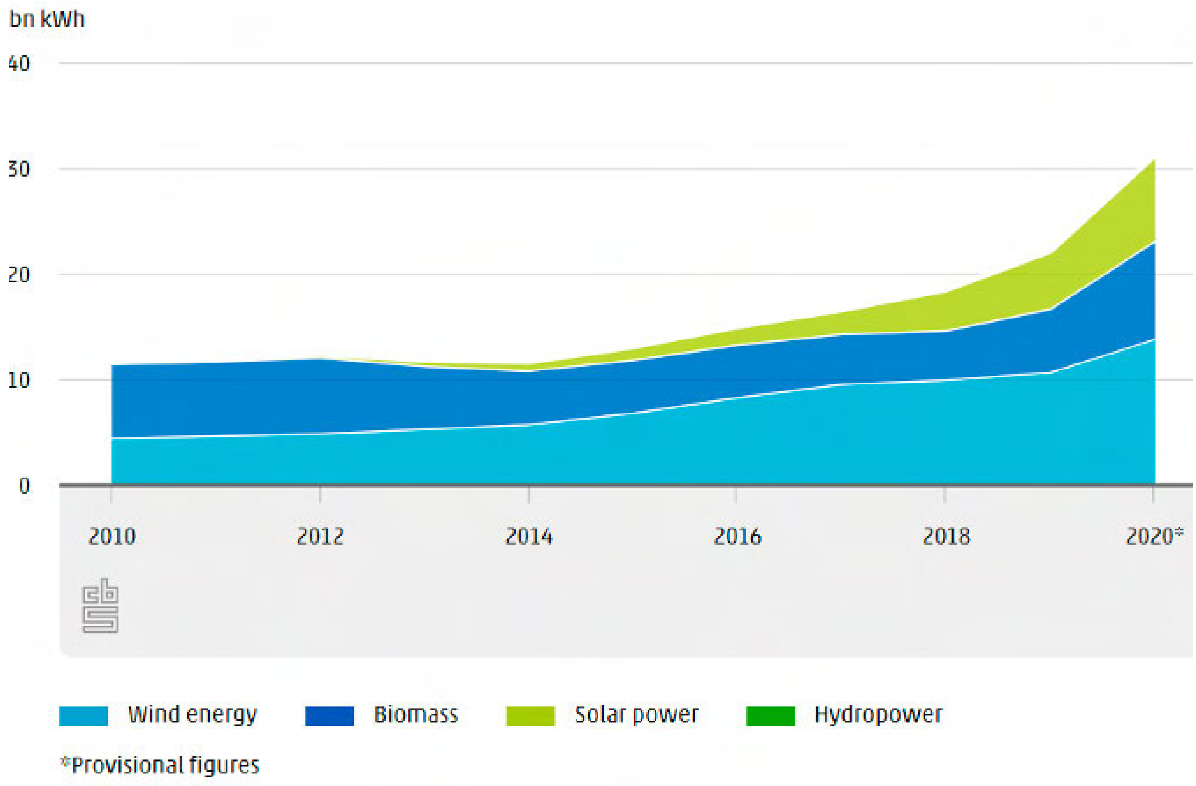
In a high growth scenario with natural gas acting as one of the main low carbon alternatives to oil and coal, electricity generation will require increased supply of gas both via pipeline and ship (the latter in the form of LNG). LNG supply could also be expected to further increase due to the increasing role for LNG as a shipping fuel in the coming years. It is furthermore driven by the increased dependence of Europe on imported gas resulting from the accelerated closure of the Groningen field and little investment in offshore small field gas developments.

3.1.2 ACCELERATED IMPLEMENTATION OF CLEAN ENERGY IN A HIGH GROWTH SCENARIO

The supply of renewable energy, mainly solar and wind, has been increasing despite the pandemic - see Figure 14 below for Netherlands. Across all regions that underwent a lockdown, the electricity supply mix shifted towards more low-carbon sources, mainly driving coal and partially gas out of the energy mix. The recovery rate from the pandemic and the connected increasing energy demand will influence the role of renewables in the electricity mix, with a slower recovery putting more pressure on coal and gas. In the high growth scenario in this report, we expect a higher contribution of RES and hydrogen in the energy mix, as more government support funds might be available and energy prices, from competing carriers to RES power will be higher.

41 “Europe’s unusually low gas stocks set to underpin prices” - Reuters Commodities News - March 2021

Figure 14: Renewable power production, Netherlands, 2010-2020



A. THE INCREASED RES-INDUCED VOLATILITY CAN BE DEALT WITH WITH SEVERAL MECHANISMS

With renewables growing in the electricity supply mix, power grids have had to manage larger volatility due to RES infeed. This has led to increased volatility in electricity prices (due to the unpredictable nature of the RES) and brought about further uncertainties about long-term price levels.

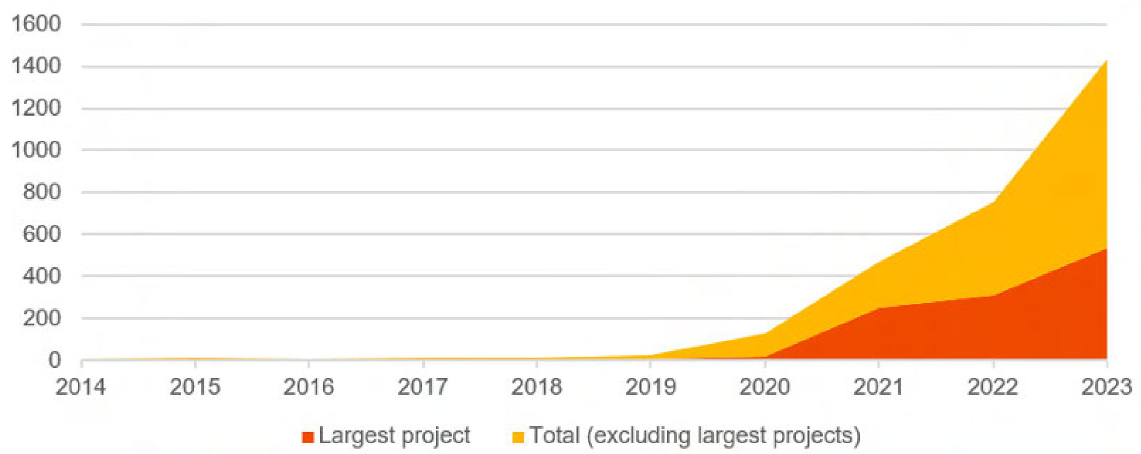
More robust grid integration as well as flexibility and storage mechanisms are going to be key to dealing with this volatility. A way for developers and off-takers to cope with this uncertainty is for example to close Power Purchase Agreement (PPA) contracts. These guarantee a fixed long-term income for developers, as well as a steady cost price for off-takers. In some cases, growing long-term wholesale price level uncertainties also give rise to uncertainties about PPA-pricing and consequent contracting. Without such agreements, renewables developers are faced with an increasing exposure to volatile prices, whereby prices are generally on the low end when they generate. This could impact the (continued) development of renewable energy project developments in the long run, where they can currently still count on (stable) subsidy income and/or PPA prices. Therefore, the introduction of more renewables to the electricity supply might lead to (and require) new and different market models in the near future.

B. STRONG INITIATIVES TO DEVELOP HYDROGEN MARKETS ARE EMERGING GLOBALLY

Another significant development in 2020 was the strong support and global awareness around hydrogen among policymakers. A sharp decline in renewable electricity generation and conversion costs over the past decade and the fact that hydrogen can be stored and shipped could fuel the emergence of a global hydrogen market. This is expected particularly in regions that have an abundance of renewable resources. Hydrogen could be the energy carrier - either cooled/compressed, or in liquid form bound to an organic carrier (LOHCs) or as ammonia/methanol - to link regions with an abundance of renewable resources (and hence low electricity costs) to regions with a large energy demand.

Around the world, the first trading links are already emerging. An example is the trading link between Australia and Japan, which is still based on hydrogen produced from brown coal. On the other hand, Europe is positioning itself as the front-runner in developing the H2 economy with a clear European H2 strategy including a target of 40 GW domestic production and 40 GW production capacity outside the EU[42]. The first initiatives for green hydrogen supply chains between the Middle East and Europe are currently being explored, for example the NEOM project aiming to produce large amounts of NH3.

Figure 15: Global electrolysis capacity becoming operational annually, 2014-2023, historical and announced (2019)(source IEA: https://www.iea.org/reports/oil-2021)

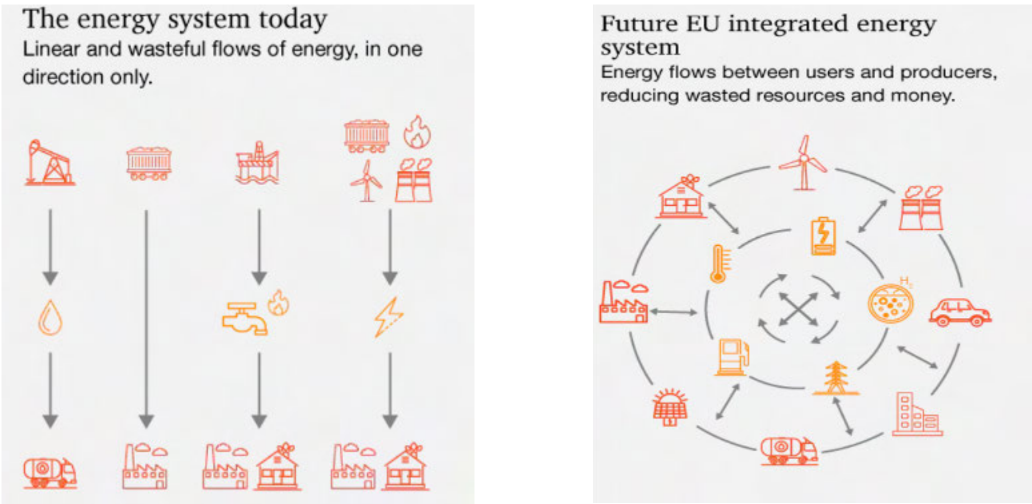


The emergence of a European and possibly global H2 market can cause a shift in the geostrategic importance of countries who act as energy suppliers towards the EU. By an increasing share of hydrogen in the energy mix, the dependency of the EU on traditional suppliers of oil and gas will lower and may lead to a more diversified energy supply landscape. In a renewable energy system the supply of energy can be imagined to be more diverse with more countries coming into the mix and less centralized large-scale players. Next to H2 coming from regions like North Africa and the Middle East, additional H2 supply chains are being developed within the European borders. This includes for example chains from renewable energy rich countries, with strong solar energy sources, such as Spain and Portugal to energy intensive industrial areas in NW Europe.

42 2x40GW Initiative – Hydrogen for Climate Action. (2014). Hydrogen for Climate Action. Retrieved March 26, 2021, from Hydrogen for Climate Action website: https://www.hydrogen4climateaction.eu/2x40gw-initiative

3.2 A FASTER EVOLVING ENERGY SYSTEM AFFECTS THE FABRIC OF INDUSTRIAL INTERDEPENDENCIES

Figure 16: Schematic illustration of the transition of the energy systems: from linear and stand-alone to circular and integrated (European Commission)



Historically our energy system has been developed as it were in silos, one column per energy carrier. Oil, coal, gas, and power are produced in their own geographies, are transported via their own specific means, and used in specific applications. Markets and price formation have been fairly independent from each other. However, the envisaged low- and eventually net-zero emissions energy system for NW Europe will be characterised by much more circularities and interdependencies. The EC has visualised the structural differences between the ‘old’ and the ‘new’ energy system as in Figure 16. If all the other Corona-year induced trend breaks discussed throughout the report are real, then in such a scenario also the transition towards this ‘new’ more integrated energy system will move more rapidly, meaning the industrial redesign will accelerate after Corona.

What we might see is industry reorganising itself in new shapes and structures. Let us look at two examples.

3.2.1 REINVENTING LINEAR AND STAND-ALONE INDUSTRIAL CONCEPTS

An optimistic scenario points to the reinvention of the industrial concept as we perceive it today, going from a linear system to a more integrated and circular system between different players in the value chain. An emerging trend in the energy transition is the entry of so called prosumers, both on industrial scale (e.g. integrated heat systems) and on a decentralized scale (households, offices and farms with solar panels on their rooftop).

The chemical industry is a good example of an industry that has experienced multiple transitions over its long and important history in the EU, with the Antwerp-Rotterdam-Rhine-Ruhr Area (ARRRA) as key cluster. Starting with coal as a feedstock and later transitioning to oil, over the past years the transition has continued with an increasing share of plastics being produced from gases (ethane, propane, butanes and more) and bio-based feedstocks.

The introduction of cheap LNG to the market due to the shale gas boom in the US reshaped the market the last decade, resulting in a new ethane-based cracker being under construction in Antwerp for the first time in two decades. The period towards 2030 and beyond could mark the introduction of yet another transition in the chemical industry, with the increased use of recyclable feedstocks and renewable sources for heat and power supply. This could result in increased development of chemical recycling plants, with for example pyrolysis oil being introduced as new feedstock for chemical crackers.

3.2.2 RECONSIDERING AND DE-RISKING OF SUPPLY CHAINS

As a result of disruption of supply chains for industrial manufacturing and assembly processes during the lockdown, industry may revert to shorter supply chains and increase the number of local suppliers. According to PwC's Global CEO Survey (PwC, March 2021) global supply chains are being reconsidered, and some crucial links are being repatriated closer to the end-user markets. Shortening supply chain will minimize the risk of production stops as a result of a lack of components or materials, but might also result in a smaller volume of container transport, global shipping and cargo flights which will reduce the need for ship fuels and kerosene globally.

With respect to commodities, NW Europe will continue to be reliant on both exports and imports. Europe is traditionally a large importer for energy carriers, such as coal, oil and gas[43], and the import dependency increases while traditional domestic resources decline and conditions for solar are limited. Also future clean energy carriers, such as hydrogen or ammonia for example, will be imported. The EU target is to import green hydrogen from neighbouring countries such as North Africa, UK or Ukraine. Middle Eastern hydrogen generation could also make it a player. Therefore the EU could be expected to be less dependent on imports from farther countries in Australasia or the US for new energy carriers.

43 https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-2c.html

3.3 INFRASTRUCTURE CHALLENGES: FROM PIPELINES TO ENERGY STORAGE

The possible change of the energy supply mix - partly accelerated by the COVID-19 pandemic and partly by other 2020 developments - will require adaptation of existing infrastructure and the introduction of new infrastructure in order to facilitate the supply and guarantee the security of supply. The need for large scale storage infrastructure for the energy system as a whole, both in the form of electricity as well as in molecular form, will increase in the coming years, especially for the realisation of the high growth scenario.

On the electricity side, an integrated and interconnected electricity system within the EU may become increasingly important as supply will become more fluctuating. Developing the required electricity interconnections is important to increase the share of renewables in the EU electricity mix. Integrating more renewables into the electricity grid will require an increased grid capacity, smart energy systems, and increased battery storage infrastructure to ensure security of supply and prevent congestion challenges due to more distributed sources.

Furthermore, as more industrial companies are facing the challenge to lower their CO_2 emissions towards 2030, additional infrastructure will be required in the coming years to facilitate this transition. Carbon Capture, Usage, and Storage, or CCUS, is an effective method to start reducing net CO_2 emissions in the relatively short-term. The method is controversial, because it doesn’t prevent but stores CO_2 emissions, and because storage is not considered without long-term risks by everybody. Yet various large-scale CO_2 projects have been announced in the past years. The port of Rotterdam area is one of the front-runners in developing permanent CO_2 underground storage infrastructure. The development of the Porthos project is seen as an important CCS project within the EU. The immediate reduction effect CCS has on CO_2 emissions is considered more and more necessary to realize the 2030 emission reduction targets in the EU. As such, more companies within the EU may soon start looking to permanently store CO_2. This will not only require CO_2 pipeline infrastructure, but also liquid CO_2 shipping and tank storage infrastructure. The purpose of these is to connect all large industrial emitters across the EU to permanent CO_2 storage facilities, for example in Norway.

In a high growth scenario where supply of H2 in different forms increases in the coming decade in the EU multiple infrastructure solutions are required. Part of the existing natural gas infrastructure can be re-used to transport H2 which can be via a blend between H2 and natural gas or via repurposing of natural gas infrastructure as dedicated H2 pipelines. This is for example currently being studied in the Netherlands, amongst others in the HyWay 27 study of The Dutch Ministry of Economic Affairs and Climate Policy, TenneT and Gasunie. Next to pipeline infrastructure, H2 supply in liquid form via ships will also be required in different forms (Liquid Organic Hydrogen Carriers, or LOHC, ammonia or NH3, and Liquid H2). This will require new infrastructure, for example for liquefied hydrogen and ammonia, but can partly also be supplied via existing oil/fuel infrastructure when transporting H2 in the form of LOHC.

In short, the transition to a more diverse and fluctuating energy supply will require additional infrastructure solutions and a more integrated energy system with the EU. In order to achieve this, it is key to start developing this infrastructure sooner rather than later due to the long lead times associated with large scale infrastructure projects. The perspectives that a high growth scenario offer can serve as a catalyst for the development of infrastructure investments.

3.4 SOME SPECIFIC 2020 EVENTS THAT MAY HAVE STRUCTURAL EFFECTS

Some other developments of 2020 may also shift the long-standing dynamics in energy demand and supply, disrupting the future energy mix in NW Europe.

A. REDUCING THE DEPENDENCE OF MATERIAL CRUCIAL FOR ENERGY SUPPLY FROM ONLY A FEW COUNTRIES

Our new energy systems require certain new materials in large amounts, and for certain crucial energy supply materials there is an increased dependency on a limited number of countries. For example, materials required for the production of wind turbines such as Neodymium or batteries such as Cobalt and Lanthanum are supplied from a few countries, with China as in some cases the sole supplier[44]. China happens to be the producer in 2019 of over 62% of the global rare earth materials. In addition to that, China is investing heavily in securing scarce resources in overseas regions such as Africa. This trend has intensified over the Corona-years, when China succeeded in resuming 5+% economic growth in a matter of 6 months after Corona hit.

In anticipation of the strategic scarcity, battery producer companies worldwide are now working on alternative materials. The EU has decided to start a battery alliance to stimulate production of batteries within the EU and develop alternative concepts that depend less on rare materials. Tesla has decided to start a factory in Germany for the European market[45]. There are identified limitations on rare materials, but no shortage is perceived on the short term. COVID seems to have given a signal that we might be too dependent on some countries. Increasing pressure on shortening supply chains could promote innovation and stimulate circular processes. This may have an impact on the energy mix only on the long term, and changing such processes would be a long term development.

B. EMBRACING THE PARIS OBJECTIVES, ALSO OUTSIDE EUROPE

A major 2020 development with potentially a high impact on the energy mix included the election of Joe Biden as the new US president, who has very soon after the inauguration rejoined the US to the Paris Agreement[46] and issued a decarbonisation policy strategy with a tag of US$ 1.9 trillion, part of which to boost investments in renewable energies.

44 https://www.instituteforenergyresearch.org/international-issues/china-dominates-the-rare-earths-supply-chain/
45 https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/112520-tesla-plans-to-turn-berlin-plant-into-worlds-largest-ev-battery-plant
46 https://news.un.org/en/story/2021/01/1082602

Other global developments such as increased and accelerated targets in China, Japan and South Korea[47] on renewable energy and hydrogen, the global ambition to create a liquid hydrogen market, probably will accelerate the deployment of low carbon and renewable energies in the global energy mix. This could be facilitated with pipeline interconnections and shipping options for long distance transport of hydrogen or derived energy carriers such as Ammonia, LOHC or liquefied hydrogen.

The global adoption of the Paris agreement into national targets and policies NDC’s[48] may drive an accelerated change in the energy mix for various markets, for example it could be imagined that the power market will move from coal and gas fired power stations towards wind and solar power, the mobility sector moving to light electric vehicles or fuel cell electric transport modes. Also industry and the built environment are increasingly considering low carbon alternatives as new policies and CO_2 taxes are planned to be imposed on these markets.

C. BREXIT INCREASES THE COSTS OF COORDINATION OF REGIONAL ENERGY AND CLIMATE POLICIES

In 2020, Brexit became a reality, causing the UK to leave the EU. This could impact the collaboration with respect to the North Sea developments and collaboration in the area of offshore wind and CCS. It is still unclear if the UK will leave the North Sea Energy Collaboration[49] platform that was initiated to coordinate the transition of the North Sea as a mature oil and gas basin towards a renewable powerhouse for North West Europe supplying clean electrons and hydrogen to the market. Also, the development of offshore energy infrastructure such as interconnections and energy hubs is unclear at date.

At the same time, in the area of offshore wind, hydrogen and CCS, the UK is more ambitious than before, and so is the EU with its ambition to cut emissions by 55% by 2030[50]. Growth ambitions have been increased and offshore wind development plans are accelerated. It may lead to an increase in competition in the market in the EU and UK which can accelerate the learning curves and cost reduction for offshore wind.

Brexit leaves Ireland in a delicate position, being very dependent on its energy supply from the UK. Ireland is concerned about its limited energy interconnection with continental Europe[51]. We might see a structural change in the Irish developing their connections with the rest of Europe and new energy infrastructure developed for power and gas. In the long term, Brexit may accelerate deployment of offshore wind and competitiveness and strengthen interconnections with Ireland.

In any event, Brexit will mean at the very least the rising of the costs of coordination of energy and climate policies in NW Europe.

47 https://asia.nikkei.com/Opinion/China-Japan-and-South-Korea-have-good-news-for-planet-Earth
48 https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs
49 https://ec.europa.eu/energy/topics/infrastructure/high-level-groups/north-seas-energy-cooperation_en
50 https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1599
51 https://www.europarl.europa.eu/ireland/en/news-press/the-celtic-interconnector-connecting-ireland-and-europe

3.5 COVID-19 INDUCED TRENDS IN ENERGY TECHNOLOGY AND INNOVATION

Due to COVID-19, industries were facing major disruptions in often globally optimized supply chains[52], while demand for various resources dropped due to consumer restrictions. Furthermore the epidemic raised awareness and urgency of the significant challenge of the global climate change we are facing, while developments in energy technology and innovation have only accelerated. In order to support economies and mitigate social impact, monetary stimulus has expanded and various recovery funds have been introduced in both the US and the EU. The purpose of this chapter is to give an overview of the current and potential future impacts that 2020 had and might have on technology and innovation. This overview comes with a set of recommendations to secure a greener future.

In the scenario of an accelerated energy transition, the following trends could be thought of:

3.5.1 ACCELERATED DIGITALISATION: WORKING FROM HOME AND E-COMMERCE

Perhaps an obvious yet important trend is digitization, at first primarily driven by travel restrictions both nationally and internationally. Two main developments could be distinguished in the more advanced economies globally, and in NWE in particular: working from home (WFH) and booming e-commerce[53]. The former development is expected to have a lasting impact on how people communicate and collaborate in various organisations and, hence, also on how people will commute. The latter has resulted in different ways people engage with business, as well as more direct consequences such as tremendous growth in parcel shipping. Both developments would require a more resilient digital infrastructure and more data centres. After an initial decline in power consumption in the early stages of the pandemic[54], the (sudden and rapid) increase of digitization ultimately also resulted in a more rapid increase of WFH and digital services. If continuing, the growth of data centres will likely result in higher electric loads as well. To counter increasing loads, efficiency improvements are required[55].

52 "Supply chains were disrupted since the start of the pandemic" according to comments made by Albert Jan Swart, sector economist Industry at ABN AMRO, on https://nevi.nl/nieuws/groei-zet-door-nevi-pmi-februari-59-6

53 Parcel shipping shipping in the Netherlands grew by 103% over the past year, see: https://www.ecommercenews.nl/sendcloud-103-meer-pakketten/ and https://www.logistiek.nl/supply-chain/nieuws/2021/03/pakketbezorging-groeit-103-procent-groei-in-2020-101177259

54 See 'EU's electricity consumption still below normal levels', Eurostat, on https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20200907-1

55 See: https://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_saving_statistics

At the same time, the increasing load raises societal concern over crowding out renewable resources. 'Crowding out' refers to the development that generated renewable power is largely consumed by big industrial players or data centres. These are sometimes located very close to the renewable generation site (e.g. a wind farm), reducing the availability of this green power for households and other sectors. Although this might help in starting to build an economically healthy supply and demand for renewables, it may in turn reduce the support for local renewable development. These humanizing factors, though less tangible, must be considered as well given the perceived developments.

3.5.2 INCREASING SHARE OF WEATHER-DEPENDENT POWER GENERATION

Since the COVID-19 pandemic, investments in renewable energy and the energy transition surpassed 500 billion $ for the first time in 2020[56], partly coinciding with a low oil price environment. New investment is directed towards alternatives and existing oil majors are reconsidering their strategies[57]. Financial institutions (debt providers) as well as pension funds (equity providers) are also more and more directing their funds towards sustainable investments[58]. This shift is partly driven by an increased sense of urgency in society at large, but also specifically by shareholders. However, also the economics became more favourable for renewables with sharply declining levelized cost of electricity (LCOE)[59]. Significant progress has been made in offshore wind, with commitment of the EU to further increase the capacity to over 300 GW by 2050[60]. This yet again poses new challenges in itself, since further grid development will become critical (both on- and offshore) and larger and various forms of energy storage will be needed.

56 Bloomberg New Energy Finance, 'Energy Transition Investment Hit $500 Billion in 2020 – For First Time', 19Time | BloombergNEF. (2021, January 2021 on19). Retrieved March 15, 2021, from BloombergNEF website: https://about.bnef.com/blog/energy-transition-investment-hit-500-billion-in-2020-for-first-time/

57 Please see following URLs for statements by different companies: https://www.nsenergybusiness.com/features/oil-companies-net-zero/
https://www.bp.com/en/global/corporate/news-and-insights/reimagining-energy/net-zero-by-2050.html
https://www.total.com/media/news/total-adopts-new-climate-ambition-get-net-zero-2050#
https://www.eni.com/en-IT/media/press-release/2020/02/long-term-strategic-plan-to-2050-and-action-plan-2020-2023.html
https://www.shell.com/media/news-and-media-releases/2021/shell-accelerates-drive-for-net-zero-emissions-with-customer-first-strategy.html

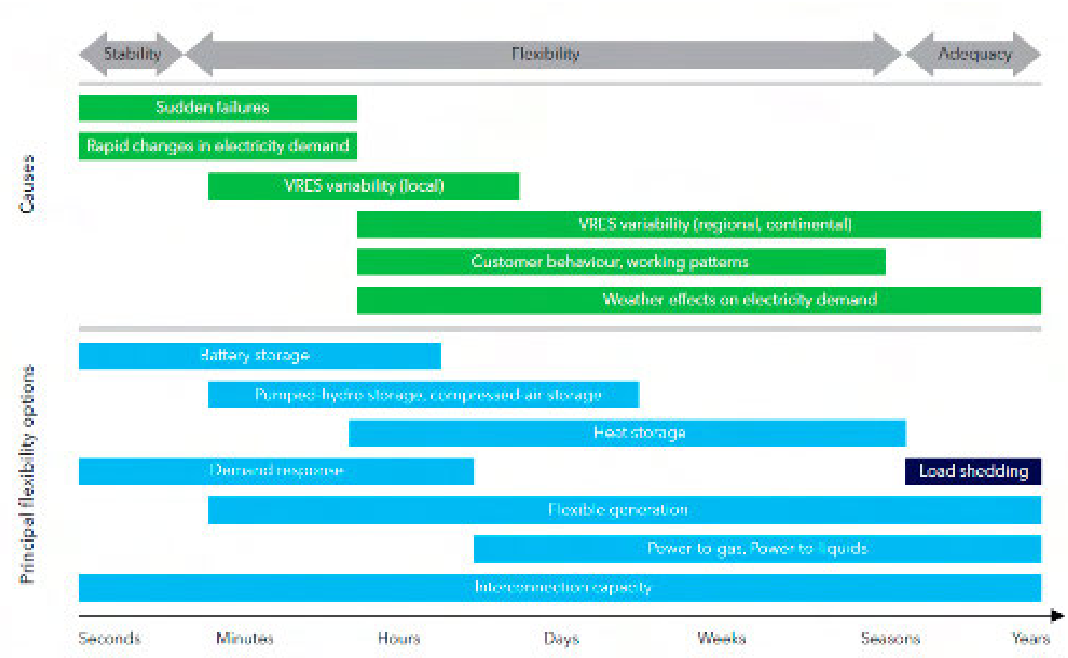
58 https://www.uk.mercer.com/newsroom/new-mercer-survey-shows-significant-jump-in-european-pensions-schemes.html

59 See for example "Projected costs of generating electricity 2020", IEA on https://www.iea.org/reports/projected-costs-of-generating-electricity-2020

60 Press corner. (2021). Retrieved March 26, 2021, from European Commission - European Commission website: https://ec.europa.eu/commission/presscorner/detail/en/IP_20_2096

Electrical energy storage (EES) systems entail a variety of technologies with large ranges of storage system sizes and on various duration scales, which are required for the system to cope with the increasing variability of generation from wind and solar. This system requirement for more technologies that can provide power at varying capacities and timescales, to cope with the increasing variability of generation from increasing shares of weather-dependent wind and solar generation, is also referred to as the need for more 'flexibility' in the energy system. Hence, to allocate the right EES technology for flexibility provision, the variability on specific time cycles is key. In the Figure 17, an overview of the various causes of disruptions is provided and linked to the suitable principal flexibility options that have specific time cycles. It should be noted that a combination of different flexibility options is needed in order to maintain grid stability, flexibility as well as system adequacy.

Figure 17: Time scales for flexibility needs in the electricity system, including principal flexibility options (DNV, Promise of Seasonal Storage).



The initial power demand drop[61], due to the COVID-19 pandemic resulted in increasing challenges for network operators, especially where lower loads coincided with higher generation from intermittent renewables. The relatively high dependence upon renewable sources of generation in these instances, have in some cases resulted in network operators being concerned about the availability of sufficient and adequate balancing reserves. It has led to increased thinking about which new market products and services need to be developed to ensure appropriate system balancing (e.g. balancing services being provided by variable renewable sources of generation and/or aggregated demand; smaller required bid sizes and auction timeframes changing the definition and reach of certain balancing services,

61 Betram et al (2021), 'COVID-19-induced low power demand and market forces starkly reduce CO_2 emissions', Nature: https://www.nature.com/articles/s41558-021-00987-x

and the possibilities for (new) technologies to bid into these markets/ services) need , and ultimately ensure security of supply. This, throughout the energy transition and (more urgently) the short-term impacts of demand changes due to the pandemic in combination with ongoing increasing renewables penetration, advances the current thinking about things like the aggregated response of households and electric vehicles, balancing services provided by renewable generation, possible capacity remuneration to ensure system adequacy in the long run, and the possible flexibilization of baseload industrial demand. Opportunities of this latter option are likely to grow with more electrification of industrial energy supply in time and increasing price volatility due to the integration of more renewable generation; industry will want to reduce the risk of being exposed to moments of (very) high prices and this can be achieved through e.g. (fixed price) power purchase agreements (PPAs), or by increasing the options to flexibly consume power by applying more flexibility to (electrified) heat production processes, to cooling, and/ or to the conversion of electricity into alternative energy carriers/ products.

Furthermore, the Green Deal will drive hydrogen harder across Northwest Europe. There is a real push to construct, repurpose and update large scale energy infrastructure to enable for instance hydrogen grid development. Besides, the interest of companies and politics in advancing hydrogen and enabling it to become a viable alternative in hard-to-abate sectors. If carbon prices also increase and LCOE of renewables continues to drop as foreseen[62], this will also influence the levelized cost of hydrogen (LCOH), which is then also likely to become ‘green’ (hydrogen from renewable energy) to a large degree. In turn blue hydrogen, which is grey hydrogen in combination with carbon capture and storage (CCS), could ease this transition and enable infrastructure development in the short run.

3.5.3 ELECTRIFICATION AND ALTERNATIVE FUELS

If we want to use the COVID19 crisis as an opportunity to build back better, electrification across all sectors largely powered by renewables is needed to attain deep decarbonization. In manufacturing, electrification will be key in production processes, low-grade heat, and automation. In the building sector, electrification will become essential for low temperature heat by making use of heat pumps. In transportation, electrification is especially developing rapidly with the advent of electric vehicles. However, also indirect electrification could soon take off by using power-to-gas technology and fuel cell technology. Aviation has been hit by the COVID-19 pandemic, having seen a tremendous decline in energy consumption. Nonetheless, sustainable aviation fuel (SAF) could soon be a viable alternative to conventional aviation fuels, already showing cost parity in some regions of the World[63]. Even more, the adoption of more sustainable alternatives in aviation could see a further push by government subsidies. Nevertheless, COVID-19 could have a lasting impact, especially on commuter behaviour even after the pandemic.

62 See for example: DNV, ETO 2020

63 Kalavasta - Carbon Neutral Aviation (2018). (2018). Retrieved March 19, 2021, from Kalavasta.com website: https://kalavasta.com/pages/projects/aviation.html

3.5.4 SLOWING DOWN ENERGY EFFICIENCY IMPROVEMENT

As mentioned before, increased energy efficiency is of great importance to realize the Paris goals. In 2018 the EC has set a 32.5% efficiency improvement level for 2030 (compared to the 2007 base level). This will most likely have to be increased further to realize the emission reduction target of 55% as set in 2020[64]. However, the recent pace of improvement in energy efficiency has slowed down. Since 2015, improvements in global energy intensity have been weakening each year. In 2018, primary energy intensity - an important indicator of how much energy is used by the global economy - improved by just 1.2%, the lowest rate since 2010[65]. Historically high oil prices (a proxy for energy prices) have probably affected innovation in energy efficiency. Prospects of cheap energy, however, will probably reduce the incentive to innovation in the energy and end-use energy services sectors, in absence of policy interventions[66]. The current fossil fuel price environment (including taxes) are not yet causing material change in consumer behaviour towards more sustainable alternatives.

This calls for urgent policy action to increase energy efficiency. Efficiency measures could include renovation plans, improving the efficiency of electric devices, smart metering and monitoring, use of waste-heat in the industry, etc. In turn, energy efficiency improvements could help lowering energy bills as well as securing long-term economic and environmental benefits. However, serious energy efficiency measures in some industries would need financial incentives, such as a more substantive CO_2 cost, subsidies, and/or a further reduction in the price of renewable technologies.

64 Press corner. (2021). Retrieved March 15, 2021, from European Commission - European Commission website: https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1599
65 Energy Efficiency 2019, IEA
66 Energy, Efficiency Gains and Economic Development: When Will Global Energy Demand Saturate? IMF working paper, 2020.

3.5.5 NEED FOR SKILLED ENERGY SECTOR WORKFORCE

One of the economic impacts from COVID-19 is that many businesses will face longer-term downturns, for instance in the travel and mobility industry. This could lead to a large number of employees being let go. On the other hand, electrical engineers etc. are needed in large numbers for the energy transition. A recent publication by the International Renewable Energy Agency expects 40 million jobs in renewable energy globally by 2050[67]. The northern parts of Netherlands also foresee an investment potential of 9 billion euros in the hydrogen economy, which would lead to 25.000 FTE in 2030 and 41.000 FTE in 2050[68]. In order to make this happen, re-schooling is required. Funds directed here will lead to job creation and acceleration of the energy transition.

Furthermore, a different approach should be taken towards work. Competition in the energy industry is fierce now that established players are increasingly under threat of technological innovation. The traditional employee employer relation might no longer hold true with increasing uncertainty in the business environment. ■

67 Energy Transformation Can Create More than 40m Jobs in Renewable Energy. (2020). Retrieved March 18, 2021, from Irena.org website: https://www.irena.org/newsroom/pressreleases/2020/Jan/Energy-Transformation-Can-Create-More-than-40m-Jobs-in-Renewable-Energy

68 https://www.mijntoekomstiswaterstof.nl/mijn-toekomst/

4

MAKING THE ENERGY TRANSITION MORE ATTRACTIVE FOR INVESTORS

It is one thing to raise the emission reduction ambitions for 2030 to 55%, as the EC has done in 2020, closing the immense financial deals is quite another. In this chapter, we will discuss three developments related to the recent policy changes which can help to realize the higher ambitions levels. The constructive trends range from a change in attitudes of financiers to concrete supporting schemes by the governments.

4.1 INCREASED BLACK SWAN AWARENESS

The perspective on how COVID-19 may affect the activities of EU governance and the EU itself in accelerating the energy transition strongly hinges on the political coalitions within the EU, on the international climate mitigation support in the USA, China, and other key global players’ governments, and on the overall budgetary margins. Apart from that, it is conceivable that COVID-19 will also have a lasting policy impact as a result of the grown notion that black swans still do exist and that preparing for these events to the extent possible is an important long-term government and industry responsibility. Recent anecdotal evidence, e.g. from the most recent PwC annual 500 key CEO dinner or World Economic Forum events (Great Reset) and publications, seems to suggest that COVID-19 has indeed pushed government and industry leaders to have a renewed focus on black swans[69].

In other words, the growing notion that low likelihood high impact events can have a pervasive impact on society may encourage the EU and its member states to really go for the 2050 climate targets, and there is evidence from recent surveys that they do. While climate change is anticipated to occur and is not a Black Swan itself, the shocks from climate change can be very sudden and very impactful, similar to the effects of COVID-19 crisis.

Illustrating what policy impacts these unexpected disastrous effects can lead to is the fact that the ca. 670B€ Next Generation EU Recovery and Resilience Fund (RRF), in itself already unprecedented in terms of size and speed of decision-making, will be financed with the help of so-called COVID-19 bonds, without much of the discussion every single common measure triggers in the EU, and despite the fact that so far the pandemic bond concept has been a topic of widely different views and heavy debates. The symbolic importance of this RRF is not only its scale or conditionality but rather and foremost its historic significance in terms of the region’s policymakers crossing the hitherto unreachable red line of liability sharing. This is all the more notable given the current absence of market pressure upon the region’s politicians to rise above national interests and act on a supra-national level.

It is virtually impossible to quantify how a lasting black swan’s awareness may work out towards the energy transition, but that impact may be serious indeed, and can contribute to making the difference between a slow but gradual energy transition and a faster and more decisive process to a more resilient and green energy and feedstock system.

69 PWC. CEO Panel Survey huw business can emerge stronger. sl : www.pwc.com/ceopanelsurvey, 2020.

Next to the overall mood in the political discussion towards greening the economy and the notion that black swans do matter, there are a number of concrete policy initiatives that may provide some guidance as to how COVID-19 may affect the energy transition, including the introduction of hydrogen.

4.2 NEXT GENERATION EU RECOVERY AND RESILIENCE FUND

One illustration of the enforced resolve of the EU to respond coherently to a common threat is the speed, size and scope of the Next Generation EU RRF. The European COVID-19 pandemic support packages, which add up to about 1000 billion euros, not even counting the national schemes, are disbursed at an unprecedented speed (2020-2021). There are indications that European governments want to use this enormous transfer partly to accelerate supporting the greening of the energy system. The EU has indicated that it aims to use approximately 37% (or some €240 billion) of the European RRF (€672.5 billion) to support the sustainability and mostly decarbonisation of the European energy system, and will assess the various national allocations accordingly[70]. Table 18 provides a budget overview allocated to various EU-support mechanisms.

Figure 18: EU COVID-19 support mechanisms 2021-2027[71]

	BUDGET (€ BN.)	TIMING
NextGeneration EU (750B€)		2021-2027
Recovery and Resilience fund	672,5	2021-2027
React-EU	47,5	2021-2022
Horizon Europe	5	
Investees	5,6	
Rural development	7.5	
Just Transition fund	10	
RescEU	1,9	
Other short-term Support measures (500B€)		
Sure	100	
EIB	200	2021-2027
ESM	240	2021-2027

70 European Commission. Commission welcomes political agreement on Recovery and Resilience Facility . sl : https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2397, 2020.
71 European Commission. A hydrogen strategy for a climate-neutral Europe. 2020.

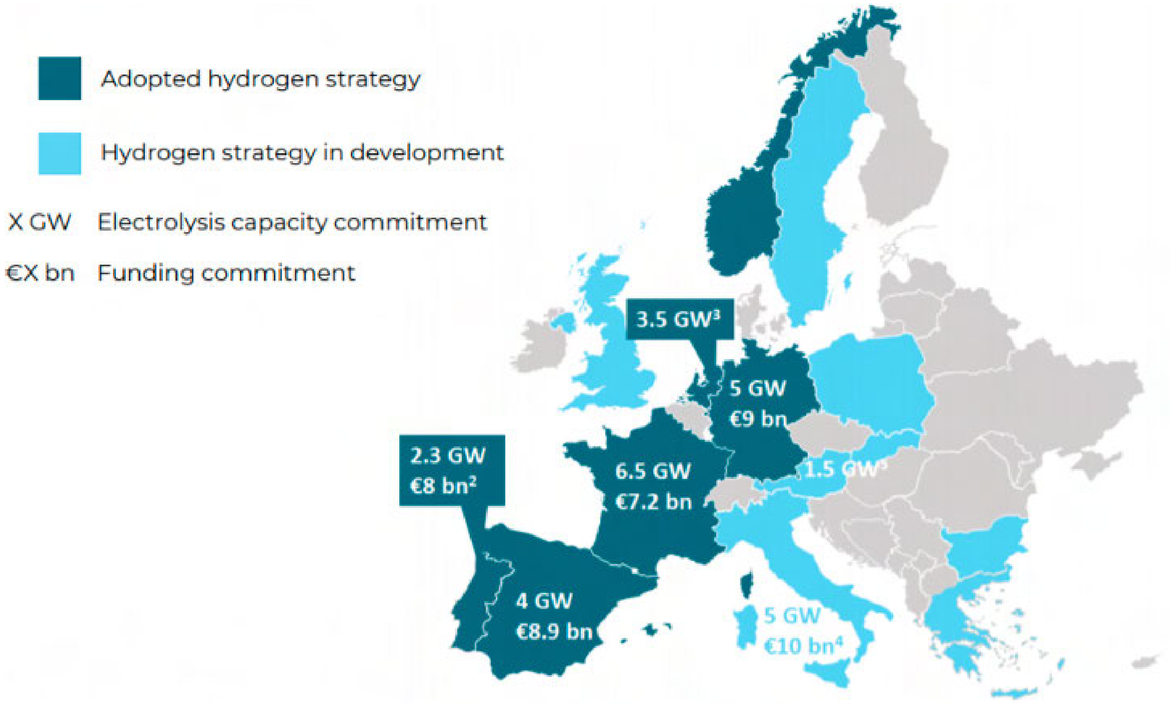
As also indicated in our 2020 report, ‘Phasing Out Carbon’, so far the discussions and policies on greening the energy mix have mostly been aimed towards renewable electricity generation and electrification of energy consumption. However, the energy mix currently consists of over 70% of molecule-based energy carriers (oil, gas, coal) and this is expected to remain substantial per 2050. Thus, stronger focus on the molecule-based part of the energy mix is crucial.

Assuming that at least a considerable part of the 37% target can be reached, an unexpected opportunity arises to accelerate the European climate policy by greening the molecules in the energy system. The key element is introducing hydrogen into the energy and feedstock mix. Even if only a tenth of the Recovery and Resilience Fund (RRF) of €672.5 billion were to be used for hydrogen development, this would imply over €65 billion of funding becoming available. Combined with the funding commitment announced by the individual member states (see Figure 20 for further details), an amount towards €100 billion can be made available for the desired build-up towards 40GW conversion capacity in 2030 (starting with the 6 GW target for 2024). In general, some 1 to 3 billion Euros per GW is reserved by individual member states to support the capacity roll-out announced in their national hydrogen strategies. (see Figure 19 and 20)

Figure 19: EU RRF assumed support for realisation of hydrogen strategy

	CAPACITY	INVESTMENT (€BN.)	EU RRF ASSUMED SUPPORT (€ BN.)
Electrolysers	40GW	24-42	20
RES (dedicated wind and solar)	80-120GW	220-340	30
Infrastructure (backbone)		27-64	10
End-use appliances	e.g. steel installation	0.12-2	
Small scale refuelling stations	400	0.85-1	5
Total			**65**

Figure 20: Overview of strategy and budget commitments in the EU[72]



[1] Spanish and Italian figures refer to mobilised investments while German and French figures refer to spent public funds. 2. Electrolysis target is 2-2.5 GW and total mobilised investment is 7-9 bn including 1 bn public funding. 3. Electrolysis target is 3-4 GW 4. Figures according to National Hydrogen Strategy Preliminary Guidelines 5. Draft strategy refers to electrolysis target of 1-2 GW.

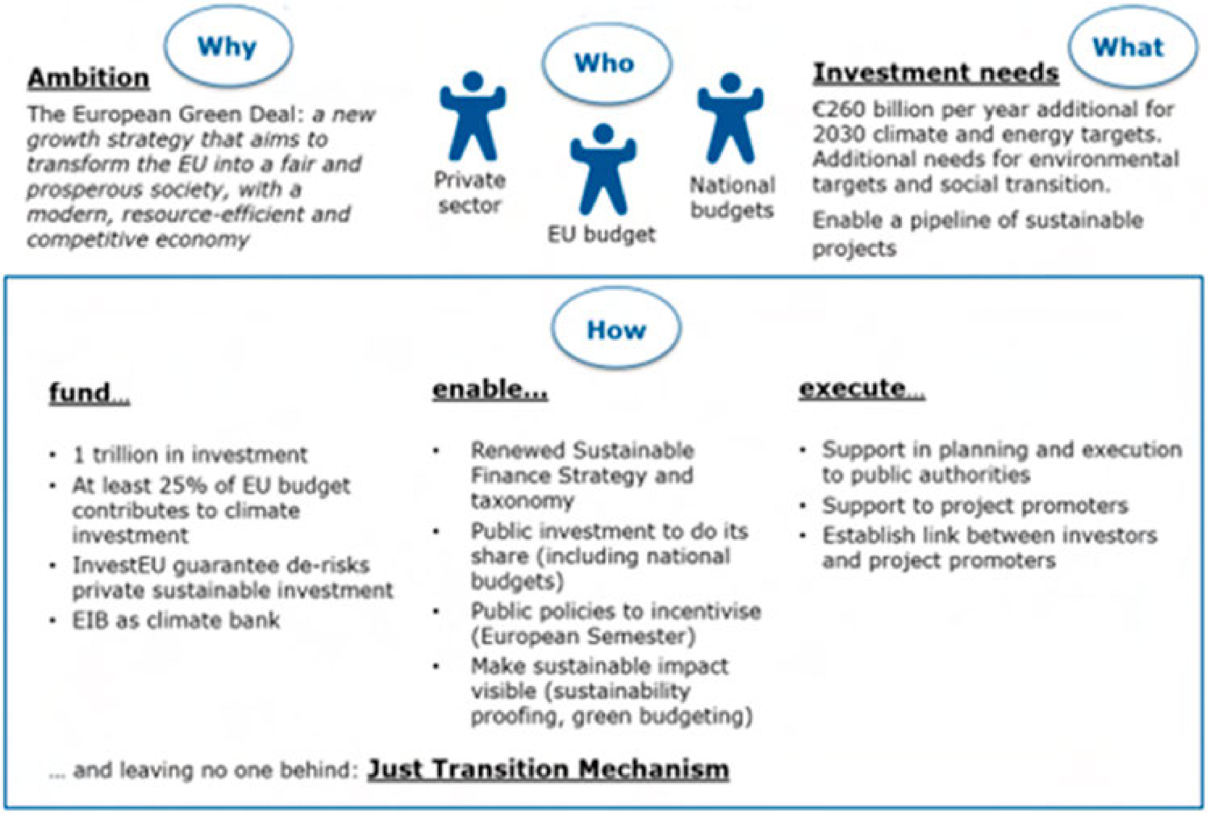
4.3 EU TAXONOMY

A second illustration of EU's resolve to tackle the common threat is the speedy introduction of a measure to greatly reduce the uncertainty for investors around 'green' investments. As the momentum since 2020 for sustainability seems to have risen, it's important to attract indispensable private funds to the game. The EU Taxonomy Regulation, that went into force in July 2020, is an important piece of regulation for the sustainable finance sectors.

The EU Taxonomy is a framework to facilitate sustainable investment. It contains a list of economic activities that help to transform the economy to a low-carbon, resilient and resource-efficient economy. In order to be eligible, the economic activity must meet strict conditions and technical performance thresholds. With the EU Taxonomy, the EU established a common definition of environmentally friendly economic activities, which prevents confusion about what, is "green" and what is not. It mitigates reputational risk and avoids greenwashing. This enables investors, financial institutions and other financial market participants to direct their capital flows to truly sustainable activities that are in line with the European Green Deal, Europe's new growth strategy.

72 PWC. CEO Panel Survey huw business can emerge stronger. sl : www.pwc.com/ceopanelsurvey, 2020.

Figure 21: Sustainable Europe investment plan[73]



The EU Taxonomy is applicable to financial markets participants offering financial products as environmentally sustainable investments or as investments having similar characteristics. This includes, amongst others, financial institutions such as banks and asset managers, but also EU Member States and all organisations and companies that are subject to the Non-Financial Reporting Directive (NFRD) or the Sustainable Finance Disclosure Regulation (SFDR). These are approximately 6,000 companies[74]. In order to comply with the EU Taxonomy Regulation, they must disclose the Taxonomy-eligible share of their turnover, capital expenditures and operational expenditures (if relevant). This allows investors or investments that are marketed as sustainable, to report which share is Taxonomy-eligible.

The group of sustainable investors is growing rapidly - see Figure 22 below -, and with it, the pool of sustainable investments. This implies that the need for green Taxonomy-eligible assets will grow fast. Green assets will be better bid in the financial markets, which, in theory should lead to a lower cost of capital for issuers of green capital.

73 European Commission. Commission welcomes political agreement on Recovery and Resilience Facility . sl : https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2397, 2020.
74 https://ec.europa.eu/commission/presscorner/detail/en/IP_19_3034

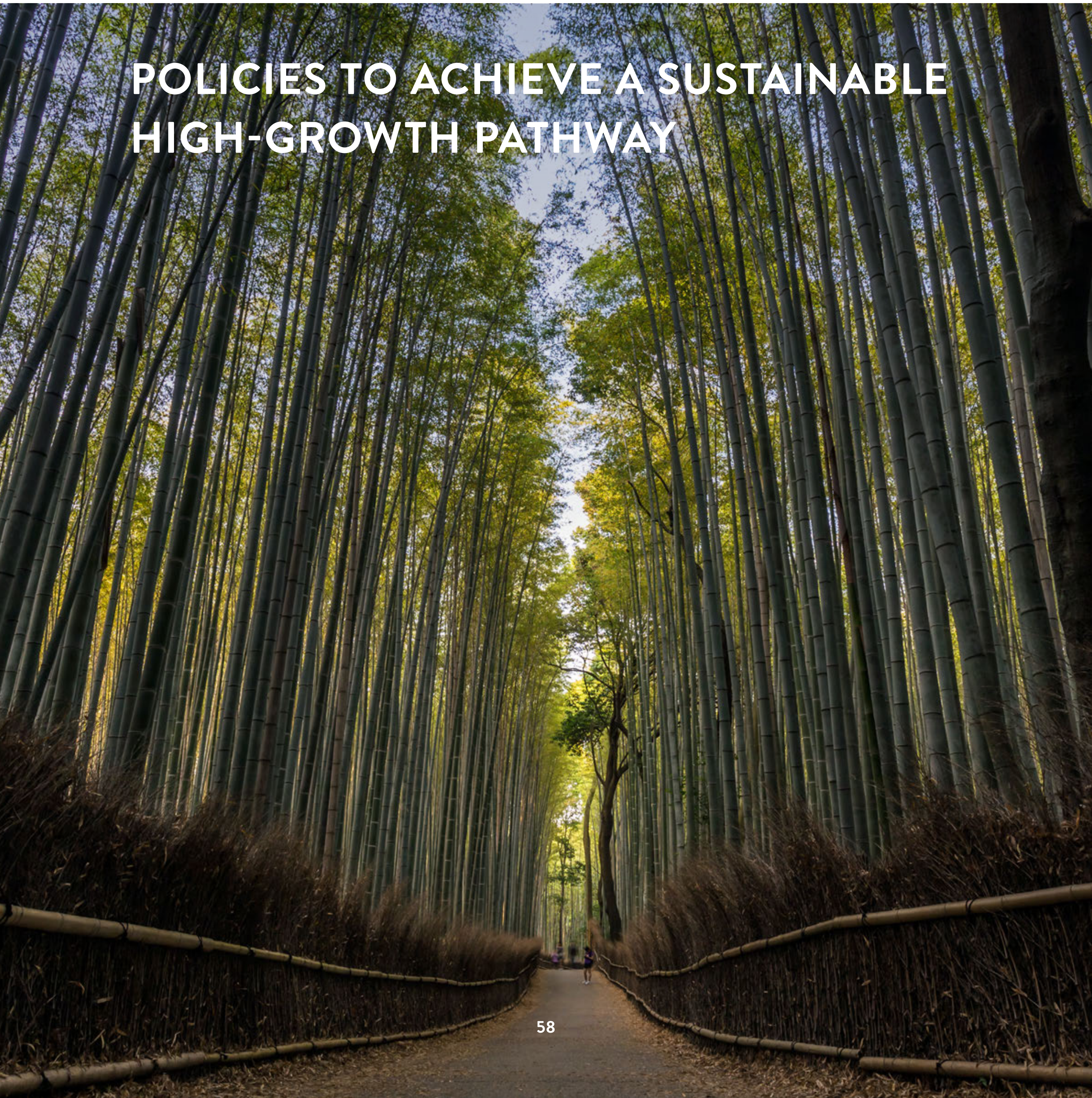
Figure 22: Assets in ESG funds, 2006-2019, (in US$ billion).

The EU Taxonomy is a work in progress. The list with economic activities that are Taxonomy-eligible is not complete yet, and a group of experts referred to as The Platform on sustainable finance is still advising the European Commission on further developing the EU Taxonomy. The EU Taxonomy will therefore be implemented in phases. The first phase must be implemented before 1 January 2022 by all the participants to whom the EU Taxonomy applies. For those that do not invest in Taxonomy-compliant activities a statement will need to be made, saying that the relevant investments do not take into account the EU Taxonomy Regulation.

The EU taxonomy can be perceived as a signal that the EU wants to have an accepted green denominator to help steering priority access to financial flows for the greener activities and firms. ■

5

POLICIES TO ACHIEVE A SUSTAINABLE HIGH-GROWTH PATHWAY



The momentum and policy resolve to go for the self-imposed 2030 and 2050 emission targets may be there, we argued in the previous chapter. And as we illustrated, several unprecedented policy initiatives seem to be promising to emerge better and greener out of the crisis. Never waste a good crisis may be an apt term indeed.

But the momentum might slip, once the economies start growing again, and the deep government funding crater becomes apparent and other urgent societal needs become pressing. That is why in this chapter we take a look at how the recovery funds spending can achieve a high growth scenario and at the same time speed up the energy transition, and on how resilient and sustainable the policy schemes might be.

Where there are opportunities, there will also be challenges. Therefore we take an optimistic view - leading to high growth and high energy transition speed - and a less optimistic view - modest growth and modest speed energy transition.

In essence what will determine the outcome is whether the current momentum is sufficient to cross certain tipping points, or points of no return. We will show how important the next few years' EU political decision making will be in setting in motion a self-sustained pathway towards net-zero in 2050.

5.1 CAPTURING THE MOMENTUM FOR A HIGH GROWTH SPEEDY ENERGY TRANSITION SCENARIO

An optimistic scenario is aimed at directing the RRF towards an accelerated transition towards green solutions. This means that the energy mix in the EU may change significantly towards low carbon solutions such as solar, wind, biomass and technologies such as CCS, with a stronger role of hydrogen.

The European Commission's stated target of 40 GW conversion capacity by 2030 could perhaps even be accelerated, if the entire hydrogen value chain is developed simultaneously. The fact that the existing state aid rules seem to be progressively relaxed in the sense that, apart from the production of green energy, the development of conversion capacity can also be supported by public funds, can certainly be helpful in accelerating the introduction of hydrogen. Just to illustrate, a quote from Executive Vice President of the European Commission, Margrethe Vestager in charge of EU competition policy: "the €30 billion Dutch SDE++ scheme will support projects that will lead to substantial reductions in greenhouse emissions, in line with the objectives of the Green Deal. It will provide important support to environmentally-friendly projects, including renewable energy, use of waste heat, green hydrogen production and carbon capture and storage, in line with EU rules[75].

75 European Commission. State aid: Commission approves €30 billion Dutch scheme to support projects reducing greenhouse gas emissions. sl : https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2410, 2020.

What could also contribute to the accelerated introduction of hydrogen in NWE is the fact that, partly under the influence of Covid-19, much more active thought is being given to accelerating the build-up of offshore wind capacity, whether or not based on hybrid tenders for wind and conversion capacity. For instance, by the end of 2020, the German parliament passed an amendment to the development and acceleration of offshore wind capacity reaching already 20GW in 2030 and 40GW in 2040[76]. The acceleration of offshore wind, and other RES-production, is even more important since the electricity used in the production of green hydrogen must often comply with additionality requirements. This means that renewable hydrogen production is only permitted if also additional renewable energy generation is realized.

Figure 23: Offshore wind strategies with in North-West European countries[77,78,79]

	2030	POST 2030
Netherlands	11.5GW	38 -72GW
Germany	20GW (5GW extra)	40 GW
Belgium	4GW	
UK	40 GW (10GW extra)	
Norway	0.5GW	40 GW
Denmark	7.2GW	

The acceleration of offshore wind can thus have an effect on the medium- and long-term hydrogen developments if it is assumed that, while realising, for example, 40GW electrolyser capacity, the CAPEX but also OPEX can drop with 50-70% from current levels. This lowers the production costs of carbon neutral hydrogen by roughly 1 Euro per kg, so that the current cost difference between grey and green hydrogen roughly halves from about 2 Euro / kg to about 1 Euro / kg.

This positive development can be further reinforced by the easing of financing conditions due to the reduced perceived risks of investment in hydrogen technology, lowering the required rates of return and weighted average cost of capital (WACC). If over the same period towards 2030 there would be an increase in the CO_2 penalty by approx. 100 Euros / ton, the CO_2 costs for the production of grey hydrogen would become ca. €1 per kg hydrogen produced (1kg of hydrogen produced based on natural gas results in approx. 10kg of CO_2 emissions). Thus, without even any other policies and measures,

76 European Commission. Commission welcomes political agreement on Recovery and Resilience Facility . sl : https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2397, 2020.
77 European Commission. Commission welcomes political agreement on Recovery and Resilience Facility . sl : https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2397, 2020.
78 Europe, Hydrogen. https://hydrogeneurope.eu/sites/default/files/Map_%20National%20H2%20Strategies.pdf. 2020.
79 European Commission. Sustainable Europe Investment plan. sl : https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0021&rid=7, 2020`.

green hydrogen could compete in terms of costs with grey hydrogen at the current electricity and gas prices. In short, it is not inconceivable that due to the corona crisis, a chain reaction towards an accelerated introduction of hydrogen will be triggered, which ultimately contributes to the fact that the green hydrogen can be produced at competitive levels much earlier than is usually assumed, i.e. already by 2030 or even earlier than that.

It is important to note that the leverage towards greening available to the government in the context of Covid-19 support can be used in all directions:

- Towards industry by accelerating the efforts to use green molecules for replacing fossil molecules, for example in refineries, chemical and metal sectors;
- Towards mobility by speeding up the introduction of green fuels in the EU in, for example, (short-haul) air traffic and heavy transport by road and water, or mobility in the context of public transport;
- Towards the service sector by supporting energy efficiency improvement via accelerated digitization and automation, reducing its need for green power.

It is not unreasonable to expect that the demand for green energy will accelerate on the medium-term anyhow. This will on the one hand increase the pressure on expanding European clean energy production capacity (see above), but on the other hand increase the awareness that Europe will have to import more green energy. The rationale is simple: In all scenarios, there will be insufficient RES production capacity in the EU to meet its total demand for green energy. Policy will need to be developed to facilitate the required green energy imports. Given the virtually prohibitive costs of storing and transporting electrons over very long distances, it can be expected that, as always before, the vast majority of the imported green energy of the future will be in the form of molecules, i.e. liquids (ammonia / methanol, liquid green gases, etc.) or gases (hydrogen or syngas). This places great demands on the adaptation of the transport system and the required infrastructure for energy storage, because these have been developed for fossil molecules and will therefore have to be converted for partly different molecules.

In addition to a focus on the hard aspects of preparation for interregional flows of clean electrons and molecules, it makes a lot of sense to also further develop the diplomatic and economic relationships with the prospective regions that might in the future become significant energy providers.

The energy transition will also have spatial implications. Seaports’ regions, for instance, will become turning points in the European energy systems with import terminals, transfer facilities, landfall of offshore produced energy, and increasing energy-intensive industrial activities (chemicals, metals, data centres, etc.). This creates in this High Growth - High RES scenario a new dynamic along the North-western Europe coastlines providing competitive opportunities, innovation, and new jobs.

5.2 WHAT IF MOMENTUM FOR A HIGH GROWTH AND SPEEDY ENERGY TRANSITION SLIPS

Unlike the positive scenario, the pessimistic scenario does assume that the COVID-19-fund will not seriously succeed in introducing energy transition investment and hydrogen economy investment in particular. Most of the funding, so it is assumed, will be used to restore income losses in those parts of the economy that turned out to be relatively vulnerable for the various lock-down measures across the EU. The fear for massive bankruptcy among the owners of shops, restaurants, small production units, or even larger enterprises in transport and tourism in particular is the key source of inspiration of the support schemes based on the recognition that massive bankruptcy could easily develop in a new financial crisis comparable to the crisis of 2008. Hydrogen investment and serious upscaling will in this scenario therefore not benefit sufficiently from the support schemes that will be made available in roughly the period until 2024. For the period thereafter, until about 2030, this pessimistic scenario assumes that considerable public support schemes will no longer be available at significant scale, because governments focus on restoring debt ratios and therefore try to reduce budget deficits strongly, which may also raise interest rates relatively quickly in the second half of the decade.
For a survey of the negative budget implications of national COVID-19 support schemes, see Figure 24. Compared with the second quarter of 2019, all ten North West European member States but Ireland (-0.3 percentage points) registered an increase in their debt to GDP ratio at the end of the second quarter of 2020. The largest increases in the ratio were recorded in France (+14.9 pp), and Belgium (+12.9 pp).

Figure 24: Impact of corona on debt to GDP ratio (retrieved from:[80]

80 Cojoianu, T. F., Collins, E., Hoepner, A., Magill, D., O'Neill, T., & Schneider, F. I. . In the Name of COVID-19: Is the ECB Fuelling the Climate Crisis?. . sl : Environmental & resource economics, 1–7. Advance online publication. https://doi.org/10.1007/s, 2020.

In this pessimistic scenario, after the COVID-19 support schemes have done their job, there will therefore be little public support available for serious upscaling of the hydrogen capacities in terms of production, as well as transport and storage. Most of the investment in hydrogen capacities will therefore have to come from private initiatives, probably loosely supported by some policies in the tradition of mandatory blending and increasing CO_2 penalties. The latter, for example, in the spirit of the Netherlands policy initiative (the CO_2-levy to amend the EU ETS by introducing annually increasing minimum penalty levels through a variable tax, leading to an over 100€/ton CO_2 penalty by 2030 for all industries covered by the current EU ETS systems.

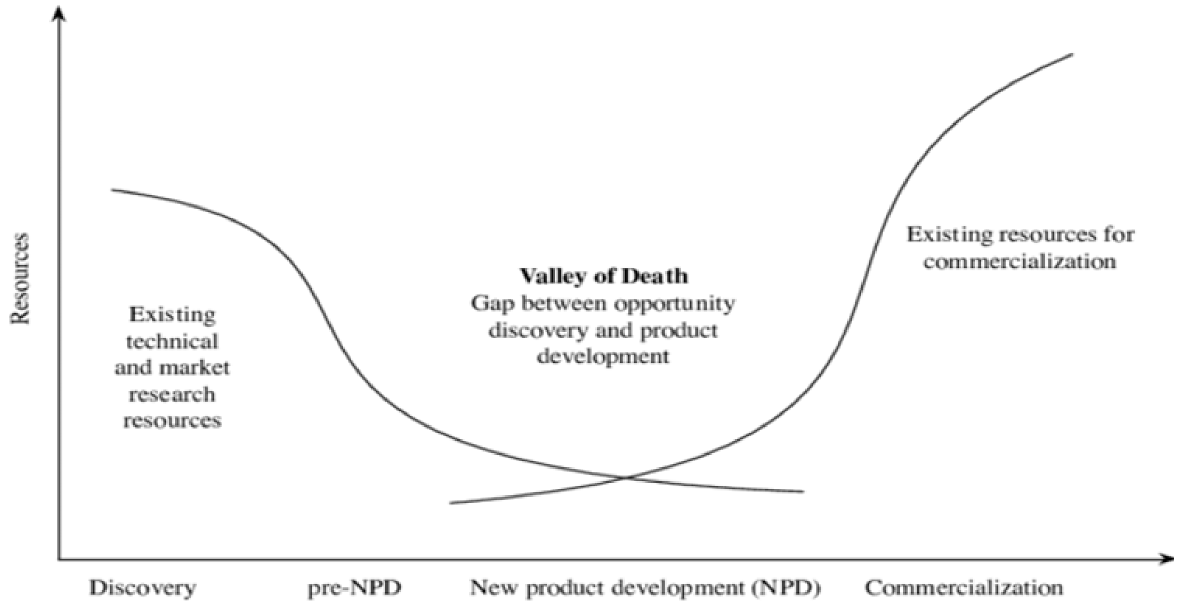
In this scenario the belief in the market that green hydrogen may well become competitive around 2030, will not develop, which may slow down the willingness of industry to accept the investment risks in hydrogen technology. All this creates a downwards spiral of low expectations, low investment given risks and high interest rates, difficulty in developing the value chain in a balanced manner, and low tendency to innovate. With the willingness to invest in major energy transition technology being low, the increasing amounts of new jobs expected in the positive scenario will not come into existence or to a lesser degree.

A long-term impact of the pessimistic scenario is that the European ‘valley of death’ with respect to hydrogen technologies will not be tackled in the period up to 2030, if at all. The result on the longer term would therefore be that Europe remains strongly dependent on outside regions for the supply of the green molecules it needs for energy and/or feedstock purposes. The industrial activities related to the new energy activities related to hydrogen and all related economic activities will therefore be typically developed outside the EU. This way not only will the import dependence of energy remain high, but also the opportunity to create a strong internationally competitive clean energy technology will be lost.

5.3 TIPPING POINTS THAT WILL DECIDE WHAT SCENARIO MIGHT PREVAIL

Both scenarios outlined have one thing in common - processes in terms of the energy transition have the ability to accelerate each other. If done in the right direction, the transition becomes easier and faster by itself once the primary steps have been taken. It can also get increasingly difficult and slower if the transition stagnates in the earlier stages. If the ‘valley of death’ is overcome sooner, the economies of scale will work themselves out faster, competitiveness of European industry will be enhanced, risks for the industry due to immaturity of technologies will get smaller, government policies will be less uncertain, coverage of the value chain will be sufficient, and the cost of finance (both public and private) and required returns on capital will be reduced. Success in the energy transition will enhance employment, which in itself again may support political decisions to continue the green growth path set out.

Figure 25: Schematic illustration – resources needed to pass a valley of death[81]



If however, the 'valley of death' is not overcome, the more pessimistic scenario could be expected to be unfolding. Green technologies not only with respect to hydrogen (electrolysers) and fuel cell technologies, but also for greening the chemical industry and other industrial processes, will not develop quickly, nor will economies of scale develop as quickly as in other regions outside the EU where processes move faster. The EU will then continue to perceive the green technologies as risky and costly, pulling out financial support and reducing the pool of capital available from private investors. Employment and innovation will be slower, and with it over time, political and public support to put the energy transition activities high on the political agenda, or introduce strong greening policy measures such as mandatory blending schemes, or serious increases in CO_2 penalties.

In other words, there seems to be an early stage path dependence: once Europe embarked on an optimistic scenario, developing successfully economic strength based on the energy transition becomes increasingly easier. If, however, this for one reason or another, does not work out, the energy transition becomes increasingly problematic while the opposite will happen in other regions in the world that do have accelerated their green growth path in time. This makes it all the more crucial if and to what extent the formidable public Covid-19 recovery injections, currently foreseen, will succeed in accelerating the energy transition, closing the 'valley of death', and building up an innovative new green set of industrial activities that can compete successfully at a global scale.

81 Overcoming the Valley of Death: A Design Innovation Perspective - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/the-valley-of-death-in-Markham-et-al-2010_fig1_325782671 [accessed 19 May, 2021]

The evidence on how greening will shape the COVID-19 recovery agenda is so far mixed. While the recovery support to the aviation sector is relatively less green, there is a hopeful sign in the form of the speed with which a large number of EU member states have introduced, especially in the second half of 2020, considerable multi-billion euro initiatives to boost their hydrogen activities, including the capacities for offshore wind and other RES. This has been discussed in the earlier sections of this report. The tipping point so far has been discussed for the European situation. In fact, the same tipping point could apply in the USA and possibly also China. In the USA already during election campaigns the current president Biden announced his US$ 3 trillion Green New Deal to support the energy transition in the USA and try to help in getting the American economy nearly carbon neutral by 2050[82]. Whether this plan will become reality depends to a large extent on the Congress, where opinions still are quite divided on it. So far the recently accepted US$ 1.9 trillion dollar COVID-19 recovery plan seems to contain serious links with greening initiatives, although exactly how the Plan may affect the Green New Deal is yet to be seen. ■

82 https://www.nytimes.com/2021/03/22/business/biden-infrastructure-spending.html

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