Green paper for a sustainable energy system

– How to free ourselves from Putin's fossil fuels

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Introduction

Putin's inhumane war in Ukraine has exemplified how vulnerable Denmark and the rest of the EU are. Since February 24th, the EU countries have imported Russian energy worth €600 million every day. We are financing Putin's war machine. [1] This must not continue. Freeing Europe from the chains of Russian fossil fuels is urgent, and this task is vital to our future security and prosperity.

Therefore, we need to develop a new and ambitious energy plan. The plan must speed up the green transition and focus all our efforts on increasing energy savings and investment in sustainable energy. Denmark has a unique position as one of the green frontrunner nations in the EU, but now is the time also to show a European leadership with a tremendous increase in offshore wind in the North Sea that can help free the EU from Russian energy.

Never have we seen such *urgency*. Failure is not an option. But success in this expedited green energy transition requires historically strong political and economic leadership.

This green paper makes up Mandag Morgen's proposal for how we can quickly, effectively, and realistically free ourselves from this dependence and lay the groundwork for a new energy system where sustainable processes create electricity and heat.

Mandag Morgen's work on this green paper is supported financially by Pension Danmark, Copenhagen Infrastructure Partners, COWI, Green Hydrogen Systems, and SYNERGI. Together with many independent experts, scientists, and NGOs, they have shared and debated their ideas, professional input, and analyses in many meetings over March, April, and May 2022. Furthermore, we have performed desktop research using Danish and international reports.

We need broad and innovative cooperation spanning all common and special interests to implement the suggestions presented in the green paper. Even though we welcome the recent green transition initiatives by the Danish government, several EU countries, and the European Commission, there is a convincing argument that these ambitions should be further increased.

More than short-term oil and gas embargos and hard economic sanctions are necessary to deal with an aggressive regime like the Kremlin. We must prepare ourselves for a long and painful war. The current international energy crisis could worsen in the next months as consumers and industries will experience toilsome and stressful situations with hard choices.

We are now heading for a long and tough winter where Russia might disrupt their gas supplies to EU member states, but the European gas storage is not sufficient to ensure enough gas for both the heating of houses and for core industries. In June 2022, the EU member states agreed to reduce their gas demand by 15 per cent comparted to their average consumption in the past five years, and it was an important step forward. A common "alert" system at the EU-level was also introduced. Nevertheless, it is time to move way beyond short term fixes.

We must push forward the date of our freedom from Russian energy and deliver an effective response to the climate crisis.

This green paper delivers a new and ambitious plan for a sustainable and integrated energy system in Europe where we accelerate the transformation towards a fossil free society.

[1] *https://www.euronews.com/my-europe/2022/04/06/eu-has-spent-35bn-on-russian-energy-and-just-1bn-on-aid-borrell*

All EU member states should take courageous decisions to save energy with more aggressive measures while turbocharging a scale up of investments in renewable energy

In Denmark we need to reduce our energy usage by at least 23 per cent before 2030, and the EU should set much higher ambitions for the 2020´s reaching at least a 20-21 per cent reduction. Unfortunately, political decisionmakers at the national and at the European level waver and hesitate to challenge the business as usual. The current high energy prices have made it economically sound to move far beyond the 13-14,5 per cent energy efficiency goal for 2030 that are put forward in trilogue negotiations between MEP´s, the Commission, and the Council. The lack of courage is also appearing in the discussions about new EU goals for renewable energy and future oriented investments in an integrated European transmission network. Even though that decisionmakers are moving forward it is still not with the scope, speed and scale needed.

The green paper contains 25 main recommendations necessary to reach our ambitious goals. Furthermore, we have created an expanded solution catalogue with 130 specific and detailed proposals targeting individual focus areas.
It shows how Denmark can become fully self-sufficient with electricity in 2030 by radically upscaling the production of green energy from solar and wind power on land by a factor of seven – supplemented by geothermal energy, biogas, and waste heat utilisation. With this, we can free the enormous wind potential in the North Sea for a new Danish export adventure and help our European neighbours become free of Russian energy. Among our recommendations is also a substantial increase of offshore wind in the North Sea, so Denmark can export 30 GW of offshore wind power already in 2030 and 65 GW in 2035, realised through new tender models and a more market-oriented approach. Such an acceleration of offshore wind could play a crucial role in the struggle to liberate the EU from the imports of fossil fuels from Russia.

The principles behind our suggestions are to maximise output from sustainable energy sources that support the green transition and reduce CO_2 emissions. We need to limit future costs from climate damage, and therefore we also recommend that Denmark and the EU avoid unnecessary extra investments in fossil fuels. Our analysis shows what barriers must be overcome to accelerate the green energy transition. We have looked at the possible and cost-effective energy solutions and prioritised those with the shortest possible time to market and the quickest realisation.

It is no longer enough to set pretty future targets. Now, without delay, we must act. Tomorrow is not soon enough. But if we succeed, we can take decisive leaps over the next one, three, and eight years, accelerating the transition and clearing the way for a green energy revolution in Europe.

We hope Denmark can act as a green forerunner and inspire many other European countries to follow, so Putin and other authoritarian regimes can no longer fund their wars with our money.

About the green paper

Green paper for a sustainable energy system – How to free ourselves from Putin's fossil fuels gives the reader insight into an open, collaborative process with a plurality of actors and ideas. On the whole, Mandag Morgen, as a think tank, has the final responsibility for the paper and its contents. The paper should not be construed as a definitive, exhaustive answer to designing the fossil-free energy system of the future should. Instead, the green paper is a journalistic analysis and vision for how we can turbocharge the green transition, supplemented by an extensive action catalogue with concrete solutions.

Together, the Think Tank Mandag Morgen and the Weekly Newsletter Mandag Morgen created the green paper because of Russia's invasion of Ukraine on the 24th of February 2022. This line of thought was not unique, as universities, trade unions, and government organisations presented their solutions. What separates this green paper from the rest is that it offers a cohesive new vision for a sustainable energy system that will end dependence on Russian energy and address the climate crisis with its ambitious yet realistic suggestions. Also, the paper contains a sizeable solution catalogue developed with input from a broad range of individuals and organisations with deep topical and economic knowledge.

The first stage of the green paper's creation saw the entrance of the six financial partners; CIP, COWI, Green Hydrogen Systems, PensionDanmark, SYNERGI and Ørsted. Together with them, Mandag Morgen sketched out the green paper's scope, content and basis.

Next came a democratic process, where Mandag Morgen invited representatives from the partners mentioned above and any interest partners – citizens and key individuals in the energy and utility industries – to a public kickoff meeting in Mandag Morgen's yard in Copenhagen on April 6th 2022. Here, all participants could contribute their knowledge, perspectives and desires regarding where and on what the green paper should focus. We used many of these contributions in the creation process.

Third came the three expert panels held from April to May 2022. Mandag Morgen invited experts and representatives from the partner circle to workshop-style meetings where the goal was to find and scope concrete solutions and suggestions pertaining to freedom from Russian gas and fuelling the green transition. Common to the meetings were the horizons of one, three, and eight years. In order, the meetings had the following themes: 1) supply and demand 2) barriers to the green transition, 3) solutions and prioritisation of these.

Contributing experts represent state, municipality, private and grass-roots interests within the energy and utility industries. The colophon contains a list of participants.

Mandag Morgen developed all the suggestions in the green paper and digital action catalogue based on these expert panels and information from various reports.

Reader's guide

The green paper starts with a summarising executive summary, which lists the green paper's five ambitious goals and fundamental preconditions, from which the following recommendations spring. We have condensed the action catalogue into 25 key recommendations, constituting a manageable go-to plan.

Afterwards comes the green paper's body text, which is divided into five parts:

Part 1 – A green energy revolution (behaviour)

Part 2 – The race before next winter (energy effectivisation)

Part 3 – Avoid fossil lock-in (district heating and gas)

Part 4 – The next energy adventure (offshore wind and onshore solar and wind)

Part 5 – Free us from fossil distortion (economic incentives and priorities)

Each section has its own colour and icon and contains several sub-topics and illustrations to support messages and recommendations in each focus area. In each chapter, a box concisely presents the concrete main suggestions.

Executive summary

The following summarises the green paper's core messages: the five key goals, their seven vital prerequisites, and 25 bona fide main suggestions selected from the extensive action catalogue.

Five ambitious goals

- **Total coverage from onshore solar and wind:** Denmark's electrical power needs – including for new Power-to-X (PtX) plants on land – must be covered by onshore sustainable energy before 2030. This requires increasing green energy production by at least sevenfold, mandating an accelerated capacity expansion to 30 GW of solar power and 20 GW of wind on land and in coastal areas.

- **Fit for 65 via massive scale-up of North Sea offshore wind:** Denmark must increase its offshore wind production 13-fold to at least 30 GW in 2030, so we can reach 65 GW of Danish offshore wind in 2035. A new, market-oriented approach will enable rapid development in the North Sea, delivering green electricity and hydrogen to our European neighbours and creating a gigantic Danish export adventure. Offshore wind must no longer be an excuse for not expanding solar and wind power on land. Instead, it must be seen as a promising export industry that can turbo-charge the EU's freedom from fossil fuels and help support Danish welfare in the future.

- **No fossil fuel use in 2040:** By 2040 at the latest, Denmark's energy usage must be 100 per cent local and driven by sustainable energy on land and in coastal areas. We must couple this with a modern, fourth-generation district heating network with low temperatures and minimal energy waste. Furthermore, by 2040, Danish offshore wind should be scaled up to over 100 GW and be utilised purely for export. The power will be part of a cohesive European energy grid – where the free movement of sustainable energy is the union's fifth freedom tenet – allowing the EU countries to end fossil fuels in 2045 at the latest.

- **World-class energy effectivisation:** Energy savings are the new green gold, which can allow a cost-effective transition. The EU must require member states to reduce energy consumption by 20 per cent by the end of the decade. Denmark should be a forerunner, saving 23 to 25 per cent of energy usage by 2030. If the EU could agree to a 23 per cent goal, energy consumption could be reduced by the equivalent of Russia's annual gas supply to the EU.

- **Rapid heating gas decoupling:** All oil and natural gas heaters in Danish homes must be removed before 2027, and these homes should instead have heat pumps or be coupled to the district heating network. The heating supply must be freed from fossil fuels before 2030. In the EU, more consumers must utilise district heating, and we should install at least 30 million heat pumps to accelerate energy-effective heating electrification.

Seven fundamental prerequisites to reach the goals

A) **We need a war zone mentality:** In recent years, several mega crises have rocked Europe, and we are now in the middle of an international energy crisis, where Putin's war of aggression requires us to gear up. This time, we must act quickly and decisively as if at war. We need strong leadership which takes action. Just like during the Covid-19 pandemic, a temporary operational staff should be established to ensure rapid execution of the green energy plan.

B) **Close and inclusive cooperation.** Nobody can solve these monumental challenges alone. Like never before, we need agility and broad partnerships. Thus, keystone corporations and organisations must also take responsibility for designing the right solutions and turbo-charging the green transition.

C) **Energy effectivisation first.** Each energy unit saved is money in the bank. The higher our energy efficiency, the faster we can accomplish fossil energy freedom. At the same time, we can effectively act against the climate crisis, strengthening our competitiveness in an era of soaring energy costs.

D) **Getting ahead of the curve:** On all levels, we must ensure all industries' fast and effective scale-up of sustainable energy and electrification. This will allow us to found the future's sustainable, CO_2-neutral energy system already within the next few years.

E) **Green Lean:** All bureaucratic and legal tripwires for the green transition must be removed, and all approval and execution processes coordinated and optimised.

F) **Think synergetically:** We must coordinate energy planning throughout Denmark and the EU, utilising regional cooperation and the development of a sustainable, robust and integrated European energy system. This will allow for the quickest green transition and fast international transmission.

G) **Common process ownership:** It is essential to involve local users, companies and civil society in the great green energy sector transition to avoid NIMBY activism and similar backlash. Early involvement, open processes and democratic engagement can ensure a quicker green transition without major setbacks.

Twenty-five main recommendations

We have built an extensive solution catalogue with 130 action proposals to implement our ambitions. You can request the catalogue from boas@altinget.dk, but here are **the green paper's 25 most important suggestions:**

1. Implement a high, uniform CO_2 tax of at least €160/ton CO_2, gradually rising to at least €200/ton CO_2. The proceeds will go to a climate fund, through which we reinvest them to speed up the green transition of society and business.

2. Create an ambitious green subsidy for energy renovations during 2022 to 2025 worth €400 to €700 million, where the subsidy rate drops off every six months, encouraging Danes to push forward energy renovations.

3. Require municipalities and regions to create an energy savings plan by January 2023, so they will save at least 23 per cent of their energy usage over this decade.

4. From 2023, implement a yearly energy renovation requirement of 3 per cent on municipal and regional government buildings like what already exists for national government buildings. Furthermore, most municipal and regional government buildings must be improved to at least energy label C by 2030.

5. Starting from 2025, forbid any new public sector construction that is not zero or plus energy, reducing lifelong CO_2 emissions. From 2027, all new buildings must, as a minimum, reach energy zero and possess intelligent energy control systems.

6. Promote a national energy savings campaign for quick behavioural wins. For example, lower the temperature in buildings by one degree Celsius, install intelligent energy systems in buildings, and lower road speed limits by 10 km/h Also, help factories sell waste heat to local district heating plants.

7. Whenever establishing new sustainable energy infrastructure, promote local participation and ownership through better and earlier citizen involvement. Start green citizen councils in the municipalities with local, grass-roots and business representatives to facilitate dialogue and citizen involvement and speed up proposals to city councils. We can invite local citizens in as community co-owners and stakeholders with new profit-sharing models.

8. By the 15th of October 2022, the Danish government should have agreed with the municipalities which gas-heated areas should be converted to district heating. And in November 2022, at the latest, it should send letters to affected citizens regarding the schedule for their district heating network integration. At the same time, it should set up an opt-in arrangement for district heating to simplify and accelerate the connection process.

9. The Danish heat supply must be gas-free before the end of 2027. At least 200,000 to 250,000 gas-heated homes should be converted to district heating, and bridging ordinances and extra subsidies should be given to realise this goal. Furthermore, 100,000 to 150,000 outlying homes must have heat pumps installed over the next three years.

10. Freeze all black energy projects until 2024, and postpone larger building and infrastructure projects to free up as many resources as possible for the transition to district heating and heat pumps, enlarging the power grid and quickly rolling out sustainable energy. Municipalities must also postpone any beautification projects that take up too much workforce.

11. By the end of 2030, we should free all district heating plants from fossil fuels and prepare them for fourth-generation district heating with low temperatures.

12. Speed up case management, approvals and construction of onshore solar and wind power on land and sea. The time required to process, approve and construct a solar power plant on a green field should be kept between six to twelve months instead of two to three years. For land wind, it should be two years at most. The future Danish offshore wind parks should be approved and built faster. We should shorten times to six to seven years through predetermined energy zones and improved tender procedures.

13. Free market forces and private initiative. Make it attractive for citizens, farmers, businesses and municipalities to sell energy to the grid through plus energy houses and sales of surplus sustainable energy from roof and field projects. We need a prosumer revolution, where more actors become energy creators and contributors to the common grid. This bottom-up approach can free a massive amount of resources.

14. Before the end of 2022, the Danish government should create a master plan, setting aside swathes of the North Sea for new offshore wind projects and energy islands, allowing at least 65 GW of offshore wind in the North Sea by 2035. The data to make this plan is already there.

15. Before the summer of 2023, the Danish government should commence a cluster tender for 10 GW of new offshore wind in the North Sea, where consortiums can bid to lease the area for 40 years. Implement a new profit-sharing model so the consortiums do not have to pay the state beforehand. Inspired by the hydrocarbon taxes on oil and gas extraction in the North Sea, a running profit share can be established. In parallel, open a track for more market-driven offshore wind establishment in extended North Sea zones. Before the end of 2022, the government should furthermore set aside areas for new greenfield sites, where the market can develop new, innovative energy projects within offshore wind and PtX. This should ensure at least 10 GW more offshore wind by 2030 or 2031.

16. Avoid a race to the bottom in the Danish offshore wind adventure, where competition occurs at the lowest possible price. In Denmark, we should compete on quality, environmental standards and innovation. The next generation of offshore wind in the North and Baltic Seas should emphasise system integration, and quality standards should be established in regards to measurable life cycle CO_2 emissions, a 40- to 50-year minimum lifetime for the windmills, resource usage, local supply, biodiversity and more.

17. Increase investment in the power grid, allowing connections by new wind, solar and PtX plants, and energy islands. This will ensure that the green transition will not be hindered further. As an independent public transmission system operator, Energinet should take social responsibility and invest in front of the curve, recognising that grid demands will skyrocket during the transition and electrification processes. Also, investments must be made in new distribution networks supporting the new wind and hydrogen adventure in the North Sea.

18. In the EU, the Danish government should work towards an expansion of the European energy union, allowing green power to flow freely and become the fifth tenet of freedom in the inner market. The EU should more than quadruple its solar and wind power production by 2030. Also, the commission must strike decisively against national grid operators practising electrical border controls and shutting down ongoing transmissions from other member states.

19. Green hydrogen from sustainable energy will be essential in producing sustainable fuels for the heavy and energy-intensive industry, as well as for long-distance planes and maritime transports. Therefore, more money should be allocated to R&D in high standards for green hydrogen and PtX production, minimising leaks, certifying quality and complying with sustainability requirements.

20. We should give the Danish hydrogen industry better economic conditions and subsidies, allowing high-quality green hydrogen to become a new Danish export adventure towards 2050. Industry conditions should be comparable to those in neighbouring countries, and we should develop a new common infrastructure with large gas pipes to distribute hydrogen to our neighbours – including setting aside suitable areas for PtX factories, where excess heat can be reused for district heating.

21. All fossil fuel subsidies in the EU should be slashed already in 2023 rather than wait until 2025.

22. For the sake of the green transition, coal should be pensioned by 2030 at the latest.

23. Reform the EU CO_2 trading system, so the free quotas can be removed during 2023, all sectors can be included, and the quota prices increased. Agree upon a common EU floor under the CO_2 tax level. In the member states, the CO_2 tax, including EU's quota prices, should be at least €160 to 200 per ton.

24. Establish a green transition fund in the EU, which promotes investments in sustainable energy, new energy-efficient technologies, and energy optimisations in energy-intensive industries. The funds will come from the reform of the CO_2 quote trading system, which could bring in up to €50 billion/year.

25. By 2024 at the latest, introduce a simple CO_2 duty on the borders of the single market, avoiding job loss due to carbon leakage.

1 A green energy revolution

"Never let a good crisis go to waste," Winston Churchill said when he was working to form the United Nations after WWII. The same is true today. Now, the task is to create a fundamental turning point in our energy system.

Unfortunately, there is no quick fix for the current energy crisis, which may surpass the international energy crises of the 1970s in size and extent. Transition is difficult in an EU that imports 40% of its gas and coal and 25% of its oil from Russia. However, we spend twice as much money buying oil as we spend on gas from Russia. Thus, we do not just need to free ourselves from Russian gas but reduce imports of all fossil fuels.

Our choices and investments over the next few years will drastically impact our future freedom and sovereignty. We must reconfigure our entire energy system to replace all the fossil fuels that heat up our homes and stores today and propel the machines of industry, farming and transport. Over the next eight years, we can start a series of comprehensive reforms to create a more robust, sustainable, future-proof, integrated energy system.

These are critical decisions requiring us to think of today and tomorrow. Energy infrastructure investments typically have an economic lifetime between 20 and 60 years, so our decisions towards 2030 will determine whether we can build a climate and carbon-neutral Europe by 2050. In this process, we must end silo thinking and embrace a more holistic view, allowing us to create energy-effective solutions in all sectors.

FROM SILO THINKING TO SYSTEM INTEGRATION

Denmark is part of an European energy system built on several parallel and vertical energy value streams, which determine the type and vehicle of energy sent out to end users in industry, service, farming and housing. The EU countries' primary energy consumption amounts to 1,176 MTOE (megatons of oil equivalent), or 13,676 TWh (see EU reference scenario 2020. Energy, transport and GHG emissions – Trends to 2050, European Commission 2021).

Coal and gas still dominate the power grid and the heating systems, but sustainable energy sources have an increasing impact, more than doubling in contribution since 1990. Oil is still dominant in transportation and industry, but electrification – of transport and swathes of industry and service – is expected to pick up in the coming years. Electric car sales are exploding, and within a few years, electric cars will be cheaper than fossil-fuelled vehicles at market rates, increasing electricity demand.

The European energy system is still divided. The electric and gas networks are planned and controlled independent of each other. In the same way, silo thinking still characterises EU and member state laws inherited from earlier generations. Divided as they are, the energy systems are suboptimal and cause large energy losses, making it advantageous to think across the old silos in circular fashion. The greatest possible share of the economy must be electrified, while heavy industry, mineralogical processing and large

shares of shipping and air transport will be supplied by biogas, green hydrogen and other low-emission fuels.

Source: Powering a climate-neutral economy: An EU Strategy for Energy System Integration, COM (2020) 299 final, European Commission.

A wake-up call for the future

If we – Denmark and the EU – had reacted to Putin's invasion of Crimea in 2014 by accelerating green energy investment, it would have been timely. Then, Putin would not have had such a war chest to invade Ukraine. Additionally, fossil fuel prices have soared, costing Danish and European consumers and businesses dearly. In the second half of 2021, European natural gas prices skyrocketed, causing electricity prices to rise to four or five times historical levels. This year alone, the EU countries will import €400 billion of fossil fuels from Russia and authoritarian regimes in the Middle East with different values from us, undermining our security.

Our energy system's addiction to fossils simultaneously worsens global climate change. The latest IPCC report published in April established that we have three years to flip the global emissions curve at best.[2] The message is clear: We are at a crossroads. It is now or never if we want to keep the global mean temperature increases to around 1½ degrees celsius or significantly under the critical 2 degrees over pre-industrial levels. Without immediate and deep reductions in all sectors, reaching the goals set at the UN climate summit in Paris and cemented at the latest summit in Glasgow will be impossible.

"Our appeal to the government and the parliament are to take the existing plans with political backing, turbo-charge them and move them forwards. The investors are ready to move our investments forwards. The operators are ready. All the suppliers are ready. There is no reason to not start digging in the sea."

Torben Möger Pedersen, *managing director, PensionDanmark, at the green paper's kick-off meeting on the 6th of April 2022.*

Together with the UN's climate report, the invasion of Ukraine is our last wake-up call. There is no time to waste, but the good news is that it is not too late. What we need are historically large investments in a green transition of the energy sector at "Tesla tempo", as Germany's green vice chancellor Robert Habeck expressed it.

Denmark's advantage is that our energy system is much less exposed to the crisis than most other EU countries'. Also, we already have companies which are global leaders within energy effectivisation, heating, wind energy and climate knowhow, who can deliver state-of-the-art climate solutions. Also, we've done it before. We have reason to believe that we can handle the task, even though it is extremely difficult. There is hope still.

We have done it before

Several times in history, Denmark has shown a surprising ability to mobilise enormous innovative forces, entrepreneurship, cooperation and political leadership when external threats have shaken our society. The economic crisis of the 1880s gave birth to the cooperative movement. During the great depression of the 1930s, we created a broad social contract with the Kanslergade Agreement.

[2] *Climate Change 2022: Mitigation of Climate Change, IPCC, april 2022. https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/*

After the devastation of WWII, we built one of the world's most developed welfare states. And during the 1970s energy crises, we laid the foundation for the Danish wind adventure and a wave of energy efficiency businesses. Adversity has strengthened us when we have worked together to solve complex, shared challenges.

Most recently, during the Covid-19 pandemic, we saw how the country's politicians, organisations and businesses quickly came together to make extensive and brave decisions, which helped bring Denmark through the difficult situation in better shape than most other countries. And thanks to close cooperation in the EU, it was also possible to purchase billions of vaccines and agree on a historic common loan of €750 billion, of which at least 37 per cent was earmarked for climate investments. We vaccinated citizens at record speeds, the weakest economic actors kept afloat, and we set aside large sums for targeted climate and digital transition investments.

In the first year of the pandemic alone, the EU and its member states found over €4,8 trillion for economic emergency stimulus packages to support the economy and stave off depression. Never has Europe shown such will to invest itself out of a crisis. It is the same bravery, decisiveness and political leadership needed to deal with the energy safety crisis, which hit us after Putin started his war of invasion on February 24th.

The good news is that we have the technology and the energy-effective solutions which can ensure total freedom from authoritarian hydrocarbons. We also have the money, as pension and investment funds are ready to invest in offshore wind, solar plants, green hydrogen, and other promising energy projects. What we are missing is a new master plan which can free companies, pension funds, civil organisations and citizens to take active co-ownership of the green transition.

The politicians can create planning security by formulating clear and ambitious mid- and long-term goals for a new, sustainable European energy system. This means that companies, investors, organisations and citizens have a green compass after which to navigate. Then, they can make qualified choices, whether these relate to investments, energy solutions, production layouts, R&D, education and careers.

Citizens are already poised to change their behaviour. The 2022 Security Survey by TrygFonden showed that a full 74 per cent of Danes want to roll out sustainable energy as soon as possible to stave off Russian gas dependency.[3] Also, 36.9 per cent want to reduce energy consumption. Simultaneously, the share of people supporting further local windmill construction rose sharply, with 67 to 83 per cent of citizens desiring more windmills in their municipality. Another fresh survey by Wilke shows that 59 per cent of the population supports postponing or cancelling planned infrastructure projects to find the money for energy investments and district heating.[4] To summarise, the citizens have understood how serious the situation is, and that prioritisation is necessary. Suppose they are involved earlier and better in processes such as renewable energy development in their local area. In that case, there is a greater chance of avoiding negative setbacks and not in my backyard reactions.

The other citizens of the EU also desire sustainable energy development and the promotion of more energy efficiency. 39 and 49 per cent of Europeans think it is important and very important, respectively. Less than a tenth of citizens do not think it important.[5] 87 per cent of European citizens also support more energy renovations. Most citizens want to do much more. Suppose the politicians can agree on a clear and ambitious green project for the future. In that case, it will also become more manageable for the citizens to engage in the colossal task of becoming free of fossil dependence.

[3] *Security Survey ("Tryghedsmåling") 2022, YouGov survey among 2,069 representatively selected Danes over 18 years conducted on behalf of TrygFonden, March 2022.*

[4] *Flertal af danskerne vil have genåbnet stor politisk aftale om infrastruktur, Thomas Bo Christensen og Anja Hauge, Mobility Watch, 25th of May 2022.*

[5] *Special Eurobarometer 517. Future of Europe, Eurobarometer, januar 2022.*

RECOMMENDATIONS:

One must avoid NIMBY and other negative reactions that can delay the green transition. Therefore, citizens and other key actors must be turned into collaborators. Behavioural change must be initiated at scale, and the faster people are involved in the processes, the greater chance of success in transition.

1. When establishing new sustainable energy infrastructure, one should promote local participation and co-ownership through better and earlier citizen inclusion. Make green citizen councils in municipalities with representatives from the local citizens, civil society and businesses to facilitate dialogue, better citizen involvement and present proposals to city councils for approval faster. Local citizens can be invited inside in new green projects as co-owners and stakeholders, and new profit sharing models should be developed. This can also be a lever for developers of solar and wind farms. On a national level, representatively selected citizens can be invited to a citizen's thing, where they can present ongoing suggestions and ideas for how the green transition of the energy sector can be accelerated.

2. Free market forces and private initiative. Make it attractive for citizens, farmers, businesses and municipalities to sell energy to the grid through plus energy houses and sales of surplus sustainable energy from roof and field projects. We need a prosumer revolution, where more actors become energy creators and contributors to the common grid. This bottom-up approach can free a massive amount of resources. At the same time, it will create a more robust energy system, if many small decentral energy producers can supplement the large, central sustainable energy farms and infrastructure. Electric car batteries should also be integrated as storage capacity in a new, integrated, intelligent energy system.

Free us from fossil fuels

Climate change, the invasion, and the new safety threats form a gloomy backdrop, challenging every EU country. At the same time, crises also mean a unique opportunity to forge stronger alliances in the EU and accelerate the transition. The severity of the situation requires extraordinary decisions and the decisiveness to implement them.

If politicians can foster a wartime mentality, where everyone understands that rapid action is necessary, everything says that far-reaching decisions can be taken in a very short time. All good powers may now work together to bring to life the common vision of a Denmark without fossil fuels.

Even though rising energy costs and shocks to the world economy cause inflationary pressure, there is no lack of capital for investments in green energy like solar and wind power. Today, they are cheaper on market terms than oil and gas, which moreover lead to big climate costs in the future. See figure on page 17.

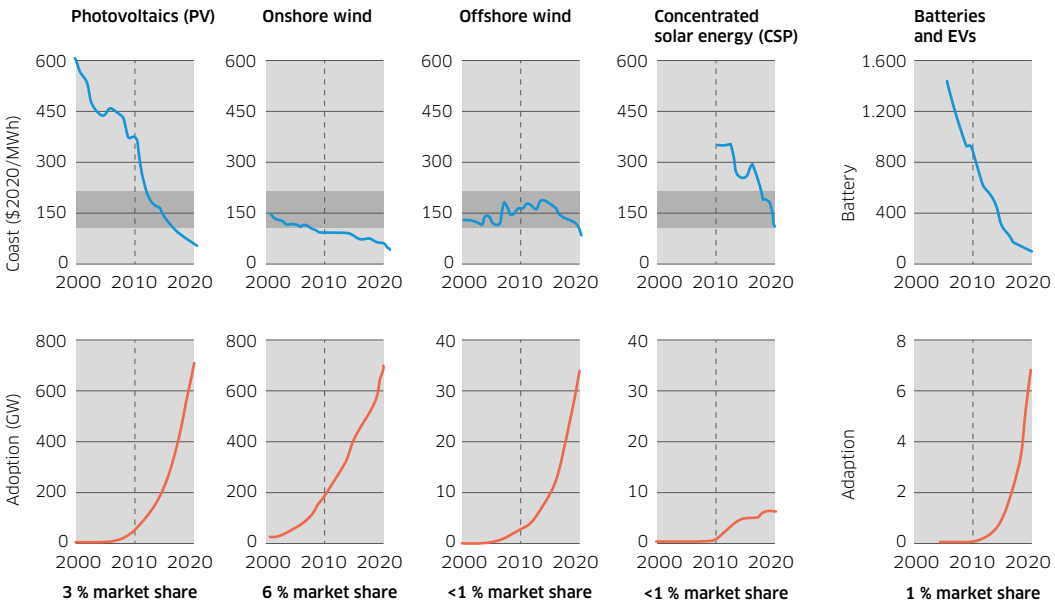
The cost of installing offshore wind in Europe has fallen from €5.5 million per MW in 2012 to €3.5 million today, and the price of new land windmills has fallen from €1.9 to €1.3 million per MW in the last five years.[6] Due to rising materials costs, supply chain disruptions and increasing inflation because of rising energy costs, it is probably not likely that the prices of wind parks will fall further. However, they will still be cheaper than fossil fuels. According to the International Energy Agency (IEA), their competitiveness against fossil fuels has risen as oil and gas prices have increased even more.[7]

Simply put, it has become good business – and an investment in our common security – to replace fossil fuels via energy savings and sustainable energy. At the

[6] *Financing and Investment Trends. The European Wind Industry 2021, WindEurope, april 2022.*

[7] *What is the impact of increasing commodity and energy prices on solar PV, wind and biofuels?, IEA, 1. december 2021.*

UNIT COSTS OF BATTERIES AND CERTAIN RENEWABLE ENERGY TYPES HAVE FALLEN SIGNIFICANTLY, AND THEIR ADOPTION CONTINUES TO INCREASE



Source: IPCC, Climate Change. Mitigation of Climate Change, April 2022.

same time, the EU's new green taxonomy will make it even more attractive for financial institutions to invest in sustainable energy sources. Therefore, there is reason to expect investment to accelerate over the coming years.

The market follows when politicians set out a new course with clear and realistic sub-goals. Upscaling the green transition faster should be a core political goal. The Danish government has suggested that Denmark quadruple its renewable energy supply, and the red-green-yellow "traffic light government" will do the same in Germany. If more countries follow, it will be a big step forward for the green transition. At the same time, the European Commission wants to triple the amount of solar and wind power in the EU by 2030.

It is positive and encouraging that green frontrunner nations and the Commission are pushing to speed up the development of sustainable energy. But as this green paper shows, this increased supply will not meet future demand. If we are too unambitious with energy savings and under-invest in sustainable energy, we can be forced to invest in more fossil infrastructure and other emergency solutions, that can make it more difficult and expensive to solve the climate issues. Instead of a safe place behind the curve, it is now about getting in front of it, so we in Denmark and the EU as a whole get on the front foot of the green transition and accelerate freedom from fossil fuels.

Even before 2030, it is possible to at least septuple sustainable energy on land, so Denmark will then be fully self-sufficient with electricity without fossil fuels. And in 2040, all of Denmark's energy needs can be met with sustainable energy if we start a rapid upscaling of wind and solar power on land – supported by biogas, geothermal energy and waste heat. We must create new, inclusive processes to support the roll-out. When we can produce energy close to where it is needed, it minimises energy loss. By betting on total onshore renewables coverage, we can free the gargantuan winds on the North Sea for a new Danish export adventure.

Within the next few years, we simultaneously need a massive expansion of offshore wind in the Danish North Sea, so we can help our neighbours free themselves from Russian energy faster. It is also good for us. Not only does it strengthen our security, but it also helps the climate and reduces air pollution if we can help the Germans get rid of their dated coal plants ahead of schedule.

Towards 2030, we can use a new, offensive public tender strategy to secure an accelerated and market-driven increase of Danish offshore wind from 2.3 GW to a massive 30 GW. In 2035, Denmark can deliver 65 GW of offshore wind for Europe. It is both technically and economically feasible to reach these goals. If the demand for green electricity in Europe rises during the first half of the 2030s – as expected due to the coming electrification revolution in the transport sector and other changes – the power grid and renewable energy supply must be developed further.

Today, the Danish Energy Agency (DEA) and the Danish Ministry of Finance use far too conservative assumptions for their models, which are even below the lower bound of recommendations from the EU's Fit for 55 programme.[8] Many EU countries are now significantly upscaling their climate goals and demanding far more green power. Moreover, the 2030s may bring even more inner market demand for green power due to the war and the new energy supply crisis. Therefore, it may be necessary to scale up even further, to maybe 105 GW in the North and Baltic Seas by 2040, and we should take this decision between 2030 and 2032 at the latest.

The recurring surplus from the new energy islands and offshore wind parks will replace the old carbon dioxide tax and provide a solid income that can also help finance future welfare. Therefore, we should simultaneously accelerate and scale up offshore wind development in the North Sea within the next few years. The decision should be made this year so we can hurry fossil freedom. At the same time, it will be a solid contribution to solving the climate crisis.

Decisiveness

This green paper contains concrete proposals for how we can redeem the great potential inherent in running the future's European energy system with sustainable energy instead of fossil fuels. It requires that we immediately raise the common goals and increase action speed in Denmark and the rest of the EU.

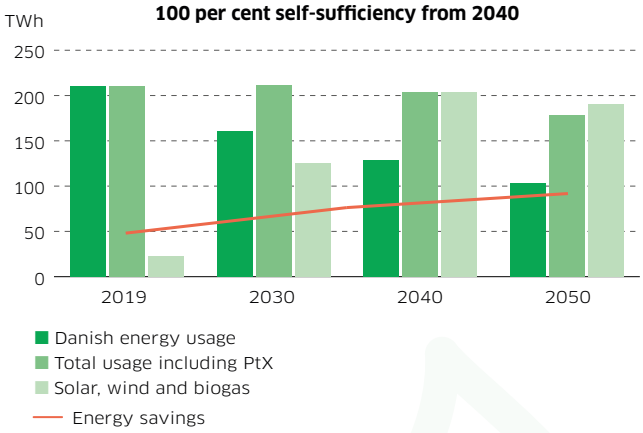
> "We have all kinds of crises right now, and the green transition solves them all: The energy supply crisis, the climate crisis, and a food crisis. So there are all kinds of good reasons to look at this and accelerate the green transition. I hope that we can use the green paper to visualise the need to bite down now. Because the crisis awareness we have right now can easily disappear again."
>
> ***Lars Gert Lose,*** *Head of Global Public Affairs, Communication and Marketing, Copenhagen Infrastructure Partners, at the green paper's kickoff meeting on the 6th of april 2022.*

To bring the green paper's ambitious suggestions to life requires much more cross-sectional cooperation, stronger integration between sectors, more investments, more citizen involvement and innovative models to accelerate the green transition. Denmark has a unique chance to become a living demonstration country for how the EU can free itself from Russian energy imports and develop a robust, safe and sustainable energy system. In 2040, Denmark can have a new energy system where we are fossil fuel free – not just in the electrical sector but in all walks of society. [9]

Extreme energy productivity and innovative energy solutions will help us strengthen our competitiveness and secure future savings. Moreover, a sustainable

[8] *Dansk energi- og klimapolitik bygger på et sort analysefundament, Karsten Capion, Concito, 22th of November 2021.*

[9] *IDAs Climate Answer 2045: This is how we become climate neutral ("IDAs Klimasvar 2045: Sådan bliver vi klimaneutrale") Henrik Lund, Brian Vad Mathiesen and more from Aalborg University and the Danish Society of Engineers, IDA. They assess that it is possible to transition Denmark's entire energy supply to sustainable energy in 2045. Still, their ambition level for the sustainable energy rollout is significantly lower than suggested in this green paper.*



Corrected gross energy usage per year converted from PJ to TWh.

- Land wind increases to 45 GW in 2040 via repowering and more windmills.
- Solar power increases from 30 to 40 GW i 2040.
- Biogas can be increased from 5 TWh in 2020 to 13 TWh in 2030 – after this, no further increase to keep CO_2 emissions down.
- We have left biomass out of sustainable energy numbers due to the insecure climate effects and import dependency.

energy system is far cheaper to run than if you choose business as usual and lock yourself to the old model with fossil import dependency.

However, it takes time to reconfigure complex energy processes and make citizens and companies change their behaviour. Therefore, the green paper recommends that politicians already in the next one to three years make the strategic decisions that will put this massive energy transition on track. Setting pretty targets for what you want to achieve in 10 or 20 years is no longer enough. Action is needed now. Within a few months, we in Denmark should commission a national operative staff, which can ensure rapid execution of the green energy sector transition. The European Commission should do the same. Strong and decisive leadership is essential to remove all the tripwires and bring the master plan to life.

There is no time to waste.

2 The race before next winter

Business-as-usual is a non-strategy. It has shown to make our society very vulnerable, and if Russia or the EU shut the gas taps off because of the war in Ukraine, many large companies that depend on Eastern gas would have to close.

In the first weeks of the war, European governments prepared to start emergency supply plans, where citizens with gas furnaces and vital societal functions could receive gas in place of the companies. But we are on borrowed time, not just due to the invasion of Ukraine. It is because of how we have set up our society and economy. We are too vulnerable to outer shocks, and robustness is lacking.

Fully 57 per cent of EU energy consumption is imported, and 24.4 per cent of the Union's energy comes from Russia.[10] In the EU, we import up to 400 billion cubic meters (BCM) of gas each year, and a large share of this, 155 BCM, are from Russia. Thirty-five per cent of this gas is used in residential and commercial buildings, 31 per cent goes to electricity and heating utilities, and we use 23 per cent in industry. At the same time, in 2021, the EU imported 3,1 million barrels of oil a day from Russia.[11]

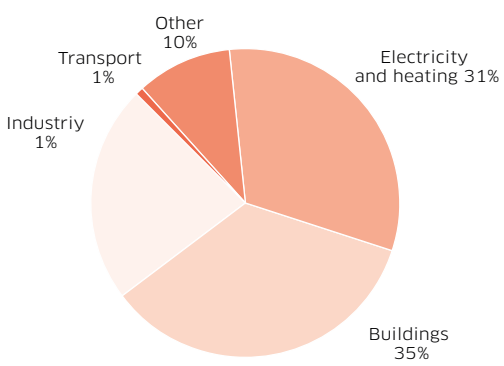
Our fossil dependence has risen over the last three decades, even though international climate scientists have urged us to cut CO_2 emissions and start the green transition for years.

Our current energy system is not sustainable. Fossil fuels are still the dominant energy source, and oil, gas, and coal provide 68 per cent of EU energy usage – see the figure at the bottom of the page. The faster we can free ourselves from them and transition to clean power, the faster we can solve the climate crisis. However, we must understand that it is a highly demanding task, requiring strong leadership, decisiveness and quick execution.

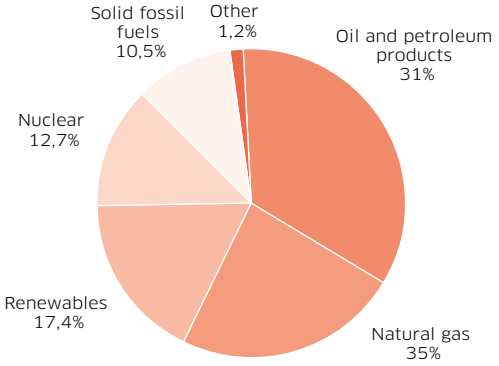
[10] *Eurostat, 2022.*

[11] *Converted to million tons of oil equivalent, the energy content equals 158 Mtoe.*

GAS CONSUMPTION BY SECTOR IN 2020 (EUROSTAT)



EUROPÆISKE UNION ENERGY MIX 2020



We are still moving backwards into the future

During the economic setbacks of the Covid-19 pandemic, energy usage and CO_2 emissions fell for a time, but now we are again moving in the wrong direction. In Denmark, CO_2 emissions from actual energy rose 1.5 per cent in 2021 because coal consumption rose 39 per cent, while sustainable energy only rose by 14 per cent.[12] Again, in the last three months of 2021, the EU sent over a billion tons of CO_2 equivalent into the atmosphere – a level that you need to go back to 2018 to find.[13] The soaring natural gas prices made several countries fire their old coal plants hotter. Also, in 2021, too few windmills were set up to reach the EU's Green Deal goals by 2030. Only 11 GW was installed in 2021, but at least 32 GW of wind is needed each year if we want to succeed in reducing EU CO_2 emissions by 55 per cent in this decade.[14]

> "We have moved beyond the point where we need more goals. Now, we need operational decisions."
>
> ***Thor Möger Pedersen,*** *director of Green Transition and Sustainability, COWI, at the green paper's kickoff meeting on the 6th of April 2022.*

Unfortunately, the low level of political ambitions also threatens the otherwise strong supply chain built in the European wind industry in recent years. The large windmill producers find it difficult to turn a profit because of rising materials and logistics costs. They must let people go, even though the times call for a rapid scale-up.

Today, we Europeans do not live up to the common goals set in the European Climate Law, and national action plans are also stumbling behind. There are still too many bureaucratic tripwires, as it can take years to approve new sustainable energy projects. These should be removed so that we can speed up the green transition.

We have navigated in darkness for too many years, naively clinging to business as usual. It is no longer viable, if it ever was, and it is time to change the course for our safety and the climate. If we do not act now, we will have to pay a much larger climate bill down the line.

Eat the elephant one bite at a time

Changing electricity and heat generation is no longer sufficient. We must reconfigure our entire energy system, behaviour, and all economic value chains. They did not build Rome in a day. Therefore, this green paper's recommendations are divided into what we should do before 2023, before the end of 2025, and before 2030. Each phase has concrete actions that must be initiated in Denmark and the wider EU.

To begin, we need to make a plan for how to cut Russian energy imports by as much as possible before next winter. At the same time, we need to make critical societal decisions within the next one to three years, allowing us to gain a robust and sustainable energy system that can free us from fossil fuels in the medium-long run. We cannot postpone these decisions, as it can take up to 5 to 10 years to transition heating away from gas. And it can take seven to ten years or even more to build new offshore wind farms that can replace oil and gas imports. Denmark can lead the way in several areas, showing green leadership. However, as we have tightly coupled our energy system with the rest of the countries in the common market, it is also essential that Danish plans are in line with the choices made in the European community.

As Prime Minister Mette Frederiksen has said, we cannot be 100 per cent free from Russian gas before the entire EU is free of it.

[12] *Energiforbruget steg sidste år, Danish Energy Agency, 6th of April 2022.*

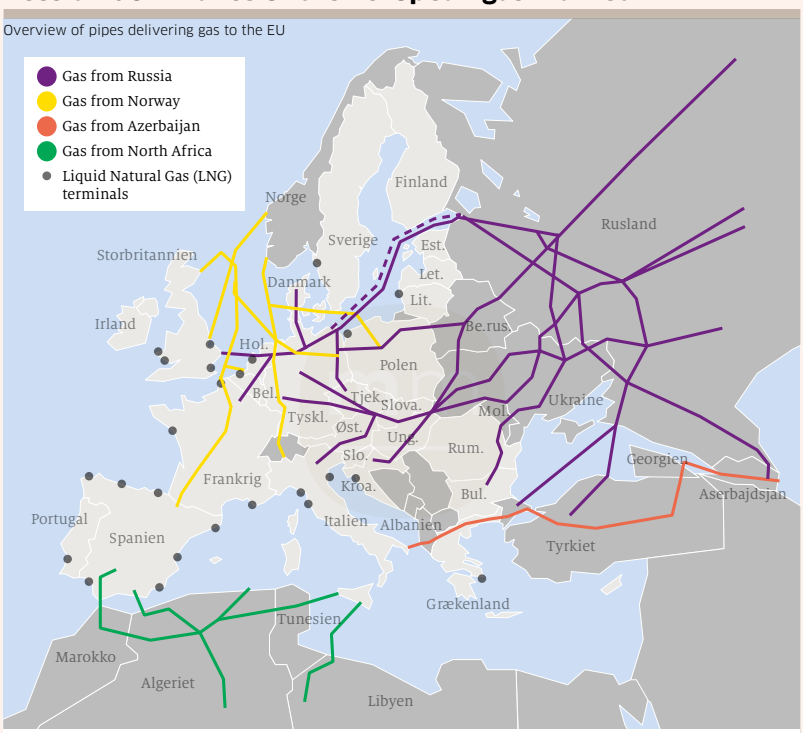
[13] *EU economy greenhouse gases above pre-pandemic levels, Eurostat, 16th of May 2022.*

[14] *Financing and Investment trends, The European wind industry in 2021, WindEurope Business Intelligence, April 2022.*

Whether the war in Ukraine is over by winter or not, the EU countries must reduce gas and oil imports from Russia to a minimum so we do not help refill Putin's war chest. Today, our oil and gas imports finance almost a fifth of the Russian state budget. It is fairly easy to replace Russian oil with imports from other countries, but it is much more difficult to substitute Russian gas, as most of it is delivered through the extensive pipe network from Russia to the EU. After substantial pressure, Germany finally stopped Nord Stream 2, but large amounts of Russian gas are still going through the existing pipes, and the EU countries could not agree on a Russian gas embargo. See the map below.

Denmark is one country which will be able to end Russian gas usage quickly because gas is a smaller part of the energy supply than in most other EU countries. Also, Denmark has a larger share of sustainable energy in electricity generation than most other EU countries. We have a highly intelligent electrical controls network and an extensive and robust district heating network. Moreover, when the Baltic Pipe partially reopens in October 2022 and fully opens in January 2023, Norway can pipe gas to Denmark and Poland. By the winter 2023/24 when the Danish Tyra gas field in the North Sea reopens, Denmark will become a net gas exporter.

Russian dominance of the European gas market



FIGUR 1 – Russia dominates the European gas market. If the ambtion to free Europe from Russia before next winter is to be achieved, all the purple lines must be erased.

KILDE – US Energy Information Administration.

The Danish government will allow advancing and temporarily increasing gas extraction in the North Sea in already licensed fields to substitute some Russian gas in the EU. However, this is only a drop in the ocean.

The need for common European solutions

Even though the Tyra field is large, it can only produce around 7 per cent of Germany's Russian gas imports. Today, many EU countries so depend on Putin's energy that it can take several years to free them. If Russia shuts off the gas from one day to the other, it will cause an economic shock in EU nations, where gas-fired industries risk standstill due to a lack of gas. Over the Union, considerable efforts are made to convert production use oil or electricity inputs. Russia has already partially or completely cut off gas supplies to several EU member states to punish them and cause dissent in the EU. We need lasting European solutions to the challenge.

Freedom from Russian energy should be considered a shared investment in future security. It's not enough to merely free ourselves in Denmark because the other EU countries' weaknesses and safety are ours, too. Putin's war in Ukraine has demonstrated it. That's why it was positive that the European Commission presented its REPowerEU plan and related strategies on the 18th of May, comprehensively answering the obstacles. The goal is to reduce gas imports from Russia – 155 BCM in 2021 – to a third before winter.[15] Energy savings, more heat pumps, sustainable energy, and extra imports of natural gas and LNG will help realise it.

Towards 2030, the Commission will invest up to €300 billion in freeing the EU countries from Russian energy dependence. Still, they expect to save around €93.7 billion on oil, gas and coal imports from Russia. Thus, the investment plan is financed by future savings.[16] In the short term, we must fill European gas storage at least 85 per cent before November 1st.[17]

Citizens and companies must save more energy. Around 10 million energy-efficient heat pumps will be installed in European homes in the next five years. This allows natural gas-fired to be coupled to electrical heating instead. 10 million heat pumps will save 12 BCM/year in the residential sector. Denmark has around 400,000 gas-fired homes, and it is urgent to free them from gas and switch them to district heating or heat pumps.

A large challenge on the road can be a lack of skilled workers – electricians, plumbers, and welders – to install heat pumps, extend the electrical network, weld district heating pipes and do digging work. The number of excavators is also limited. An analysis from the green think tank Concito shows that the green transition can add another 20 thousand jobs in Denmark alone from 2025 to 2030. Increased further training and imports of skilled labour from abroad can solve part of the problem. But it is equally important that public employers prioritise new building projects effectively, so the country's energy security and green transition have priority.

See action proposals in the box atop page 24.

Energy savings mean more freedom from Russian gas

The Commission suggests implementing binding energy savings targets for 2030 of at least 13 per cent compared to 2020 levels. This is more ambitious than the previous goal of saving 9 per cent of energy before 2030 – or 32.5 per cent compared to 2007 levels. The Commission will remove energy usage equal to 43 BCM of Russian gas by increasing the saving goal.

The Commission encourages member states to immediately start energy savings campaigns, and it will also make a European campaign to ensure rapid behaviour changes among citizens and companies. Inspired by IEA recommendations, the suggestions include turning down the heat in homes by one degree, avoiding using electricity in peak periods, and turning off the lights after oneself. This sounds like recycled material from the energy crises of the 1970s, but it actually makes a difference. The Commission approximates that such quick fix savings are equal to 13 BCM of natural gas.

[15] *REPowerEU, European Commission, 18th of May 2022.*

[16] *Implementing The Repower EU Action Plan: Investment Needs, Hydrogen Accelerator And Achieving The Bio-Methane Targets. SWD (2022) 230 final, European Commission, 18th of May 2022.*

[17] *EU Clinches deal on mandatory gas storage for next winter, Euractiv, 19th of May 2022.*

FREE DANISH HOMES FROM RUSSIAN HYDROCARBONS

Recommendations:
The Danish heating supply should be freed from gas before the end of 2027, and all fossil fuels phased out by 2030.

1. The Danish heat supply must be gas-free before the end of 2027. At least 200,000 to 250,000 gas-heated homes should be converted to district heating, and bridging ordinances and extra subsidies should be given to realise this goal. Furthermore, 100,000 to 150,00 outlying homes must have heat pumps installed over the next three years.
2. By the 15th of October 2022, the Danish government should have agreed with the municipalities about which gas areas it should convert to district heating. And in November 2022, at the latest, it should send letters to affected citizens regarding the schedule for their district heating network integration. At the same time, it should set up an opt-in arrangement for district heating to simplify and accelerate the connection process.
3. Freeze all black energy projects until 2024, and postpone larger building and infrastructure projects to free up as many resources as possible for the transition to district heating and heat pumps, enlarging the power grid and quickly rolling out sustainable energy. Municipalities must also postpone any beautification projects that take up too much workforce.
4. By the end of 2030, all district heating plants should be freed from fossil fuels and prepared for fourth-generation district heating with low temperatures.

Another point on the long to-do list is installing smart heating systems in buildings, isolating poorly isolated structures, and installing energy-efficient windows and heat pumps. Among the quick fixes are also lowering motorway speeds by 10 km/h and lowering speed limits in towns and cities. These initiatives can save 9 BCM. The Commission also encourages governments to promote electrification of the transport system, set up more charging stations for electric cars, invest in more bike paths, and lower prices on public transport so more people will avoid driving to work. Member states can pick and choose between these proposals. More states could find in inspiration in Spain and Germany where the governments want to enforce maximum temperatures of 19 degrees in public buildings, and in Spain they also want to prevent offices, shops and other venues from setting air condition temperatures below 27 degrees. Unfortunately, too many governments are not acting with the speed and radicality needed in the current energy security crisis. Much more can be done.

"We will have a greater need of burning fossil fuels if we do not make concrete demands of both municipalities and citizens. Think about this: A house with energy label G uses 20 times more energy as one with energy label A. Can we afford this in Denmark? Hell no."

Bendt Bendtsen, *board chairman, SYNERGI, and former minister and chairman of the Conservative Pary, at the green paper's kickoff meeting on April 6th 2022.*

However, the heavy hitters in the fight for medium-long run energy savings are found in coming directive changes; of the energy effectivisation directive, the building directive, and the new directive for ecological design of sustainable products. Negotiations about these directives are ongoing.

Besides, one can increase the ambitions of the EU's climate law, Fit for 55-programme, and increase the implementation speed. The Commission mentions that member states can, for example, remove all fossil subsidies.

The Commission recommends that member states remove all subsidies for fossil-driven heating systems. It suggests that they improve the poorest buildings from energy labels G to D. Also, it emphasises that all new buildings in the EU should have zero emissions – public buildings from 2027 and others from 2030.

The REPowerEU plan includes a long wishlist from the Commission, urging the European Parliament and Council to develop more suggestions for realising further energy savings. There is room for improvement, and Denmark should exploit this to press for even higher energy savings demands in the EU. If we can turn down energy usage over the next few years, we advance the day of complete freedom from Russian energy. At the same time, it is vital for our common climate goals.

The European Parliament wants to increase the EU's 2030 energy effectivisation goal, so 40 per cent of primary energy use is removed compared to the 2007 level.[18]

WORLD CLASS ENERGY SAVINGS

Recommendations:
In the 2020s, the EU must have a binding 20 per cent energy savings target, and Denmark should lead by saving 23 to 25 per cent of energy by 2030. Every energy unit saved is money in the bank. Here are some of the most important proposals from our action catalogue:

1. Implement a high, uniform CO_2 tax of at least €160/ton CO_2, gradually rising to at least €200/ton CO_2. The proceeds will go to a climate fund, through which they are reinvested in accelerating the green transition of society and business.
2. Create an ambitious green subsidy for energy renovations during 2022-2025 worth €400 to €700 million, where the subsidy rate drops off every six months, encouraging Danes to push forward energy renovations.
3. Require municipalities and regions to create an energy savings plan by January 2023, so they will save at least 23 per cent of their energy usage over this decade
4. Starting from 2025, forbid any new public sector construction that is not zero or plus energy, reducing life-long CO_2 emissions. From 2027, all new buildings must at the least be zero energy and possess intelligent energy control systems.
5. Promote an energy savings campaign for quick behavioural wins. For example, lower the temperature in buildings by one degree Celcius, install smart energy systems in buildings, and lower road speed limits by 10 km/h. Also, help factories sell waste heat to local district heating plants.

If the European Council accepts this proposal, the EU countries must save 14.5 per cent of their energy usage from 2020 to 2030. This is not ambitious enough. If the EU member states save 19 per cent of their energy usage from 2020 to 2030 they could save the equivalent of 133 BCM of Russian gas. By increasing energy efficiency by 19 per cent, the EU could remove 87 per cent of Russian gas imports.

However, going higher is technically feasible. Calculations from the respected Fraunhofer institute of Germany have shown that the EU countries can reach up to 23.4 per cent energy savings in 2030.[19] This level of effort will save 162 Mtoe extra compared to the original 9 per cent effectivisation goal. At the Fraunhofer level, the Union can stop using Russian gas and cut a further 24 per cent of other gas usage. If we act now, the EU can be free from Russian gas in five and a half to six years.

[18] *Manglen på arbejdskraft risikerer at blive en hindring for den grønne omstilling, Concito, 3. juni 2022.*

[19] *Will the Fit for 55 package deliver on energy efficiency targets? A high-level assessment. Fraunhofer og Stefan Scheuer, oktober 2021. I rapporten er nogle af initiativerne i 23,4-procent-reduktions-scenariet kun opgjort som næsten omkostningseffektive, men i dag antager vi, at de også vil være cost-effektive, da de fossile energipriser er steget en del ift. rapportens forudsætninger.*

Some of the energy savings reduce oil and not gas consumption. Still, as we must free ourselves from both Russian gas and oil, it is better to ensure higher energy savings than the more cautious ones presented by the Commission.

The green paper recommends that the EU as a whole makes a detailed energy savings plan, which over several sub-goals, will ensure that we, by 2029 or 2030, have saved just as much energy as contained in the Russian gas import. At a minimum, this requires a binding energy savings target of 20%. The countries which can go further should do so.

In Denmark, a group of energy researchers from Aalborg University have developed a forward-thinking heating plan. Supported by Danfoss, Grundfos and Innargi, they estimate we can reduce Denmark's total energy usage by 25 per cent by 2030.[20] If we complete these initiatives, we will cut fossil fuel usage in half and take a great leap forward towards a fully sustainable Danish energy supply. Another plan has shown that Denmark can reduce gas usage by up to 79 per cent within the next five to eight years with some targeted actions.[21] Thus, Denmark has the proper prerequisites for leading by example among the EU countries.

[20] *Heating plan Denmark 2021. A climate neutral energy supply ("Varmeplan Danmark 2021. En klimaneutral energiforsyning"). Brian Vad Mathiesen, Henrik Lund et al.., Aalborg University, October 2021.*

[21] *Fast Track away from natural gas in Denmark and Europe ("Fast Track væk fra naturgas i Danmark og Europa."). Brian Vad Mathiesen and Pernille Hagedorn-Rasmussen, IDA, 8th of March 2022.*

3 Avoid fossil lock-in

The European Commission's REPowerEU plan entails that the EU should import no Russian gas from 2027, which is both realistic and possible. However, the task is still very large, and all member states must do their part with more ambitious energy plans. For example, an extra 375 to 400 GW of production in the EU will be required to permanently substitute Russian gas with solar and wind energy. And if green hydrogen must replace the old gas usage, it will require at least 500 GW of sustainable energy.

It takes time to build this extra capacity, so the commission has sought temporary solutions to stop the gap in the coming years. For example, countries like Belgium and France keep older nuclear power plants running longer than planned, but the German government will not do the same. This provides extra energy equal to 7 BCM. Several member states, among them Poland and Germany, have decided to burn more coal during the current energy crisis. This replaces 24 BCM of natural gas, but worsens the climate crisis.

The Commission will also invest in gas pipes from Turkey and Azerbaijan and centralise gas and hydrogen purchasing to improve prices. Here, they are building on the experiences with pooled vaccine purchases from the pandemic.

Another central element in the Commission's plan is to spend $10 billion building new gas terminals and new infrastructure for liquified natural gas, so the EU can import 10 million tons a year from Africa, the Middle East, USA and Japan. The idea is to double the EU countries' natural gas imports to 20 metric tons in 2030, replacing up to 50 BCM of Russian gas annually. The idea is to replace a third of the Russian gas with LNG to find a quick response to a situation where Russia shuts off the gas taps.

However, this is easier said than done. Even though the United States has temporarily agreed to increase gas exports to the EU, and new deals are struck in the Middle East and Africa, a wave of the hand can not solve a significant supply crisis. Most of the global LNG market has been tied up in long-term contracts with Asian high-growth countries, so the EU countries can be pressured to pay a significant premium. Even though there is no lack of tankers to transport the gas, a lack of terminals and other infrastructure limits capacity, challenging this part of the plan.

The LNG race

Nevertheless, the member states are already immersed in a wild LNG hunt, competing to sign orders. Germany's Green vice chancellor, Robert Habeck, has dropped all ideology for a moment and has been in countries like Qatar to ink LNG supply deals for the German industry.

Germany wants to build four LNG terminals in record time, as the country has none today. Only 10 EU countries have these terminals, and there is also a lack of supplementary infrastructure to convert the liquid gas into gaseous form and send it into the gas network. See figure on page 22.

It takes two to three years to build new terminals. The price is high, and it takes 20 to 30 years to gain a positive return on investment. This increases the risk of fossil

lock-in for the EU, which would then spend billions of euro replacing Russian fossil imports with other fossil energy, which will not solve future challenges.

However, the Commission sees gas as an essential step in the great green energy transition and suggests that the new LNG infrastructure should also be capable of transporting green hydrogen. This will require some retrofitting of existing gas pipes, as the pressure used for hydrogen is higher.

Increased production and import of LNG will increase climate problems. Fracking gas from the USA converted into LNG is far more injurious to the climate than Russian gas. EU thus has to choose between two evils. Fracking emits 40 to 60 per cent more methane than conventional natural gas. Also, methane can trap up to 84 times more heat in the atmosphere than similar amounts of CO_2.[22] The EU countries risk shooting themselves in the foot if they depend too much on liquid gas. Economically, it is also an expensive option, where the EU risks paying premium prices on the world market.

The climate balance

The path the EU finds out of the current energy crisis must not lock us to new expensive fossil infrastructure, hindering our efforts to solve the accelerating climate crisis. We must avoid unnecessary investments that can worsen climate problems and increase future costs. The latest IPCC report also warns against wasting money on new fossil infrastructure.[23]

For the world to reach its climate goal by limiting temperature increases to less than 2 degrees Celsius, at least 30, 50, and 80 per cent of known oil, gas and coal reserves must stay underground. To stick to the one-and-a-half degree limit agreed on at the UN climate summit in Paris in 2015, even more fossil energy must stay buried.

The climate panel's analysis shows that fossil infrastructure worth between 1,000 and 4,700 billion USD can lose its value and be dumped towards 2050, assuming that world leaders wish to reach the two-degree goal. So investing in more fossil infrastructure, for example, a massive LNG terminal and support expansion – when EU CO_2 emissions have started to rise again – is folly. Perhaps it is reasonable to see such an expansion as a short-term emergency reaction to the supply crisis forged by Putin. But unfortunately, it would increase the climate crisis and tie up enormous financial resources in time-limited fossil infrastructure.

When the IPCC launched their report in April, UN Secretary-General António Guterres stated, "it is moral and economic madness to invest in new fossil infrastructure." Yet, as it is now, the world is – given the realisation of current action plans – headed for global temperature increases on the order of 2.8 to 3.2 degrees in this century.[24] Worryingly, instead of CO_2 reductions, emissions are rising, both in the EU countries and globally.

In May, the World Meteorological Organization (WMO) warned that there is now a 50-50 risk of the global temperature mean being one and a half degrees Celcius above the pre-industrial level in one of the next five years.[25] If we do not change course, the price will be very high.

The British economist Nicholas Stern's calculations say that if global temperatures rise two to three degrees above pre-industrial levels, it may cause an average prosperity loss per capita of around five per cent and up to ten per cent at higher temperature levels.[26] Costs will drastically rise if nothing is done, and it is much cheaper to act now than when climate change accelerates and finally spins out of control. The more timely action, the more money can be saved in the future.

[22] *Fracking may be a bigger climate problem than we thought, David Roberts, Vox, 29th of August 2019.*

[23] *Climate Change 2022: Mitigation of Climate Change, IPCC, April 2022.*

[24] *Emissions Gap Report 2021. The Heat is On. UNEP, 26th of October 2021.*

[25] *WMO State of the Global Climate 2021, WMO, maj 2022.*

[26] *Stern Review: The Economics of Climate Change, HM Treasury, 2006, s. 144.*

Today, the EU is a global leader of the green transition. Through exacting standards and new trade deals, the Union has been able to pull other countries and businesses up with it over the last decades. That is also why it is so important that the EU – amidst the crisis – does not embark on short-term emergency solutions that conflict with its ambitious climate goals.

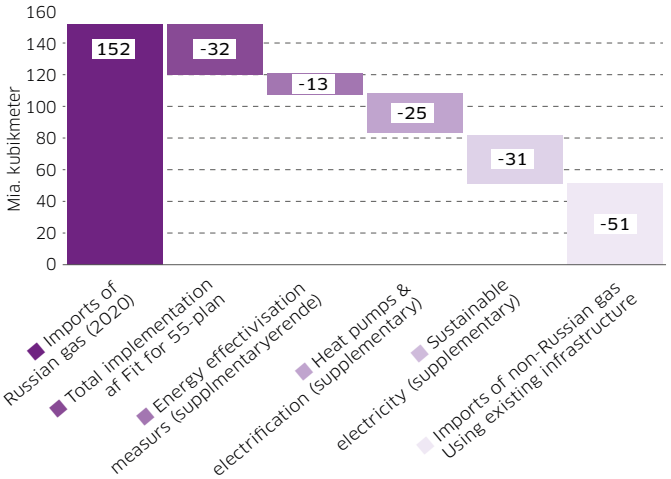
Alternative paths

However, there are serious and economically sound alternatives to the Commission's suggestion to invest temporarily in more liquid natural gas.

For example, the energy think tank Ember has shown that all EU countries can do without Russian gas already in 2025. Also, they demonstrate it is unnecessary to invest in new LNG terminals or to raise coal extraction in EU countries.[27] They argue that two-thirds of the current Russian gas imports can be covered. For that to happen, the EU must cultivate large-scale energy savings, invest more in sustainable energy, and install even more energy-effective heat pumps. Most importantly, the Fit for 55 plan must be carried out. Before 2030, it will ensure a 55 per cent reduction of the EU countries' CO_2 emissions. The plan alone will reduce gas usage by 100 BCM by 2030. According to Ember, extra piped gas from Algeria, Turkey, Azerbaijan and the new Baltic Pipe can substitute the last third of the Russian gas. See the figure below.

EU CAN STOP IMPORTING RUSSIAN GAS IN 2025

Imports of Russian gas will end in 2025 at the latest with the implementation of *Fit for 55* and supplementary clean energy solutions.

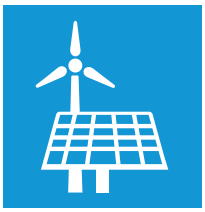


Sources: Analysis by Bellona, E3G, Ember and Regulatory Assistance Project (RAP).

[27] *EU can stop Russian gas imports by 2025. Accelerating clean energy avoids fossil lock-in. EMBER, Bellona, RAP, E3G, marts 2022.*

It is possible to invest far more in energy savings and sustainable energy so one can eliminate the need for Russian energy by 2030. We have done it before. According to Ember, if the EU countries have not increased energy efficiency targets over the last few decades, gas usage would be one-fourth higher today, requiring additional energy imports worth 1.000 TWh. Increased roof insulation alone can reduce energy usage in gas-fired homes by 14 per cent.

As mentioned in chapter 2, this green paper recommends setting high energy efficiency targets in Denmark and the EU. Hence, the total energy savings are equal to the energy in the Russian gas imports. If we simultaneously set ambitious targets for expanding sustainable energy, it will also reduce EU CO_2 emissions by 60 per cent or more by 2030. Also, electrification of the heating sector should be advanced to avoid the fossil lock on which the Commission inadvertently suggests with its suggestion for extra investment in LNG infrastructure. The latter is a short-sighted and non-sustainable solution.



4 The next energy adventure

Sustainable energy is key to freeing us from fossil fuels and creating an economy that emits zero CO_2 in 2050. All future scenarios showing net to zero economies require a massive scaleup of sustainable energy. At the same time, we need to electrify as much of the energy system as possible. This will minimise energy loss and make systems integration easier.

International studies show that it is realistic to electrify up to 80 to 85 per cent of the energy used in the EU – the rest can, for example, be covered by green hydrogen and other liquid fuels produced using sustainable energy or nuclear power.[28] This is the only way to reach the overarching political goal of removing so much carbon from the economy that Europe can have a carbon-neutral society with no net emissions in 2050. However, the road ahead is long.

> "A quick calculation says that if Europe is to fully substitute Russian gas by energy produced using offshore wind, it requires another 500 gigawatt of capacity. The world's total capacity today is 35 gigawatt. And in Denmark, we thought ourselves very ambitious, when we talked about another ten gigawatt in the North Sea. So the challenge is large, but not impossible."
>
> ***Torben Möger Pedersen,*** *managing director, PensionDanmark, at the green paper's kickoff meeting on the 6th of April 2022.*

The Commission's vice president, Frans Timmermans, has said that the EU must build out sustainable energy at warp speed and increase European Green Deal goals. In its REPowerEU-plan, the Commission suggests using €86 billion more on solar and wind power from 2022 to 2030. However, the lion's share of the expansion will be market-driven, as solar and wind power are already competitive with other energy sources. The EU and the member states must simply ensure the correct framework for making it happen.

On the 18th of May, Danish prime minister Mette Frederiksen hosted a disruptive summit in Esbjerg, where the Commission's president, Ursula von der Leyen, took part, together with government heads from Germany, the Netherlands and Belgium. They signed a common declaration, promising that before 2030, 65 GW of offshore wind will be installed in the North Sea and 150 GW in 2050, providing green power to 230 million European homes. This means installing 10,000 windmills covering around 1% of the North Sea. "We are writing European history," tweeted Brian Vad Mathiesen, professor at Aalborg University. The energy summit, which sets the stage for joint investments, can begin a new offshore wind between the four EU countries by the North Sea. This integrated cooperation can, coupled with the European energy grid, strengthen Denmark's energy security.

These plans will require an investment of no less than €135 billion, but private investors queue up to join the new wind adventure in the North Sea.

So the governments do not necessarily need to pay out of pocket for the project. Immediately after the summit, Copenhagen Infrastructure Partners reported their

[28] *Climate Change 2022: Mitigation of Climate Change, IPCC, april 2022, s. 1029.*

readiness to mobilise around €27 billion to build a new energy island on Dogger Bank, 300 km out in the North Sea. They plan to have the first section, an energy island with 10 GW of offshore wind and green hydrogen, operational by 2030. And this is just the beginning.

Based on market forces, one can found a green industrialisation of the North Sea with a potential even higher than discussed at the summit. In a report ordered by WindEurope, analysts from BVG Associates estimate that the entire North Sea – including the British and Norwegian parts – can produce up to 480 GW of offshore wind under the right conditions.[29] Other analyses show even higher numbers – see the box on page 34.

However, moving forwards will require a rethink of the tender and auction models for offshore wind. For several years, governments have auctioned off offshore wind sites at high prices, seeking to wring out extra funds. This has lowered the expansion tempo. The big risk is committing the same mistake as when European governments weakened the value chain of the otherwise so strong European mobile industry through expensive 3G network auctions.

That is why the green paper suggests we rework the tender model. We should develop new concession agreements with high weight on qualitative demands for sustainability, reuse percentages, system integration, development of local value chains, and biodiversity instead of having governments optimise for the highest auction proceeds. Instead of racing to the bottom in brutal price competition where international oil companies underbid the market, we need a sustainability and quality race to foster innovation and strong value chains in the European wind industry.

If authorities in each country parcel large shares of the North Sea for sustainable energy zones, market consortiums can bid on new projects faster. Today, it often takes six to ten years to approve new offshore wind projects because there is much red tape: pre-screening, environmental approval, hearings and appeals, as well as the grid connection itself. With these roadblocks pre-solved, new offshore wind farms can be set up and installed in three to four years.

At the same time, the expansion rate must be sped up by opening for more market-driven innovation in the offshore zones, which governments must quickly choose. See our digital solutions catalogue for concrete and specific proposals for how the Danish state can approach this.

We recommend Denmark increase its national offshore wind development target to at least 30 GW in 2030, which market actors believe is realistic. Together with the announced national targets from the governments of Germany (30 GW), the Netherlands (21 GW) and Belgium (8 GW), the Danish contribution can help ensure that the North Sea will produce at least 89 GW of offshore wind for Europe in 2030. This means 6,000 windmills producing green power for 134 million European households.

Rapid approvals

It is positive that the Commission has suggested several vital changes in EU's directive 2018/2001, improving energy usage from sustainable sources. If implemented, it may cause a quantum leap to ensure quicker approvals in member states, who must within two years zone land and sea areas for sustainable energy. On land, it encourages states to choose already built-up areas, large roofs, parking lots, transportation infrastructure, industrial districts, mines, artificial lakes, and low-yield farmland. At the same time, the Commission emphasises avoiding protected Natura2000 areas and sites on important bird migration routes.

[29] *Our Energy, Our Future. How offshore wind will help Europe go carbon-neutral. Rapport af BVG Associates for WindEurope, november 2019.*

We must guarantee wind and solar farms quick case processing in these new energy zones. Small installations below 150 KW must be approved or rejected within six months. Larger ones must take a year at the most, with an extra three-month allowance for extraordinary circumstances. Public case processing outside the new energy zones must be completed within two years.

The Commission wishes these energy installations to be treated as if in the highest public interest. EIAs must still be performed. However, regarding specific projects, authorities are to emphasise how solar and wind are part of "fighting climate change, reducing energy costs, lower EU dependency on fossils and ensure energy supply," as well as promoting health and security. [30]

Quicker case processing will speed up approval in the member states, regions and municipalities. The Commission aims for at least 45 per cent of European energy supply to come from sustainable sources by 2030.

Accelerated renewables expansion

The Commission wants to reach 510 GW of wind energy compared to the current 190 GW. Roughly, this will require the installation of 13 GW of wind on land or sea every six months until January 1st, 2035.

At the same time, it wants to increase solar capacity from 195 GW today to 320 GW in 2025 and then to 592 GW in 2030 – tripling installed capacity within the decade. A big part of this is to increase rooftop solar adoption dramatically. It suggests requiring all new public and commercial buildings over 250 m2 to be built with solar cells by the end of 2026. A year after, this will encompass all existing public and commercial buildings after this threshold, and before the end of 2027, all new buildings must come with rooftop solar.

Where existing buildings are not suitable, it will be possible to make a power purchase agreement with an external solar developer. Solar energy can also supplant a large share of fossil usage in industry, where heating makes up 70 per cent of all energy usage. In addition, industrial processes up to 500 degrees celsius can be powered by solar.

The Commission's solar and wind energy targets may seem very ambitious, but in reality, much more is needed to accelerate the green transition and avoid unnecessary temporary investments in fossil infrastructure. In fact, the Commission is not ambitious enough and has not seriously done away with business-as-usual.

For example, the new EU target is significantly below the business-as-usual scenario with 672 GW in 2030 presented by the trade association SolarPower Europe before the invasion of Ukraine.[31] This interest organisation believes that the supply chain can bear increasing installation speed bringing installed solar capacity to 1050 GW by the decade's end. See figure on page 34. The required investment amounts to around €700 billion, creating over 1.1 million new full-time jobs in the EU countries.

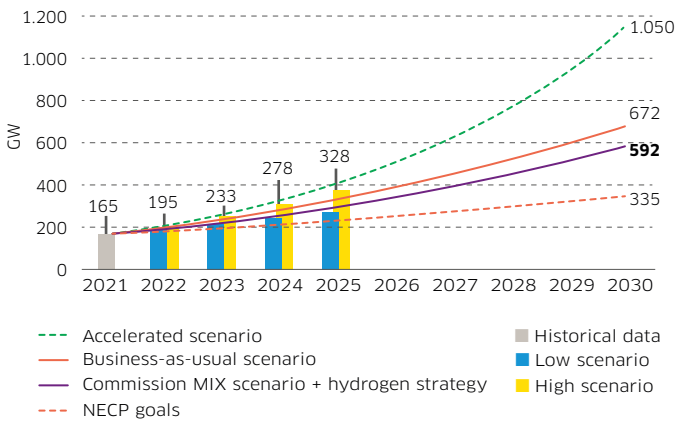
If we can deliver so much extra solar power, we can permanently replace two-thirds of Russian gas imports to the EU. However, if we want to realise the vision of one terawatt of solar capacity in the EU, it requires us to bring forward existing solar projects and, from 2025, set a common EU target of at least 100 GW of new installations each year.

The key challenge is that today, China controls 80 per cent of the solar cell value chain. Suppose the EU is to increase sovereignty and control of its energy supply. In that case, we must make sizeable investments to build a solid European solar cell

[30] *REPowerEU Plan, COM (2022) 230 final, European Commission, 18th of May 2022.*

[31] *Raising Solar Ambition for EU Energy Independence, Position paper, SolarPower Europe, 2022.*

Scenarios for solar installation 2022 to 2030, EU27



industry and create a more robust value chain. Also, the EU must make sustainability demands on the solar panels through the Ecodesign directive, pushing European manufacturers to compete on sustainable design. In the wind industry, Europe already has a well-developed value chain with large and strong windmill producers and many highly specialised subcontractors.

However, increasing the common European goals for sustainable energy on land and sea is not unrealistic. For example, in Germany alone, the government aims to go from 22.6 GW of solar capacity to 215 GW in 2030. In terms of onshore wind, the Germans want to go from 56 GW to 115 GW, while the amount of offshore wind is to quintuple, from 7.8 GW to 40 GW in 2030.

This green paper recommends that we in the EU set a goal of at least 1000 GW of solar capacity in 2030 and increase the Commission's wind goal by 30 per cent to 663 GW. An increase in this order will increase sustainable energy production by 30 per cent more than the energy content of EU oil imports from Russia. We can cover the increased demand for green power for the following years while giving place to expand green hydrogen production.

HUGE RENEWABLES POTENTIAL

The EU countries' potential for expanding renewable is much larger than previously thought, and can cover their energy usage several times over. Calculations by the global consultancy Ricardo Energy & Environment based on the EU's ENSPRESO database show, that the EU27 could potentially produce 4,730 TWh of solar electricity and heating, 7700 TWh of onshore wind energy on land, 7800 TWh of offshore wind and 200 TWh of geothermal energy whilst staying in compliance with the existing zoning and spacing requirements. That is more than twice as much as the estimated total energy demand in the EU countries in 2050 given current energy effetivisation trends.

Source: Renewable electricity requirements to decarbonise transport in Europe with electric vehicles, hydrogen and electrofuels. Ricardo Energy & Environment. Report developed for Transport & Environment, 4th of december 2020.

The chief advantage of solar farms is that they are much quicker to set up on land than windmills, and we can complete new installations in one to two years. However, grid connections are a challenge, as cable size limits transmission capacity. In

Denmark, this has shown to be a real barrier. According to public grid operator Energinet, it often takes two to five years to get solar and wind power connected to the transmission grid, and if the grid must first be reinforced, it can take up to 10 years.

The Commission would like to solve this problem, and it suggests setting aside another €39 billion to improve transmission capacity and the connections between the EU countries. However, the national transmission operators will have to invest several times that.

In total, we must invest at least €585 billion in upgrading the transmission grid by 2030. And if the EU is to increase offshore wind capacity by, for example, a factor of 25, this alone will require investments of over €800 billion, according to the Commission. Of this amount, €500 billion is needed to increase grid capacity. This green paper views this as a positive. We further recommend close cross-border cooperation between the grid operators to ensure cost-effective investment and grid development to help us develop a future-proof and integrated inner energy market.

If we do not upgrade the electrical grid in time, it will be a severe roadblock to the green transition. This roadblock will delay the expansion of renewable energy, so much electricity will still come from fossil sources over a long transition period. We must avoid this under-investment trap.

The quicker we can build up the grid, the quicker we can scale up renewables expansion. In the future, it will ensure large savings on the import of fossil fuels from Russia and other authoritarian states.

RUN THE UNION ON GREEN POWER AND AVOID FOSSIL LOCK-IN.

Recommendations:
This green paper recommends the EU to set a goal of at least 1000 GW of solar power in 2030 and increase the Commission's wind target by 30 pct. to 663 GW. Rapid solar and wind scale-up will allow us to avoid fossil lock-in and associated extra costs. By 2030, Denmark must have septupled onshore green power to 20 and 30 GW of wind and solar, respectively, allowing Danish electricity supply to be driven by renewable energy. At the same time, we suggest rapid scale up of offshore wind in the North sea via new tender models, giving Denmark 30 GW in 2030 and preparing for 65 GW in 2035. Offshore wind should be built to export green power and hydrogen to the rest of the Union.
In Denmark, we should do the following:

1. Speed up case management, approvals and construction of onshore solar and wind power on land and sea. The time required to process, approve and construct a solar power plant on a green field should be kept between six to twelve months instead of two to three years. For land wind, it should be two years at most. The future Danish offshore wind parks should be approved and built faster. Through predetermined energy zones and improved tender procedures, times should be shortened to six to seven years at most
2. Free market forces and private initiative. Make it attractive for citizens, farmers, businesses and municipalities to sell energy to the grid through plus energy houses and sales of surplus sustainable energy from roof and field projects. We need a prosumer revolution, where more actors become energy creators and contributors to

the common grid. This bottom-up approach can free a massive amount of resources. At the same time, it will create a more robust energy system if many small decentral energy producers can supplement the large, central sustainable energy farms and infrastructure. Electric car batteries should also be integrated as storage capacity in a new, integrated, intelligent energy system.

3. Before the end of 2022, the Danish government should create a master plan, setting aside swathes of the North Sea for new offshore wind projects and energy islands, allowing at least 65 GW of offshore wind in the North Sea by 2035. The data is already there.
4. Before the summer of 2023, the Danish government should commence a cluster tender for 10 GW of new offshore wind in the North Sea, where consortiums can bid to lease the area for 40 years. Implement a new profit-sharing model so the consortiums do not have to pay the state beforehand. Inspired by the carbon dioxide tax, a running profit share can be established. In parallel, open a track for more market-driven offshore wind establishment in extended North Sea zones. Before the end of 2022, the government should furthermore set aside areas for new greenfield sites, where the market can develop new, innovative energy projects within offshore wind and PtX. This should ensure at least 10 GW more offshore wind by 2030 or 2031.
5. Avoid a race to the bottom in the Danish offshore wind adventure, where competition occurs at the lowest possible price. In Denmark, we should compete on quality, environmental standards and innovation. The next generation of offshore wind in the North and Baltic Seas should emphasise system integration, and quality standards should be established in regards to measurable life cycle CO_2 emissions, a 40- to 50-year minimum lifetime for the windmills, resource usage, local supply, biodiversity and more.
6. Increase investment in the power grid, allowing connections by new wind, solar and PtX plants, energy islands, and that the green transition will not be further hindered. As a public Transmission System Operator, Energinet should take social responsibility and invest in front of the curve, recognising that grid demands will skyrocket during the transition and electrification processes. Also, investments must be made in new distribution networks supporting the new wind and hydrogen adventure in the North Sea.
7. In the EU, the Danish government should work towards an expansion of the European energy union, allowing green power to flow freely and become the fifth tenet of freedom in the inner market. The EU should more than quadruple its solar and wind power production by 2030. Also, the commission must strike decisively against national grid operators practising electrical border controls and shutting down ongoing transmissions from other member states.

Green hydrogen is the missing link

We can go far with increased electrification and renewables investment, but some processes are very difficult to electrify because of storage, mobility or sheer energy demands. These areas are most often found in maritime businesses, long-distance air transport, and energy-dense industrial processes.

Green hydrogen is the missing link which can help us transition to a carbon-neutral economy in the future. In Power-to-X plants, electrolysis, which can be performed with captured carbon dioxide or nitrogen, can extract hydrogen from water. Thus, we can produce hydrogen using renewable energy, creating energy-dense, next-generation e-fuels for sea and air transport as well as industrial processes. Also, it is possible to create green ammonia for chemical products and fertiliser. It is critical for the green transition that the electrolysis is as effective as possible, promotes circular energy usage with captured carbon, and, where possible, sends waste heat into the district heating system.

In Denmark, interest in PtX and increasing green hydrogen production has flourished in recent years. In 2021, Danish politicians presented their long-awaited PtX strategy. With a revised deal made across the political spectrum in March 2022, the Danish state has set aside €170 million for PtX development over the next ten years. The idea of the agreement is to increase synergy between PtX products and the rest of the energy system, creating a base for quickly industrialising and upscaling Danish PtX production.

The politicians have also aired the idea of changing the electrical duties paid by PtX producers to accelerate investments in developing this new export adventure. Especially challenging are the cost duties which make it more expensive and difficult to construct PtX installations. We should optimise duties to promote the construction of PtX plants near areas with large current or future green energy production – coupled directly to the grid or by developers producing PtX directly from renewables in a closed system. Energinet prefers companies to place power-intensive production like PtX where it can be connected directly to the grid. However, high duties have caused leading Danish PtX producers to move their production to countries with lower duties and cheaper electricity.

> "With the history Denmark has for going first as a country, we should be much more ambitious."
>
> ***Jens H. Binger,*** *Head of Investor Relations, Green Hydrogen Systems, at the green paper's kickoff meeting on the 6th of April 2022.*

In the 2022 to 2026 period, the Danish politicians have also set aside €7.6 million for supportive initiatives including a PtX taskforce and a secretariat in the Danish Energy Agency meant to guide project developers and authorities. However, it is not only the Danish state which sees opportunities in green hydrogen. Several companies and developers are building PtX plants around the country, and existing projects can reach 7 GW of hydrogen/year by 2030. Furthermore, a political agreement will ensure an extra 4 to 6 GW of PtX before 2030. Production of, for example, 10 GW of hydrogen will require the production of up to 50 TWh of green energy, which the Danish Energy Agency calculations have not factored in. We must have enough green energy for the increasing Danish production via electrolysis.

The newly inked Esbjerg deal between Danmark, Germany, Belgium and the Netherlands regarding 65 GW of offshore wind from 2030 and at least 150 GW in 2050

can open for far greater production of green hydrogen on the new energy islands, which is a step essential to providing for the European market in the future.

Green hydrogen is also prominent in the EU, which is positive. It has been a few years since the Commission presented a joint hydrogen strategy. With REPowerEU, it is setting targets for green energy expansion, which will more than double the 2030 hydrogen target to 100 GW of electrolysis capacity.

The Commission's proposal can help speed up the development of a competitive European green hydrogen industry. The International Energy Agency assesses the EU can achieve the capacity to produce 10 million tons of hydrogen or ammonia yearly by 2030[32]. To put these numbers in perspective, this requires around 18 per cent of the EU's current electricity usage. For example, it would require 110 GW of offshore wind to deliver enough energy for the new European PtX facilities. It also requires a significant financial outlay, as the Commission estimates investments on the order of €335 to 471 billion to reach the capacity to produce 10 million tons of green hydrogen, and two-thirds of this money will go to building enough sustainable energy to power the facilities.[33]

According to the EU's 2020 reference scenario, the capital cost of green hydrogen is €1600/KW. Through innovation, the cost may be lowered to around €200/kW. Periodic costs are estimated to around €200/KW, but they are expected to be gradually lowered to around €10/KW.

Green hydrogen is still an immature technology under development, and that is a challenge. At the VILLUM Power-to-X Accelerator at DTU, which works with integrating research and market developments, they assume a six to eight year research horizon before it is possible to say definitely how best to upscale green hydrogen production in Denmark and Europe.[34] Globally, there is only 0.5 GW of electrolysis capacity, and work is still ongoing to improve energy input efficiency and minimise the leaks that may otherwise lead to climate damage. There is no direct CO_2 emission, but leakage can have an indirect climate effect, as hydrogen mixes with oxygen in the stratosphere and becomes water vapour, increasing global warming.[35]

We still lack a proper certification process and common European standards for when hydrogen can be marketed as green. We should make precise quality demands for facility construction, carbon dioxide capture, and sector integration in terms of storage, delivery and usage of green hydrogen and liquid chemicals for heavy transport or large-scale production. Already, there are many ongoing initiatives from Danish and European decision-makers and private actors. The green paper recommends proposals and actions in the following areas:

[32] *The Future of Hydrogen, Technology report 2019, IEA. According to the IEA, 70 million tons of electrolytic hydrogen produced from sustainable energy requires 3600 TWh of dedicated electricity. The Commission estimates that 500 TWh of sustainable energy is needed to produce 10 million tons of green hydrogen..*

[33] *Implementing The REPowerEU Action Plan: Investment Needs, Hydrogen Accelerator and Achieving the Bio-Methane Targets. SWD (2022) 230 final, European Commission, 18th of May 2022, p. 28.*

[34] *PtX-day at Mandag Morgen on the 19th of May 2022.*

[35] *Hydrogen, the Double-Edged Sword in the Climate Change Story, Open Mind, BBVA, 30th of November 2021.*

GREEN HYDROGEN CAN BECOME A DANISH EXPORT ADVENTURE

Recommendations:

1. More money should be allocated for R&D in high standards for green hydrogen and PtX production, minimising leaks, certifying quality and complying with sustainability requirements.
2. The Danish hydrogen industry should be given better economic conditions and subsidies, allowing high-quality green hydrogen to become a new Danish export adventure towards 2050. Industry conditions should be comparable to those in neighbouring countries.
3. A new common infrastructure with large gas pipes should be developed to distribute hydrogen to our neighbours – including setting aside suitable areas for PtX factories, where excess heat can be reused for district heating.
4. Money should be set aside in the EU for a common standardisation of green hydrogen and PtX production, guaranteeing quality and sustainability now and as the industry grows.

5 Free us from fossil distortion

A vital prerequisite for accelerating the transition from fossil fuels is to price in all negative externalities of environmental contamination and CO_2 emission. Unfortunately, many of the European fossil economy's side effects are not priced correctly today. For example, up to 400,000 Europeans die early each year due to air pollution from fossil fuel burning,[36] the equivalent of over 4.5 million lost years of life. If we can reduce these deaths by 40 per cent, this equates to health care savings on the order of €200 billion a year as calculated by the Commission.

In January, the European Court of Auditors (ECA) published a report showing how the EU countries' taxation policies are not congruent with the joint climate goals.[37] Together, the member states give €55 billion a year in direct fossil subsidies. Other economic studies have shown that the amount may be as high as €95 billion a year, including indirect support. In the last half a year, some EU countries have even increased subsidies to compensate consumers and businesses for the rising energy prices.

Over half of the subsidies go to the energy and transport sectors. The Court points out that many member states tax coal less than natural gas and that they tax some fossil fuels lower than electricity. In 15 EU countries, fossil fuels still get more subsidies than renewable energy sources, which hurts the green transition. As a result, the current energy taxation directive should be revised. One way forward could be to advance the date when all fossil subsidies in the EU must be phased out from 2025 to 2023. At the same time, they could encourage member states to make green duty and tax reforms, increasing taxes on pollution.

This can give companies and citizens better economic incentives to save energy, invest in energy-efficient technology, renovate their buildings, and exchange their combustion cars for electric cars.

Reform the emissions trading system

A positive trend is that allowance prices in the EU's emissions trading system (ETS) have increased fourfold in the last three years. With prices around €80 to 90 per ton of CO_2, green investment has become more attractive, everything else being equal. In principle, the quote system covers emissions from electricity and heat production, large industrial and steel plants, oil and gas extraction, and a lot of European air traffic. However, there are still many free allowances, distorting the market. Air traffic and energy-heavy industry must only purchase a fraction of their CO_2 allowances, and others, like the maritime trades, are entirely free. Thus, only half of EU countries' CO_2 emissions are covered, creating a massive market distortion. As substantiated by the ECA, gratis allowances have delayed climate investments in industry.

The EU institutions are currently negotiating a reform of the ETS, hopefully allowing a quicker end for the no-cost allowances. Buildings and road transport will gradually be covered, and the free allowances for sea and air companies are likely to be phased out. The European Parliament is pressing for the gratis allowances to be phased out between 2026 and 2030, and that maritime business will lose them already in 2027. Unknown as the final compromise is, it is still very important to ensure a high reform speed, so as many free allowances as possible can be phased out quickly, levelling the market for all sectors.

[36] *European Environment Agency, Air quality in Europe — 2020 report, p. 107-108. Burning fossil fuels leads to increased emission of PM2,5 particles and NO2 gasses, which are thought to cause 379,000 and 54,000 early deaths in 2018, respectively.*

[37] *Energy taxation, carbon pricing and energy subsidies, European Court of Auditors, January 2022.*

The Commission has created unnecessary unrest regarding the allowance system in the middle of everything. To raise €20 billion to finance REPowerEU, it wants to sell off extra allowances on the ETS market extraordinarily, equal to 250 million quotes at current prices. The suggestion caused an immediate price drop of over ten euro per ton.

We must avoid this kind of emergency intervention and supply shock. It is much better to reform the allowance system at once, creating long-term clarity for market actors. Research shows that if most no-cost allowances are removed, all sectors included, and allowance prices are increased, the proceeds can be up to €50 billion annually.[38]

We should reinvest the money in the green transition. Part of the proceeds could, for example, go to an EU green transition fund, helping energy-heavy industries by investing in cleaner technology, sustainable energy and innovative solutions so that they can compete on the new, green market conditions within a few years.

Besides the coming emissions trading reform, all member states should pass green tax reforms, ensuring high floors under CO_2 emissions for all sectors. Such a CO_2 tax should reflect the social costs of the pollution and be fair and transparent. As a minimum, one should ensure that businesses pay at least €160 to 200 per ton, including EU carbon allowance costs.

To avoid carbon leakage and job loss to countries outside the EU, it is also important to implement a CO_2 tariff on the outer borders – the so-called CBAM. In March, the Council approved a set of general principles for this tariff, which will cover imports of iron, steel, cement, fertilizer, aluminium and (fossil fuel-derived electricity, which all are carbon dioxide heavy. Still, a number of technical difficulties must be solved during the negotiations in the European Parliament and Commission, and it is not known when the new tariff will be phased in. If an agreement is reached on removing the free allowances in the ETS and establishing a CO_2 tariff on the border, it will seriously increase the speed of the green transition in Europe.

Everything else being equal, this will make full chain energy savings more attractive. At the same time, it can lead to far greater investment in energy sources with no or low CO_2 emissions in their whole lifecycle.

Nuclear is not the right fit

Some argue to expand nuclear power in Europe because it can deliver stable carbon-neutral power. As a result, some EU countries, such as France, Belgium, Spain, Poland and Hungary, are building new nuclear power plants. However, in recent years, nuclear power installations have stagnated in Europe because of high initial capital costs, causing a poor ROI.

University of Munich, September 2020.

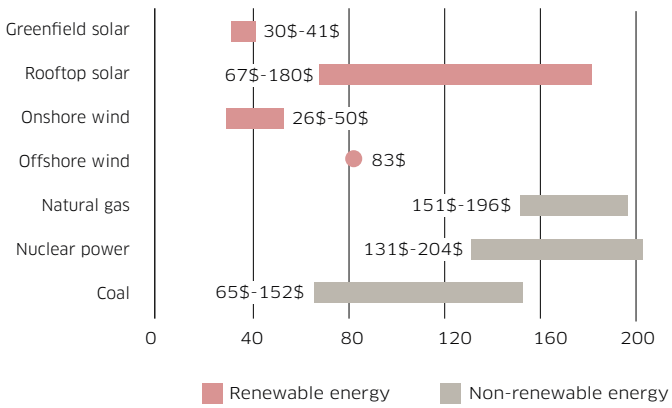
We view the growth potential of nuclear as limited. It does not free us from Russian dependence, as more than 20 per cent of enriched uranium for European nuclear power plants come from Russia, and a further 20 per cent from Russian ally Kasakhstan. Electricity production from European nuclear power plants has fallen steadily over the last decade, and it typically takes 14 to 20 years to build new plants. It took 16 years to build the new Olkiluoto 3 reaktor in Finland, and it was only running 21 years after it was first licensed. Renewable energy sources like solar and wind power are much quicker to build than nuclear power and are more attractive solutions to decouple us from fossil dependence and act on global climate issues.

[38] *Clemens Fuest and Jean Pisani-Ferry, Financing the EU: New context, new responses. EconPol Policy Report, No. 24, Ifo Institute – Leibniz Institute for Economic Research, University of Munich, september 2020.*

The nuclear industry will require much innovation if nuclear is to be attractive again. In recent years, the price of nuclear power has risen rather than fallen. According to the consultancy, Lazard, new nuclear power plants cost four to five times as much as onshore wind over their life cycle, five times more than greenfield solar and around twice as much as offshore wind. See the figure below.

While solar and wind prices continue to fall in the coming years, it does not look like nuclear power will become an economically attractive alternative for the European energy supply. Excepting new technological innovations, we expect that atomic energy will at most supply 8 to 12 per cent of the total energy used in the EU countries.

PRICE OF VARIOUS ENERGY SOURCES $/MWH



Calculations of total production costs of new power plants. Levelised Cost of Energy – LCoE. This is a comparable number for total development, capital, financial and lifetime costs without state subsidies.

Source – Lazard, 2021.

Make ready for the great electrification

Demand for green power will increase markedly in the coming years. Most of the transport sector – except shipping and long-distance air traffic – stands in front of a wave of electrification, which also propagates to heavy industry, farming, and heating systems. We can do it much faster than earlier estimates have suggested. The shock of Putin's war and the soaring gas and oil prices may lead to installing 30 million heat pumps in Europe.

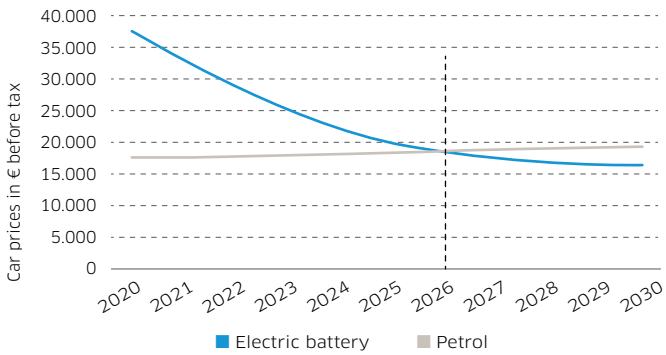
Many companies and district heating providers want to install industrial heat pumps to free themselves from gas vulnerability. Due to high prices at the pump, consumers will advance any plans of replacing their old combustion vehicle with an electric one.

Market analysis shows that Europeans have started to replace their petrol and diesel cars much faster, and this may only be the beginning. The Commission and a majority in the European Parliament's environmental committee want to stop sales of combustion cars from 2035.

As soon as this expiration date becomes law, it will further increase European mobility electrification. Moreover, several analyses show that electric cars will compete with combustion cars on price from 2026 or 2027. See the figure below.

The main reason is that battery costs are falling rapidly – one unit of lithium power storage is 90% cheaper than in 2010. We can accelerate fossil freedom if the EU already stops sales of new combustion cars from 2030.

ELECTRIC CARS WILL BECOME CHEAPER THAN COMBUSTION CARS IN 2025 TO 2027



Source: BloombergNEF: Hitting the EV inflection Point, 2021

Politicians should start preparing for a transport revolution occurring within the next ten years, where not only cars, but also mopeds, motorbikes and trucks will be electrified. In addition, short-distance ferries and aeroplanes will also likely begin to be electrified. At the same time, intercontinental air transport and maritime shipping will still need liquid fuels such as ammonia, e-kerosene or hydrogen.

The coming transport revolution can increase the demand for electricity in the EU. An expert report shows that fully electrifying road and rail requires an extra energy supply of around 2400 TWh.[39] This is equal to approximately 17 per cent of current EU energy usage, which will, in isolation, require at least 633 GW extra wind power, or 42,200 of the largest offshore windmills.

Moreover, the report shows that an increased hydrogen share in future mobility may further increase energy usage to 2800 TWh. The more transport we can electrify, the smaller the energy loss in the system as a whole.

Another reason why we need a massive scale-up of sustainable energy.

A new vision for future European energy

For the EU it is both technically and economically feasible to to perform a faster and more thorough transition to a sustainable energy system without fossil fuels. This is also as anticipated by the Commission's plans and in the Fit for 55 programme. Today, over 68 per cent of the EU countries' collective energy usage comes from fossil fuels, but by 2040 to 2045, all fossil fuels should be removed from the energy supply and replaced by zero-emission power sources.[40] For the sake of the green transition, coal power should be retired by 2030, and all new investment in fossil infrastructure should be stopped. If these policies are implemented, it might bring the EU on course for a 65 per cent reduction in CO_2 emissions towards 2030.

By 2040 to 2045, at least 85 to 90 per cent of energy supply should come from renewable sources. At least 85 per cent of this energy should be sent directly into the grid, while the rest is used to produce green hydrogen and chemical fertilizer in Power-to-X plants. Hydrogen and the district heating network may provide extra stability where sustainable energy fluctuates with wind and weather. The growing fleet of electric cars can, at the same time, provide extra battery capacity

[39] *Renewable electricity requirements to decarbonise transport in Europe with electric vehicles, hydrogen and electrofuels. Ricardo Energy & Environment and Transport & Environment, 4th of December 2020.*

[40] *See. Building a Paris Agreement Compatible (PAC) energy scenario, CAN and European Environmental Bureau, June 2020, among others. The PAC project is sponsored by the German finance ministry.*

that households can draw upon in the morning and evening so as not to overload the network.

The EU countries have enough renewable energy potential within solar, wind, hydropower, and geothermal heating to create a fully self-powering energy network. A group of researchers at Stanford University have calculated that the 143 most energy-consuming countries – including all 27 EU members – can technically and economically transition their entire energy supply to solar, wind and hydropower already by 2030.[41] However, for social and political reasons, the researchers suggest that the countries set a target of at least 80 per cent renewable energy in 2030, with a goal of total renewable usage in 2050. It is probably unrealistic that EU countries can increase sustainable energy that much in the 2020s. But if one already now speeds up renewable installation tempo and keeps it high over the 2030s, we can, in 2040 to 2045, be free of fossil fuels. In Denmark, this should be possible already from 2040. Market actors will speed up development when economic incentives and frameworks are first in place.

The Stanford experts' calculations say that a total investment of €5.2 trillion is enough to build an energy system powered by renewables only. Instead of seeing this as a cost, politicians should see it as an investment in future security and energy self-sufficiency.

It may sound like a lot of money, and some politicians will run away screaming. But, in reality, it is not much more than what the EU and the member states set aside for economic rescue- and stimulus packages during the Covid-19 pandemic. It should be possible to mobilise a similar amount over the next five to ten years to lay the groundwork for a European energy system free from the whims of authoritarian regimes who do not share our democratic ways and threaten our safety. Also, the transition will be a good investment in terms of economics and employment.

An investment in future savings

The Stanford experts have calculated that a fully renewable energy system uses 57 per cent less energy than fossil business as usual. As a result, such a system costs less than the fossil alternative and creates considerable healthcare savings due to lessened pollution. More than that, the transition will create a net total of 28 million new, long-term full-time jobs in Europe compared to our current model. Moreover, according to the scientists, total private sector energy costs will be 61 per cent lower towards 2050 if we focus on renewables instead of fossil fuels.

When laying the final plans for developing a sustainable energy system in Denmark and the EU, one should price in the positive economic effects of reduced air pollution, healthcare savings and lessened future climate damage. Beyond this, the EU countries can save over €400 billion a year on fossil fuel imports. For some time, extra materials imports will be required to produce windmills, solar panels and components for energy-saving systems. However, through the EU, we can gradually increase demands for recycling and circular production principles to bring down these costs.[42]

The consultancy McKinsey & Company has also simulated a scenario until 2050, where over 80 per cent of the EU countries' energy comes from renewables, and significant cleantech investments are made. Even though the new sustainable solutions seem to require high initial investments, the EU countries will save €130 million in annual operation costs.

The status quo is an unrealistic, unsustainable strategy. Even business-as-usual scenarios with more fossil fuels will require considerable investment in the com-

[41] *Mark Z. Jacobson, Mark A. Delucchi, Mary A. Cameron, Indu Priya Manogaran, Yanbo Shu and Anna-Katharina von Krauland, Impacts of Green New Deal Energy Plans on Grid Stability, Costs, Jobs, Health, and Climate in 143 Countries. One Earth 1, 20th of December 2019, p. 449-463.*

[42] *How the European Union could achieve net-zero emissions at net-zero cost. McKinsey, 3rd of December 2020.*

ing years. A large part of the European energy network is old and run down, requiring large investments either way.

All in all, it will be cheaper for us to go on the offence and invest in future-proof solutions rather than cling to expensive short-term solutions or patching up existing fossil infrastructure. Through rapid upscaling of investments in renewable energy and energy-efficient technology we can simultaneously free a new wave of green innovation and new business models. By implementing this green paper's recommendations, Denmark can go first, inspiring the whole EU to become free from fossil energy quicker.

A more detailed solution catalogue with 130 concrete action proposals accompanies the green paper. Together, the solutions will ensure that renewables on land cover Danish electricity consumption entirely by 2030, so we can start a great export adventure with offshore wind and green hydrogen from the North Sea. At the same time, we can take a decisive step toward creating a new, sustainable energy system and a climate-safe zero-emission society, where all Denmark's energy comes from renewable energy in 2040.

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Notes

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