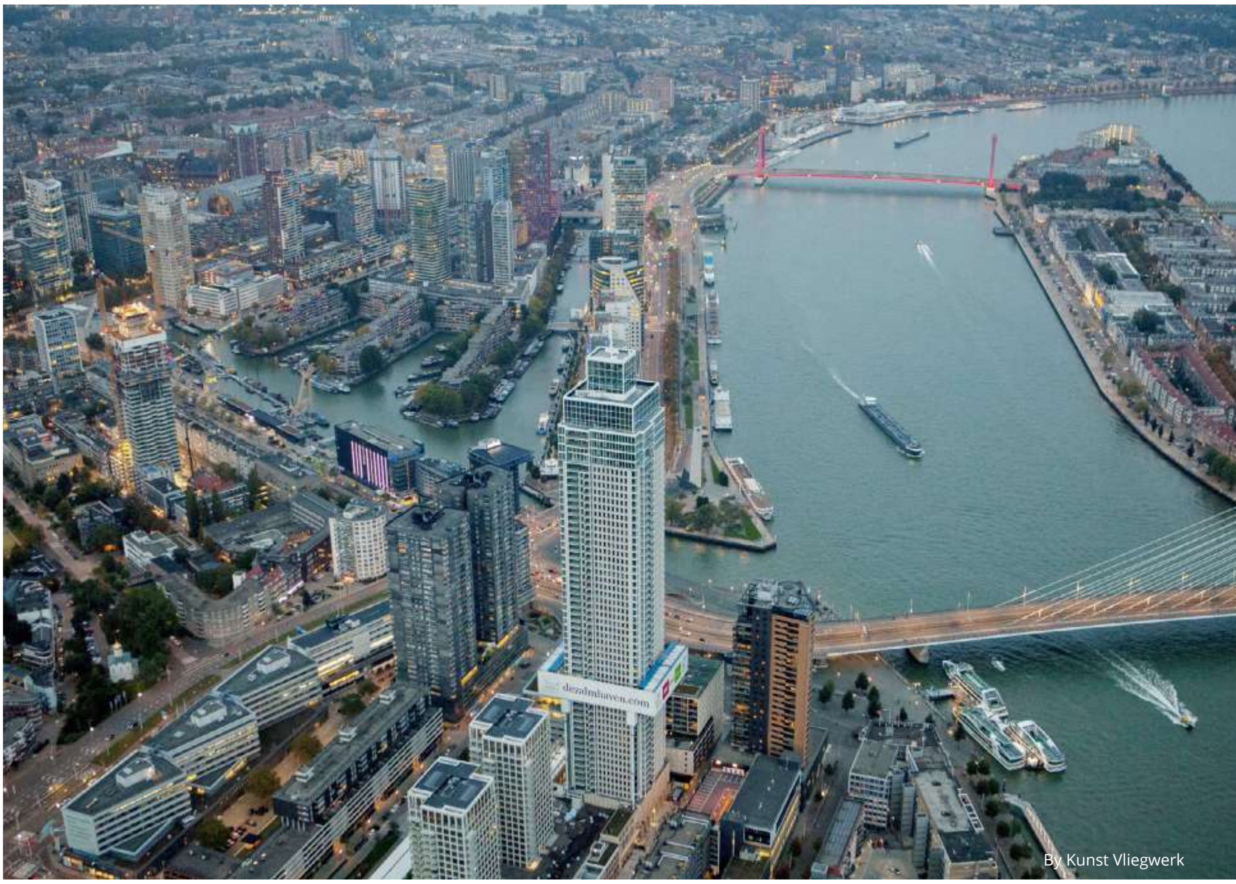
WORLD ENERGY COUNCIL | THE NETHERLANDS



By Kunst Vliegwerk

SHOWING ALL ELEMENTS OF THE ENERGY TRANSITION

ABOUT THE WORLD ENERGY COUNCIL

The World Energy Council is the world's oldest independent and impartial community of energy leaders and practitioners. Through our Humanising Energy vision, we involve more people and communities in accelerating clean and just energy transitions in all world regions. Formed in 1923, the Council has convened diverse interests from across the full energy ecosystem for a century, and today has over 3,000 member organisations and a presence in nearly 100 countries. Our global network draws from governments, private and state corporations, academia and civil society, as well as current and future energy leaders. We effectively collaborate on impact programmes and inform local, regional and global energy agendas in support of our enduring mission: to promote the sustainable use and supply of energy for the benefit of all people.

The Council convenes leadership dialogues including the World Energy Congress to enable new collaborations and drive impact; and provides a range of practical tools including the World Energy Trilemma Framework to define, support and better manage energy transitions.

Further details at www.worldenergy.org and on LinkedIn and Twitter.

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Registered Office Stichting Energieraad Nederland Bredaseweg 406
5037 LH Tilburg
The Netherlands
bestuur@wereldenergieraad.nl
Phone: +31(0)653106348

Introduction

Taking into account a wide range perspectives and interests is needed

To keep us on our unprecedented steep path towards carbon neutrality, it is important to measure progress of the energy transition credibly, consistently, and comprehensively. Traditional project evaluation, mainly focusing on meeting deadlines and achieving financial results, fails to do that. The current energy transition challenges demand more. But measuring progress credibly, consistently and comprehensively raises the question of what exactly constitutes progress. An engineer might refer to the technical feasibility and technological advancements. A banker might focus on the profitability and financial viability of the project and the business model. A voter might be more interested in seeing the potential job creation or even the impact energy related projects can have on electricity and heating costs.

We interviewed key stakeholders involved in the energy transition to better understand how to do it

We tried to address exactly the question of how to take into account different interests and perspectives in a comprehensive, measurable and clear framework for evaluating energy transition projects. To achieve this, we interviewed fifteen key stakeholders involved in either one or more of four projects or in the wider energy transition. Our goal was to better understand what different perspectives should be incorporated and how to do it, to know the challenges they are facing and to share the learnings that can be useful for others.

We focused the interviews on four different projects in and around Rotterdam

To focus the mind and make the objective concrete and practical we selected four key projects located in and around Rotterdam, home of Europe's largest port and a highly energy-intensive industrial complex, and a city with over a million citizens in the larger area. Thus, it is facing some of the most intense challenges when it comes to becoming carbon neutral. But at the same time it is already very progressively on its way to achieve the net-zero goal, and, in that sense, is a hot-bed for energy transition projects. Not coincidentally, Rotterdam will host the Global WEC conference in 2024.

We chose to focus the interviews on the following four projects because each one represents one of the four pillars of the future energy system:[1]

- One in the production of green energy: Vattenfall's offshore windfarm **Hollandse Kust Zuid**.
- One that will convert wind energy into green hydrogen, essential for the transition to an energy system with intermittent renewable power and a need for green molecules: Shell's green hydrogen plant **Holland Hydrogen I**.
- One that will transport and store CO2 emitted by the industry in depleted gas reservoirs in the North Sea, allowing the industry cluster to reduce CO2 emissions while transitioning to greener sources of energy: **Porthos**.
- And one that allows residual heat produced in the Port of Rotterdam to be used to heat homes and business in the province of South Holland: **WarmtelinQ**.[2]

[1] The 4 fundamental pillars (CO2, heat, hydrogen and electricity) are based on the new Dutch coalition agreement ('Coali tieakkoord 2021-2025: Omzien naar elkaar, vooruitkijken naar de toekomst' (15 december 2021))
[2] A more detailed description of these projects can be found in the Appendix

In this document we summarized the key insights we retrieved from the interviews

We report our findings structured around what we call six pillars: Environmental, Social, Governance, Technological, Financial and Energy Security. In the tradition of the World Energy Council the Netherlands, the work has been carried out by a consortium of institutes – see page 2.

The considered pillars have been gaining importance for project owners recently and are starting to be part of the key performance indicators. In the image below, we suggest categories that compose each of these pillars and can serve as a starting point for the development of a measurement framework. It emerged from various interviews that a variety of non-traditional indicators are already currently monitored in the four projects. For example, in Holland Hydrogen I, next to cost-effectively producing green hydrogen and realizing CO2 emission reduction, also factors such as circularity, job creation and the local ecosystem are considered. While at the start the main focus was on the traditional technical and financial points of view, over time other aspects were incorporated and became important in the project narrative. This emphasizes the necessity of measuring from a broader perspective.

Environmental

- Greenhouse Gas Emissions
- Nitrogen Emissions
- Land and Water Use
- Green Building

Social

- Job Creation
- Community relations and Impact
- Energy Accessibility and Affordability
- Ethical standards

Governance

- Environmental and Social Impact Reporting
- Governance Transparency
- Accessibility to external parties
- Permitting progress

Technological

- Competitive Edge
- Tech Multiple Effect
- Scalability
- R&D Investment

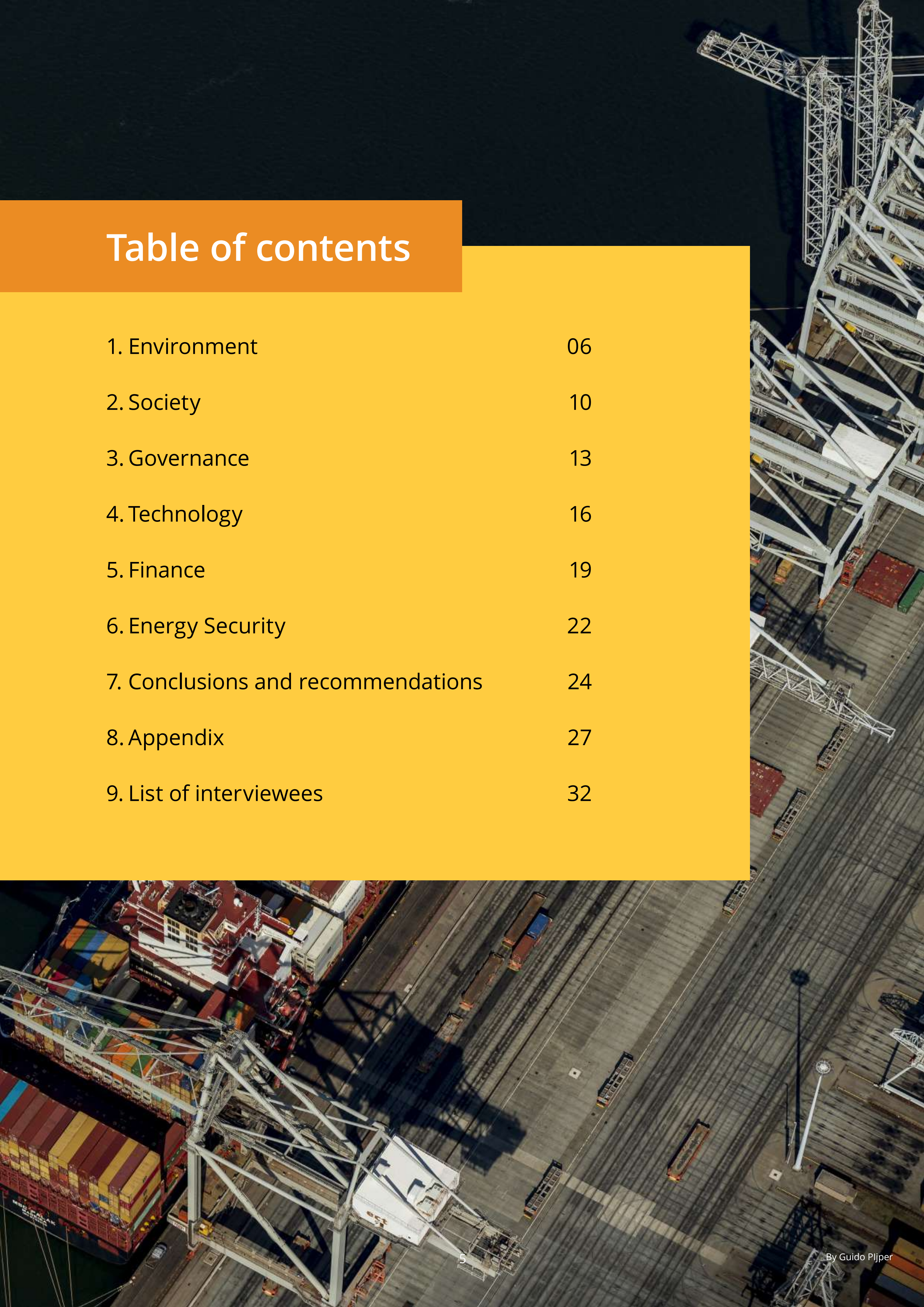
Financial

- Security of Funding
- Profitability
- Risk / Reward
- Project Progress

Energy Security

- Dependency on International Supply Chains
- Contribution to Energy Security

> “If you want to develop an energy transition project, you really need to show this in all elements you do.”
>
> Lijs Groenendaal, Project Leader of Holland Hydrogen I



By Guido Pijper

Table of contents

1

Environment

By Claire Droppert

Environment

In the **Environment** pillar, we suggest considering the impact that projects will have on GHG emission reduction, nitrogen emissions, water and land use and biodiversity.

The direct impact on CO2 in the atmosphere is one of the key parameters, but does not tell the whole story. Some projects in themselves are not expected to have huge impacts on this dimension, but can still play significant roles in the energy transition. For example, although WarmtelinQ is unique in its scale, **direct CO2 reduction** will be relatively limited compared to a Carbon Capture and Storage (CCS) project. That does not mean that the project is not valuable for the energy transition, but other indicators are needed to measure the full impact of the project in the broader sense.

CCS is a necessary **intermediary step** towards the reduction of CO2 emissions. It will have a critical role for the Netherlands and other countries to achieve Paris Agreement targets and potentially compensate for emissions necessary to guarantee flexibility in the coming years. Also, in the longer term we need negative emissions, where CCS can also play a role.

“CCS is a necessary intermediary step towards greener solutions. We probably do not want CCS in fifty or sixty years, but we need it to limit the consequences of CO2 emitting in the short and medium-run.”

Wim van Lieshout, Project Director of Porthos


By Claire Droppert

Without Porthos, it will be very hard to achieve the Dutch climate targets. CCS is an important tool to make quick steps in decarbonisation of hard-to-abate industrial processes. A similar role is identified in other CCS projects, such as Northern Lights in Norway. There, CCS is relevant to compensate for emissions of waste incineration and the cement industry and is an important element in realizing the Norwegian government’s climate goals.

Other technologies might also play important roles during transitory phases. **Blue hydrogen** might be necessary for some period of time, as truly green hydrogen production is only possible when there is an (intermittent) abundance of renewable energy.

Water and land use are other dimensions that will be included. Water availability and usage can be critical for hydrogen projects. Many might require large amounts of water desalination that can drive up costs. In water stressed countries, where many hydrogen projects are planned, the issue is even more important.

We also consider the environmental impact of **project construction** and **material usage**. In this dimension, **recycling** can have a significant impact. Often highlighted in the interviews is that we need recycling to cut emissions and also to guarantee supply of materials, reducing import dependency. New business models might emerge to help in this. Wind turbines, for example, could be leased instead of sold, creating incentives to increase circularity. Also increasing the lifetime of a wind farm, to for example forty years, could help to make more **sustainable designs**. There is still a long-way to go to make the supply chains more environmentally friendly.

The energy transition is not only about increasing renewable power generation, but also balancing it with **security and affordability** from an energy system perspective. Increased renewable power generation might not necessarily lead to lower emissions if we use too much oil and gas to address demand and supply flexibility.

“Incorporating sustainable building in project planning, as is being done in Holland Hydrogen I, is a new approach for Shell that can play a bigger role in the future.”

Lijs Groenendaal, Project Leader of Holland Hydrogen I

“Our current thinking is too narrow. We should consider the energy transition from an overall system perspective.”

Ronald Huisman, Associate Professor at the section Finance at the Erasmus School of Economics


By Worcflow

The Dutch Nitrogen Crisis and the Energy Transition

Nitrogen emissions are harming the environment. Other regions in Europe are also struggling with the harmful effects of reactive nitrogen (mainly ammonia and nitrogen oxides), but the problem is particularly salient in the Netherlands. The Dutch policy was ruled insufficient to comply with the European Habitats Directive by the Council of State, the Dutch highest administrative court, in 2019. Since then, the Netherlands has had a de facto ban on new activities that emit nitrogen. The new Nitrogen Act (July 2021) forms the legal foundation of the current nitrogen policy. This law stipulates that nitrogen emissions must be reduced by 26 percent in 2030 and fifty percent in 2035 compared to 2019.[3]

But the Dutch government gave exemptions from limits on ammonia and nitrous oxide to projects under the argument that emissions during the construction phase are just temporary. This allowed the construction sector to keep running. An environmental group contested the exemption given to the Porthos project. On the 2nd of November 2022, the Council of State ruled that the exemption violated European Law[4] and if a construction project results in nitrogen emissions, even if they are temporary, this has to be included in the environmental impact assessment. The ruling is likely to affect major construction projects across the Netherlands.

Our interviews were conducted before the Council of State ruling, but Nitrogen permits were a recurrent subject. The factor holding the Final Investment Decision (FID) for Porthos is that an irrevocable permit on Nitrogen had yet to be given. In the current high-inflation environment, there is the question if existing construction price offers remain valid in case of delays. If not, significant price increases for materials and construction may result.

[3] Pricing can help solve nitrogen problem
[4] Dutch court carbon capture project ruling alarms building sector

“

Any major construction project will emit nitrogen, even those that aim to reduce CO2 emissions, but there is no mandate in the Dutch Government to balance nitrogen to carbon impact and this creates uncertainty.

Wim van Lieshout, Project Director of Porthos

“

With a negative outcome for Porthos, WarmtelinQ and the rest of construction in the Netherlands would not make any progress. This would eliminate the possibility of more than compensating for nitrogen emissions over the lifespan.

Hans Coenen, Vice President of Corporate Strategy and Business Development at Gasunie

By Ossip van Duivenbode

2

Society

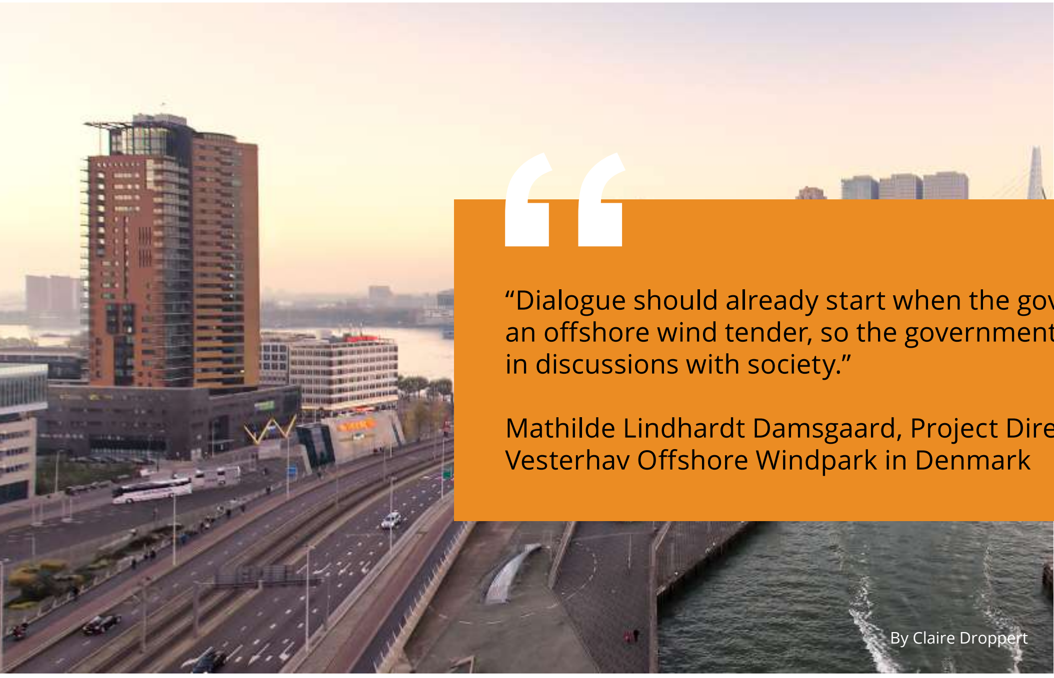
By Guido Pijper

Society

With **Society**, we recommend taking into account the community perception of the projects, the impact of the projects on energy affordability and accessibility and the number of jobs generated. Social impact is critical for the success of energy transition projects. As highlighted in the interviews, having society on board to avoid objections is very important. In the case of offshore wind, this could involve developing initiatives together with fishermen, for example.

> “Social impact is critical for the success of energy transition projects. Projects should take an integral approach, considering their impacts from different perspectives.”
>
> David Molenaar, CEO of Siemens Gamesa Renewable Energy BV

Getting **society involvement** is particularly relevant for projects where the government participates. Different spheres of government might have **contrasting views**, and it can be an issue to find a balance as the public sector wants to make projects community driven and at the same time promote them via the Government Coordination Scheme. Therefore, having society on board and aligned can prevent complicated discussions and potential delays.



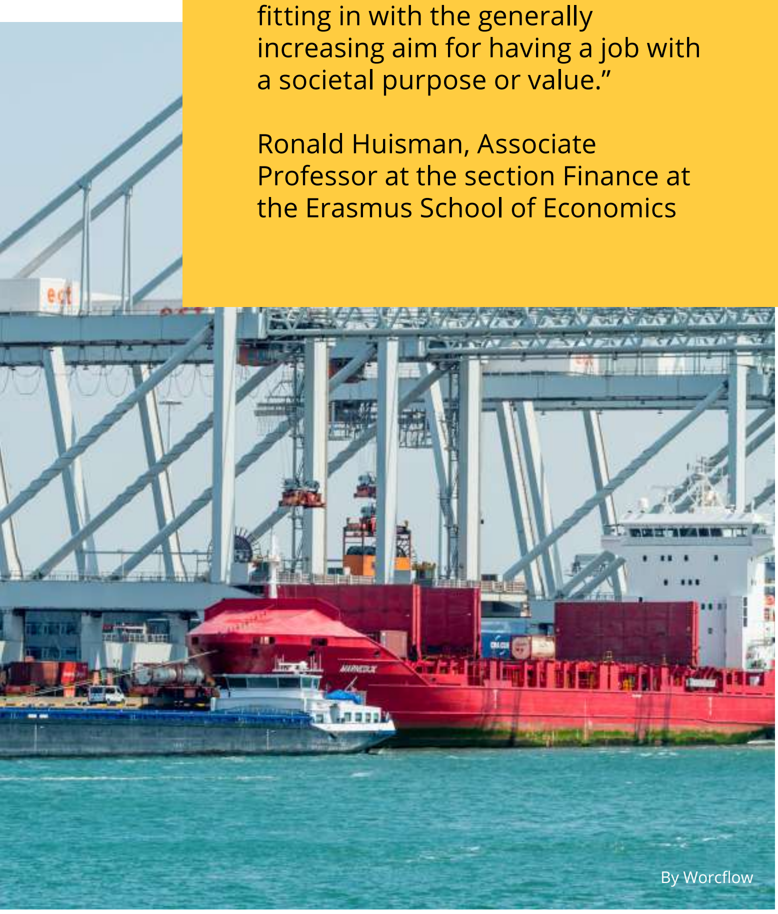
> “Dialogue should already start when the government intends to do an offshore wind tender, so the government can take a leading role in discussions with society.”
>
> Mathilde Lindhardt Damsgaard, Project Director of Vattenfall’s Vesterhav Offshore Windpark in Denmark

By Claire Droppert

Still inside the society pillar, we can expect that the investments in the energy transition and new technologies will create a number of **new job opportunities**. As pointed out during the interviews, with the shift to a clean energy system we will rebuild a significant part of the industry infrastructure. These new industrial and chemical plants are an investment for many decades, creating a long-term demand for a skilled labor force. Regions that already have a developed industrial labor market will be better positioned to attend these needs. There will be increasing opportunities for employees capable of working in the wind power generation industry, for example. So it is important to make a career prospect that is attractive to new talent. That is why collaboration with educational institutions, on all levels, is relevant.

Like many other sectors in the Netherlands (and Western Europe), the energy sector is facing large **challenges to attract talent**. On the positive side, there is an increasing interest among young professionals for jobs that have a societal value, which leads to many pursuing careers in industries involved in the energy transition. Despite that, the low interest rates and positive economic climate over the past years have spurred growth in various sectors which are all competing for the same limited pool of people. It could be that the currently increasing interest rates and change in economic tides will end the growth in some sectors and bring back some people to job markets with a high fundamental demand, like the energy sector.

> “There is strong interest among students on the energy transition, fitting in with the generally increasing aim for having a job with a societal purpose or value.”
>
> Ronald Huisman, Associate Professor at the section Finance at the Erasmus School of Economics

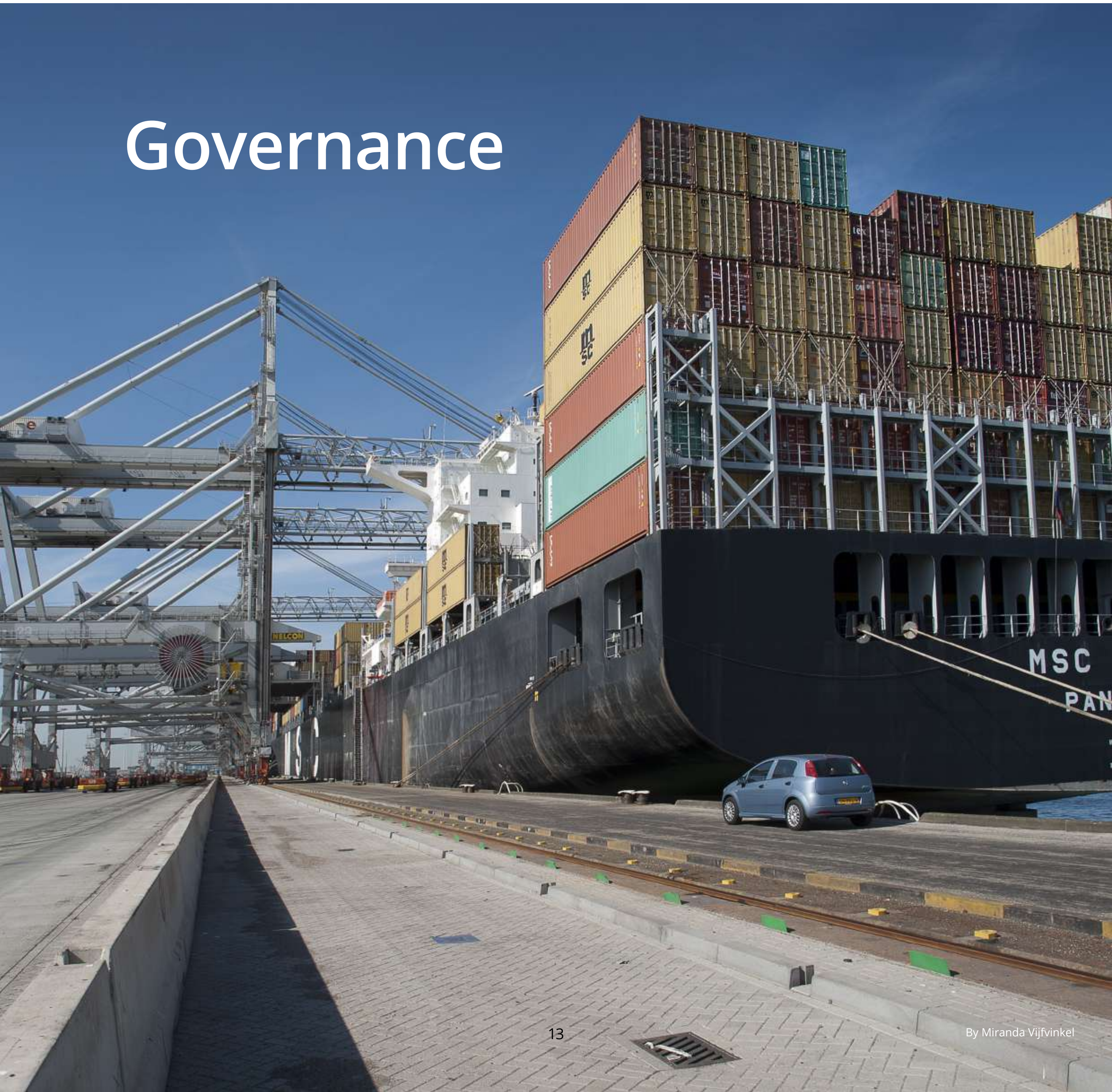


By Worcflow

Another category inside the society pillar covers **energy equity** (accessibility and affordability). This has always been central in the World Energy Council Trilemma, but the importance of this dimension has been highlighted by recent surges in **gas and oil prices**. Therefore, it is crucial to evaluate how energy transition projects affect people regarding access to affordable energy. The current energy crisis increased the pressure to unlink electricity prices and gas prices. As mentioned in the interviews, the system where marginal cost determines the price will not be justifiable in the future, as it approaches zero after an initial investment in wind or solar energy, for example.
Any changes in this pricing system can have consequences for final consumers.

3

Governance



By Miranda Vijfvinkel

Governance

In **Governance**, we propose evaluating reporting and transparency and analyzing the governance structure. For large energy projects, collaboration is key. Multiple stakeholders are usually involved and early **sharing of knowledge** can be positive. It is also important to **align expectations and responsibilities** to create a viable business model. This can be particularly relevant when the government is involved. Collaboration can also be decisive in the concession of permits, a factor that can cause delays and increases risk in project management. As highlighted in the interviews, large projects are only possible when there is a good **risk-reward distribution** between companies, government and customers. The involvement of multiple partners means that the complexity in governance regarding contracts, permits, liabilities and technologies can be significant. Many times creating a solid business case to get approval from the public stakeholders takes time and slowdown decision-making.

> "Public parties can accept a lower rate of return when developing infrastructure, but the shareholders still require a positive return on investment."
>
> Nico van Dooren, Director New Business Development & Portfolio at Port of Rotterdam

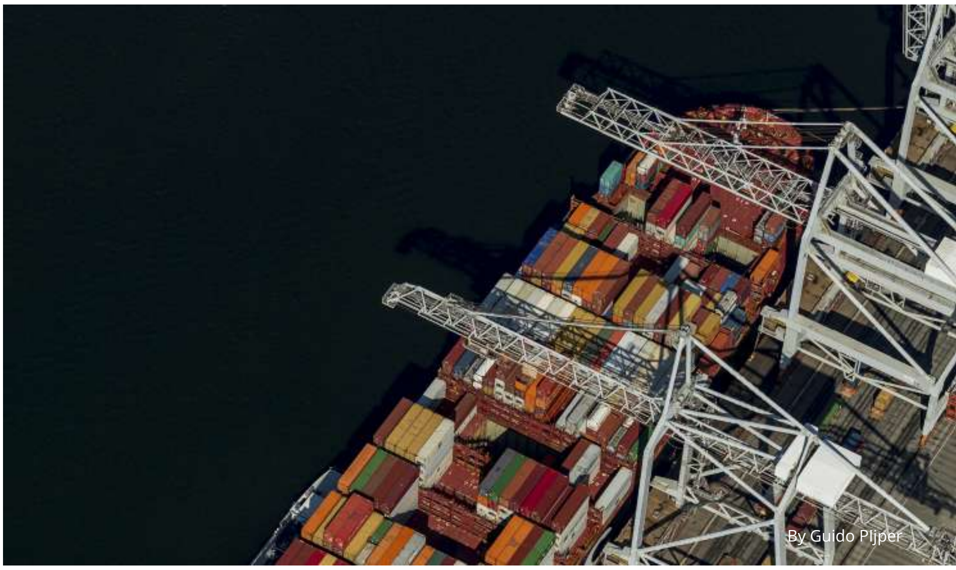
The early commitment and involvement of clients was important for Porthos, as Shell and ExxonMobil could bring technical knowledge and expertise from the beginning. The **government** also played a fundamental role from initial stages. It made a conscious choice for state companies to take the lead in **infrastructure building**, with a broader view. Private parties can play major roles in financing, construction and operation, but infrastructure continues to have a major public-good character and indecisiveness can cause major delays. More than that, the role of the government is emphasized by the fact that relatively small investments can **attract further large private investments**. For example, the hydrogen infrastructure in the Rotterdam harbor area costs around twenty to thirty million euros, but could enable billions of euros of private investments in the area. The development of infrastructure is crucial as the existence of infrastructure and an ecosystem in the Rotterdam area are essential for the projects achieving positive results.

> "It is often up to the government to take the first steps for the infrastructure: point on the horizon, create conditions, including financial and regulation."
>
> Gertjan Lankhorst, Chairman of VEMW

> "CO2 storage goes beyond commercial project boundaries as CO2 remains in the subsoil and must be properly transferred, monitored and sealed and decisions on governance have to take the long-term commitment of managing this into account."
>
> Berend Scheffers, Director of Strategy and Technology at EBN

Additionally, **permitting** can be a crucial component for a project's success. Permits can be a large business risk, as highlighted in "The Dutch Nitrogen Crisis and the Energy Transition" box on page nine. Innovative projects, such as Porthos, may face additional difficulties because authorities are entering a territory that is still unknown for them. In the specific case of CCS in the Netherlands, the complicated Dutch experience with gas extraction in Groningen adds additional pressure. During execution, usual project risks emerge, such as local objection. These complexities can delay the final investment decision. In the case of WarmtelinQ, it took eight to nine years, but this is not an exclusive Dutch characteristic as FIDs can also take a long time in other countries. Nevertheless, with sufficient commitment for all stakeholders, it is possible to speed up, as long as urgency is perceived and short-run goals are set. Projects in the energy transition are many times not seen as urgent (crisis) yet, but if they start to, we can create business and institutional mechanisms to make decisions faster.

> "Our quick reaction to the current security of supply crisis is a demonstration that we can move faster when there is sufficient interest."
>
> Hans Coenen, Vice President of Corporate Strategy and Business Development at Gasunie


By Guido Pijper

Another very important topic to consider is the difference between the **historical and current industrial landscape** versus the one of the **future**. Ports and the industries located in the Rotterdam-Moerdijk cluster are based upon the availability, processing and demand of certain energy carriers, raw materials and surroundings. If however the inputs change, so going from the coal/oil/gas based energy carriers towards a hydrogen and electricity based system, this will have a **transformative impact** on the industry. Oil and coal can be transported globally. Gas is already somewhat more local, due to its lower density and thus higher transport costs over long distances. For electricity the transport costs as part of the overall costs is much higher, and marginal production costs can even be zero in the case of solar and wind. Thus, **transport and system costs** will increase over time compared to the current system.

Taking these changes, in combination with the political choices with regards to **CO2 taxes and subsidy schemes**, into account, companies currently face the question whether or not to pursue long-term investments. These have consequences for direct employment, development of adjacent industries and local energy related infrastructure. For example, Tata Steel aims to stay in the Netherlands and go for the production of steel with the use of green hydrogen as their decarbonisation option. This basically ended the viability of the possible CCS project around the Amsterdam Harbour, forcing other companies who wanted to participate in this to look for alternatives in their CO2 abatement.

In respect of future energy needs and industrial development, the Netherlands seems to have a different view compared to the rest of Europe. Where in general the view in Europe is that the energy system may decrease by twenty to thirty percent in the coming decades, industrial planning in the Netherlands so far is considering an increase in the size of the energy system. It could be that this is the result of still thinking too much in terms of the current industrial landscape.

4

Technology

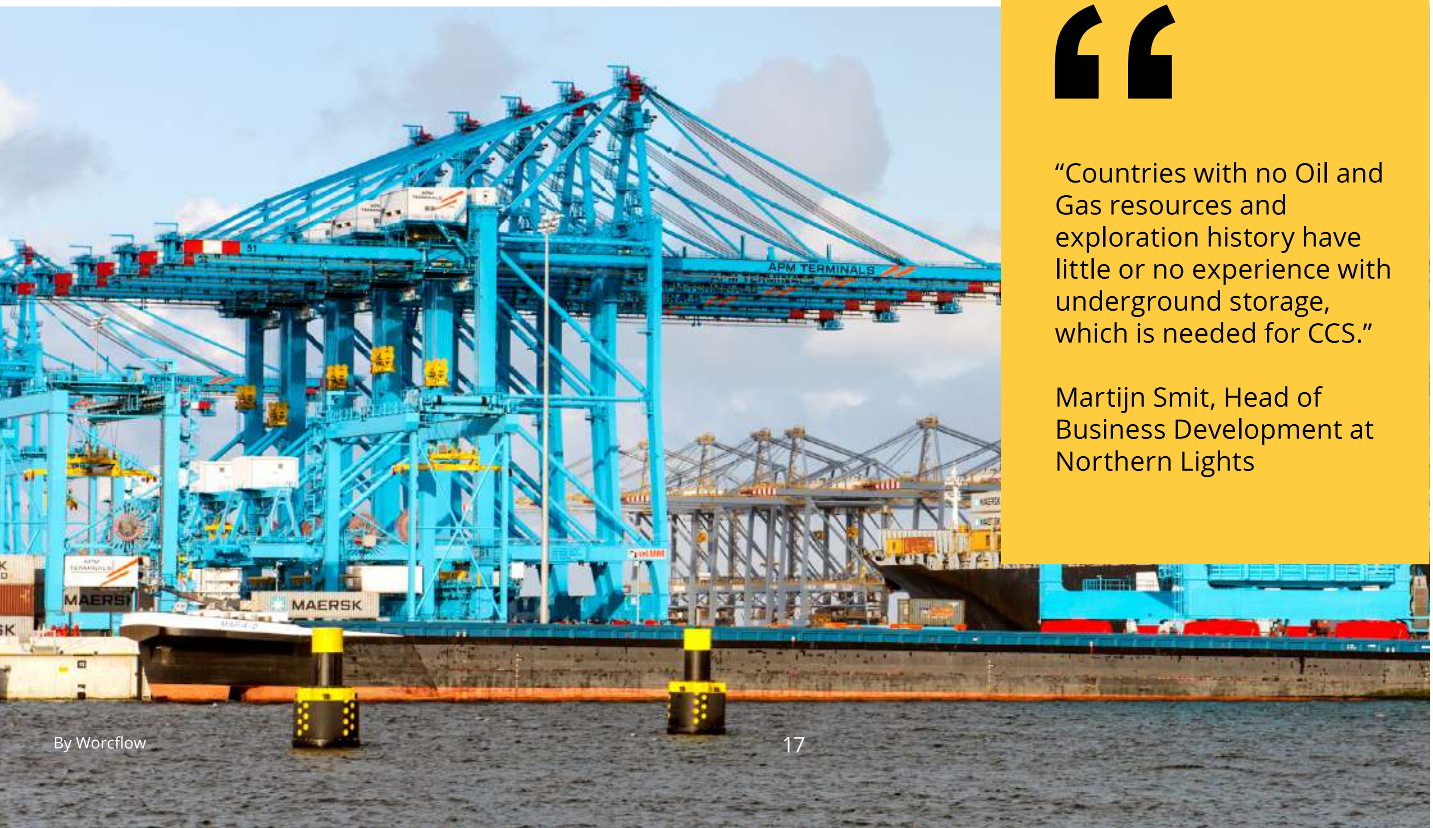
By Claire Droppert

Technology

In the **Technology** pillar, we suggest evaluating **scalability** of the projects, as we want to develop solutions that can be expanded or reproduced. We also recommend considering how the projects help in creating a **competitive edge**. Rotterdam is built on a logic that is disappearing, being the supply of oil and availability of gas. But the port is still conveniently located as a hydrogen and CO2 concentration area, either via pipeline or shipping. For that, **timing** is essential. As pointed out in the interviews, if we do not move fast enough, we might end up only being able to buy the most expensive molecules that are left in the market, as other clusters will already have guaranteed the cheaper ones.

> “Some of the largest industrial players are now looking at whether the Netherlands is still the right place to stay and invest”
>
> Bert Stuij, Manager National Programmes and Energy at the Netherlands Enterprise Agency

Another relevant point is that we need to consider that technologies can be on very **different maturity levels**. It could be argued that the offshore wind sector is nearing maturity, whereas hydrogen and CCS still need to scale up and build a track record. As highlighted in different interviews, although Porthos is small in capacity in comparison to other (future) CCS projects, being able to realize it is crucial to indicate the feasibility of the model. Porthos being a showcase or inspirational example is one of the factors to be considered when evaluating if the project is successful. The Netherlands is also considered as one of the good places to start with CCS, as the appeal and knowledge required for CCS is higher in areas where there is experience with oil and gas production.



> “Countries with no Oil and Gas resources and exploration history have little or no experience with underground storage, which is needed for CCS.”
>
> Martijn Smit, Head of Business Development at Northern Lights

In the **offshore wind sector**, further **industrialisation** is a particularly salient topic. Over the past decade there has been a constant race to develop larger and more efficient wind turbines. However, with ever changing dimensions in wind turbines, also the whole supply chain had to continuously invest in new vessels, changing foundations, etc. This is both reducing the profitability of the sector and harming the speed of the energy transition. As pointed out in the interviews, a systemic change might be needed. The sector could change the mindset from a **project-to-project basis to a portfolio approach**, which would allow for much more flexibility and efficiency in construction. Another possible approach is 'freezing' the dimensions for a certain period, such that contracts can be standardized, tenders can be simplified and bundled and contractors are provided more certainty and can deliver faster.

For **hydrogen production**, the **tech multiplier effect** is considered to be very large. Specific technologies are needed for the industry and a producing nation has a good chance of becoming a market leader on them. Also a specific context may give advantages, like in the case of Holland Hydrogen I. This facility will initially supply green hydrogen to Shell Pernis. Location advantages are the close-by availability of offshore wind power and the lack of a need for a stable stream of hydrogen output. The latter results from the fact that Shell Pernis has existing (grey) hydrogen suppliers. This also allows for having a limited storage capacity, being mainly in the transport pipelines. A similar context might not apply in other projects, thereby increasing their technical challenges to enable a stable stream of hydrogen.

WarmtelinQ's situation is also **unique**, but in another sense. There is a lot of **heat production** in and around Rotterdam from different sources, so there is more than enough available. There are also interested purchasers in the form of homes and horticulture at a short distance. This combination of supply and demand is not present in many places in the world, which is a limiting factor for the possible use of heat networks.

By Claire Droppert

5

Finance

Finance

Finance should evaluate the financial **viability and risk** of the projects. Here we also advise taking into account the project dependency on subsidies. As pointed out in the interviews, in principle, financing should not be an issue as there is high liquidity in the market, but this can be heavily dependent on the project line. The market for finance is very different for Hydrogen and CCS than it is for Wind Energy. **Without a developed market**, it is difficult to estimate risk versus return and, therefore, financing will be limited. Carbon and hydrogen markets are still developing, which makes it hard to come up with contracts to back up investments of ten to fifteen years. In terms of timing, many new technologies are at a too early stage or many projects are too small to have the real need for financing. **Scale** is also an issue. For instance pension funds need large investments with a long time horizon. To address this need, various projects could be bundled together to one larger investment.

"Wind Energy is much more mature, while on Hydrogen and CCS the technology is at earlier stages and there are more questions about the viability of the business model, what limits external financing opportunities and increases the dependency on subsidies"

Bas Bakker, Managing Director, Head Energy Transition & Circularity Europe at Rabobank


By Claire Droppert

Green hydrogen can still be **expensive** and the market is not yet ready to pay for it. Costs are expected to reduce in the future, but uncertainties in the energy markets are a risk as approximately two thirds of the cost of producing green hydrogen come from electricity and limited grid capacity is currently a bottleneck.

For some projects **different business case** models could be explored. Porthos is based on a one-stop-shop approach offering CCS as-a-service to the industry sector. Negotiating with multiple parties for the separate activities could be an alternative, depending on the project characteristics. On the other end of the spectrum a more integral approach could be explored, e.g. where offshore hydrogen production is included in the business case for offshore wind.

Another topic is the **mismatch between expectations and needs of the finance community and energy transition players**. Traditional financiers find themselves in a dilemma: they want to finance the energy transition and have funds available for that. But in many cases it is a challenge to find suitable projects with strong business cases. There are many new technologies and early stage projects looking for equity or loans, but they are often considered too risky by banks or pension funds that tend to focus on more mature and proven technologies. For projects with an innovative technology angle that still needs to be upscaled and proven technically and economically viable, venture capital, private equity or innovation funds might be better options. An alternative source of finance could be corporations with an interest in the specific technology/ solution.

A factor of concern brought forward during the interviews are **increasing interest rates**. In the long period with low interest rates, private equity funds and other investors have financed all sorts of companies, but it is unclear if these companies can survive with more restricted credit markets. Currently there is also a lot of concern with regard to the energy prices. The industry is still looking how these high prices will reflect on the industry. Uncertainties around a potential windfall tax could also lead to a reduction of liquidity in the market.

A last point highlighted during the interviews in the finance pillar is how **efficient pricing mechanisms** can play a crucial role in the future. The significant cost of a carbon tax increases the incentives to reduce or compensate for carbon emissions. If the EU Emissions Trading Scheme carbon prices are high, there is a smaller need for subsidies.

“A carbon pricing mechanism is a crucial factor behind Air Liquide’s decision to join Porthos. The significant cost of a carbon tax increases the incentives to reduce or compensate for carbon emissions.”

Robert Haffner, Manager of Public Affair at Air Liquide

"The geopolitical risk is very high. Investors are more wary about the long-term perspective."

Pieter Plantinga, Executive Director of Project Finance at Rabobank

By Claire Droppert

6

Energy Security

Energy Security

As our last pillar, we include Energy Security. The developments of the Ukraine war highlighted the importance of Europe shifting to not only a greener energy matrix, but also one that is less dependent on energy imports. So here, we suggest considering how the projects are part of this larger plan and contribute to energy supply security.

The current situation might lead to an urge from the market to come up with solutions quicker and this can be beneficial for **hydrogen projects**, as they **can make Europe less reliant on Russian energy**. For example, Germany would still be dependent on hydrogen imports for its industry, but not so dependent on a single supplier. With this in mind, it is betting on the hydrogen backbone to import from the Netherlands.

> “European level cooperation is critical to achieve energy security and reduction of CO2 emissions at the same time”
>
> Prof. Juergen Peterseim, PwC Global Alternative Fuels

Another potential room for international cooperation is in **CCS**. If the storage capacity is there, from an economical, technical and entrepreneurial perspective, there is no need to limit storage to Dutch emissions, so **CO2 could be imported** for storage at the right price. A comparison with waste import is not a hundred percent accurate because CO2 emissions from other countries also affect the Netherlands. From an economical perspective, an open model might be more efficient, but is it politically feasible? As shipping CO2 for storage can be expensive, we might need a developed pipeline infrastructure to guarantee that this model is possible.

One more point highlighted during the interviews is that we may become much more dependent on where we are and what is available, as markets become partly **more local**. We can easily transport oil and coal worldwide, but this is more difficult for gas and even more for electricity. Production costs for electricity are low, sometimes zero, but, as mentioned, transport and system costs are higher than in the current oil and gas system.

Having **connected local value chains** can improve security of supply, affordability and address climate change at once. For instance, if you currently would have your own offshore wind park in combination with an electrolyser facility, the cost gap between green hydrogen and grey hydrogen is now less wide due to high gas prices.

7

Conclusions and recommendations

By Claire Droppert

Conclusions and recommendations

The interviews indicate that while the aspects contained in our six pillars are recurrent topics and perceived as important both in terms of project progress and goals, many of them are not yet part of project evaluation criteria. In addition, the importance of having a framework that is flexible and able to incorporate dimensions that gain relevance in the near future became clear. We separate our main conclusions and recommendations per pillar:

Environmental

While CO_2 reduction is already an established measure for energy transition projects, local environmental impact and circularity of materials are increasingly considered as important factors. This does not yet necessarily translate into these elements being incorporated on key performance indicators and project planning. It could be considered to broaden the Environment scope to also take into account other relevant environmental factors such as methane and particulate matter emissions.

Social

The interviews highlighted the importance of getting communities “on board”. Societal support can smooth the process of obtaining permits and reduce the risks of legal challenges. Some projects will have long-term impacts on citizens’ lives, therefore it is crucial to assess and be transparent about these. It is important that communities perceive that they are sharing the benefits of the projects. That can be financially, but also can take the form of jobs creation or preferential access to the production, for example.

Governance

Firstly, permitting seems to be on the critical path, and should be included in the framework to measure progress. Projects in the Netherlands face additional challenges because of strict Nitrogen emission regulations, highlighting that our framework has to be adaptable to different contexts in order to be able to incorporate the national and regional specificities. In addition, the role of the government in the development and popularization of new technologies has been brought forward. It can be hard for the private market to take the risks of investing in infrastructure and technology that still lack an established market.

Technological

Timing is crucial. Being the first mover carries a risk, but taking too long can result in falling behind and ending up paying higher prices for blue or green energy. In this sense, it is important to create the conditions to act at the right moment. In addition, technology has to be connected with the business case for the transition to be successful. Fixing technology standards and industrialisation of production is needed to lower costs and speed-up progress.

Financial

There seems to be a mismatch between entrepreneurs and financiers. Entrepreneurs perceive there is a lack of financing. At the same time, financiers believe there are enough resources, but not always strong business cases as large system projects struggle with unsecured risks that are not in balance with earning potential. Improving this match is key to speeding-up progress in the energy transition.

Energy

The war in Ukraine has put the security-corner of the trilemma back at the top of the agenda. While in the past few years the focus has been on making the energy mix greener, since February 2022 Energy Equity and Energy Security have regained attention. The Netherlands will remain dependent on energy imports, but the origin of them will change. There will probably be a smaller dependency on a limited number of trading partners.

By Worcflow

8

Appendix

By Guido Pijper

The four projects

Hollandse Kust Zuid

Electrification is an essential part of making the Rotterdam-Moerdijk industrial cluster more sustainable. Within the port, the consumption of electricity is expected to increase significantly due to electrification of industry, shore power for ships and the production of green hydrogen. At the same time, the current electricity production in the Port of Rotterdam is currently decreasing (mainly due to the phasing out of existing coal-fired power stations).

The Dutch government decides where wind farms will be built and who will build them. Vattenfall won two tenders to become responsible for the (at that time) largest subsidy-free wind farm at the sea in the world. BASF purchased 49.5% of the shares of Hollandse Kust Zuid, later selling 25.2% to Allianz after securing a long-term fixed-price corporate power purchasing agreement.[5] The government is responsible for issuing ready-to-roll licenses and guaranteeing connection to the national grid.

140 wind turbines of 11MW will be positioned in the sea, reaching a total capacity of 1.5 Gigawatt. Using fewer turbines than the maximum permitted by the government, but making them larger, Vattenfall expects to increase efficiency and reduce environmental impacts.[6] The first power from Hollandse Kust Zuid wind farm has been successfully delivered to the Dutch electricity grid. The wind farm is expected to be fully operational still in 2023.[7]

[5] BASF is selling a part of wind farm Hollandse Kust Zuid to Allianz

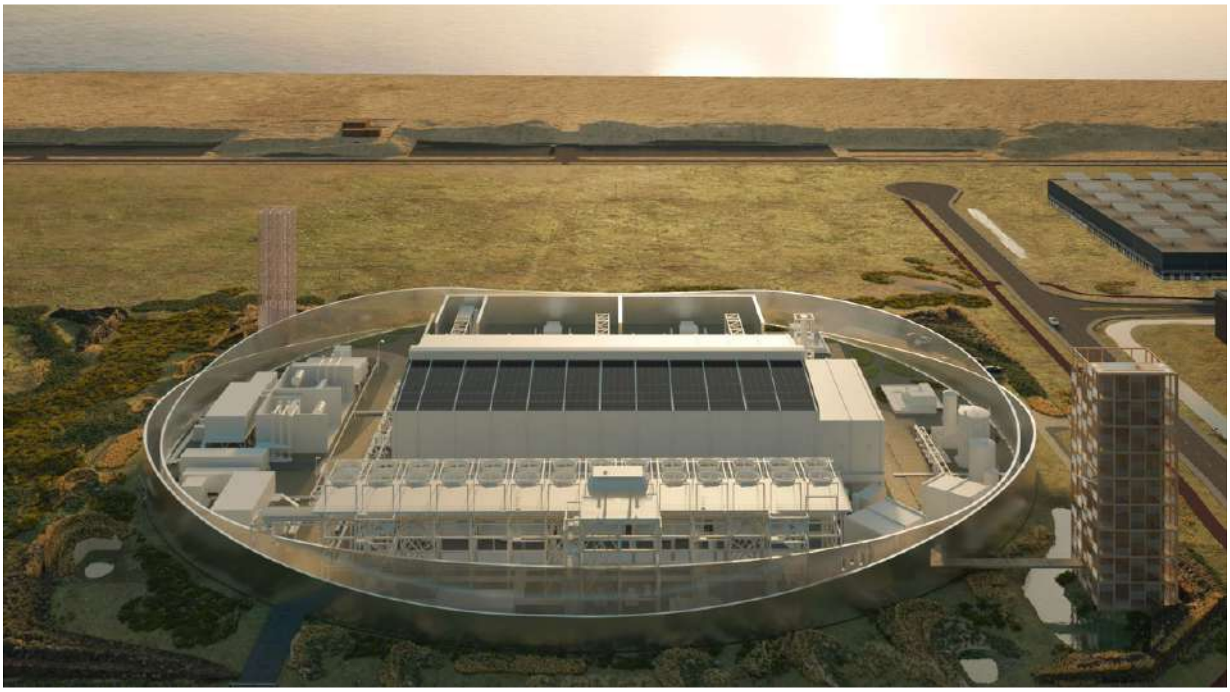
[6] Hollandse Kust Zuid Wind Farm

[7] First power from offshore wind farm Hollandse Kust Zuid delivered

Holland Hydrogen I

Shell plans to build the largest Green Hydrogen plant in Europe in the Maasvlakte in the Port of Rotterdam. Energy from the wind farm Hollandse Kust Noord will be converted into Green Hydrogen. Production is expected to commence in 2025, after the final investment decision was taken in 2022. Gasunie will partner with Shell to develop the pipeline that will connect the plant to Shell's facilities further down the harbor.

Factory design actively aims to blend with surroundings, minimizing carbon-footprint and not harming the environment. Measures go from use of circular materials in construction to purifying water and air in the operational phase, also including adding solar panels to the plant's walls.[8]



[8] Meet the Holland Hydrogen I

Porthos

Porthos is the name of a CO_2 storage and transport project in the Port of Rotterdam ("Port of Rotterdam CO2 Transport Hub and Offshore Storage"). Porthos is a joint venture between Gasunie, EBN and the Port of Rotterdam Authority.[9] The project is made out of the three components:[10]

- Transport of CO2 using an underground transport pipeline from the CO2-producing industry. The pipeline consists of a land section, located in the Rotterdam port area, and a sea section, from the Maasvlakte to an offshore platform.

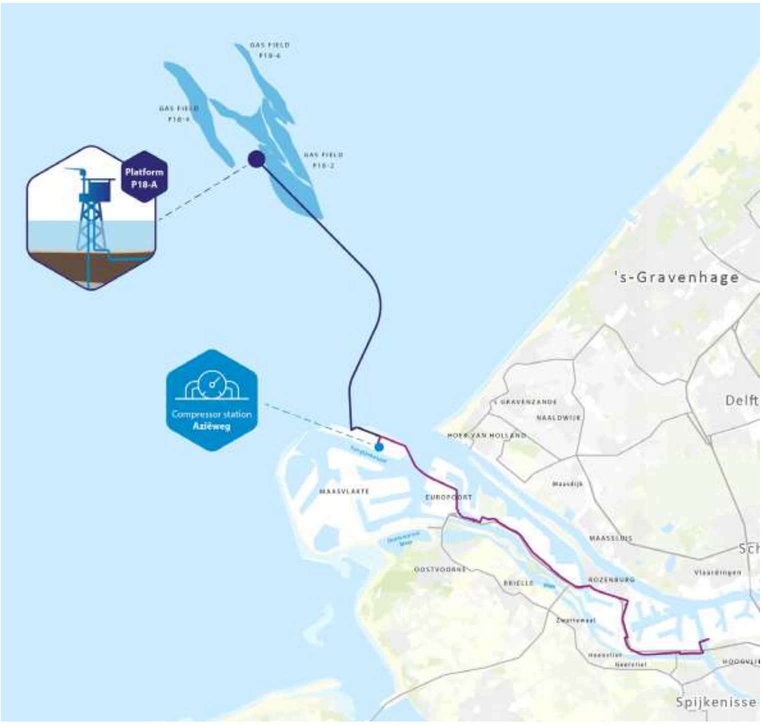
- The compression of CO2, to the desired pressure for injection, in a compressor station on land.

- CO2 storage in gas reservoirs under the North Sea.

Porthos signed final contracts with four companies in the Port of Rotterdam in December 2021: Air Liquide, Air Products, ExxonMobil and Shell. They will build capture facilities to capture CO2 from their existing plants. Together, they want to capture 2.5 Mton CO2 annually from their plants in Rotterdam in the first 15 years starting in 2024.[11] Thanks to Porthos, Rotterdam industry is expected to emit approximately 10% less CO2 in the near future.

Porthos has been recognized by the European Union as a Project of Common Interest. Because Porthos can ensure rapid emission reductions, it was previously promised a European grant of €102 million. The fact that Porthos is a network to which various companies can connect also played a role in the granting of this subsidy.

The final investment decision is expected to be made in 2023 (after the permits are irrevocable). The construction of the system will take about two years. Meanwhile, the companies are constructing their capture facilities.



[9] Porthos
[10] Porthos Transport en opslag van CO_2
[11] Rotterdamse bedrijven en Porthos sluiten contracten voor transport en opslag CO2

WarmtelinQ

WarmtelinQ is an underground pipeline that allows waste heat from the Port of Rotterdam to be used to heat homes, greenhouses and businesses in South Holland. WarmtelinQ ensures that waste heat that is currently discharged can be put to good use. This residual heat comes, for example, from industries and waste incineration. WarmtelinQ plans to heat a maximum of 120,000 homes and other buildings in The Hague with the residual heat from the Port of Rotterdam. The heat pipeline from the Port of Rotterdam to The Hague should be completed by 2025. In the future other sustainable heat sources may be connected to WarmtelinQ, provided they meet the technical requirements. For example heat from water, from the ground or from other sustainable sources.[12]

[12] Kabinet geeft fiat voor warmteleiding naar Den Haag

List of interviewees

Bas Bakker, Managing Director, Head Energy Transition & Circularity Europe at Rabobank

Hans Coenen, Vice President of Corporate Strategy and Business Development at Gasunie

Mathilde Lindhardt Damsgaard, Project Director of Vatenfall's Vesterhav Offshore Windpark in Denmark

Nico van Dooren, Director New Business Development & Portfolio at Port of Rotterdam

Lijs Groenendaal, Project Leader of Shell's Holland Hydrogen I

Robert Haffner, Manager of Public Affair at Air Liquide

Ronald Huisman, Associate Professor at the section Finance at the Erasmus School of Economics

Gertjan Lankhorst, Chairman of VEMW

Wim van Lieshout, Project Director of Porthos

David Molenaar, CEO of Siemens Gamesa Renewable Energy BV

Prof. Juergen Peterseim, PwC Global Alternative Fuels

Pieter Plantinga, Executive Director of Project Finance at Rabobank

Berend Scheffers, Director of Strategy and Technology at EBN

Martijn Smit, Head of Business Development at Northern Lights

Bert Stuij, Manager National Programmes and Energy at the Netherlands Enterprise Agency

World Energy Council

World Energy Council Netherlands
Bredaseweg 406
5037 LH Tilburg
www.worldenergycouncil.nl
board@worldenergycouncil.nl
Phone: +31(0)653106348