

Wind & Hydrogen at the Port of Rotterdam

Elizabeth Endler

Shell International Exploration & Production Inc.

Principal Science Expert

Program Lead, Advanced Energy Storage; Team Lead, Energy System Integration

18 March 2021

Presentation for ESIG Spring Technical Workshop

WARNING: uncertainties ahead

This presentation contains data and analysis from Shell's Sky scenario. Unlike Shell's previously published Mountains and Oceans exploratory scenarios, the Sky scenario is based on the assumption that society reaches the Paris Agreement's goal of holding the rise in global average temperatures this century to well below two degrees Celsius (2°C) above pre-industrial levels. Unlike Shell's Mountains and Oceans scenarios, which unfolded in an open-ended way based upon plausible assumptions and quantifications, the Sky scenario was specifically designed to reach the Paris Agreement's goal in a technically possible manner. These scenarios are a part of an ongoing process used in Shell for over 40 years to challenge executives' perspectives on the future business environment. They are designed to stretch management to consider even events that may only be remotely possible. Scenarios, therefore, are not intended to be predictions of likely future events or outcomes.

Additionally, it is important to note that as of 18 March 2021, Shell's operating plans and budgets do not reflect Shell's net-zero emissions ambition. Shell's aim is that, in the future, its operating plans and budgets will change to reflect this movement towards its new net-zero emissions ambition. However, these plans and budgets need to be in step with the movement towards a net-zero emissions economy within society and among Shell's customers.

Also, in this presentation we may refer to "Shell's Net Carbon Footprint", which includes Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions but, to support society in achieving the Paris Agreement goals, we aim to help and influence such suppliers and consumers to likewise lower their emissions. The use of the terminology "Shell's Net Carbon Footprint" is for convenience only and not intended to suggest these emissions are those of Shell or its subsidiaries.

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell group" and "Royal Dutch Shell" are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Royal Dutch Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. "Subsidiaries", "Shell subsidiaries" and "Shell companies" as used in this presentation refer to entities over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", "anticipate", "believe", "could", "estimate", "expect", "goals", "intend", "may", "objectives", "outlook", "plan", "probably", "project", "risks", "schedule", "seek", "should", "target", "will" and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this presentation, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell's Form 20-F for the year ended December 31, 2019 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this presentation and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 18 March 2021. Neither Royal Dutch Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

We may have used certain terms, such as resources, in this presentation that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.



Context



THE SHELL INVESTMENT CASE

RESPECTING **NATURE**
Protecting the environment, reducing waste and making a positive contribution to biodiversity

UNDERPINNED BY
OUR **CORE VALUES**
AND OUR FOCUS
ON **SAFETY**



Driving low carbon energy supply and solutions

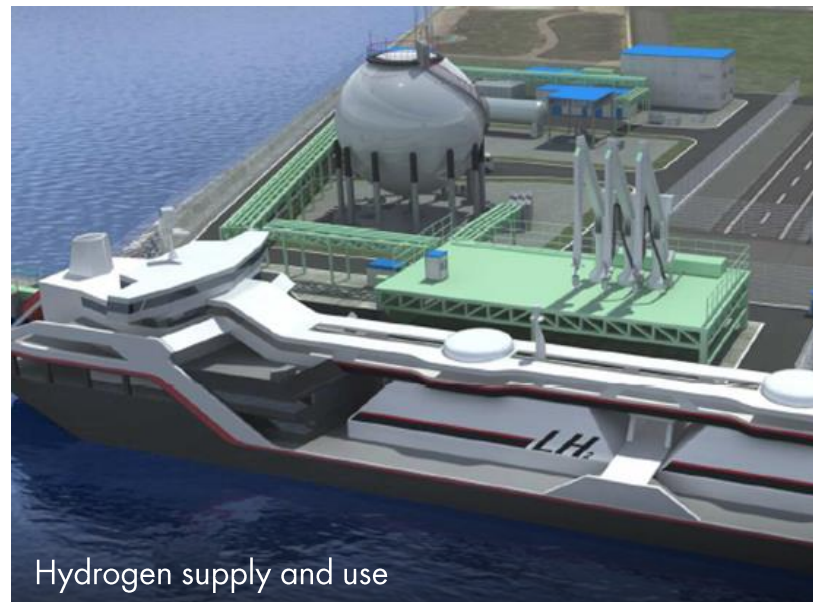
Specific themes to help accelerate the energy transition and adopting to evolving consumption patterns



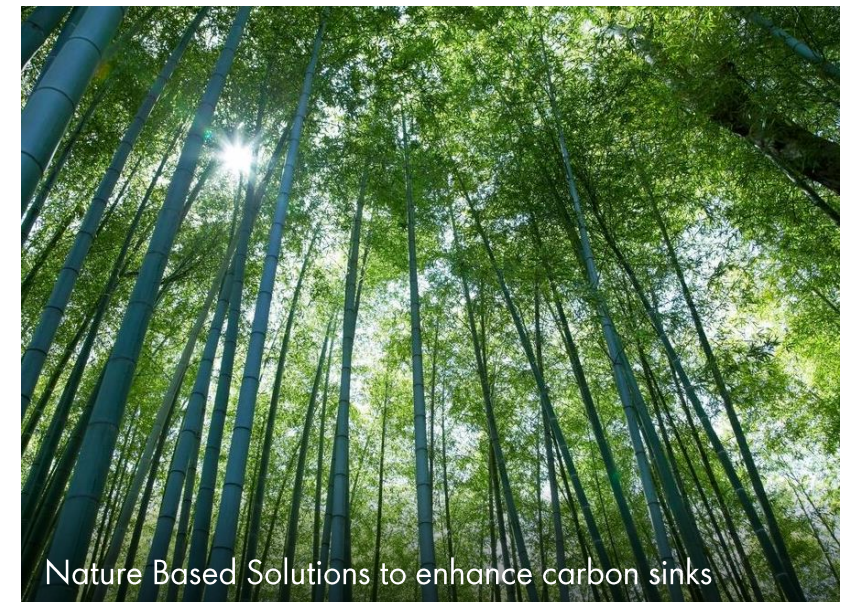
Electrification of demand



Circularity in manufacturing of products



Hydrogen supply and use

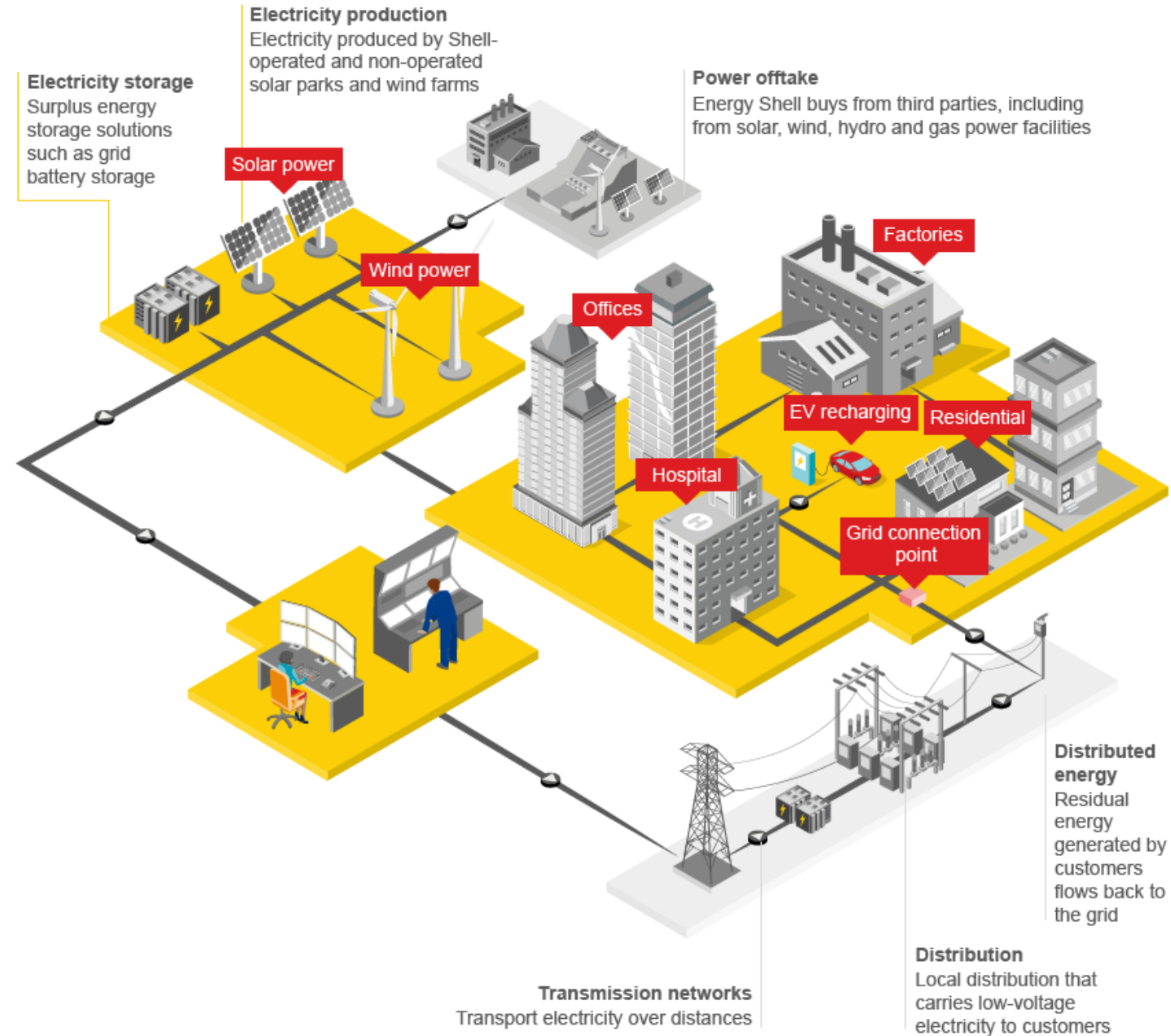


Nature Based Solutions to enhance carbon sinks

Shell and the electricity system

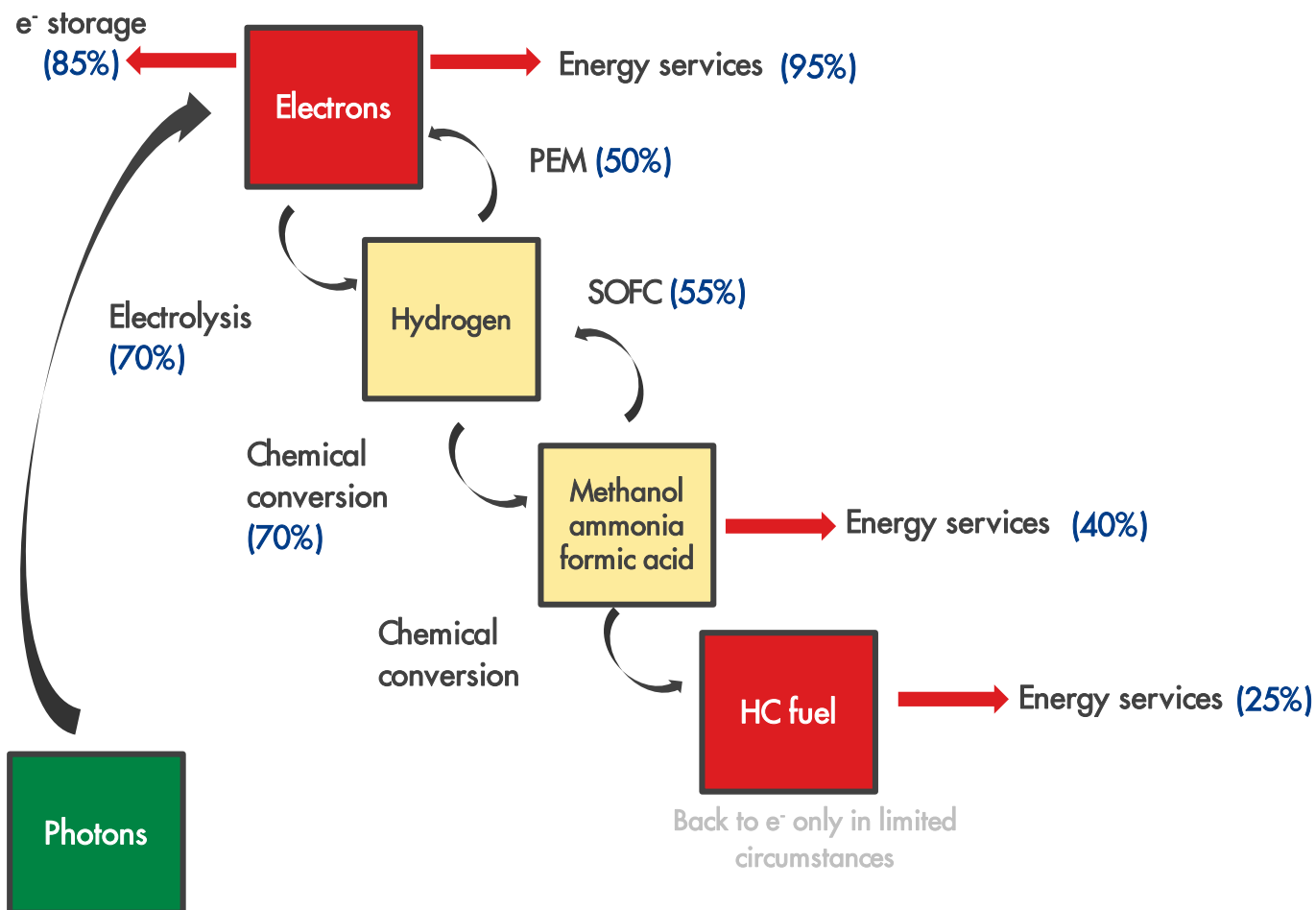
A selection of investments and acquisitions

- Hollandse Kust (noord), 2020
- Gangarri, Australia, 2020
- ERM Power, Australia, 2019
- EOLFI, FR, 2019
- Hudson Energy, UK, 2019 (Shell Energy Retail)
- Limejump, UK, 2019
- sonnen, Germany, 2019
- Greenlots, USA, 2019
- First Utility, UK, 2018 (Shell Energy Retail)
- Borssele III & IV, Netherlands, 2018
- Silicon Ranch, USA, 2018
- Cleantech Solar, Singapore, 2018
- NewMotion, UK and Europe, 2017
- Shell Recharge, UK, 2017
- MP2 Energy, USA, 2017
- WonderBill, UK, 2015



Electricity: high quality energy

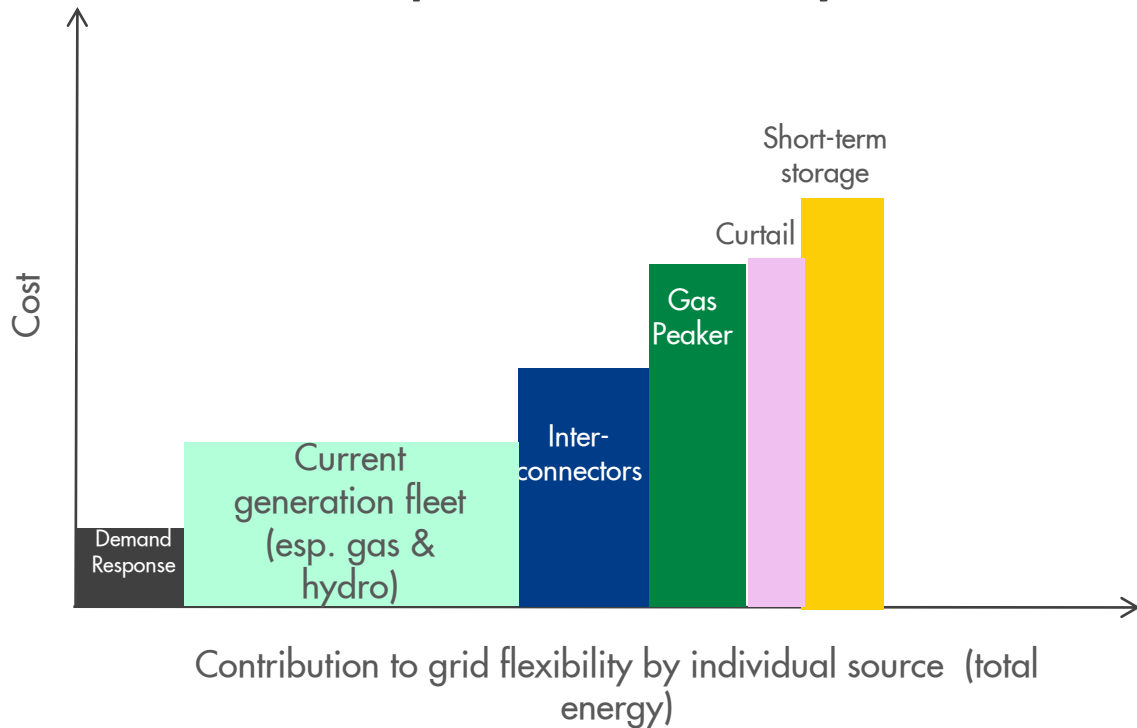
Significant reduction in primary energy demand to deliver equivalent services



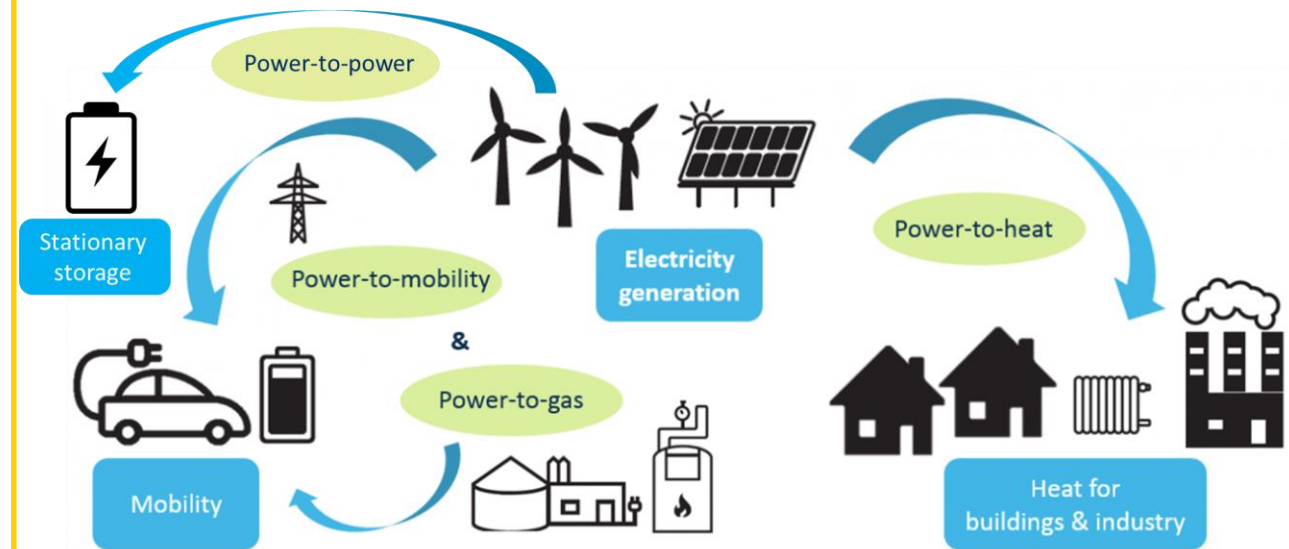
The lower the conversion process efficiencies for each step, the more advantaged “electric-only” pathways are on a primary energy basis

Flexibility can be provided in multiple ways by multiple sources

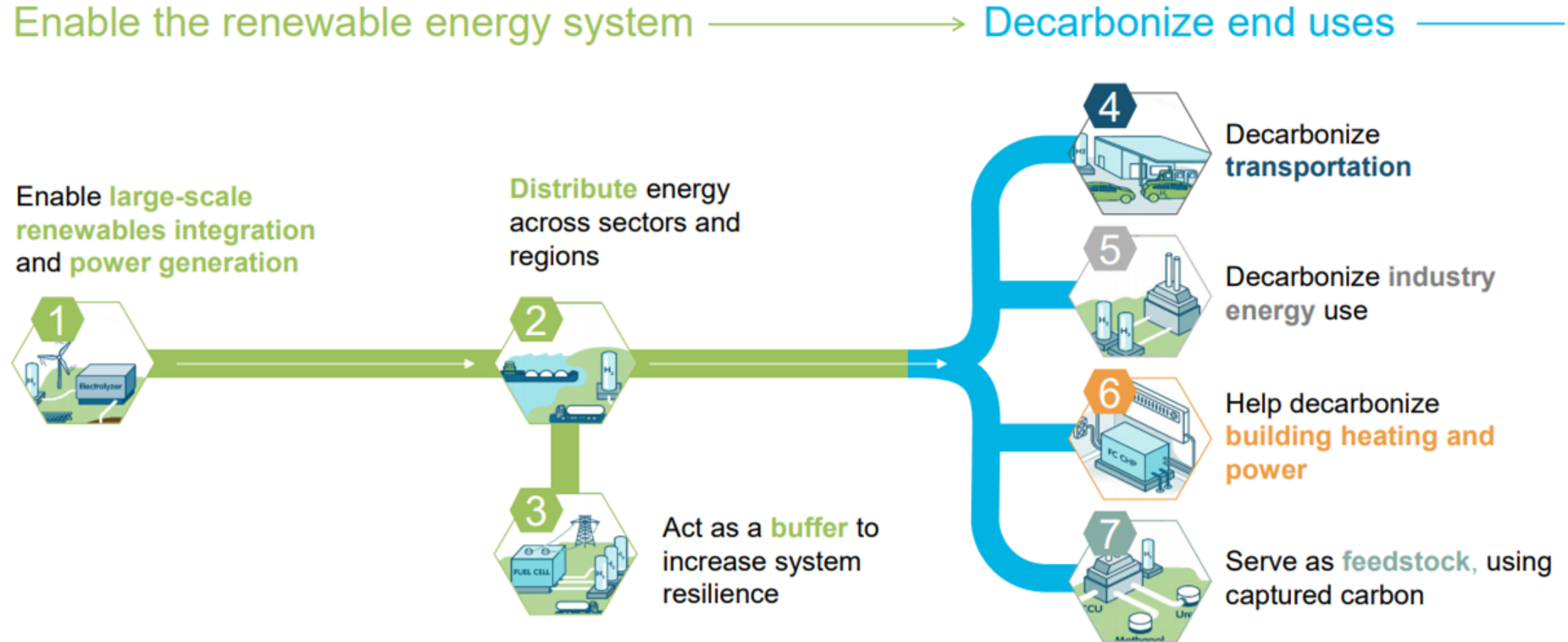
Conceptual representation of today: power sector only



Potential future: Sector Coupling



Hydrogen is the only molecular zero carbon vector and sits at the intersection of three systems: mobility, industrial and energy



Source: Hydrogen Council



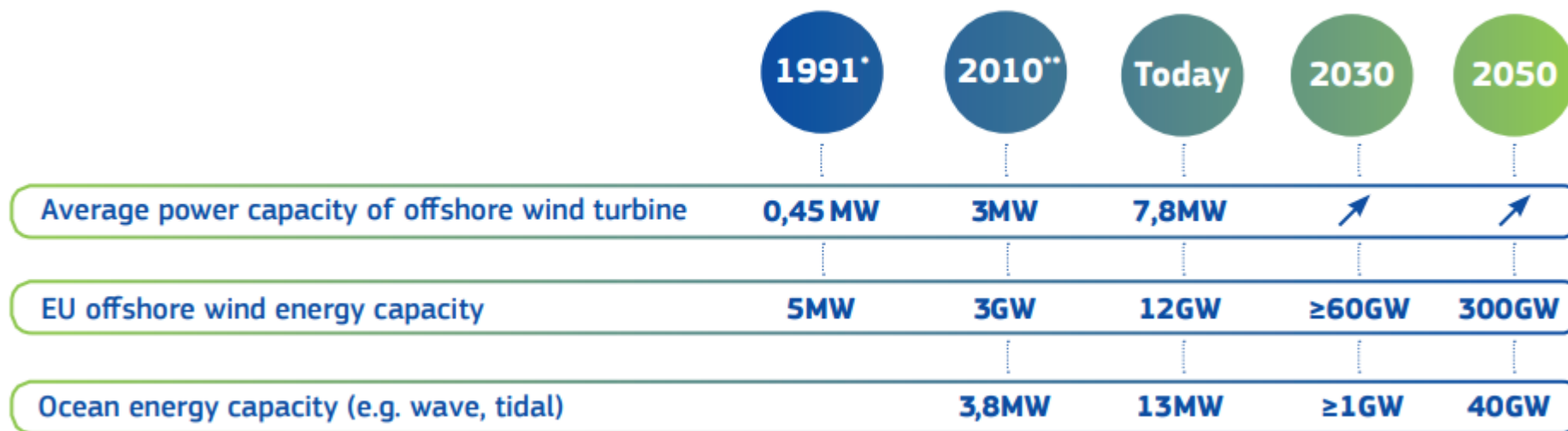
Offshore Wind



Offshore Renewable Energy Strategy

19 November 2020
#EUGreenDeal

How it started, how it's going, what's the future

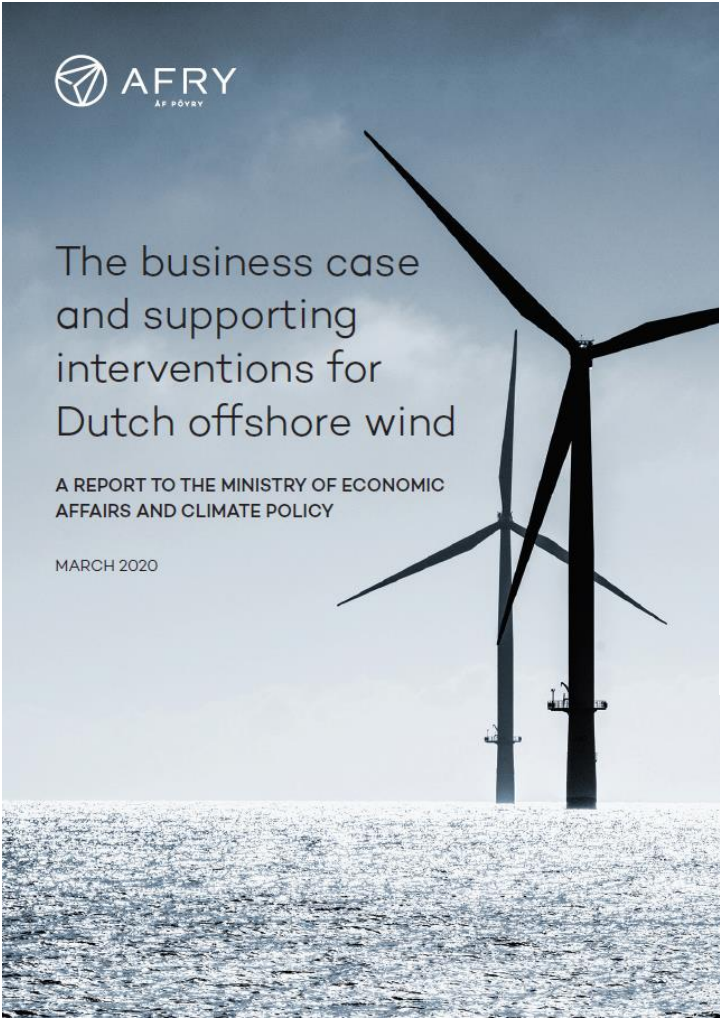


* First offshore wind farm: Vindeby, Denmark.

** Including UK



Offshore Wind in The Netherlands



STAATSCOURANT

Officiële uitgave van het Koninkrijk der Nederlanden sinds 1814.

Nr. 68472

17 december 2019

Regeling van de Minister van Economische Zaken en Klimaat van 13 december 2019, nr. WJZ/ 19201387, houdende nadere regels tot vergunningverlening windenergie op zee voor het kavel V van het windenergiegebied Hollandse Kust (noord) (Regeling vergunningverlening windenergie op zee kavel V Hollandse Kust (noord))

De Minister van Economische Zaken en Klimaat,

Gelet op de artikelen 14, tweede lid, 23, eerste, derde en vierde lid, en 24, derde lid, van de Wet windenergie op zee;

Besluit:

Artikel 1

In deze regeling wordt verstaan onder:

flexibiliteit van het leveringsprofiel van een windpark: mate waarin de levering van elektriciteit aan het net op zee in de tijd niet rechtstreeks afhankelijk is van de windcondities op het moment van de levering;

kavel V: kavel V van het windenergiegebied Hollandse Kust (noord) zoals aangewezen in Kavelbesluit V windenergiegebied Hollandse Kust (noord) (Stcrt. 2019, nr. 24545);

minister: Minister van Economische Zaken en Klimaat;

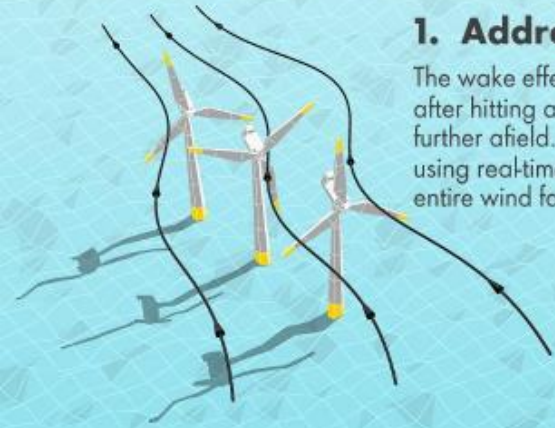
Criterium: de maatschappelijke kosten (artikel 24, tweede lid, onderdeel d, van de wet)				
Maximum aantal punten: 30				
		Kwalitatieve maatstaven	Beoordelingsmaatstaf	Ptn.
2	Het stimuleren van innovatie ten bate van de integratie in het Nederlandse energiesysteem van toekomstige windparken	De demonstratie van innovatie in het windpark of onmiddellijk daarmee verbonden middelen op kavel V die bijdraagt aan het vergroten van de flexibiliteit van het leveringsprofiel van windparken op zee in de toekomst.	Potentiële impact van de innovatie voor windparken in de toekomst als de innovatie marktrijp wordt gemaakt.	0-7
			De mate waarin de innovatie vernieuwend en vindingrijk is t.o.v. de op dit moment beste op de markt beschikbare producten, diensten of processen	
			De mate waarin aannemelijk wordt gemaakt dat de innovatie met succes kan worden gedemonstreerd in een operationele omgeving	
			De mate waarin inzichtelijk is welke specifieke, meetbare en tijdsgebonden voortgang de demonstratie zal kennen en hoe deze bij uitvoering van de innovatie kenbaar zal worden gemaakt	
			De mate waarin bij de uitvoering van de demonstratie geborgd is dat de exploitatie van het windpark als geheel geen risico loopt	
		De mate waarin kennis en ervaringen wordt gedeeld over de innovatie die wordt gedemonstreerd	De mate van kennis die wordt gedeeld	0-3
			De kwaliteit van een disseminatie- en communicatieplan	
			De mate waarin het disseminatie- en communicatieplan de te delen kennis, specifiek, meetbaar en tijdgebonden beschrijft	
			De mate waarin de doelgroepen zijn benoemd en de disseminatie- communicatiemiddelen daar bij aan sluiten	

An intelligent wind farm

The wind doesn't always blow consistently. So how can a wind farm provide electricity when there is little wind? CrossWind and its partners are exploring five different innovations designed to address these challenges. Through these innovations, an offshore wind farm could be capable of providing more constant electricity regardless of the wind conditions.

1. Addressing the wake effect

The wake effect describes how wind can slow after hitting a turbine, affecting those situated further afield. CrossWind is looking at ways of using real-time data to reduce this across the entire wind farm.



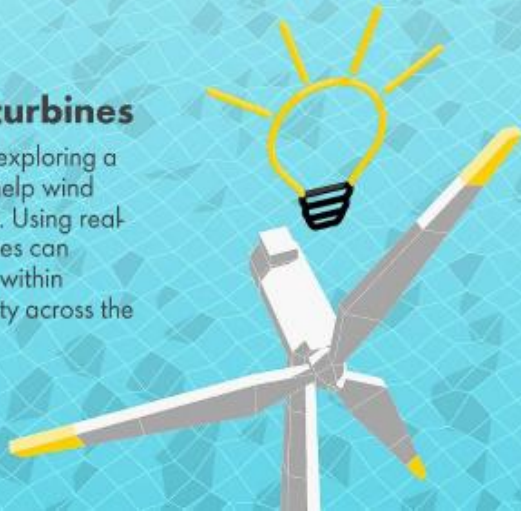
3. Floating solar energy

What about times when there is simply not enough wind to turn a turbine? CrossWind and its partners are experimenting with floating solar panels that could sit alongside the wind turbines and help to deliver more consistent energy.



2. Intelligent wind turbines

CrossWind and its partners are exploring a range of technologies that can help wind turbines in a range of conditions. Using real-time data, intelligent wind turbines can respond to changing conditions within seconds and help to keep stability across the energy grid.



5. Research and integration

CrossWind is looking at opportunities to integrate these innovations within the wind farm. We have commissioned further research to assess its feasibility. Our aim is to help the world build intelligent wind farms that can align supply with demand of renewable energy and to further power the transition into a lower-carbon future.

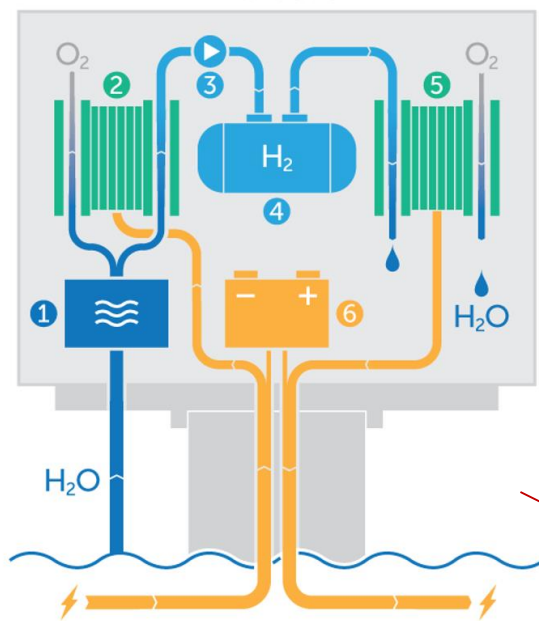


4. Storing energy

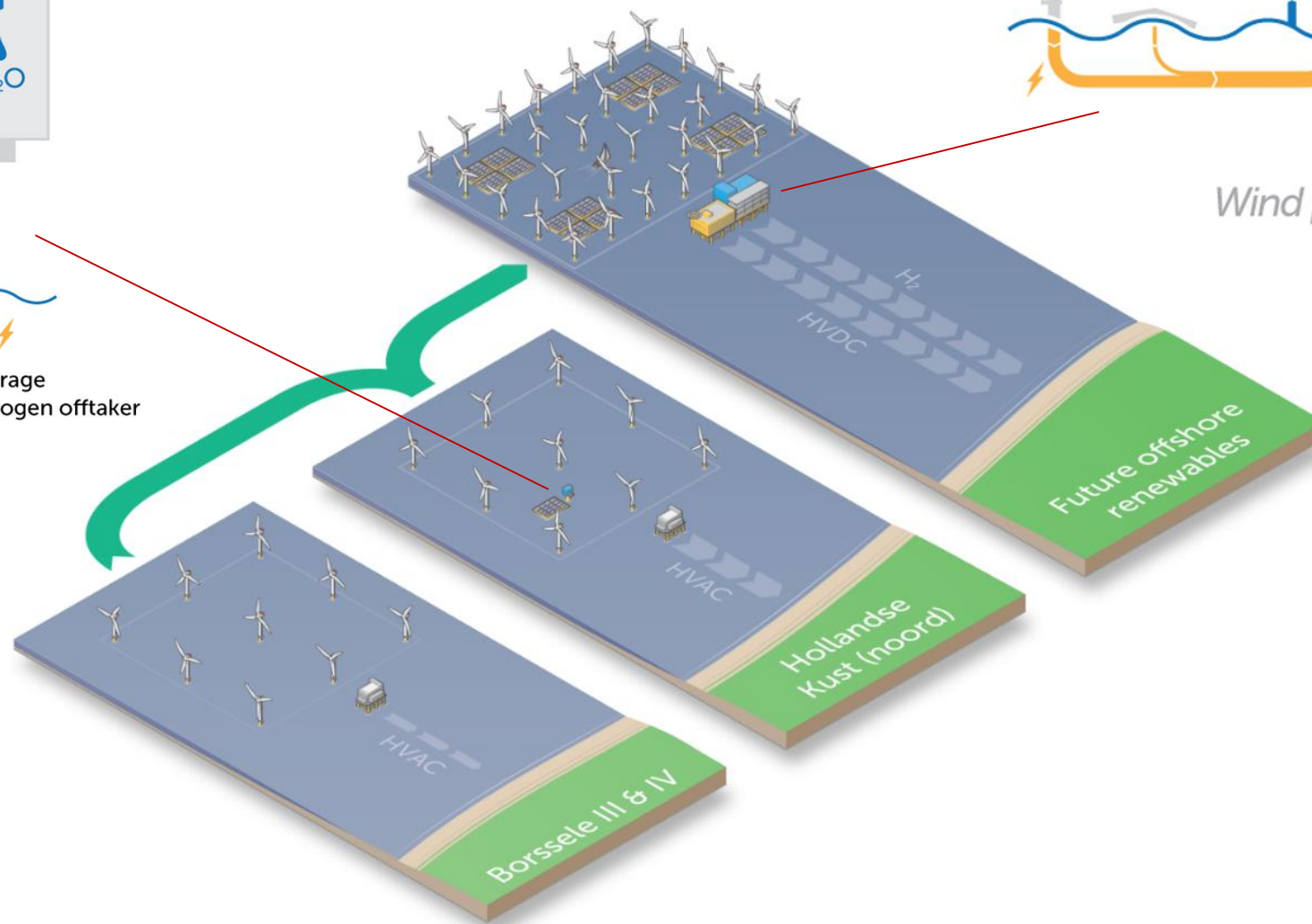
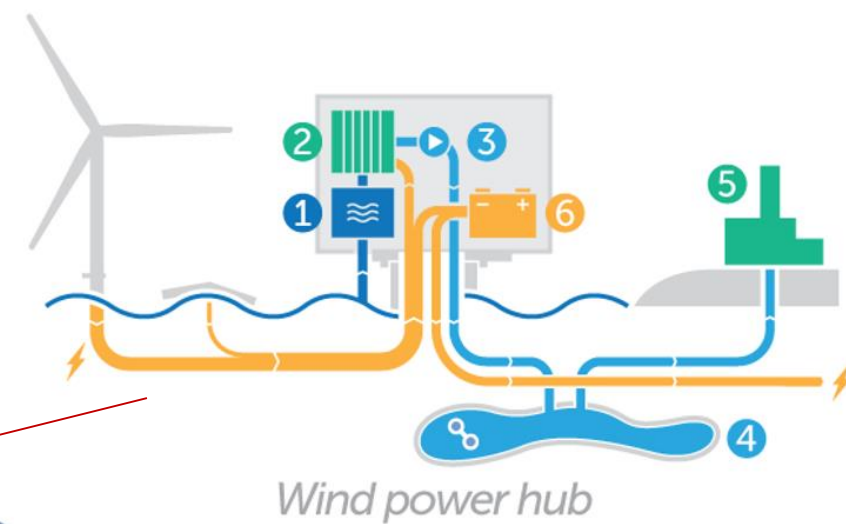
How can you store excess energy in times of low demand to supply it in times when demand is high? CrossWind and its partners are exploring energy storage solutions of batteries and even a hydrogen plant on location that produces and stores hydrogen and is able to convert the hydrogen to electricity when needed.



Pilot scale



- 1 Seawater desalinators
- 2 Electrolyser
- 3 Pump
- 4 Hydrogen storage
- 5 Fuel cell/hydrogen offtaker
- 6 Battery



Rotterdam electrolyser

~200 MW electrolyser
in the Port of Rotterdam

Green hydrogen hub in the Port of Rotterdam:

- CrossWind joint venture (Shell and Eneco) winner of tender for Hollandse Kust (Noord) wind farm with an estimated installed capacity of 759 MW.
- A potential green hydrogen plant in the Port of Rotterdam with capacity to produce 50,000 – 60,000 kg of hydrogen per day.
- Hydrogen to be initially used at the Pernis refinery, with possible future application in the trucking sector.



759 MW; On stream: 2023



Maasvlakte 200 MW on stream 2023



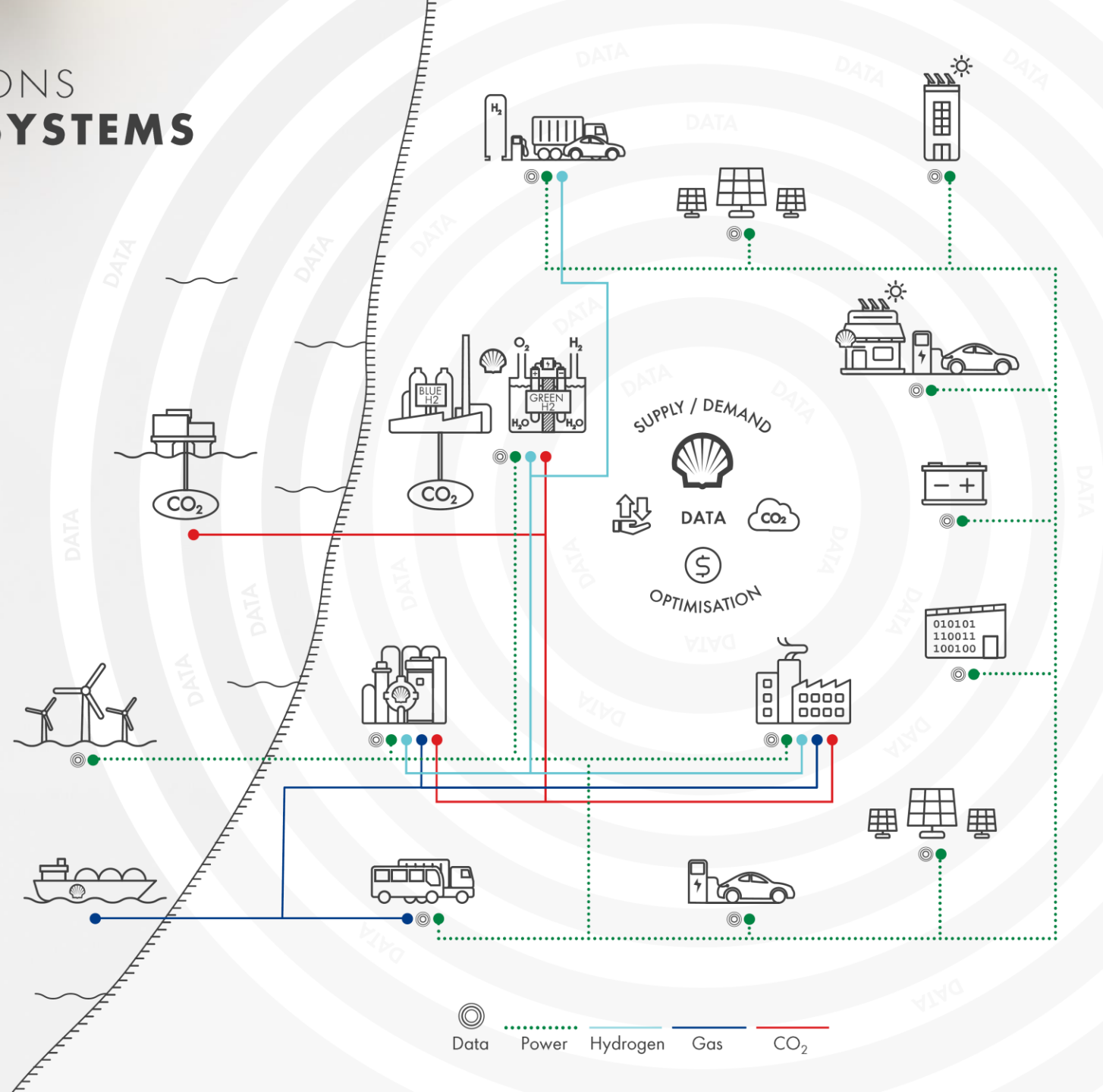
Green H₂ initially replacing grey H₂ at refinery



Pan European Hydrogen Retail network

RENEWABLES AND ENERGY SOLUTIONS INTEGRATED CLEAN ENERGY SYSTEMS DRIVING HIGHER RETURNS

- The energy system increasingly needs **system-wide optimisation** and the **integration of flexible assets** including the optimisation of customers' own assets
- Shell's capabilities to **match supply and demand** for all our customer **use cases and energy types** in an **integrated infrastructure** are essential in any future energy system
- Digital platforms provide **new means to meet customer demand** enabling Shell to tap into these **growing value pools**
- These digitally-enabled solutions **go beyond power** and will integrate into **all areas of customer activities** including EV charging, demand management, virtual power plants, LNG, CCS, hydrogen
- Our **competitive edge** to make these integrated systems carbon- and cost-efficient, as well as **trade, optimise** and convert flows of clean power, net-zero natural gas and clean hydrogen, will generate **higher returns for investors**



Thank you!

Q&A



NorthH₂

Kickstarting the green hydrogen economy

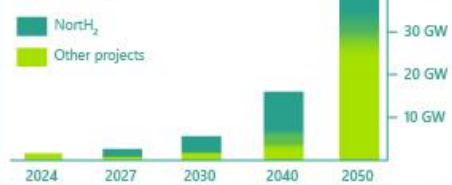
One single integrated chain in which renewable power generated by offshore wind farms is used for large-scale green hydrogen production, transmission, storage and supply. With this ambitious initiative, Equinor, Gasunie, Groningen Seaports, RWE and Shell Nederland, supported by the Province of Groningen, will help achieve the targets from the Dutch Climate Agreement.

We will be supplying large quantities green hydrogen to industry in the Netherlands and North-western Europe, reducing CO₂ emissions by 8 to 10 megatons per year. This initiative will give the green hydrogen market a real boost!

Scale-up in 2040:
More offshore wind farms and electrolysis



Scaling up green hydrogen production from 100% new wind power



Hydrogen supply to various sectors

