

The image is a composite cover for the RWE Factbook 2023. It features three main visual panels: a wind turbine on the left, a solar farm in the center, and a power transformer on the right. The entire image has a blue color scheme with a grid of white lines in the bottom right corner.

**RWE**

# Factbook 2023

# Disclaimer



This document contains forward-looking statements. These statements are based on the current views, expectations, assumptions and information of the management, and are based on information currently available to the management. Forward-looking statements shall not be construed as a promise for the materialisation of future results and developments and involve known and unknown risks and uncertainties. Actual results, performance or events may differ materially from those described in such statements due to, among other things, changes in the general economic and competitive environment, risks associated with capital markets, currency exchange rate fluctuations, changes in international and national laws and regulations, in particular with respect to tax laws and regulations, affecting the Company, and other factors. Neither the Company nor any of its affiliates assumes any obligations to update any forward-looking statements.

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**RWE GROUP**

# Company overview

## Key facts

- **HQ Location** Essen
- **Employees** ~18,300
- **Incorporation** 1898
- **Profile & Main activities** A leading operator of green generation assets with strong commercial platform
- **Geographic footprint** Europe, North America and APAC

## Executive Board



**Dr. Markus Krebber**  
CEO



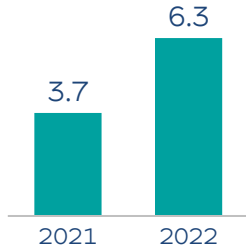
**Dr. Michael Müller**  
CFO



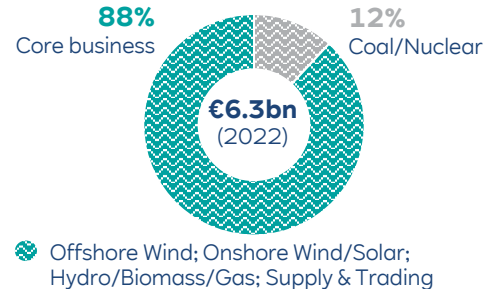
**Katja van Doren**  
CHO

## Key financials

### Adj. EBITDA, €bn



### Adj. EBITDA, breakdown by business



## Shareholders

### Ownership

Other institutional shareholders	72%
Private shareholders	12%
Qatar Investment Authority (QIA)	9%
BlackRock	6%
Employee shareholders	1%

### Market cap.

~€28bn<sup>1</sup>




### Shares

~744mn

<sup>1</sup> Note: As of 15 March 2023.

# RWE at a glance

## Driving force behind the energy transition – with a powerful position

<p><b>Well-established</b> robust company with strong financial performance</p> 	<p><b>125 years</b> track record</p>	<p><b>~18,300</b> employees</p>	<p><b>~€28 bn</b> market cap</p>	<p><b>~188%</b> total shareholder return past 5 years</p>	<p><b>€2.8 bn</b> dividend payments past 5 years</p>
<p><b>Experienced</b> operator of green generation assets with strong commercial platform</p> 	<p><b>~46 GW</b> generation portfolio<sup>1</sup></p>	<p><b>~157 TWh</b> power generated</p>	<p><b>~34 GW</b> green generation capacity in operation<sup>1</sup></p>	<p><b>70%</b> secured gross margin wind &amp; solar</p>	<p><b>Top 500</b> blue chip customers rely on RWE's commodity solutions</p>
<p><b>Positioned</b> as one of the world's leading renewable energy companies</p> 	<p><b>No. 2</b> Global Offshore<sup>2</sup></p>	<p><b>No. 2</b> US Solar</p>	<p><b>No. 4</b> US Solar &amp; Wind</p>	<p><b>No. 3</b> UK Wind &amp; Solar</p>	<p><b>No. 4</b> Europe Wind &amp; Solar</p>

Note: Data as of end 2022. | <sup>1</sup> Pro rata view as of 31 March 2023. | <sup>2</sup> China excluded.

# Energising the future - for 125 years

## Now, RWE is shaping the new energy era



**1898**  
The future starts today - 125 years ago.



Commissioning of RWE's first hydropower plant.  
**1905**



**1928**  
RWE builds the first cross-regional high-voltage transmission line.



Lignite is the key to affordable electricity.  
**1914**



Powering the economic miracle.  
**1950s**



**1970s**  
Security of supply thanks to nuclear power.



**1976**  
RWE researches, develops and tests renewables.



RWE commissions North Hoyle in the UK - one of the world's first commercial offshore wind farms.  
**2004**

**2016**  
Stock market launch for retail and grid business and foundation as generation only company.



**2019**  
The transaction with E.ON.

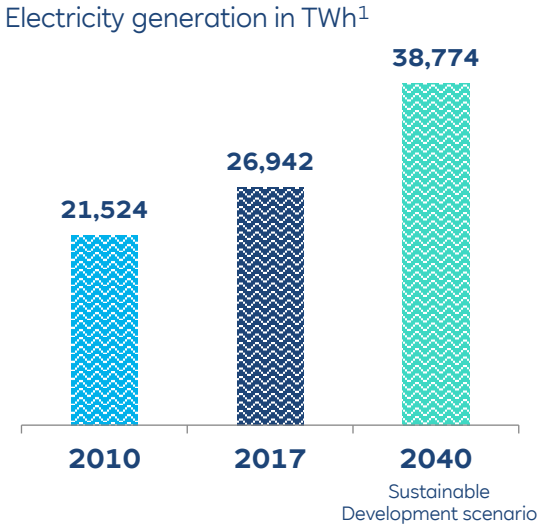
RWE becomes one of the world's leading generators of renewable electricity.



**2023**  
Combination of RWE Renewables Americas and Con Edison CEB into RWE Clean Energy.

# The global challenge of our time: Meeting increasing power demand and protecting the climate

## Global increase in electricity demand



## Key industry trends



Electrifying **mobility**



Electrifying **industry**



Electrifying **heat supply**

## Key climate protection targets



**The Paris Agreement<sup>2</sup>**  
To limit global warming to well **below 2°C**



EU-27: **55%** reduction in greenhouse gas emissions between 1990 and 2030<sup>3</sup>



Reducing U.S. greenhouse gas emissions **50-52%** below 2005 levels in 2030<sup>4</sup>

<sup>1</sup> International Energy Agency, World Energy Outlook 2020. | <sup>2</sup> The Paris Agreement on the United Nations Framework Convention on Climate Change (UNFCCC). | <sup>3</sup> Nationally Determined Contribution by EU 2020. | <sup>4</sup> Announced by the Biden Administration.



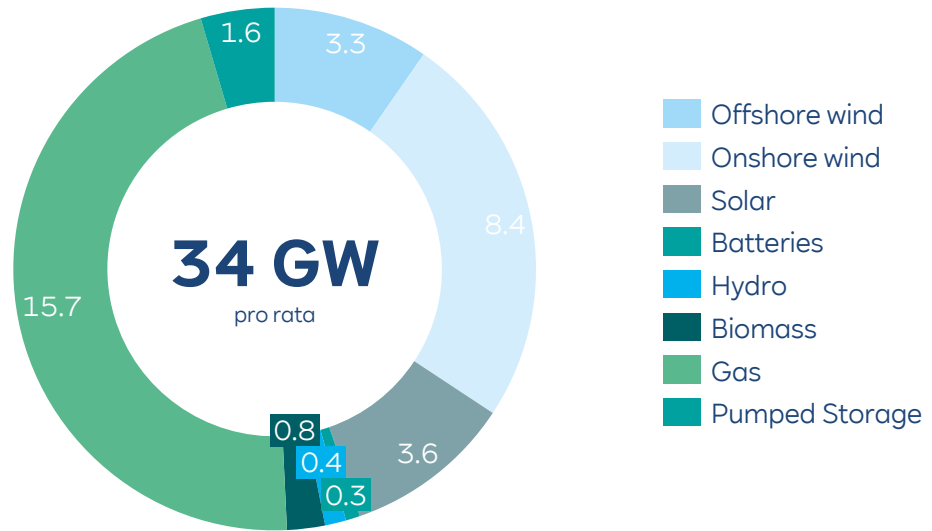
# RWE's green generation capacity

→ **Wind, solar and batteries capacity** of around 15.5 GW in operation

→ **Flexible generation capacity** comprises around 18.5 GW of gas, hydropower and biomass

→ **Flexible power plant fleet** as the secure backbone of the energy supply on our European core markets

### Total green capacity per technology<sup>1</sup>



Note: Rounding differences may occur. | <sup>1</sup> Figures as of 31 March 2023.

# Business model fully aligned with our strategic focus on the energy transition


## Core

## Non-Core

**Offshore Wind** 


- Global offshore activities

~1,660 employees

**Onshore Wind/Solar** 

- Onshore, solar and storage activities in
  - Europe & Australia
  - Americas

~2,500 employees

**Hydro/Biomass/Gas** 


- Hydro, biomass and gas plants
  - Germany, UK, NL
- Hydrogen projects

~2,700 employees

**Supply & Trading** 

- Trading/ origination
- Gas & LNG
- Commodity solutions
- Gas storage

~2,000 employees

**Coal/Nuclear** 

- German lignite operations (exit 03/2030)
- German nuclear plant (exit 04/2023)

~9,000 employees

Capacity:	3.3 GW
Adj. EBITDA:	€ 1,412 m
Adjusted EBITDA share:	22%

Capacity:	12.1 GW
Adj. EBITDA:	€ 827 m
Adj. EBITDA share:	13%

Capacity:	20.0 GW
Adj. EBITDA:	€ 2,369 m
Adj. EBITDA share:	38%

Capacity:	n/a
Adj. EBITDA:	€ 1,161 m
Adj. EBITDA share:	18%

Capacity:	11.0 GW
Adj. EBITDA:	€ 751 m
Adj. EBITDA share:	12%

Note: Pro rata capacities as of 31 March 2023.

# Our core business is leading the way to a green energy world



## Offshore Wind

Strongest growth in Europe, significant potential in global markets



## Onshore Wind/Solar

Decarbonisation pledges accelerate growth momentum in US and Europe



## Batteries & Flexible Generation

RWE's European core markets require new, low-carbon flexible capacities



## Hydrogen

Hydrogen is quickly gaining traction with projects in our European core markets



## Commercial Solutions

Decarbonisation of industry drives demand for tailored solutions

# RWE's Executive Board

## Chief Executive Officer (CEO)



**Dr. Markus Krebber**

Born 1973, with RWE since 2012,  
Member of the Executive board of RWE AG since  
2016, CEO since 2021.

### Group departments

- Group Communications & Public Affairs
- Energy Transition & Regulatory Affairs
- Legal, Compliance & Insurance
- Mergers & Acquisitions
- Strategy & Sustainability

## Chief Financial Officer (CFO)



**Dr. Michael Müller**

Born 1971, with RWE since 2005,  
Member of the Executive board of RWE AG since  
2020, CFO since 2021.

### Group departments

- Accounting
- Controlling & Risk Management
- Finance & Credit Risk
- Investor Relations
- Tax

## Chief Human Resources Officer (CHO) & Labour Director



**Katja van Doren**

Born 1966, with RWE since 1999,  
Member of the Executive board of RWE AG since  
2023, CHO since 2023.

### Group departments

- Human Resources
- Information Technology
- Corporate Transformation
- Internal Audit & Security

# Diverse and experienced Supervisory Board meets all competency requirements

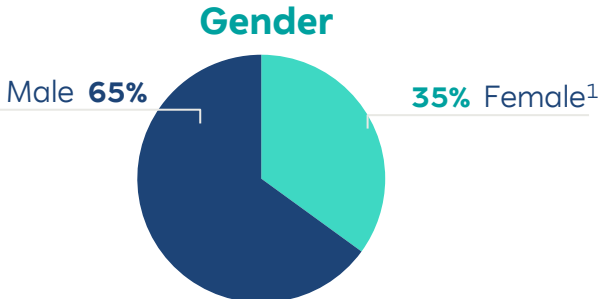
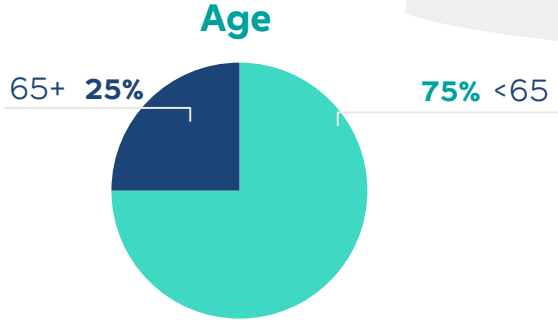
## 20 Board Members



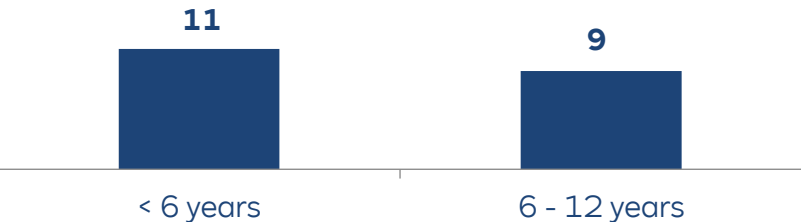
**10** **shareholder representatives** elected by the Annual General Meeting

**10** **employee representatives** elected by the employees of RWE AG & its group companies

Supported by **6** standing committees



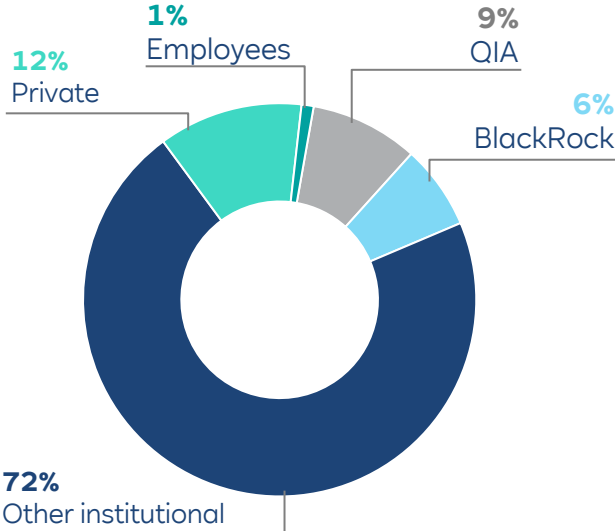
## Board Tenure in Years



<sup>1</sup> Shareholder representatives: 40%.

# Shareholder structure of RWE AG

## RWE shareholders

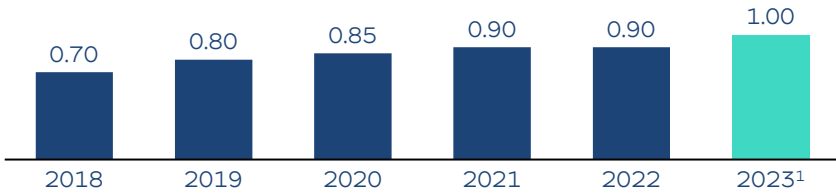


Note: As of 15 March 2023. | <sup>1</sup> Management target.

## Share indicators

		31 Dec 2022	15 Mar 2023
<b>Number of shares</b>	<b>thousands</b>	<b>676,220</b>	<b>743.841</b>
Share price <sup>1</sup>	€	41.59	38.22
<b>Market capitalisation</b>	<b>€ billion</b>	<b>28.1</b>	<b>28.4</b>

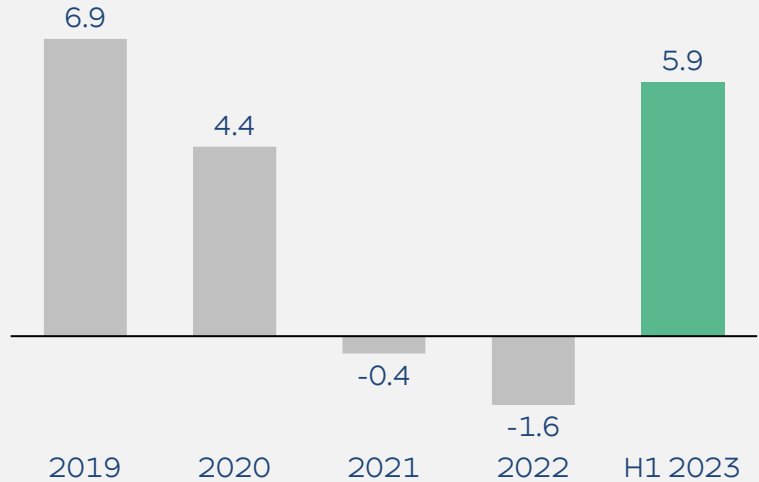
## Dividend (in €)



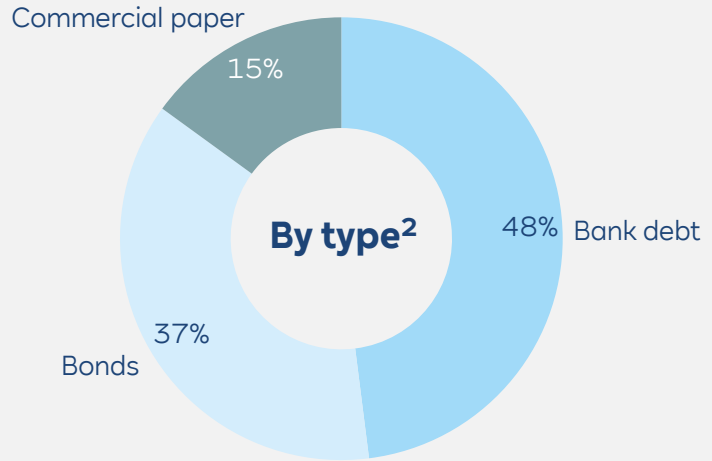
# Low levels of debt

## RWE net debt (+)/net assets (-)<sup>1</sup>

(€ billion)



## Debt split (2022)



<sup>1</sup> Net debt definition excludes financially ring-fenced coal phaseout liabilities and dedicated financial assets. | <sup>2</sup> Type of debt does not include collateral for trading activities and miscellaneous and other financial liabilities.

# Solid investment grade rating on the back of strong and sustainable financial performance

## Credit rating

MOODY'S FitchRatings

### Long-term debt

Senior debt	Baa2	BBB+
Hybrid bonds	Ba1	BBB-
Short-term debt	P-2	F1
Outlook	stable	stable

(as of March 2023)

- **Stable & sustainable** earnings backed by **balanced** financial position
- Commitment to **strong investment grade rating**
- Credit ratings **continuously improved**

*“The Baa2 issuer rating of RWE reflects its large and **well-diversified** generation portfolio; progress in executing the strategy of **growing the renewables** generation portfolio while **reducing** conventional thermal **coal-based capacity**; and solid financial metrics before the acquisition, underpinned by a **balanced** financial policy and **strong** operating performance.”*

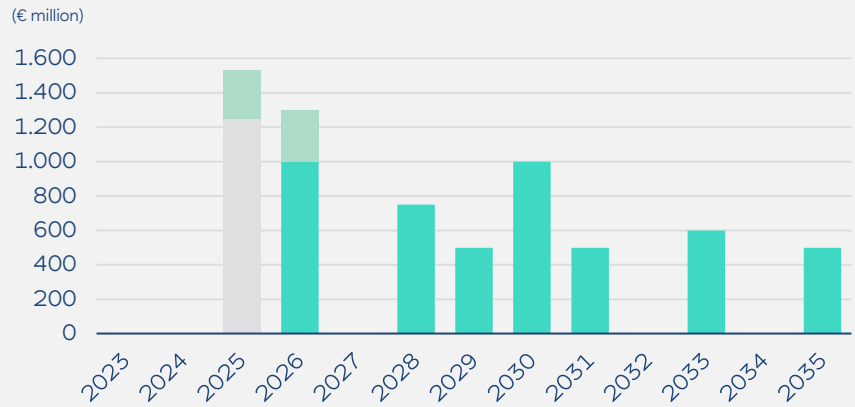
**MOODY'S**  
Credit Opinion, October 2022



# Issuances and maturities of RWE's bonds

## RWE's bond maturity profile with Green Bonds as preferred financing tool for future growth

Green Bonds    Hybrid Bonds at First Call Date    Conventional Bond



## RWE's issuances

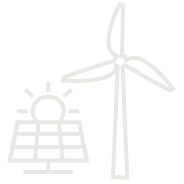
**2021:**  
**3x Green Bonds** with a total volume of **€1.85bn**

**2022:**  
**2x Green Bonds** with a total volume of **€2bn**  
**1x Conventional Bond** of **€1.25bn**

**2023 to date:**  
**2x Green Bonds** with a total volume of **€1bn**

**First Call Dates Hybrids:**  
**April 2025**  
**March 2026**

# RWE will be a frequent issuer of green bonds







100% of proceeds will be allocated to green technologies

Type	Green Format	<ul style="list-style-type: none"><li>Funding strategy serves RWE's transition to a pure renewables player</li><li>Conventional bonds only on an exceptional basis</li></ul>
Volumes	Ø €1.5 – 2.5bn p.a.	<ul style="list-style-type: none"><li>Driven by liquidity requirements and market circumstances</li></ul>
Tenors	3 – 20 years	<ul style="list-style-type: none"><li>Aiming to achieve a balanced maturity profile</li></ul>
Currencies	EUR, USD, GBP	<ul style="list-style-type: none"><li>Currencies based on RWE's asset base</li><li>Other currencies used opportunistically</li></ul>
Instruments	Senior and Hybrid	<ul style="list-style-type: none"><li>Public senior bonds as base instrument</li><li>Private placements, promissory notes (Schuldscheindarlehen)</li><li>Hybrids potential supplemental instrument</li></ul>

# Green bonds foster our renewables investments

## Examples of allocated green projects from outstanding Green Bonds

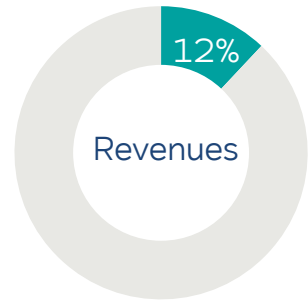
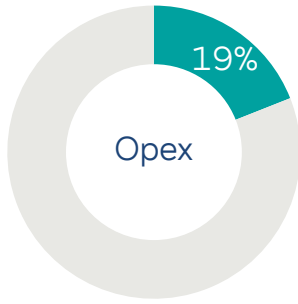
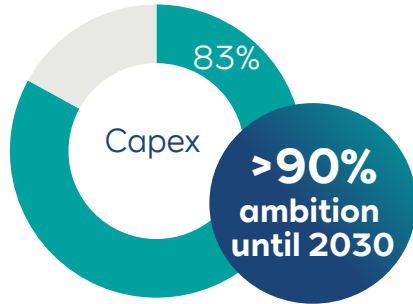
Offshore Wind	Onshore Wind	Solar & Storage	Solar
<b>Sofia</b>	<b>Blackjack Creek</b>	<b>Fifth Standard</b>	<b>Limondale</b>
			
1,400 MW	240 MW	287 MW <sup>1</sup>	249 MW
COD 2026	COD 2022	COD 2023	COD 2021
under construction	in operation	under construction	in operation



Note: Data as of end 2022.1<sup>1</sup> Including storage (137 MW), COD in H1 2023.

# Sustainable Finance at RWE

## EU Taxonomy: share of RWE's aligned business activities (2022)<sup>1</sup>



## Sustainability-Linked Financing Instruments, Frameworks and Policies:



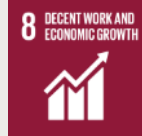



- Taxonomy-aligned KPIs integrated into RWE's **Revolving Credit Facility**
- RWE **Green Bond** Framework
- **Green Bonds** as preferred financing tool
- **ESG criteria** integrated into third-party processes and in financial investments



<sup>1</sup> Our taxonomy-aligned business activities primarily comprise electricity generation from onshore and offshore wind, solar and hydropower (run-of-river, pumped storage).

# RWE's approach to ESG contributes directly to the UN SDGs

## Seven SDGs were defined as material in relation to the business activities of RWE

						
<ul style="list-style-type: none"> <li>• <b>30% of female</b> Executive <b>Board</b> members</li> <li>• <b>20.8 % of female in management positions</b> (core business)</li> </ul>	<ul style="list-style-type: none"> <li>• Leading operator of wind, solar and batteries with <b>~15.5 GW</b> installed capacity (as of 31 March 2023)</li> <li>• Highly <b>efficient and flexible</b> power plant portfolio</li> </ul>	<ul style="list-style-type: none"> <li>• Strong employer with workforce of <b>~18,300 people</b></li> <li>• Contribution to <b>local communities</b>, support for <b>structural change</b> and socially responsible and <b>fair transition</b></li> </ul>	<ul style="list-style-type: none"> <li>• Focus on <b>innovative technologies</b> to support <b>climate-neutral transition</b>: hydrogen, storage technologies, floating offshore wind and floating PV, recyclable blades</li> </ul>	<ul style="list-style-type: none"> <li>• Support for the targets of the <b>Paris Climate Agreement</b></li> <li>• Scientifically certified <b>reduction targets for 2030</b></li> <li>• <b>Net zero by 2040</b> in all scopes</li> </ul>	<ul style="list-style-type: none"> <li>• Recultivation programme with focus on <b>biodiversity</b></li> <li>• <b>Net-positive</b> contribution to <b>biodiversity</b> by 2030 for new assets</li> </ul>	<ul style="list-style-type: none"> <li>• Strict compliance requirements with RWE's <b>Code of Conduct</b></li> <li>• Member of <b>Bettercoal</b> to promote standards in supply chain</li> </ul>



# Impressive improvement in major sustainability ratings

**ESG Rating**

**MSCI** 

AAA to CCC

2020	→	2023
<b>A</b>		<b>A</b>
Average		Average

**Top half of all Utilities**  
(Utilities Sector)

**ESG Risk Rating**

**SUSTAINALYTICS** 


100 to 0  
(0 = top mark)

2020	↗	2023
<b>33.8</b>		<b>23.1</b>
High		Medium

**Lower risk**

**Top 20% of all Utilities**  
(Utilities Sector)

**ESG Corporate Rating**

**ISS ESG** 

A+ to D-

2020	↗	2023
<b>C+</b>		<b>B-</b>
		Prime Status

**Top 10% of all Multi Utilities**  
(Utilities Sector)

**Corporate Sustainability Rating**


**S&P Global** 

0 to 100  
(100 = top mark)

2020	↗	2022
<b>63</b>		<b>70</b>

**Industry Mover 2022**

**Climate Change Rating**

**CDP** 

DISCLOSURE INSIGHT ACTION  
A to D

2020	↗	2022
<b>B</b>		<b>A-</b>
Management level		Leadership

**Better than the global average**

Note: Last shown rating scores based on the date of last comprehensive rating review.

# RWE's pathway to climate neutrality

## 2020: Existing SBTi targets



RWE AG commits to **reduce scope 1 and 2 GHG emissions 50%** per kWh by 2030 from a 2019 base year<sup>1</sup>.

RWE AG commits to **reduce absolute scope 3 GHG emissions 30%** by 2030 from a 2019 base year.



Press release, 2020

## 2021: RWE ambition



We will be **climate neutral by 2040**.

On the way there, our ambition is to reduce our emissions **in line with a 1.5°C compliant pathway**.



CMD, 2021 (p.12)

## 2023: New SBTi targets



**New targets submitted** for validation to the internationally renowned Science Based Targets Initiative.

[...] CO<sub>2</sub> reductions now in line with 1.5-degree path.



Press release, 2023

<sup>1</sup>The target boundary includes biogenic emissions and removals from bioenergy feedstocks as well as emissions from electricity purchased and from non-controlled assets. Source: RWE press releases, RWE capital market day 2021.

# Shaping the future of energy through Innovation



**Floating offshore wind power**  
In cooperation with renowned partners, we are entering completely new regions with wind power. This technology is gaining importance, especially in countries with coasts that drop away steeply, such as Japan and the USA.

## Recyclable blades

A number of the Kaskasi wind turbines being erected will be fitted with special recyclable rotor blades. Our supplier Siemens Gamesa is manufacturing them using a new type of resin with a chemical structure that allows for the different materials to be separated. This makes it possible to reuse the individual components once the rotor blade has reached the end of its lifetime.

**Multi-fuel conversion**  
By heating sewage sludge, the phosphorus it contains is separated. The remaining gas mixture of hydrogen and carbon can be processed in further steps to produce basic chemicals or fuels.

**Floating solar farms** offer potential for power generation and climate protection, and the technology hasn't been widely adopted yet. In contrast to ground-mounted systems, the PV modules are mounted on floats, which are put out on bodies of still open water and on the sea.



## Battery storage

RWE operates battery storage systems in Europe and the USA and has experience in various lithium-ion battery technologies. The innovative areas also cover second-life electric-vehicle batteries and renewable energy as well as storage applications. RWE also has powerful, intra-company capacities to integrate systems and an in-house Energy Management System (EMS).

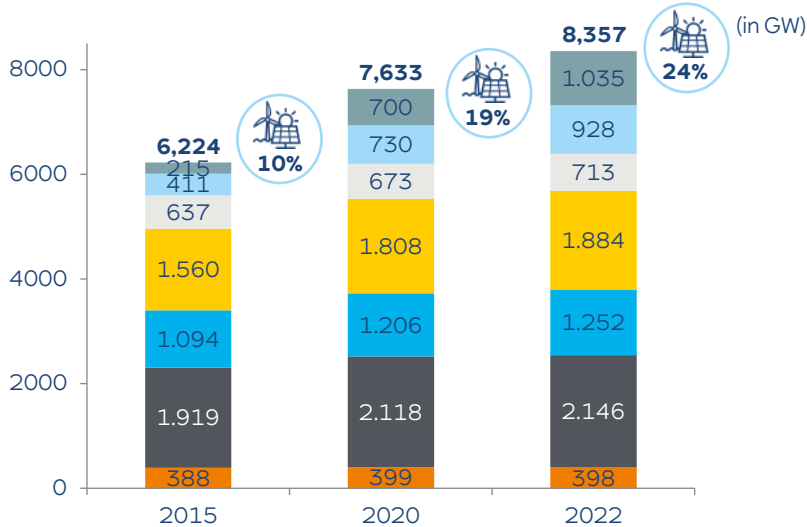




# MARKET DATA

# Global capacity and generation mix

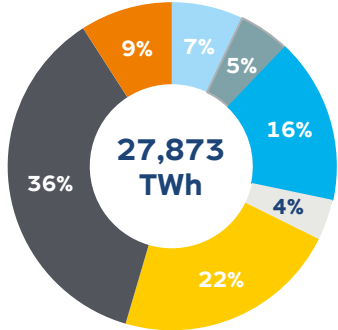
## Global installed capacity



Source: IHS. | Other includes Oil, Batteries, Pumped Storage, Biomass & waste, Geothermal and Ocean.

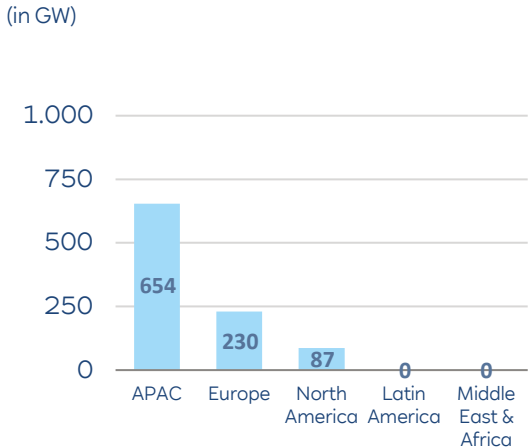
## Global generation mix in 2022

	TWh
Nuclear	2,578
Coal	9,904
Gas	6,267
Other	1,246
Hydro	4,461
Solar	1,331
Wind	2,087

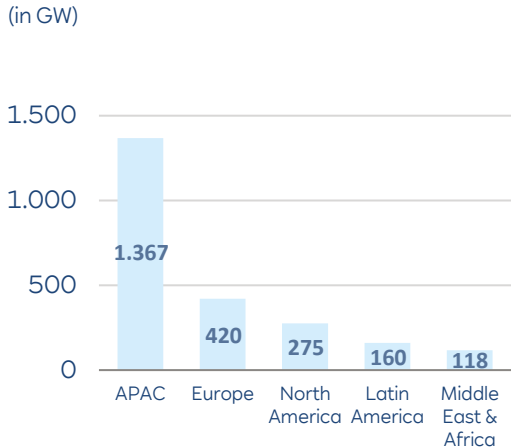


# Global region rankings for capacity additions from 2023 – 2050

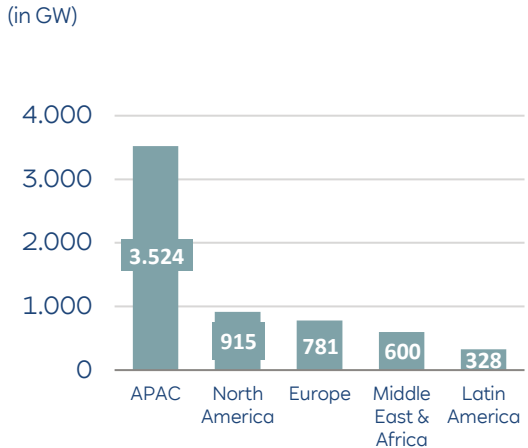
## Capacity additions for Offshore wind



## Capacity additions for Onshore wind



## Capacity additions for Solar PV and CSP



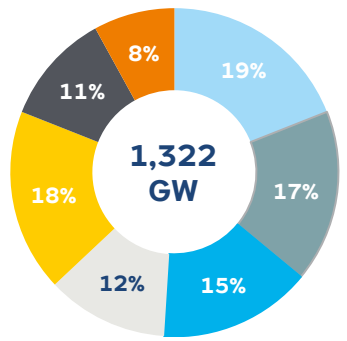
Source: IHS.



# European power generation and capacity mix

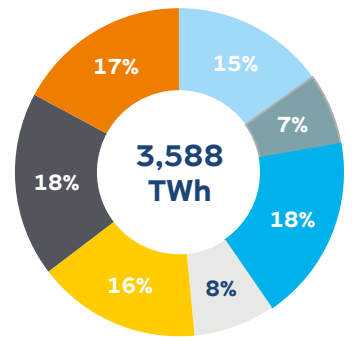
## Installed capacity in 2022

	GW
Nuclear	106
Coal	147
Gas	234
Other <sup>1</sup>	156
Hydro	198
Solar	228
Wind	253



## Generation mix in 2022

	TWh
Nuclear	618
Coal	653
Gas	592
Other	285
Hydro	663
Solar	238
Wind	539



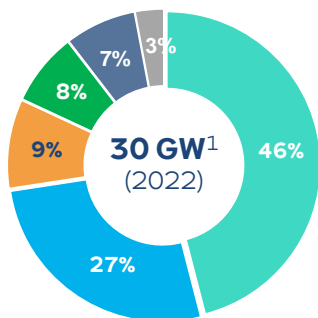
Source: IHS. | <sup>1</sup> Oil, Batteries, Pumped Storage, Biomass & waste, Geothermal and Ocean.



# European Offshore

## Offshore wind generating capacity

	GW
UK	13.9
Germany	8.1
Netherlands	2.8
Belgium	2.3
Denmark	2.3
Rest of Europe	0.9
<b>Total</b>	<b>30.3</b>

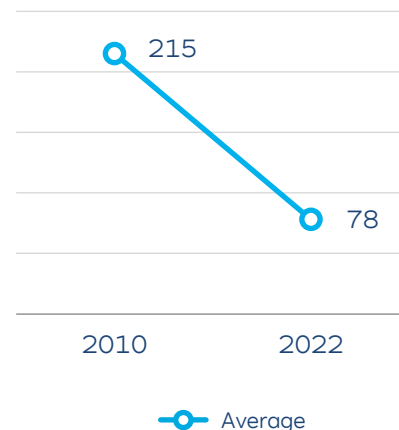


## New European capacity installed in 2022

UK	Netherlands	Germany	Rest of Europe	Total
1.2 GW	0.4 GW	0.3 GW	0.6 GW	<b>2.5 GW</b>

## LCOE<sup>2</sup> for offshore wind

(in \$/MWh)



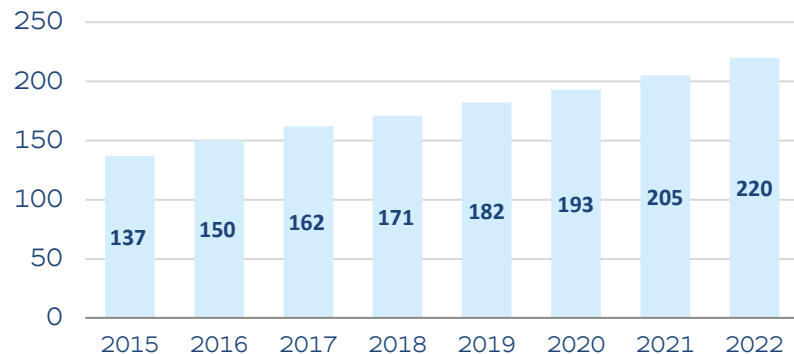
<sup>1</sup> Source: GWEC Global Wind Report 2023. <sup>2</sup> Historic benchmark of Levelised Cost of Electricity (\$/MWh, real); global scope. Source: BNEF.



# European Onshore

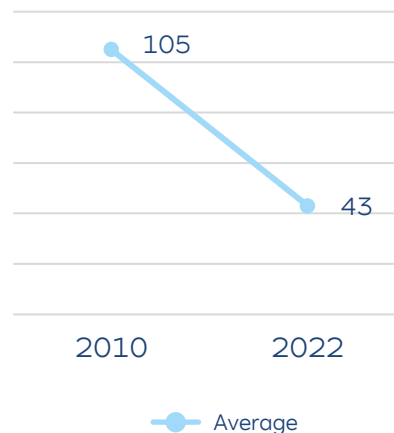
## Onshore wind generating capacity

(in GW)



## LCOE<sup>1</sup> for onshore wind

(in \$/MWh)



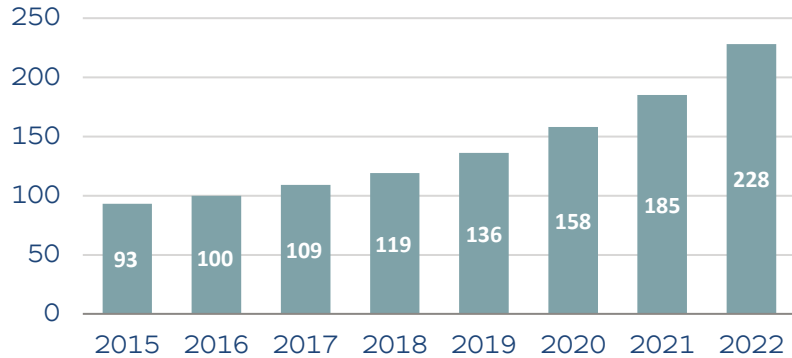
Source: IHS. | <sup>1</sup> Historic benchmark of Levelised Cost of Electricity (\$/MWh, real); global scope.



# European Solar

## Solar generating capacity

(in GW)



## LCOE<sup>1</sup> for PV (non-tracking)

(in \$/MWh)



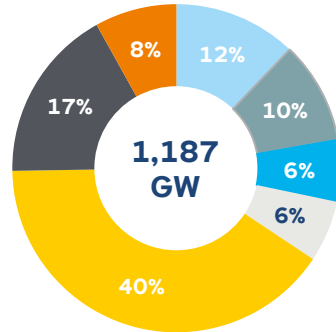
Source: IHS. | <sup>1</sup> Historic benchmark of Levelised Cost of Electricity (\$/MWh, real); global scope.



# U.S. power generation and capacity mix

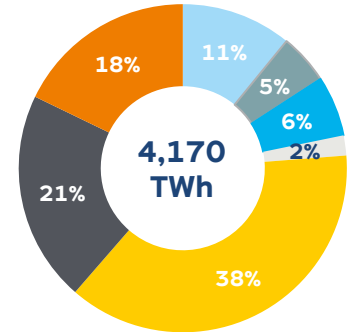
## Installed capacity in 2022

	GW
Nuclear	95
Coal	197
Gas	480
Other <sup>1</sup>	75
Hydro	76
Solar	118
Wind	146



## Generation mix in 2022

	TWh
Nuclear	770
Coal	863
Gas	1,572
Other	63
Hydro	257
Solar	205
Wind	438



Source: IHS. | <sup>1</sup> Oil, Batteries, Pumped Storage, Biomass & waste and Geothermal.

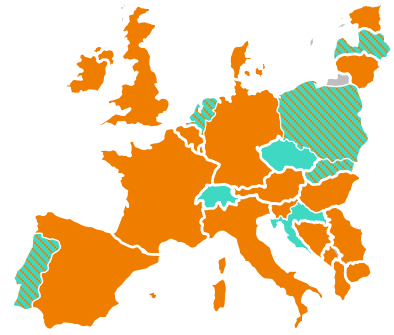




# Controllable capacity in Europe significantly decreasing

## LOLE values for the central reference scenario without CM 2025<sup>1</sup>

(Loss of load expectation, LOLE<sup>2</sup>)



**Scarcity issues are identified in 2025**

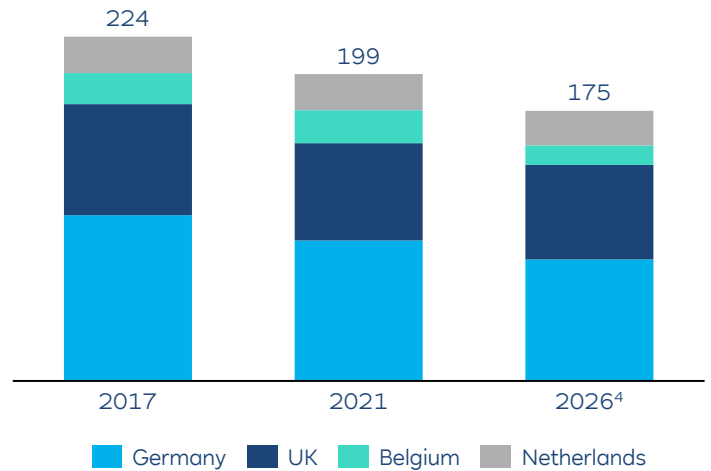
- Ireland: 24 h/year
- Malta: 22 h/year
- Germany, Italy, Spain, France and Belgium, Denmark and Hungary from 6 to 11 h/year
- Finland and Southern Sweden are also found to exceed national reliability standards in this scenario, having a LOLE of 3.5 h/year and 2h/year respectively

Central scenario without intervention / capacity mechanism

■ Null avg. LOLE   
 ▨ Avg. LOLE ≤ 0.1h   
 ■ Avg. LOLE > 0.1h

## Installed controllable capacity in Central Western Europe<sup>3</sup>

(in GW)



<sup>1</sup> European Resource Adequacy Assessment 2022 of entso-e. | <sup>2</sup> Expected number of hours where load cannot be supplied by local resources and imports. | <sup>3</sup> Controllable capacity only, i.e. without PV and wind energy. For more historic data per country, please see local databases: BDEW for Germany, Digest of UK Energy Statistics (DUKE) for UK and Central Office for Statistics Netherlands (CBS). | <sup>4</sup> RWE analysis.

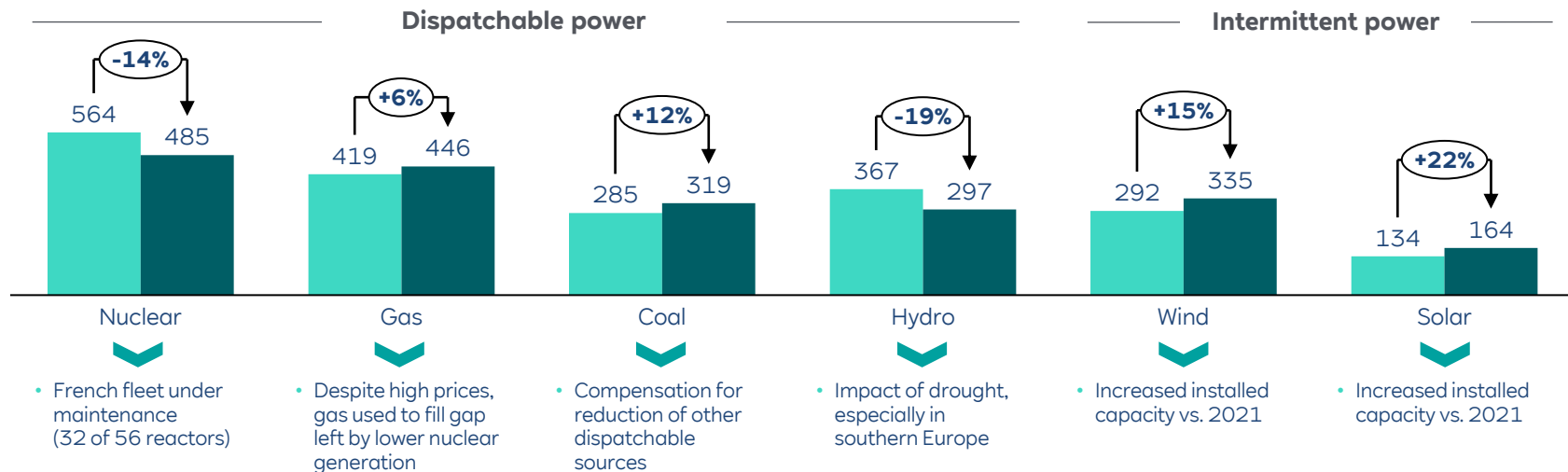


# Lower availability from nuclear and hydro sources led to increased coal output in 2022

## Power generation in Europe, 2021-2022<sup>1</sup>

(in TWh)

2021<sup>2</sup>  
2022<sup>3</sup>



Source: McKinsey & Company; Ember; European Network of Transmission Systems Operators for Electricity (ENTSO-E); Fraunhofer; International Renewable Energy Agency (IRENA); National Grid | <sup>1</sup> Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and UK. | <sup>2</sup> January to September 2021 | <sup>3</sup> January to September 2022.

# Ancillary services<sup>1</sup>

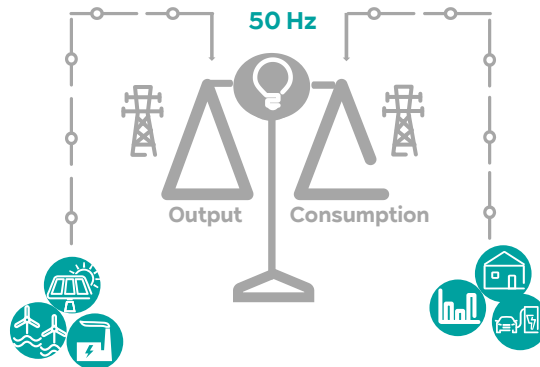
## Continuous balancing of power supply and demand

### The balancing market:

- A market operated by Transmission System Operators (TSOs) to maintain the power/frequency balance
- It is needed to ensure a continuous and stable frequency in the short term (e.g. when unexpected incidents occur - power plant outages)

### Ancillary services:

- Necessary tools/products which TSOs contract from generators in order to maintain system stability and security



### Maintains energy balance

#### Energy products

- **Frequency Control & Reserves** – to maintain system frequency at 50Hz ± x% and to provide additional energy when needed
  - **UCTE / Germany:** primary, secondary, tertiary and time control levels (FCR, aFRR/mFRR, RR)
  - **UK:** frequency response (FFR, MFR, EFR) and reserve (Fast Reserve, STOR, BM start up)

### Maintains grid quality

#### System products

- **Reactive power** (voltage support) provides the important function of voltage regulation

#### Constraint Management

- **Countertrading** – grid operators deal on exchange or OTC (Continental)
- **(Regulated) Redispatch** – ramp-down or ramp-up power stations to relieve power flows from congested grid lines

### Dedicated to restarting the grid

#### Security products / emergency

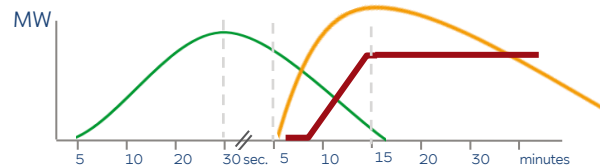
- **Blackstart** ability to restart a grid following a blackout
- **Intertrips** – automatically disconnect a generator
- **SO-SO trading** (system operator to system operator trades) – determines the direction of electricity flow

<sup>1</sup> Range of functions/products which Transmission System Operators (TSOs) contract from generators in order to maintain system stability and security.

# Overview of continental reserve category timescales

	Primary reserve	Secondary reserve	Tertiary reserve
<b>Reaction time</b>	<ul style="list-style-type: none"> <li>30 seconds (100%)</li> </ul>	<ul style="list-style-type: none"> <li>5 minutes (100%)</li> </ul>	<ul style="list-style-type: none"> <li>7 - 15 minutes (100%)</li> </ul>
<b>System</b>	<ul style="list-style-type: none"> <li>UCTE<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>Control area</li> </ul>	<ul style="list-style-type: none"> <li>Control area</li> </ul>
<b>Activation</b>	<ul style="list-style-type: none"> <li>Automatic and decentralised activation via governor control</li> </ul>	<ul style="list-style-type: none"> <li>Centralised (TSO); active call through IT</li> </ul>	<ul style="list-style-type: none"> <li>Centralised (TSO); active call through phone/IT</li> </ul>
<b>Reserved capacity</b>	<ul style="list-style-type: none"> <li>3,000 MW in UCTE</li> <li>1,400 MW joint auction (DE, FR, NL, BE, CH, AU)</li> </ul>	<ul style="list-style-type: none"> <li>Decided by TSO (+/-2,000 MW in Germany)</li> </ul>	<ul style="list-style-type: none"> <li>Decided by TSO (+1,200 MW, - 700 MW in Germany)</li> </ul>
<b>Auction</b>	<ul style="list-style-type: none"> <li>Daily</li> </ul>	<ul style="list-style-type: none"> <li>Daily</li> </ul>	<ul style="list-style-type: none"> <li>Daily</li> </ul>
<b>Remuneration</b>	<ul style="list-style-type: none"> <li>Pay-as-cleared</li> </ul>	<ul style="list-style-type: none"> <li>Pay-as-bid (Capacity)</li> <li>Pay-as-cleared (Energy)</li> </ul>	<ul style="list-style-type: none"> <li>Pay-as-bid (Capacity)</li> <li>Pay-as-cleared (Energy)</li> </ul>
<b>Typical suppliers</b>	<ul style="list-style-type: none"> <li>Synchronised generators; large-scale battery storage systems</li> </ul>	<ul style="list-style-type: none"> <li>Storage and pumped storage hydro plants; gas turbine power plants; CHP; large-scale battery storage systems</li> </ul>	<ul style="list-style-type: none"> <li>Storage and pumped storage hydro plants; gas turbine power plants; CHP; other thermal power plants</li> </ul>

- A **sudden drop** in frequency triggers automated response to **correct the frequency**, followed by **manual interventions** by power system operators.



<sup>1</sup> The Union for the Coordination of the Transmission of Electricity.



# REGULATIONS

# Regulatory regimes for renewables (1/10)



	Support regime	Remuneration
Onshore	<ul style="list-style-type: none"> <li>• <b>Production Tax Credit (PTC)</b> annually inflation-adjusted, paying out over 10 years. Full PTC value (including labor provisions) for projects that have begun construction after 2021.</li> <li>• <b>Renewable Energy Certificates (RECs)</b></li> <li>• Mandatory procurement via <b>Renewable Portfolio Standards (RPS)</b>/clean energy goals</li> <li>• <b>Modified Accelerated Cost-Recover System (MACRS)</b>: Accelerated depreciation for tax equity investors &amp; developers over 5 years, majority of capex can be expensed in year placed in service (bonus depreciation)</li> <li>• <b>Investment Tax Credits (ITC)</b> also possible, not inflation-adjusted</li> </ul>	<p>Various revenue streams depending on state and market:</p> <ul style="list-style-type: none"> <li>• <b>Tax credits</b> via PTC (\$28/MWh) or ITC (30% of capex). Certain bonus adders also may apply for Domestic Content and Energy Communities.</li> <li>• <b>Energy revenues</b> via wholesale market or PPA (10-20 years)</li> <li>• <b>Capacity revenue</b> via market or part of PPA</li> <li>• <b>RECs</b> via market or part of PPA</li> </ul>
Offshore	<ul style="list-style-type: none"> <li>• <b>Investment Tax Credit (ITC)</b> amounts to 30% for projects that have begun construction after 2021</li> <li>• <b>Offshore Renewable Energy Certificates (ORECs)</b></li> <li>• Mandatory procurement via <b>Renewable Portfolio Standards (RPS)</b>/clean energy goals</li> </ul>	
Solar	<ul style="list-style-type: none"> <li>• <b>Investment Tax Credit (ITC)</b></li> <li>• <b>Production Tax Credit (PTC)</b></li> <li>• <b>Renewable Energy Certificates (RECs)</b></li> <li>• Mandatory procurement via <b>Renewable Portfolio Standards (RPS)</b>/clean energy goals</li> <li>• <b>Modified Accelerated Cost-Recover System (MACRS)</b></li> </ul>	

# Regulatory regimes for renewables (2/10)



	Support regime	Remuneration
Onshore	<ul style="list-style-type: none"> <li>• <b>Two-sided Contracts for Difference (CfD)</b>, awarded through a pay-as-clear auction. Onshore wind was included in the first round in 2015 but then excluded until Allocation Round 4 (AR4) in 2022.</li> <li>• Future auctions will be annual. The next auction (AR5) opens March 2023.</li> <li>• <b>Onshore wind projects are also eligible for the Capacity Market (CM) Support Scheme.</b> Generators cannot have both a CfD and a CM contract and must face a one-off choice between the two. Limited take-up of CM contracts from renewables assets, with the scheme far less lucrative than the CfD.</li> <li>• <b>Onshore wind and solar PV are in “pot 1” of the scheme and from the 2023 auction will compete directly with offshore wind.</b></li> </ul>	<p><b>CfD:</b></p> <ul style="list-style-type: none"> <li>• <b>Wholesale market + CfD top-up/payback to government entity</b></li> <li>• <b>Term:</b> 15 years (CPI inflation linked)</li> <li>• Generators with a CfD sell power into the wholesale market and receive the difference between the market price and the strike price level they received in the auction.</li> </ul> <p><b>Onshore wind average CfD clearing prices (2012 money):</b></p> <ol style="list-style-type: none"> <li>1. Allocation Round 1 (2015) = £81.25/MWh</li> <li>2. Allocation Round 4 (2022) = £42.47/MWh</li> </ol>
Offshore	<ul style="list-style-type: none"> <li>• <b>Two-sided Contracts for Difference (CfD)</b>, awarded through a pay-as-clear auction. Offshore wind has been included in in each round since 2015.</li> <li>• Future auctions will be annual. The next auction (AR5) opens March 2023.</li> <li>• Offshore was given an exclusive technology budget “pot” in the 2022 auction.</li> <li>• <b>For 2023 auction onwards, offshore wind has been included in “pot 1” with onshore wind and solar and will directly compete with these two technologies for CfDs.</b></li> <li>• Offshore wind projects are also eligible for the Capacity Market (CM) Support Scheme.</li> </ul>	<p><b>CfD:</b></p> <ul style="list-style-type: none"> <li>• <b>Wholesale market + CfD top-up/payback to government entity</b></li> <li>• <b>Term:</b> 15 years (CPI inflation linked)</li> </ul> <p><b>Offshore wind average CfD clearing prices (2012 money):</b></p> <ol style="list-style-type: none"> <li>1. Allocation Round 1 (2015) = £117.86/MWh</li> <li>2. Allocation Round 2 (2017) = £68.36/MWh</li> <li>3. Allocation Round 3 (2019) = £40.38/MWh</li> <li>4. Allocation Round 4 (2022) = £37.35/MWh</li> </ol>
Solar	<ul style="list-style-type: none"> <li>• <b>Two-sided Contracts for Difference (CfD)</b>, awarded through a pay-as-clear auction. Solar PV was included in the first round in 2015 but then excluded until Allocation Round 4 (AR4) in 2022. Future auctions will be annual. The next auction (AR5) opens March 2023.</li> <li>• <b>Onshore wind and solar PV are in “pot 1” of the scheme and from 2023 will compete directly with offshore wind</b></li> <li>• Solar PV projects are also eligible for the Capacity Market (CM) Support Scheme.</li> </ul>	<p><b>CfD:</b></p> <ul style="list-style-type: none"> <li>• <b>Wholesale market + CfD top-up/payback to government entity</b></li> <li>• <b>Term:</b> 15 years (CPI inflation linked)</li> </ul> <p><b>Solar PV average CfD clearing prices (2012 money):</b></p> <ol style="list-style-type: none"> <li>1. Allocation Round 1 (2015) = £79.23/MWh</li> <li>2. Allocation Round 4 (2022) = £45.99/MWh</li> </ol>

# Regulatory regimes for renewables (3/10)

## Germany

	Support regime	Remuneration
Onshore	<ul style="list-style-type: none"> <li>• <b>Feed-in tariff (FIT)</b> with direct marketing obligation until COD 2016 (relevant for existing assets)</li> <li>• Pay-as-bid one-sided <b>Contract for Difference (CfD)</b> awarded through auctions since 2017</li> </ul>	<ul style="list-style-type: none"> <li>• <b>One-sided CfD price</b> determined in competitive auctions with Feb 2023 average 7.34c€/kWh, subject to “reference yield” corrections</li> <li>• <b>Term:</b> 20 years</li> <li>• Pre-tender phase assets receive Feed-in tariff</li> </ul>
Offshore	<ul style="list-style-type: none"> <li>• <b>(initial) Feed-in tariff (FIT)</b> with direct marketing obligation until 2016</li> <li>• Since 2017 transition to <b>central auction</b> system in form of 20 year <b>one-sided CfD</b> (for projects with COD after 2026).</li> <li>• <b>Two interim auction rounds</b> were held in 2017 and 2018 for projects in advanced stage with COD in 2021 to 2025</li> <li>• <b>In 2021 and 2022 central auction system with one-sided CfD and COD in 2026 or 2027</b> with zero bids, lottery and subsequent step-in right execution from existing projects in some cases</li> <li>• <b>Since 2023, twofold auction scheme for COD starting 2028</b> with <b>centrally pre-investigated sites</b> tendered via a set of <b>5 bid criteria</b> and <b>not centrally pre-investigated sites via the known one-sided CfD</b>. <b>Both routes foresee a financial bid</b> although for not centrally pre-investigated sites the financial bid is determined in a dynamic bidding process and only relevant in case of 0-bids in a first step.</li> <li>• <b>Remaining step-in rights for 3 out of 4 centrally pre-investigated sites</b> in 2023 auction require matching of the financial bid only</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Initial Feed-in tariff (FIT):</b> €139 - 154/MWh for 12 years (standard) or €184-194/MWh for 8 years (compression model) depending on year of commissioning</li> <li>• <b>Base Feed-in tariff (FIT):</b> €39/MWh for residual term</li> <li>• <b>One-sided CfD price in not centrally pre-developed sites</b> (and former interim and central auctions) determined in competitive pay-as-bid auctions (zero bids possible)</li> <li>• <b>No support scheme for centrally pre-developed sites</b> with focus on PPA market but auctions based on selected quantitative and qualitative criteria (of which 60% accounts for financial bid)</li> <li>• In July 2023 12,6 bln€ entry fees were paid for 7 GW determined in competitive bidding</li> </ul>
Solar	<ul style="list-style-type: none"> <li>• <b>Feed-in tariff (FIT)</b> with direct marketing obligation until COD 2016 (relevant for existing assets)</li> <li>• Pay-as-bid one-sided <b>Contract for Difference (CfD)</b> awarded through auctions since 2017 (after pilot auctions)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>One-sided CfD price</b> determined in competitive auctions with March 2023 average 7.03c€/kWh</li> <li>• <b>Term:</b> 20 years</li> <li>• Pre-tender phase and small-scale assets receive Feed-in tariff</li> </ul>



# Regulatory regimes for renewables (4/10)

## Netherlands

	Support regime	Remuneration <sup>1</sup>
Onshore	<ul style="list-style-type: none"> <li>• <b>SDE+</b> (available from 2011-2019) a technology based one-sided CfD</li> <li>• <b>SDE++</b> (available since 2020): One-sided CfD support based on <b>auction for lowest carbon abatement cost</b> As such carbon abatement technologies other than renewables can apply for subsidy</li> <li>• <b>SDE++ is being phased out for solar and onshore wind projects by 2025.</b></li> <li>• <b>A safety net support scheme</b> for Solar and onshore Wind is <b>under development.</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Term:</b> 12 or 15 years</li> <li>• <b>Pay-as-bid CfD</b></li> </ul>
Offshore	<ul style="list-style-type: none"> <li>• <b>No support scheme</b>, but auctions based on <b>beauty contests</b> based on scoring criteria e.g. experience, risk mitigation, innovation</li> <li>• <b>Financial bid amount</b> included as part of scoring criteria</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Full market exposure</b></li> <li>• Grid connection provided by TSO</li> </ul>
Solar	<ul style="list-style-type: none"> <li>• No specific support scheme for solar as primary support scheme is generic for all carbon abatement technologies onshore (see onshore)</li> </ul>	

<sup>1</sup> Not linked to inflation.

# Regulatory regimes for renewables (5/10)



	Support regime	Remuneration <sup>1</sup>
Onshore	<ul style="list-style-type: none"> <li>Assets with COD until 2013: <b>Feed-in premium</b> (FIP) to market price</li> <li><b>Auction</b> system applicable since 2013</li> </ul>	<ul style="list-style-type: none"> <li><b>Wholesale market</b> + premium <b>Premium for year t:</b> <math>(180 - \text{market price } t-1) * 78\%</math> Term: 12 years for pre-2008 COD, 15 years for post-2008 COD</li> <li><b>Auction design</b> Pay-as-bid <b>one-sided CfD</b> through auctions since 2013 and <b>two-sided CfD</b> since 2019 Term: 20 years</li> <li>Avg CfD price (Oct 2022 auction): €65.15/MWh</li> </ul>
Solar	<ul style="list-style-type: none"> <li><b>Auction</b> system applicable since 2013</li> </ul>	<ul style="list-style-type: none"> <li><b>Auction design</b> Pay-as-bid <b>one-sided CfD</b> through auctions since 2013 and <b>two-sided CfD</b> since 2019</li> <li>Avg CfD price (Oct 2022): €65.15/MWh</li> </ul>

<sup>1</sup> Not linked to inflation.

# Regulatory regimes for renewables (6/10)



## Spain

	Support regime	Remuneration <sup>1</sup>
Onshore	<ul style="list-style-type: none"> <li>• <b>Market income plus investment retribution in €/MW</b></li> <li>• Compensation since mid 2013</li> <li>• <b>CfD auction</b> system applicable since 2020</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Market income plus investment retribution (€/MW)</b></li> </ul> <p>Each technology has a regulatory life to recover their regulated CAPEX. For wind it is max. 20 years. The standard facility can recover the regulated capex in a shorter period. Once CAPEX is recovered no more subsidy is paid.</p> <ul style="list-style-type: none"> <li>• <b>Auction design</b> Pay-as-bid CfD auction. Term: 12 years</li> <li>• Avg CfD price (Oct 2021 auction): €30.2/MWh</li> <li>• Avg CfD price (November 2022 auction): 45.8 €/MWh (heavily undersubscribed only 45.5 MW awarded)</li> </ul>
Solar	<ul style="list-style-type: none"> <li>• <b>Market income plus investment retribution in €/MW</b></li> <li>• Compensation since mid 2013</li> <li>• <b>CfD auction</b> system applicable since 2020</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Market income plus investment retribution (€/MW)</b></li> </ul> <p>Each technology has a regulatory life to recover their regulated CAPEX. For PV it is max. 30 years. The standard facility can recover the regulated capex in a shorter period. Once CAPEX is recovered no more subsidy is paid.</p> <ul style="list-style-type: none"> <li>• <b>Auction design</b> Pay-as-bid CfD auctions Term: 12 years</li> <li>• Avg. CfD price (Jan 2021 auction): €31.6/MWh</li> <li>• No Solar awarded in November 2022 auction</li> </ul>

<sup>1</sup> Not linked to inflation.

# Regulatory regimes for renewables (7/10)

## Denmark

## Sweden

	Support regime	Remuneration	Support regime	Remuneration
Onshore	<ul style="list-style-type: none"> <li>• <b>Merchant</b> – Will possible be reviewed in the future</li> <li>• <b>Only rote to market</b> is <b>wholesale</b> and/or with a <b>PPA</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Wholesale</b> market</li> <li>• <b>PPA</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Wholesale market</b> with potential <b>PPA</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Wholesale market</b> with potential <b>PPA</b></li> </ul>
Offshore	<ul style="list-style-type: none"> <li>• <b>Contract for difference (CfD)</b> for the offshore wind site Hesselø (1.2GW) and Energy Island Bornholm (3.8GW), whereby CfD strike price is derived through auction process</li> <li>• For the <b>remaining 5 sites zero bids and lease payments are expected.</b></li> </ul>	<p><b>For Hesselø &amp; Bornholm:</b></p> <ul style="list-style-type: none"> <li>• <b>Wholesale market</b> plus CfD premium to reach CfD strike price plus PPAs</li> <li>• <b>CfD price</b> determined in competitive auctions (€ 0.00135/MWh in 2021 auction for Thor)</li> </ul> <p>For the five other sites:</p> <ul style="list-style-type: none"> <li>• <b>Wholesale</b> market</li> <li>• <b>PPA</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Wholesale market</b> with potential <b>PPA</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Wholesale market</b> with potential <b>PPA</b></li> </ul>

# Regulatory regimes for renewables (8/10)



## France



## Poland

	Support regime	Remuneration	Support regime	Remuneration
Onshore	<ul style="list-style-type: none"> <li><b>Fixed tariff</b> of 72€/MWh (+2.8 €/MWh management premium) inflated yearly granted through open window procedure for small scale projects (6 turbines max, 3MW/turbine max, tower height &lt;137m)</li> <li><b>Pay-as-bid two-sided CfD</b> awarded through tendering process since 2017</li> </ul>	<ul style="list-style-type: none"> <li><b>Fixed tariff or pay-as bid CfD</b></li> <li><b>Term:</b> 20 years</li> <li>Avg price (2023): €76.4/MWh</li> </ul>	<ul style="list-style-type: none"> <li>Competitive auction based pay-as-bid <b>Contract for Difference (CfD)</b> since 2018</li> <li>Two auction baskets: for projects up to 1 MW installed capacity and beyond 1 MW.</li> <li>Quota system with Green certificates until 2016 that will expire in 2031 for entitled assets</li> </ul>	<ul style="list-style-type: none"> <li><b>Term:</b> 15 years</li> <li><b>CfD price</b>, annually CPI adjusted</li> <li>Dec '22 result: &gt;1MW installed capacity: avg €56/MWh</li> <li><b>1 green certificate/MWh</b> current 2023 market price: €42/MWh</li> </ul>
Offshore	<ul style="list-style-type: none"> <li><b>Feed-in tariff (FIT)</b> with direct marketing obligation from 2012 to 2014 (6 projects)</li> <li>Pay-as-bid two-sided <b>CfD</b> awarded through a central auction system since 2015 for 20 years</li> </ul>	<ul style="list-style-type: none"> <li><b>Pay-as bid CfD</b></li> <li><b>Term:</b> 20 years</li> <li>Prices not public</li> <li>Last auction awarded for 44,9€/MWh (1 GW site off Channel coast)</li> </ul>	<ul style="list-style-type: none"> <li>Dedicated scheme set up in 2021</li> <li>Administratively awarded <b>CfD</b> for mature projects, requiring individual EU state aid notification decision and final CfD level confirmation by Polish regulator</li> <li>Competitive pay-as-bid auctions to award CfDs planned in 2025, 2027, 2029 and 2031</li> </ul>	<ul style="list-style-type: none"> <li>two-sided, CPI indexed, <b>CfD</b> strike price over 100k hours of full load generation</li> <li><b>Term:</b> not longer than 25 years</li> <li>Administratively granted initial strike price at €71/MWh, pending possible downward adjustment for each individual project at EU and/or national level</li> <li>Max. bid prices remain to be set</li> </ul>
Solar	<ul style="list-style-type: none"> <li>Support mechanisms depending on the <b>power of the unit: feed-in-tariff</b> through direct contracting for units &lt;100kWc (roof) or <b>fixed tariff</b> granted through open window procedure for units between 100kWc - 500 kWc (roof or ground)</li> <li><b>Pay-as-bid two-sided CfD</b> awarded through tendering process for units &gt; 500 kWc (ground)</li> </ul>	<ul style="list-style-type: none"> <li><b>Feed-in tariff, fixed tariff or pay-as-bid CfD</b></li> <li><b>Term:</b> 20 years</li> <li>Avg price (2023): €82.23/MWh</li> </ul>	See onshore above	See onshore above

# Regulatory regimes for renewables (9/10)



## Ireland



## Australia

	Support regime	Remuneration	Support regime	Remuneration
Onshore	<ul style="list-style-type: none"> <li><b>REFIT</b> (Feed-in Tariff) scheme, closed to new entrants in 2015. Tariffs set on a technology basis, with rates indexed with CPI</li> <li><b>RESS</b> – Pay-As-Bid two-sided <b>Contract for Difference (CfD)</b> introduced in 2020 for <b>all onshore</b> renewable technologies.</li> <li>Scheme requires mandatory €2/MWh community benefit funding</li> <li>Next auction due Q3 23</li> </ul>	<ul style="list-style-type: none"> <li><b>REFIT</b> – Current 2022 (indexed) price for onshore wind ≥5MW = €72.686/MWh</li> <li>Term – 15 years</li> <li><b>CfD averaged weighted bid price – all project category:</b></li> <li>RESS1 (2020) - €74.08 MWh</li> <li>RESS2 (2022) - €97.87 MWh</li> <li><b>Term</b> – 15-16.5 years</li> </ul>	<ul style="list-style-type: none"> <li><b>Green Certificate System</b> for large scale renewables introduced on federal level in 1999 to facilitate 33 TWh target by 2020, phaseout until 2030</li> <li>Additional <b>support schemes on state level</b>, so far auctions in Australian Capital Territory, Queensland, Victoria and New South Wales</li> </ul>	<ul style="list-style-type: none"> <li><b>Wholesale market + 1 green certificate/MWh</b></li> <li><b>2023 certificate price:</b> ~50 AUD, decreasing trend (not linked to inflation)</li> <li><b>Term:</b> To be received until 2030</li> </ul>
Offshore	<ul style="list-style-type: none"> <li><b>ORESS</b> – Pay As Bid two-sided CfD – bids for the first auction to be launched end of April 23</li> <li>Scheme requires mandatory €2/MWh community benefit funding</li> <li>Second offshore RESS auction expected 2024/25</li> </ul>	<ul style="list-style-type: none"> <li><b>First offshore</b> auction will take place in April 23 and final results published 14th June 23.</li> <li>Maximum 20-year subsidy period with partial indexation following FID</li> <li>Compensation available for oversupply / system-wide curtailment.</li> </ul>	<ul style="list-style-type: none"> <li>State of Victoria is planning a support mechanism for offshore projects with tenders expected to start 2025</li> </ul>	
Solar	See onshore above	See onshore above	See onshore above	See onshore above

# Regulatory regimes for renewables (10/10)



## Japan



## Taiwan

	Support regime	Remuneration	Support regime	Remuneration
Offshore	<ul style="list-style-type: none"> <li><b>Feed-in Premium (FiP)</b> for Offshore projects through auctions (50% qualitative and 50% price based assessment criteria)</li> <li>Cap price and Zero-FiP standard price (bottom price) for the bid is set prior to the bid. At the second round auction which will close in June 2023, price range of bid was set from JPY3 to 19 /kwh</li> </ul>	<ul style="list-style-type: none"> <li><b>20 year pay as bid FiP strike price</b></li> <li>Green certificate can be directly sold to offtakers, but the power only can be sold through retailers.</li> <li>Any bidders offered 3 yen as a bid price, can get the maximum points of price based assessment, so it push bidders for pursuing CPPA to secure the certain profit without FiP premium</li> </ul>	<ul style="list-style-type: none"> <li><b>Auction</b> for grid allocation which also locks in <b>Feed-in tariff (FiT) rate.</b></li> <li>Current auction rules with price cap 2.49 TWD/kWh and size cap 500MW (may have more 100MW from the government)</li> </ul>	<ul style="list-style-type: none"> <li><b>20 year pay as bid FiT via PPA</b> with state-owned utility</li> <li><b>Alternatively</b>, option to pursue a CPPA through the market which could allow for „zero bid“ in grid allocation process (as no need for PPA with state-owned utility)</li> </ul>



## South Korea

Offshore	<ul style="list-style-type: none"> <li>Mandated renewable quotas for state-owned generation companies and IPPs with over 500MW installed capacity through <b>Renewable Portfolio Standards (RPS)</b>, to steadily increase the renewable energy mix</li> <li>The RPS Obligors purchase <b>Renewable Energy Certificates (RECs)</b> to meet the RPS requirements</li> </ul>	<ul style="list-style-type: none"> <li>Differentiated <b>REC multiplier</b> is granted per technology while offshore wind receives the highest REC multiplier based on water depth and distance to the shore. (e.g. 2.5 - 4.9, approx.)</li> <li>Under the business-as-usual scenario, renewable electricity is sold to the state-owned utility, KEPCO, while RECs are sold to the RPS Obligors (e.g. state-owned GENCOs and IPPS over 500MW) via long-term REC offtake contracts.</li> <li>On-going discussion on the power market liberalisation continues and corporate PPA is getting a growing momentum.</li> </ul>
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# Regulatory regimes for renewables - negative pricing rules



DE

- With EEG 2023 4-hour rule to be phased out until 2027 for new assets, i.e. from 2027 onwards no support payments for any hour with negative price, however foregone support payments are recorded for simple prolongation of 20y support period
- Exemption for small scale installation (<400kW) and pilot installations
- For installations commissioned before 2023 (2021) or with auction award before 2023 (2021) the previous 4-hour (6-hour) rule is grandfathered



FR

- Onshore: Compensation in the event of 20 or more negative hours (consecutive or not) during a calendar year if installation has not produced during these hours
- PV: Compensation in the event of 15 or more negative hours (consecutive or not) during a calendar year if installation has not produced during these hours



NL

- 6-hour negative pricing rule



ES

- The incentive of the CfD contract is not paid in case the energy market price gets below a defined minimum threshold (“waiver price”)
- Currently the waiver price is set to 0€/MWh (government can also change this value)



IT

- The incentive settlement of the CfD is suspended only in case the energy zonal market price is 0 or negative for more than 6 consecutive hours. The CfD contract duration is prolonged at end of the contract (20 years) by the amount of the energy that didn't get the incentive.



DK

- Negative prices = 1 hour rule, i.e. no subsidy payments in non-positive price hours



IR

- No subsidy paid if market reference price is below €0/MWh for both onshore and offshore CfD schemes

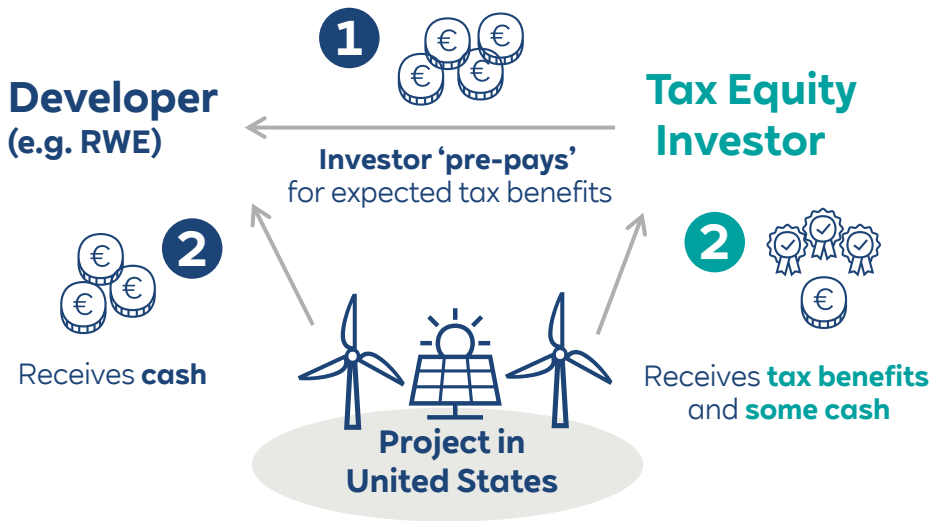


UK

- 6-hour rule was implemented for CfD Allocation Round 2 in 2017 and Allocation Round 3 in 2019
- For contracts signed from Allocation Round 4 onward rules will be stricter, with new CfDs having top-up payments stopped at any time when reference prices turn negative
- The reference price is the hourly day-ahead market price



# Tax Equity in the US - financing structure



**1**

- Tax Equity Investor invests into project **to capture tax benefits**, based on a pre-agreed financial return
- The **developer continues to manage the project**
- Tax Equity investment accounted as Debt under IFRS

**2**

- The **benefits** generated by the project will be **split between the developer and the investor** until the investor has reached a **specified return** on his investment (IRR)

- The developer **repays the investor** with a **mix of tax items** (production tax or investment tax credits and tax benefits from accelerated depreciation) **and cash**. In addition the Tax Equity Investor maintains a small residual interest in the project after repayment.

# Inflation Reduction Act (1/2)

## Recap

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**President Biden signed the Inflation Reduction Act into law on August 16, 2022**

**Bill includes more than \$350B of climate and key energy provisions including:**

- Extension of the current PTC/ITC through 2024 at 100% value (\$28/mWh for 2023)
- Creation of a technology neutral PTC/ITC at full value starting January 1, 2025 through the later of 2032 or a 25% emissions reduction from the 2022 baseline
- Includes bonuses to the PTC/ITC for domestic content and energy communities
- Establishes an ITC for stand-alone storage applications
- Provides tax credits for hydrogen production over 10 years that can be coupled with the PTC/ITC for renewable energy production

## Labor Requirements for Bonus Credit Values

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**Prevailing wage requirements for construction or operations**

- Applies to any laborers or mechanics employed by the taxpayer or contractor in construction and employed for construction, alteration or repair of a similar character in the locality
- Penalties in statute for non-compliance

**Apprenticeships: must maintain a qualified apprenticeship program for construction workers on a project, with hours-worked requirements:**

- 12.5% of total hours for projects beginning construction in 2023
- 15% of total hours for projects beginning construction after 2023
- Penalties in statute for non-compliance, allows for good faith exemptions

# Inflation Reduction Act (2/2)

## Bonus Credit Value

### Domestic Content Bonus: 10% bonus value PTC and ITC if domestic content requirements met

- 100% of steel and iron structural products used to be produced in U.S.
- 20% (amount increases after 2025) domestic content cost requirement for OSW projects
- 40% (amount increases after 2025) domestic content cost requirements for onshore projects

### Energy Communities Bonus Credit Value

- 10% bonus adder to PTC/ITC for energy communities
- Energy Community criteria made up of the following requirements:
  - Brownfield sites;
  - MSA or non-MSA which had, after 12/31/2009, 0.17% or more direct employment or 25% or greater local tax revenues related to extraction, processing, transportation or storage of coal, oil or natural gas; and Unemployment rate at or above the national average for the previous year; OR
  - In a census tract (or adjacent tract) with closure of a coal mine or coal generation station

## Other Provisions

- **Stand-alone Storage ITC:** 6% base, 24% bonus for labor requirements as well as domestic content and energy communities bonus credit value, 2023+
- **Hydrogen PTC:** \$0.60/kg for zero-carbon resource, \$3.00/kg for zero-carbon resource meeting labor requirements, also may qualify for ITC, 2023+
- **EV Credit:** \$7,500 for commercial vehicles with weight rating less than 14,000lbs or \$40,000 for other qualifying commercial vehicles
- **EV Charging ITC:** maximum credit of 30% for expenses up to \$100,000, including bi-directional charging stations, but only 6% for items subject to depreciation
- **Advanced Manufacturing:** provides PTCs for solar components, inverters, wind turbine components, offshore wind foundations (fixed and floating), battery energy storage components, and a 10% ITC for offshore wind vessels and critical mineral production
- **Direct Pay:** only for tax exempt entities, except for Hydrogen PTC, Carbon Capture and Sequestration Credit, or Advanced Manufacturing Credit

## Transferability

- **Inflation Reduction Act** makes ITC, PTC, tech-neutral ITC, tech-neutral PTC, clean hydrogen PTC, and advanced manufacturing PTC eligible for transfer beginning for tax years after 2022 to an unrelated taxpayer or taxpayers
- **Does not allow for the transfer of tax losses** generated by accelerated depreciation
- **Compensation received by the taxpayer** transferring the credit would be tax exempt to transferor
- **In the case of partnerships and S corps**, the election would be made at the entity level, but the tax-exempt income from the sale would pass through to the owners
- **Allows for extended carryback** periods of 3 years

# Power Purchase Agreement (PPA) - tailored subsidy-free contract for long-term certainty

## Characteristics & benefits



- PPAs provide **financial certainty** to a project developer
- Customers can **avoid** long-term **commodity price risk**
- Customers can **achieve** their **carbon reduction** goal cost-effectively
- With the secured income RWE can offer an even **larger portfolio** and more PPAs
- Additionally, customers can **support** the **transition** to a renewable energy supply

- A Power Purchase Agreement (PPA) is a **long-term supply contract** between a power company and a customer for (green) electricity. Power producers conclude PPAs either bilaterally with a consuming company (**Corporate PPA**), or with a trader who purchases the electricity produced and sells it on the market (**Route to market PPA**).

# Global corporate PPAs

## Corporate PPAs by technologies

(in GW)

Country	Offshore wind	Onshore wind	Solar	Other <sup>1</sup>	Total
Australia	0.2	3.3	2.0	-	5.5
Belgium	1.0	0.1	-	-	1.1
Denmark	0.3	0.1	1.0	-	1.4
Finland	0.0	1.8	-	-	1.8
France	-	0.1	1.1	0.0	1.1
Germany	1.0	1.5	0.5	0.3	3.2
Greece	-	-	0.2	-	0.2
Ireland	-	0.8	0.7	-	1.5
Italy	-	0.2	0.4	-	0.5
Netherlands	1.8	0.8	0.0	0.0	2.7
Norway	0.0	2.3	-	0.1	2.4
Poland	-	0.4	0.3	-	0.7
Portugal	-	0.0	-	-	0.0
Spain	-	2.5	3.3	-	5.8
Sweden	-	3.9	0.3	0.1	4.2
UK	0.7	1.0	1.1	0.0	2.8
US	0.1	28.9	57.6	0.4	87.0

Source: BNEF 2023. | Note: PPAs estimated signing years from 2000-2022. | <sup>1</sup> Other includes Hydro, Run of River, Fuel Cells , Biomass & Waste.

# Power Purchase Agreement (PPA)

## PPA Type

### Physical PPA



## Main characteristics

- RWE delivers power **directly** to the customer and receives the PPA price
- RWE sells surplus power to grid
- The customer buys additional power from the grid/utility
- The customer receives **guarantees of origin** (where available)

### Financial / Virtual PPA




- RWE delivers power to the grid and is reimbursed via its existing market access
- The customer buys power from the grid and pays the spot price
- RWE and the customer settle the difference between the spot price and PPA strike price
- The customer receives **guarantees of origin** (where available)

# RWE's successful PPA footprint across the globe (1/2)

Illustrative



 15-year tailored PPA with **Honda** for a 120 MW wind farm in Oklahoma ([link](#))



 10-year PPA with **Volkswagen** on a German PV asset 170 GWh ([link](#))




 15-year CfD PPA for 860 MW **Triton Knoll Offshore** Windfarm ([link](#))



 15-year CfD PPA for 1.4 GW **Sofia** Offshore Windfarm ([link](#))




 5–15-year agreements with **Deutsche Bahn** for offtake from Amrumbank and Nordsee Ost offshore wind farm ([link](#))




 10-year PPA for an existing onshore wind farm in the UK with **Molson Coors** ([link](#))



 13-year offtake PPA for power, ROCs & REGOs for 219 MW **Humber Gateway Offshore** Windfarm ([link](#))




 10-year tailored PPA with **Freudenberg Group** for offtake from TrammGöthen, Mecklenburg photovoltaic park ([link](#))




 20-year 150 MW renewable PPA with **TVA/Facebook** for a solar/storage asset in Tennessee ([link](#))




 10-year PPA for a new onshore wind farm in Italy with **Sofidel** ([link](#))



 Route-to-market optimisation PPA for the first **RWE battery projects** in Europe ([link](#))



 2-year tailored PPA of 100 GWh with **BMW** for offtake from run-of-river hydro power plants on the Isar and Lech rivers ([link](#))

# RWE's successful PPA footprint across the globe (2/2)

Illustrative



10-year tailored PPA for 175 GWh per year with **SKW Piesteritz** for offtake from RWE's hydropower plants ([link](#))



10-year PPA with **Górażdże Group** for 70 GWh per year from the 132 MW Windfarm Polska III ([link](#))



10-year PPA with **SWM** for 180 GWh from Polish onshore wind farm "Windfarm Polska III ([link](#))



10-year PPA with **Lafarge Cement** for 110 GWh from the 132 MW Windfarm Polska III ([link](#))



10-year PPA with **Asahi** for 80 GWh per year from wind farms in northern Poland including Lech Nowy Staw ([link](#))



10-year PPA with **Sofidel** for 21 GWh per year from the 210 MWp photovoltaic plant Katerini along with PPC renewables ([link](#))



10-year tailored PPA with **11 major German companies<sup>1</sup>** and a **large municipality<sup>2</sup>** for offtake from Amrumbank & Nordsee Ost offshore wind farm for 1,500 GWh per year ([link](#))

<sup>1</sup> Badische Stahlwerke, Bosch, Freudenberg Group, Infraser Höchst, Messer, Schott, Telefónica, Verallia, Vodafone, Wacker, ZF | <sup>2</sup> Mainova.



# Policy support for green technologies gaining momentum



## European Green Deal

- **55% GHG** reduction target **by 2030** vs. 1990 levels
- **60 GW offshore** wind capacity installed **in 2030** with offshore wind to become **the largest single source** of electricity in Europe by 2040
- Also **promoting emerging ocean energy technologies**, e.g. floating solar and wind, and tidal energy
- **600 GW solar PV** capacity installed **in 2030**, 320 GW by 2025
- **40 GW electrolyser** capacity by 2030 producing up to 10 million tonnes of renewable **hydrogen**
- **€750bn** recovery package – 37% earmarked for climate **spending**
- **2050** target to reach **CO<sub>2</sub> neutrality**




## US Policy on Climate Change



- **50%** reduction in U.S. GHG emissions from 2005 levels **by 2030**
- **Carbon-free** power system **by 2035**
- **30 GW** offshore wind capacity target by 2030<sup>1</sup>
- **Rejoining** the Paris agreement; administrative fast tracking and planned new seabed lease auction rounds

Source: Europa.eu; eur-lex.europa.eu; congress.gov; whitehouse.org. | <sup>1</sup> Announced by the White House end of March 2021.


# Major regulatory measures for the European utility markets (1/3)

	Market design	CO <sub>2</sub> reduction	Renewables	Conventional generation
	<ul style="list-style-type: none"> <li>Reform of Electricity Market Design: proposal presented by EU COM on 14 March, including revision of several pieces of EU legislation, notably the Internal Electricity Market Regulation and the Internal Electricity Market Directive</li> <li>EU Commission proposed Hydrogen &amp; Gas Market Decarbonisation Package in December 2021. EP and Council adopted positions in February resp March 2023</li> </ul>	<ul style="list-style-type: none"> <li>EU Emissions Trading Scheme: Emissions in the sectors covered by the EU ETS must be reduced by 62% by 2030; package formally adopted by end of April 2023</li> <li>European Climate Law: climate neutrality in 2050, -55% until 2030; the process of setting an interim 2040 target has begun. The Commission is likely to propose a possible target in 2024.</li> </ul>	<ul style="list-style-type: none"> <li>EU Renewable Energy Directive (RED): EP and Council agreed reform in March 2023: overall binding RES target of 42.5% by 2030. Subtarget for transport and industry (for the latter: share of green hydrogen in total hydrogen used should be 42% by 2030 and 50% in 2035.), faster RES permitting procedures and enhanced sustainability criteria for biomass.</li> </ul>	<ul style="list-style-type: none"> <li>EU Action Plan “Zero Pollution for Air, Water and Soil” <ul style="list-style-type: none"> <li>Industrial emissions directive: Proposal for revision presented on 05 April 2022. Council adopted position in Spring 2023, EP in July 2023. Trilogue negotiations start in Q3.</li> <li>Ambient air quality directive: Proposal for revision presented on Nov. 2022, EP adopt position in July 2023, positioning of Council still unclear</li> <li>Next BREF-LCP (rolling process) will not start before 2025</li> </ul> </li> </ul>

# Major regulatory measures for the European utility markets (2/3)

	Market design	CO <sub>2</sub> reduction	Renewables	Conventional generation
	<ul style="list-style-type: none"> <li>Energy-only with strategic reserve components; new platform to prepare revision, additional power plant strategy announced</li> <li>Acceleration of grid expansion &amp; new provisions for redispatch</li> <li>CHP support until 2026, however, prolongation unclear</li> </ul>	<ul style="list-style-type: none"> <li>Climate Protection law               <ul style="list-style-type: none"> <li>– Climate neutrality by 2045</li> <li>– Minus 65% by 2030 based on binding sectoral targets, minus 88% in 2040</li> <li>– Revision announced for 2023</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Renewable Energy Act (EEG): last two revisions agreed upon increased RES targets, acceleration of permitting, deletion of EEG levy, introduction of H2 tenders</li> <li>Wind at sea act with new auction design</li> <li>National implementation of REDII in transport sector (37. BImSchV) planned for Q3</li> </ul>	<ul style="list-style-type: none"> <li>Coal phaseout by 2030 for Rhenish lignite area fixed by law in Dec. 2022, by 2038 for Eastern Germany (fixed by law in 2021, assessment for earlier phase out in Aug. 2026)</li> <li>Nuclear exit completed &amp; final storage regulation</li> <li>Power plant strategy with tenders for new H2 ready gas fired power plants announced</li> </ul>
	<ul style="list-style-type: none"> <li>New Energy Law sent to parliament still in preparation phase. Not clear when this will be send to Parliament</li> <li>Execution of National Climate Agreement</li> <li>Inframarginal Tax applied since 1 December 2022, runs until end of June 2023, not formally in place yet</li> </ul>	<ul style="list-style-type: none"> <li>Coalition Agreement: 55% CO<sub>2</sub> reduction by 2030, aim for 60%, electricity sector fully decarbonised until 2035</li> <li>Climate fund of 34 bn EUR</li> </ul>	<ul style="list-style-type: none"> <li>SDE+ regulation (Stimulation Renewable Energy) since 2011 main instrument</li> <li>Offshore wind tender foresee in '24: 2x2GW</li> </ul>	<ul style="list-style-type: none"> <li>Coal phaseout: end of 2024 for plants built in the 1990s and end of 2029 for plants built in 2000 and thereafter</li> <li>Government announced 1bn EUR for converting gas stations to H2 ready before 2030</li> </ul>

# Major regulatory measures for the European utility markets (3/3)

	Market design	CO <sub>2</sub> reduction	Renewables	Conventional generation
<p><b>UK</b></p> 	<ul style="list-style-type: none"> <li>Energy Market Reform (EMR) with a Capacity Market, CfD regime and Balancing Market - Review of Electricity Market Arrangements (REMA) continuing through 2023</li> <li>Energy Bill currently in legislative process – expected completion Summer 2023</li> </ul>	<ul style="list-style-type: none"> <li>Climate Change Act (Net zero target by 2050)</li> <li>6<sup>th</sup> Carbon Budget – 78% CO<sub>2</sub> reduction by 2035</li> <li>UK ETS with Auction Reserve Price</li> <li>Consultation around CBAM in 2023</li> <li>Revamped Net Zero Strategy (“Powering Up Britain”) announced with changes for hydrogen and carbon capture usage and storage</li> <li>Energy Bill to create legislative framework for CCUS and Hydrogen business models</li> </ul>	<ul style="list-style-type: none"> <li>CfD regime - annual auctions announced from 2023; consultation on introduction of non-price criteria 2023</li> <li>British Energy Security Strategy: 50GW Offshore Wind, 5GW Floating Wind by 2030; support solar deployment; CfD also for onshore wind</li> </ul>	<ul style="list-style-type: none"> <li>Power System Decarbonisation 2035 Target</li> <li>Coal Phase out by Oct 2024</li> <li>Future of BAT</li> </ul>

# Emissions Trading System in the EU and UK as key tool for reducing greenhouse gas emissions

## EU ETS

- Established by the EU Emission Trading Directive; entered into force on 1 January **2005**. Covers ~40% of EU greenhouse gas emissions.
- The Fit-for-55-Package by EU commission to reach targets of EU Green Deal (climate neutrality 2050, 55% reduction by 2030 vs 1990) have entered into force. The revised changes for the EU ETS will apply from 2024 onward.
- Emissions** under the system are **capped** and expected to be reduced by 62% by 2030 vs 2005 under the new cap. This is an increase vs. the earlier target of 43% and will be consistent with the new 55% EU GHG reduction target.
- Based on '**cap and trade**' system, whereby a cap is set on the total amount of greenhouse gases that can be emitted by installations covered by the system.
- The **Market Stability Reserve (MSR)** as a rule-based mechanism that allows the supply of allowances to respond to market oversupply stays in place and the MSR intake rate will be kept at 24% until 2030.
- The cap is reduced over time in line with the **Linear Reduction Factor (LRF)**. Within the cap, companies receive or buy emission allowances which they can trade with one another as needed. The **LRF** will be increased to 4.3% for 2024 to 2027 and thereafter to 4.4% (from previously 2.2%). The increased LRF should be combined with two downward adjustments of the cap (rebasings) so that the new LRF has the same effect as if it had been applied from 2021.

Source: [ec.europa.eu/clima/policies/ets\\_en](https://ec.europa.eu/clima/policies/ets_en).

## UK ETS

- The UK Emissions Trading Scheme went live on 1 January 2021, **replacing the UK's participation in the EU ETS**. On 19th May, UK ETS auctions commenced. The first Compliance date was in Q1 2022 for 2021 emissions.
- The scheme largely **mirrors the operation of the EU ETS**, by introducing the supply of allowances via auctions which can subsequently be traded in a secondary market.
- The **total number of allowances** available for auction in 2023 is ~79 million. This is more than half of the total UK ETS 2023 **cap** of ~147 million allowances. The number allowances are **set to fall** by 2.2% annually until 2030.
- The Auction Reserve Price (the **minimum price** for bids in auctions) is set at £22. Auctions take place twice a month. Auctions carried out by UK government at ICE.
- The Total Carbon Price that power sector emitters face is comprised of the Carbon Price Support (at £18) plus the price of UK ETS permits.
- UK government will be conducting reviews into the scheme at the latest by 2023 to set it on a Net Zero trajectory. The **implementation** of it is **planned for 2024**. The Governmental consultation proposed a net-zero aligned cap between 887 and 936 million allowances. Compared to the current legislation this would result in a cap reduction of 30-35%.

# Current regulatory developments in the core H2 markets

## European Union

- **Consolidated compromise of RED III:**
  - **RFNBO** (Renewable fuels of non-biological origin, including green hydrogen) **target for industry: 42%** of total hydrogen consumption by 2030 and **60%** by 2035. Can be reduced under certain conditions and pink H2 can be used
  - **Combined sub-target of 5.5%** for advanced biofuels and renewable hydrogen, with a minimum requirement of **1% renewable hydrogen in 2030**
- **Delegated Act (DA):** Final and official publication in the Official Journal of the EU, **enter into force** on July 10 2023
- **Fit-for-55:**
  - **Political agreements** on EUFuel Maritime, ReFuel Aviation, AFIR
  - Ongoing legislative work on **gas package**, start of dialogue
- **H2 Bank Communication:** 1st pilot auction for gH2 in fall with 800M€ budget. Auction conditions to be published before summer

## Germany

- **Draft "National Hydrogen Strategy" (NWS):**
  - Overall target: **10 GW until 2030**
  - Permitting **other forms of low-carbon H2** for the ramp-up
  - **1 GW of Offshore H2 by 2030 planned** – auctions to start by end of 2023 / beginning of 2024
  - **H2 Acceleration Act** to simplify planning and approval procedures
  - **Hydrogen grid company** should no longer be state-run: a central company for the planning, realisation and operation of the H2 pipelines is still envisaged
  - Announcement of **import strategy** and a **carbon management strategy**
  - **Final NWS announced before the political summer break**
- **CCFDs are published**, pre-procedure for participation on the first auction round started
- **No exact timeline** for the publication of the three **ordinances from the Easter package** known

## Netherlands

- **Spring Climate Package:** The NL Government has launched (26.04) a climate package in order to ensure the 2030 CO2 emissions reduction target. This package includes various green H2 initiatives with a total budget of 7.5 billion euro, of which 4.9 billion euro have been allocated to support large scale electrolyser projects.
- **H2 policy update:** The NL Govt sent a letter to Parliament (23.06.) explaining the various funding instruments and other incentives, like the RFNBO obligation for industry and mobility, to boost domestic green H2 production capacity and promote imports.
- **H2 backbone update:** The NL Government has provided an update (03.07.) on the H2 backbone development. The main take-away is that Gasunie has joined the pending Delta Rijn Corridor project and that the Government will release the next status update after the summer.
- **Draft National Plan Energysystem (NPE):** The NL Government has sent (03.07) this extensive package of outlook and underlying reports to Parliament. Hydrogen is considered as a key energy carrier in the future energy system (2030/40/50), resulting in a significant growth of demand and associated domestic production and import.

## United Kingdom

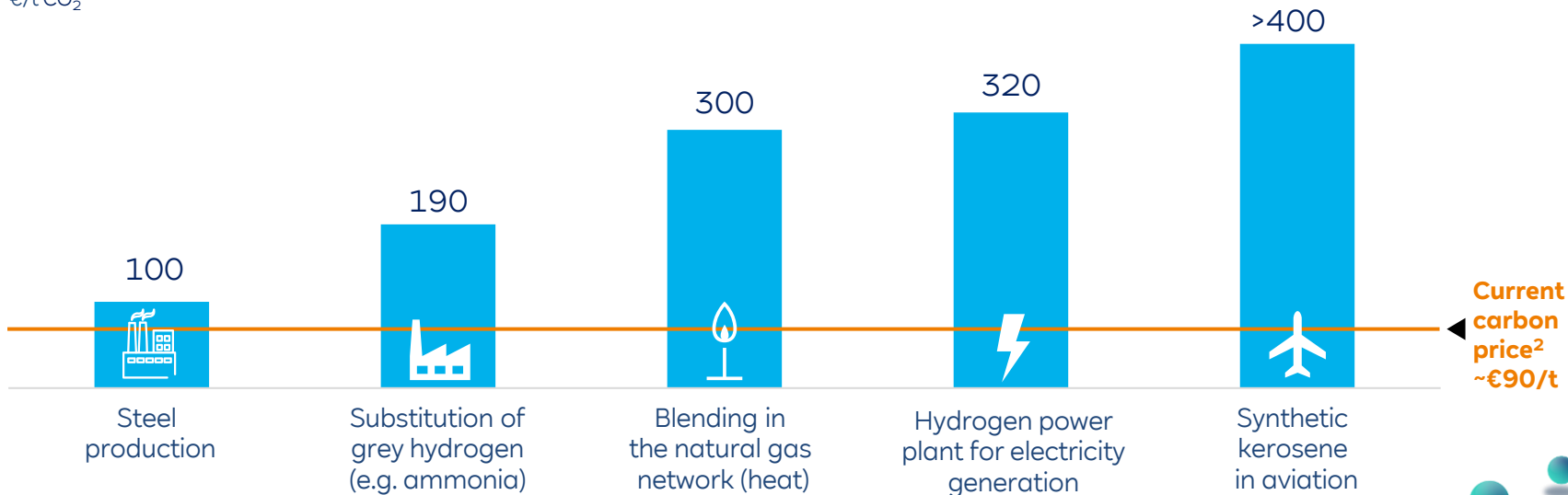
- **UK hydrogen strategy:** Target capacity doubled to 10 GW – of which at least 50% should come from electrolysis
- **By 2025:** 2 GW of low-carbon hydrogen (green & blue), certification and „business models“ for storage and transport
- **Decisions on gas blending** are expected to be made by the government in Q4/23, following a review of safety and cost-benefit
- **DESNeZ** have announced the outcome of 2022's funding applications, including a successful RWE project. Strand 1 and 2 funding windows have opened with Strand 3 window expected to open in Q4.



# Hydrogen applications require further financial support based on the current carbon price

## CO<sub>2</sub> avoidance costs<sup>1</sup> of selected hydrogen applications

€/t CO<sub>2</sub>



Source: RWE AG. | <sup>1</sup> Based on reference year 2030 and a hydrogen cost of €3/kg. | <sup>2</sup> Certificate price in the European Emissions Trading System.



# Use of natural gas infrastructure for hydrogen

## Gas pipeline hydrogen repurpose

A large part of the **European long-distance gas network** can be **repurposed** for hydrogen transport

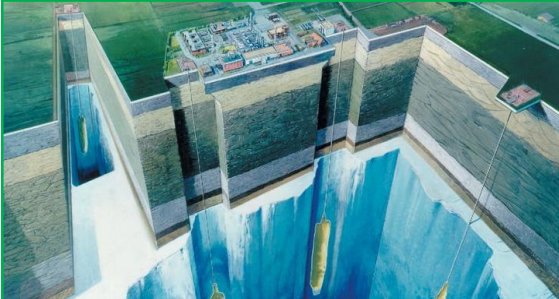


80%

...energy transport capacity of hydrogen vs. natural gas pipeline<sup>1</sup>

## Gas storage hydrogen repurpose

**Salt cavern storage facilities** are considered **suitable** for hydrogen storage; suitability of other gas storage facilities still uncertain



25%

...max. energy storage capacity of hydrogen vs. natural gas in a salt cavern

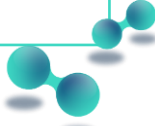
## Hydrogen production from natural gas

Production of **natural gas-based carbon-neutral hydrogen** via methane pyrolysis could enable hydrogen supply far from coastal areas



Part of the existing natural gas infrastructure remains necessary to transport natural gas

Source: RWE AG. | <sup>1</sup> Capacity loss limited by hydrogen's higher flow speed.

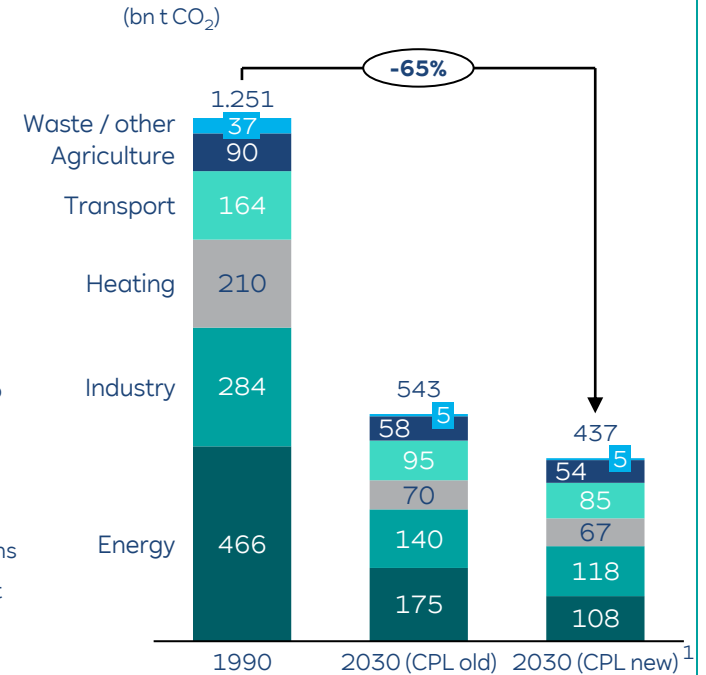




# Climate Protection in Germany

## Energy

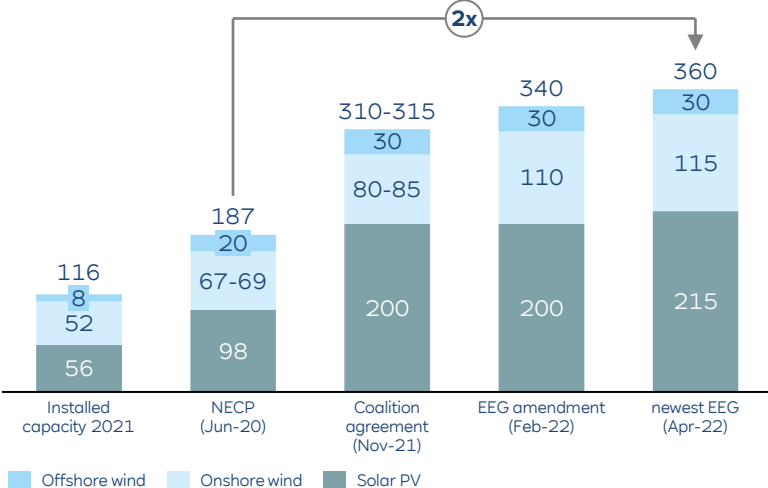
- **Climate protection target 2030: -65% compared to 1990**
- **80% RES share in gross electricity production 2030**
- **Target for the energy sector** in Germany:
  - **108 Mio. t CO<sub>2eq</sub>** instead of 175 Mio. t CO<sub>2eq</sub>
- Acceleration of market ramp-up for green H<sub>2</sub> including financial support schemes
- **Coal phaseout by 2038; RWE coal phaseout by 2030**
- **Further acceleration of** expansion of RES – targets 2030:
  - **Wind offshore: 30 GW, Wind onshore: 115 GW, Solar: 215 GW**
- **Use of renewable energy** in public interest and serving public safety, to increase permitting
- Every state is obligated to **dedicate an average of 2 % of its land for onshore wind** (target needs to be met by 2032); nationwide, a total of 0.8 % of land is currently earmarked for wind energy
- **Framework for offshore wind** redesigned by introducing a **two-track system**
  - Two tracks system involve **different auction criteria and procedures**
  - **Pre-examined sites** must satisfy qualitative criteria as well as financial bidding considerations
  - **For sites that have not yet been investigated**, all of the auction participants bid for support (further financial bidding round in the event of several zero bids)



# German 2030 renewables ambitions

## Germany has nearly doubled its 2030 renewables ambitions over the past two years

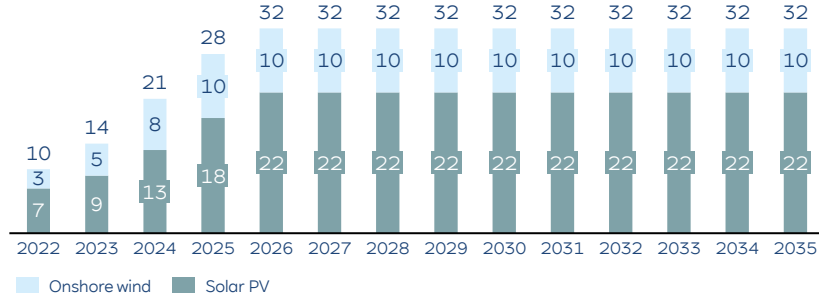
Installed capacity targets for 2030 (GW)



Source: European Commission, Federal Ministry for Economic Affairs and Climate Action and IHS.

## New addition targets

Targeted onshore wind and solar additions (GW) scenario for 600 TWh renewables electricity in 2030



### Offshore wind

Based on the offshore law, the expansion targets for **offshore wind** will be significantly increased to at least **30 GW by 2030**, at least **40 GW by 2035** and at least **70 GW by 2045**. At the same time, the tender volumes will be increased and the WindSeeG revised in order to implement the accelerated expansion.

# Road Map of German Coal Exit

## Different approaches for lignite and hard coal

In October 2022 the German Parliament decided on the coal exit by 2038 with following milestones:

- **By 2022 reduction** to a total remaining capacity of **15 GW lignite** and **15 GW hard coal**
- **By 2030 reduction** to a total remaining capacity of **9 GW lignite** and **8 GW hard coal**
- **Reviews in 2023, 2026 and 2029** (climate protection, security of supply, power prices, regional development and employment)

In 2022, RWE, the German Federal and Northrhine-Westphalian Government agreed on termination of lignite power production in rhenisch lignite area already by 2030. The coal exit will therefore be accelerated according to plans of coalition of social democrats, liberals and greens.

Program to foster investments in secured capacity announced by government (“power plant strategy” / “Kraftwerkstrategie”)

Find out a list of agreed **lignite** power plants here:

[https://www.buzer.de/Anlage\\_2\\_KVBG.htm](https://www.buzer.de/Anlage_2_KVBG.htm)

### Implementation of the recommendations differs between lignite and hard coal:

#### Lignite:

- Decision on **which lignite** power plants will be shut down at what point based on **Coal Exit Law (Kohleausstiegsgesetz)**
- **Compensation** for shutdowns of power plants including costs for open cast mines
- State aid approval by EU Commission still pending

#### Hard Coal:

- Decision on **which hard coal** power plants will be shut down at what point based on decommissioning **auctions** (basically voluntary). Results of already finished auctions:
  - 1<sup>st</sup> auction round 1 Dec, 2020: 4,8 GW
  - 2<sup>nd</sup> auction round 1 Apr, 2021: 1,5 GW
  - 3<sup>rd</sup> auction round 14 July, 2021: 2,1 GW
  - 4<sup>th</sup> auction round 15 Dec, 2021: 0,5 GW
  - 5<sup>th</sup> auction round 20 May, 2022: 1,0 GW
  - 6<sup>th</sup> auction round 14 Oct, 2022: 0,5 GW
- From 2027 onwards and in case of missing coal capacity to achieve auction targets as of 2024: **administrative shut down** mainly based on age **without any compensation**

# UK is first major economy to pass net zero emissions law

UK is **first G7 country** to legislate a **net zero**<sup>1</sup> greenhouse gas emission target by **2050**.

## Implications of the target

- **Full decarbonisation** of the power sector **by 2035** (subject to security of supply), through a combination of renewables, nuclear, gas with CCS<sup>2</sup> and low carbon hydrogen. This will result in a 98% reduction in power sector emissions by 2035 when compared to 1990<sup>3</sup>.

### Electricity demand

- Expected **40-60% increase in demand** for electricity by 2035
- **50 GW of offshore wind by 2030** incl. 5 GW of floating wind<sup>4</sup>

### Hydrogen use

- Production capacity ambition of **10 GW by 2030**, with at least half of this from electrolytic hydrogen, which could increase to **17 GW** by 2035 depending on the role of hydrogen for heat<sup>5</sup>

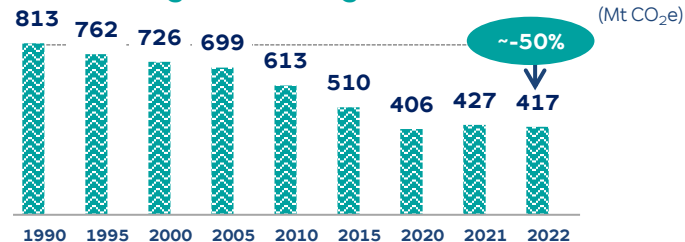
### CCS

- **Deliver four carbon capture usage and storage clusters by 2030**, capturing 20-30 MtCO<sub>2</sub> across the economy, including 6 MtCO<sub>2</sub> of industrial emissions, per year

## The UK has been a leader in cutting emissions whilst growing the economy

- By **2022**, UK reduced its total **GHG emissions** by **~49%** vs 1990
- **Coal less than 2%** of power generation **compared to 65%** in 1990; Government wants to phase it out completely by Oct **2024**
- **50 GW offshore** wind target **by 2030** (13.7 GW installed in 2022)
- **5 GW floating** wind target by **2030**

## Final annual greenhouse gas emissions in the UK<sup>6</sup>



<sup>1</sup> Net zero means any emissions would be balanced by schemes to offset an equivalent amount of greenhouse gases from the atmosphere, such as planting trees or using technology like carbon capture and storage.

<sup>2</sup> Carbon capture and storage. | <sup>3</sup> CCC Progress Report, June 2023. | <sup>4</sup> Targets set in the British Energy Security Strategy, April 2022. | Source: UK Department for Business, Energy & Industrial Strategy; UK Climate Change Committee. | <sup>5</sup> UK Net Zero Strategy, Oct 2021. | <sup>6</sup> GHG National Statistics. CO<sub>2</sub> emissions.

# GB capacity market

## Establishment

- **Adopted in 2013** as part of the Energy Act 2013 in the UK
- Provides generators with the ability to set the price at which they are willing to commit to keeping plant available

## Price

- Auction price can be between £0 – 75/kW
- Auction price is **determined by the marginal capacity**. All units receive the price of the highest successful unit ('descending clock' format)
- Units which leave the auction before it closes will not be offered a Capacity Market Agreement

- **Used to secure supply** since Q4 2017
- UK government determines amount of capacity needed for each delivery year (quantity-based-mechanism)

## Capacity quantities

- The largest part of the capacity is awarded in the first auction (T-4); a small part follows in another auction one year before the respective delivery year (T-1 auction)
- The 'agreement' terms are between 1 and 15 years – depending on whether it is existing plants or new plants
- Delivery year begins on the 1<sup>st</sup> October through to the 30<sup>th</sup> September

Delivery Year	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27
T-1 Auction (£/kW)	6.95	6.00	0.77	1.00	45.00	75.00	60.00			
T-4 Auction (£/kW)		19.40	18.00	22.50	8.40	6.44 <sup>1</sup>	15.97	18.00	30.59	63.00

Source: RWE Analysis. | <sup>1</sup> In 2020 a T-3 auction replaced the T-4 auction, which was unable to take place in 2019 given the standstill in the GB Capacity Market following the legal challenge by Tempus Energy.

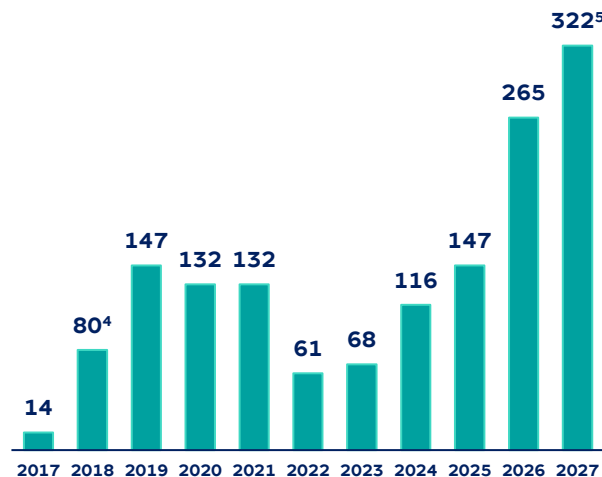
# GB capacity market - RWE plants

## RWE plants in GB Capacity Market

Derated capacity (MW)	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27
Aberthaw <sup>1</sup>	1,475	1,486	1,490	1,475	1,486	0	0	0	0	0
Didcot B (excl. OCGT)	1,358	1,364	1,380	1,395	1,395	1,395	1,395	1,395	1,409	1416
Little Barford	681	683	691	699	699	699	699	699	706	709
Great Yarmouth	359	361	365	369	369	369	369	369	373	374
Staythorpe	1,626	1,633	1,652	1,670	1,670	1,670	1,670	1,670	1,687	1,695
Pembroke	2,081	2,090	2,114	2,138	2,138	2,138	2,138	2,138	2,159	2,169
King's Lynn			329	333	333	333	333	333	333	333
Other <sup>2</sup>	322	425	382	390	466	426	426	371	331	331
<b>Total (qualified)</b>	<b>7,901</b>	<b>8,043</b>	<b>8,403</b>	<b>8,468</b>	<b>8,556</b>	<b>7,030</b>	<b>7,031</b>	<b>6,975</b>	<b>6,999</b>	<b>7,027</b>
<b>Total (successful capacity)</b>	<b>7,901</b>	<b>7,991</b>	<b>6,913</b>	<b>6,951</b>	<b>6,989</b>	<b>6,938</b>	<b>6,895</b>	<b>6,895</b>	<b>6,999</b>	<b>7,027</b>

## Revenue from capacity market<sup>3</sup>

(in £ million, pre inflation)

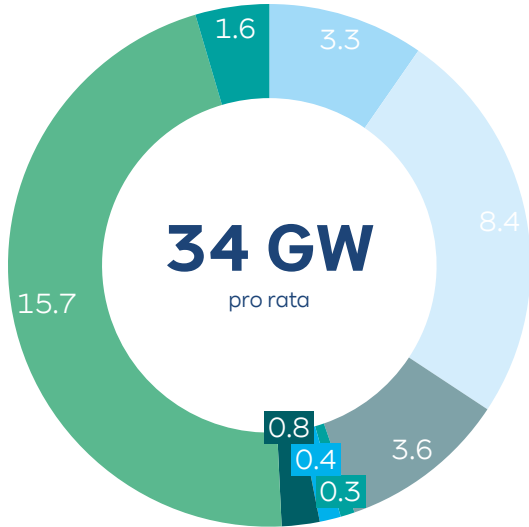


<sup>1</sup> Due to the closure of Aberthaw in March 2020 the Power Station's existing Capacity Market agreements for the years 2019/2020 and 2020/2021 were transferred to third parties and a small proportion to other units within RWE's fleet. | <sup>2</sup> Includes Cowes OCGT, Didcot OCGT, Cheshire GT, Conoco Phillips, Hythe, Grimsby A. | <sup>3</sup> Based on cleared capacity prices (nominal) and capacity contracts secured by RWE. | <sup>4</sup> This includes approximately £42m that was received in 2019 due to the suspension of payments in 2018. | <sup>5</sup> This includes full year for assets with 15 year agreements at King's Lynn, Grimsby and Cheshire, and to September 2027 for other units; rounding differences may occur.

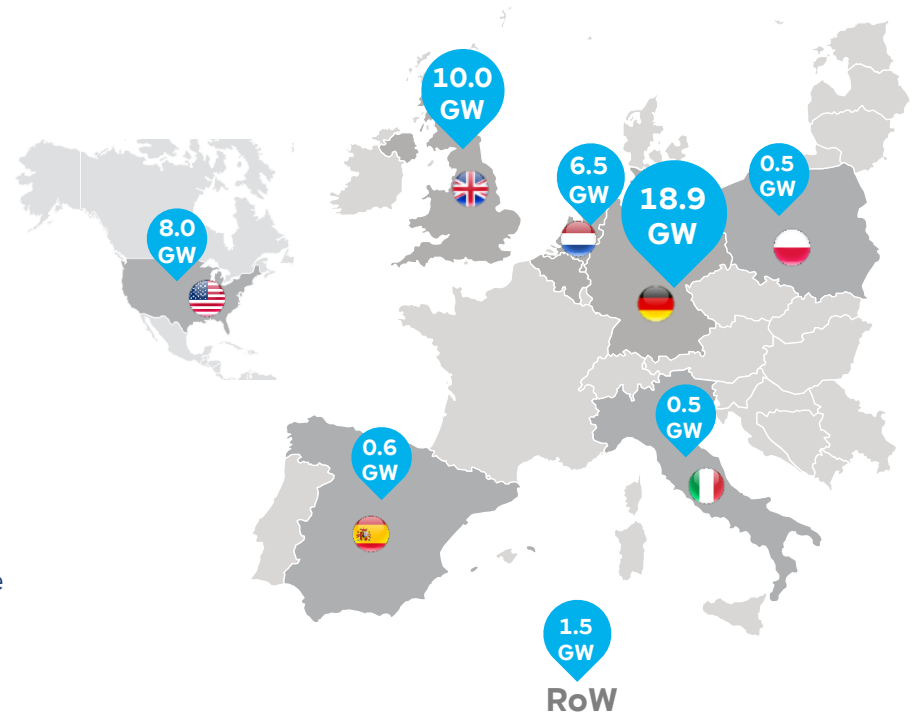


# TECHNOLOGIES

# RWE's power generation portfolio



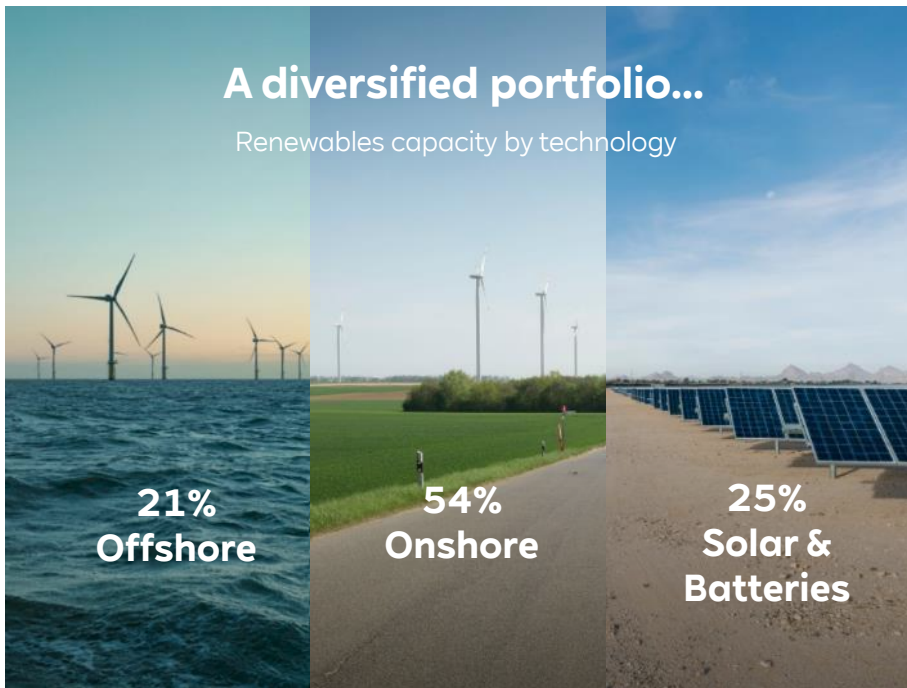
- Offshore wind
- Onshore wind
- Solar
- Batteries
- Hydro
- Biomass
- Gas
- Pumped Storage



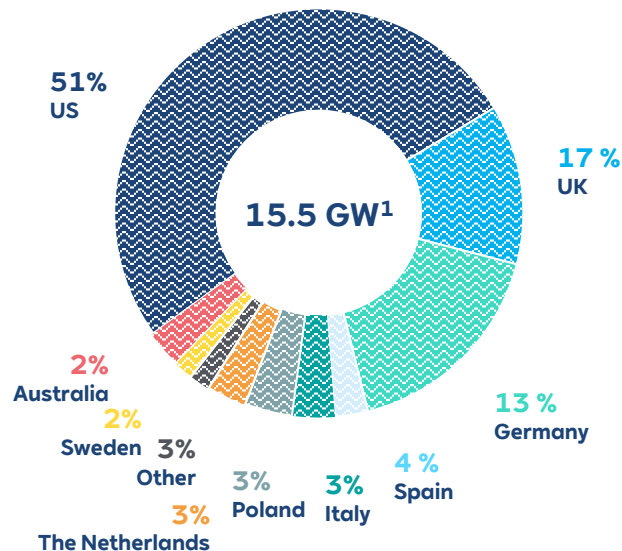
Note: rounding differences may occur; map also includes capacities for Lignite (8.3 GW), Hard coal (2.3 GW), Nuclear (1.5 GW) and Other (0.3 GW).



# Powerful position in wind, solar & batteries



## Wind, solar and battery capacity by country



<sup>1</sup> Pro rata view as of 31 March 2023; rounding differences may occur.

# Having a closer look at our different business pillars



## Offshore Wind

Strongest growth in Europe, significant potential in global markets



## Onshore Wind/Solar

US green ambitions and European Green Deal accelerate growth momentum in US and Europe



## Flexible Generation & Batteries

RWE's European core markets require new, low-carbon flexible capacities



## Hydrogen

Hydrogen is quickly gaining traction with projects in our European core markets



## Commercial Solutions

Decarbonisation of industry drives demand for tailored solutions



# Strong market position



RWE Group



Market Data



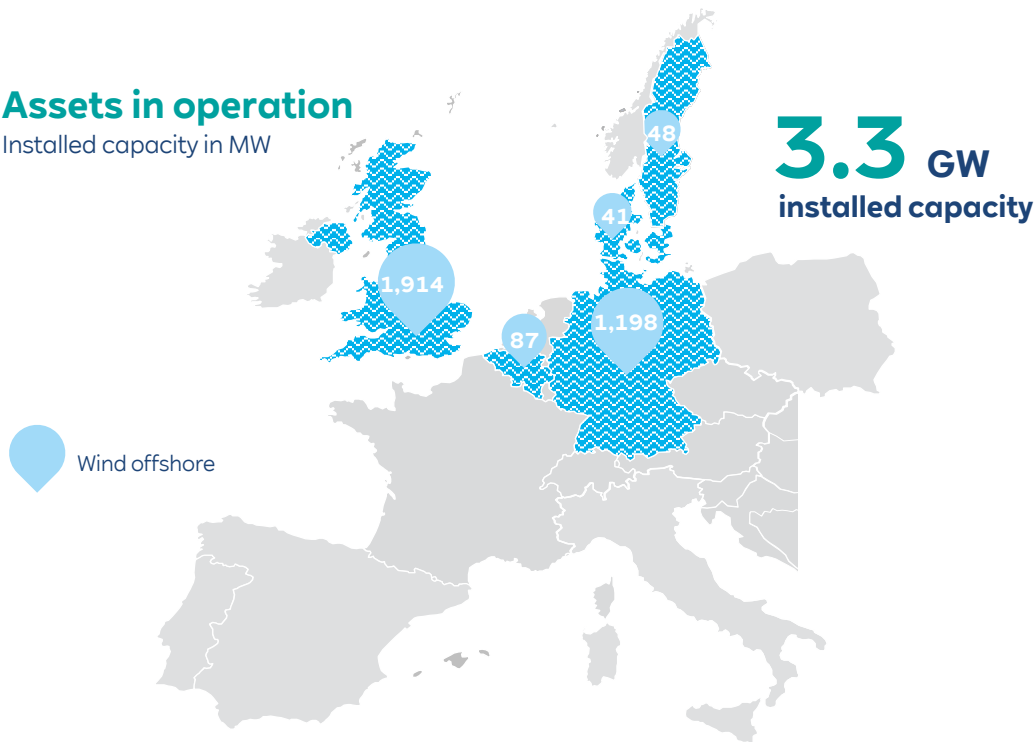
Regulations



RWE Technologies

## Assets in operation

Installed capacity in MW



**#2** leading global market position<sup>1</sup>

- **Extensive experience** in technology & **high-class partnerships** in new markets

**10.2** TWh power generation<sup>2</sup>

**>28** assets in Europe   
Sofia (1.4 GW) and Thor (1.1 GW) wind farms **under construction**

- Continuous **improvement of our operations** by taking over windfarms into **self-perform/in-housing** and by exploiting synergies

Note: Pro rata view as of 31 March 2023; rounding differences may occur. | <sup>1</sup> China excluded. | <sup>2</sup> Accounting view as of 31 Dec 2022.



# We are the forefront of technological innovation



## Our offshore innovation projects support our sustainability strategy ...

## ... and go beyond conventional applications

### Recyclable blades

We are testing the **world's first recyclable wind turbine blade**, made by Siemens Gamesa



### Vibratory pile driving

We are investigating new installation techniques for offshore foundations to **reduce noise emissions**



### Offshore hydrogen

We are part of the AquaVentus project family driving the production of hydrogen on offshore wind farms in the North Sea



### Floating wind

Our ambition is to safely develop, build and operate cost-competitive, commercial-scale floating projects around the world



Picture sources: Siemens Gamesa, AquaVentus.

Photo credit: University of Maine



# We have established a leading offshore wind platform in the U.S. ~4 GW<sup>1</sup> of seabed lease capacity lies on both the East and West Coasts



01

## California

- Approximately 1.6 GW
- First commercial-scale floating offshore wind project
- Project is expected to be in operation by the mid-2030s ([Link](#))



02

## New York Bight

- Approximately 3.3 GW (RWE share 2.4 GW)
- Joint development with National Grid under Community Offshore Wind
- Project is expected to be in operation by the end of this decade ([Link](#))

<sup>1</sup> Pro rata view.



# European wind power at sea



03

## German cluster

- Approximately 1.6 GW of four cluster projects
- COD for Nordseecluster A: 2027
- COD for Nordseecluster B: 2029 ([Link](#))



04

## Dublin Array

- 824 megawatts offshore wind project would be RWE's first offshore wind farm off the coast of Ireland
- Target COD date of 2028 ([Link](#))



# Offshore Wind assets - operational



illustrative

## Triton Knoll (UK, North Sea)



- COD: 2022
- RWE share: 59%
- Capacity: 857 MW
- 90 x MHI Vestas 9.5 MW turbines
- Water depth: 15-24 m
- Location: 32 km distance to UK mainland (Lincolnshire)
- Subsidy scheme: two-sided CfD with a strike price of 74.75 £/MWh<sup>1</sup> for 15 years
- ~0.8 million potential UK homes supplied annually
- One turbine rotation can power a typical home in the UK for 29 hours

## Kaskasi (Germany, North Sea)



- COD: 2022
- RWE share: 100%
- Capacity: 342 MW
- 38 x Siemens Gamesa 9 MW turbines
- Water depth: 18-25 m
- Location: 35 km north of the island of Heligoland in the “Heligoland Cluster” together with the offshore wind parks Amrumbank and Nordsee-Ost
- Subsidy scheme: one-sided CfD with a strike price of 48.6 €/MWh for 20 years
- ~0.4 million Germans homes will be supplied annually
- RWE to pilot first ever recyclable rotor blades by Siemens Gamesa at Kaskasi

<sup>1</sup> 2012 prices.



# Offshore Wind assets – under construction

illustrative

## Sofia (UK, North Sea)



- COD (expected): 2026
- RWE share: 100%
- Capacity: 1400 MW
- 100x Siemens Gamesa 14 MW
- Water depth: 20-35 m
- Location: Dogger Bank, 195 kilometers from the nearest point on the UK's Northeast coast
- Subsidy scheme: two-sided CfD with a strike price of GBP 39.65<sup>1</sup>/MWh
- ~1.4 million potential households supplied annually
- About 50% of Onshore and Offshore station to be manufactured locally in UK
- Will employ the worlds longest and most powerful HVDC-System to date

## Thor (Denmark, North Sea)



- COD (expected): 2026
- RWE share: 100%
- Capacity: 1080 MW
- Water depth: Avg. 30 m
- Location: 22 kilometers off the coast of Thorsminde on the west coast of Jutland
- 30-year operational license with further 5-year extension possible
- ~1 million potential households supplied annually
- Grid connection agreement with Energinet
- Will be biggest Danish Offshore Wind project

<sup>1</sup> 2012 prices.





# Offshore Wind: Evolution of RWE's offshore wind farms

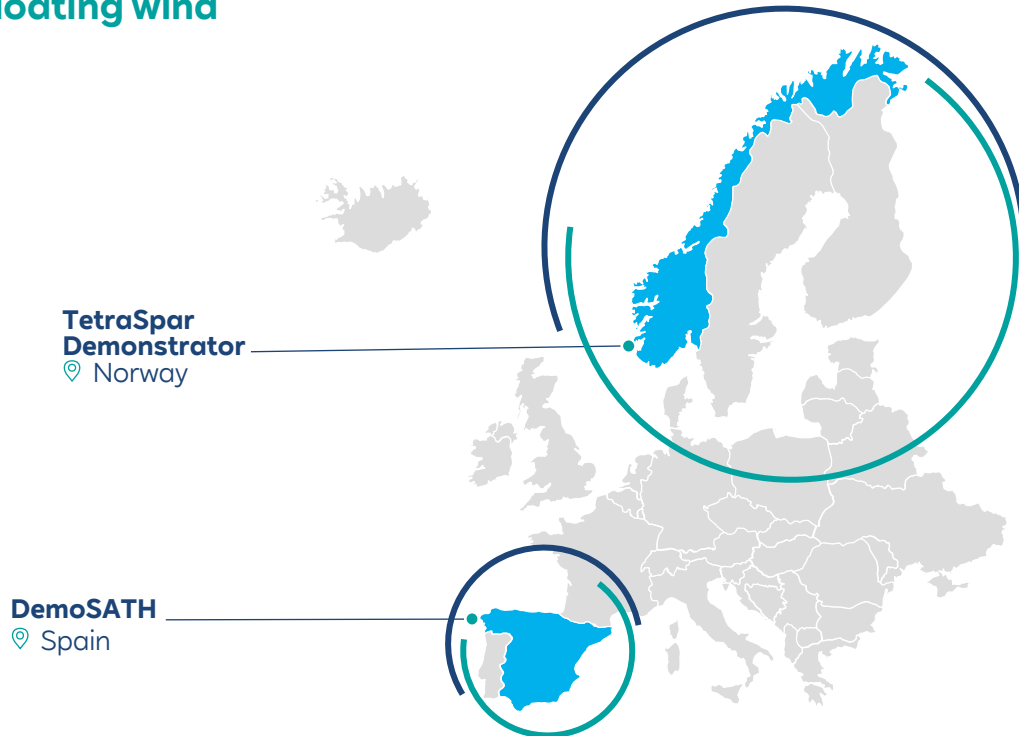




# Floating Wind

RWE is building on its extensive offshore wind experience to become a market leader in floating wind

- RWE aims to have up to **1 GW** of floating capacity deployed or under construction **by 2030**
- RWE is also developing a multi-gigawatt **global pipeline** of activity to deploy in the 2030s and beyond
- We have a global approach & **international growth strategy** with activities planned globally





# Floating Wind

## RWE is actively participating in several high-profile floating demo projects for detailed insight and experience

- Floating offshore wind has great potential and **opens attractive market opportunities** not accessible via fixed bottom installations
- The demonstration projects are providing **unique insights** into the particular challenges and opportunities of different structure types, materials, mooring systems, and installation methodologies.
- RWE was successful in securing a **1.6GW floating wind lease area** off the California coast.
- RWE has also **pre-qualified to bid** for two upcoming floating wind auctions in **France**, will participate in an upcoming tenders with our partners in **Norway** will take part in the Celtic Sea auction in the **UK** and is exploring floating wind in further markets as well

### Demo project TetraSpar Demonstrator

- Location: Norwegian coast
- Water depth: 200 metres
- Distance to shore: 10 km
- Capacity: 3.6 MW
- Platform type: Suspended counterweight
- Platform material: Steel
- Achieved in: 2021



### Demo project DemoSATH

- Location: Bay of Biscay, Spain
- Water depth: 80 metres
- Distance to shore: 3 km
- Capacity: 2 MW
- Platform type: Barge
- Platform material: Concrete
- Expected COD: 2023





# RWE takes an active role in advancing the development of offshore solar

RWE is well positioned to kick-start early development of Offshore Solar

- 1 Strong offshore player (6 GW deployed) with proven **track record in early adoption and commercialisation of new technologies**
- 2 Experienced **in-house engineering teams** for all relevant technology aspects
- 3 RWE is involved in **3 demonstration projects** to get learnings from testing in relevant environment
- 4 **RWE closely cooperates with key technology designers** to support industrialisation and fast-track the commercialisation

## PILOT PROJECTS



### SolarDuck Offshore Pilot<sup>1</sup>

SolarDuck Pilot Project (0.5 MW) in Dutch North Sea, 2023



### EU SCORES Pilot & Research Project<sup>2</sup>

Oceans of Energy Pilot Project (3 MW) in Belgium, 2023



### HKW SolarDuck Demonstration 5 MW<sup>1</sup>

Integrated into commercial HKW windfarm



<sup>1</sup> <https://www.rwe.com/en/research-and-development/solar-energy-projects/offshore-solar/merganser/>

<sup>2</sup> <https://www.rwe.com/en/research-and-development/solar-energy-projects/offshore-solar/eu-scores/>



# Pilot funding and tenders with innovation criteria accelerate development, regulatory frameworks required for scale up



RWE Group



Market Data



Regulations



RWE Technologies

## TWO BUSINESS MODELS

### 1 OFFSHORE SOLAR STAND-ALONE PROJECTS IN REGIONS WITH LIMITED WIND RESOURCE



- Opportunity for large scale solar energy projects close to demand centers at low visual impact

### 2 HYBRID SOLAR AND WIND PROJECTS IN SPACE CONSTRAINT REGIONS



- More space-efficient renewable energy generation with smoothed production profiles

## ROADMAP TO COMMERCIALISATION

### PILOT PROJECTS

<5 MWp

### STEPPING STONE PROJECTS

<100 MWp

### COMMERCIAL PROJECTS

>100 MWp



## FACTORS TO SUCCESS



### Scale up of technology & supply chain

- Address technology challenges and optimize design
- Develop supply chain & standardize to proven product for scale up



### Regulatory and financial stability

- Introduce targets, regulatory frameworks and finance beyond innovation phase
- Regulate grid access and curtailment for hybrid projects



### Cost optimisation

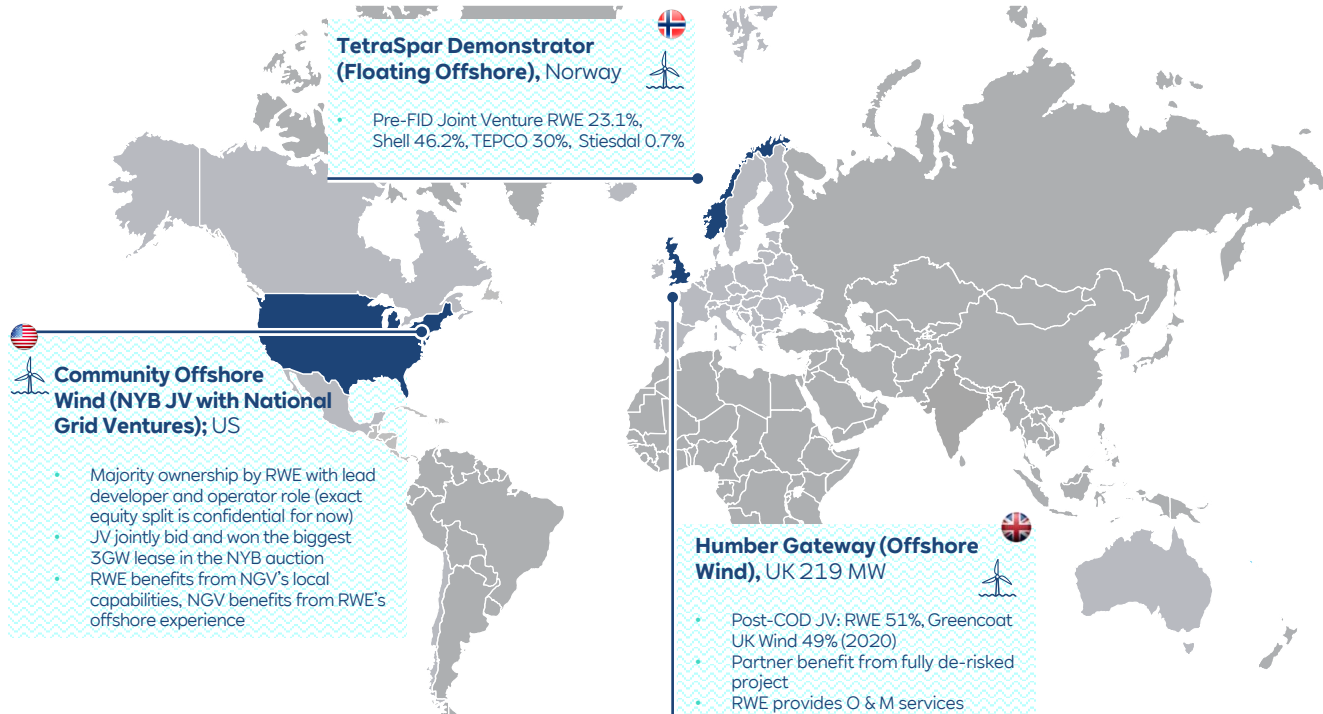
- Drive down cost by making the right design decisions, optimizing the design for the target region, efficient manufacturing and economies of scale



# Partnerships at all stages of the value chain

Partnerships are an essential part of RWE's business model to support our growth ambition

illustrative



# Having a closer look at our different business pillars



## Offshore Wind

Strongest growth in Europe, significant potential in global markets



## Onshore Wind/Solar

US Green ambitions and European Green Deal accelerate growth momentum in US and Europe



## Flexible Generation & Batteries

RWE's European core markets require new, low-carbon flexible capacities



## Hydrogen

Hydrogen is quickly gaining traction with projects in our European core markets



## Commercial Solutions

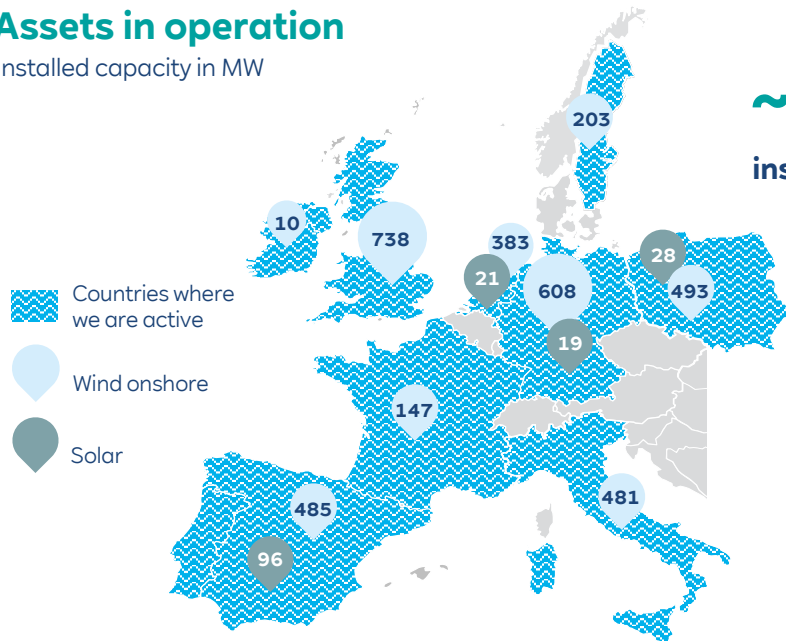
Decarbonisation of industry drives demand for tailored solutions



# Onshore Wind/Solar Europe and Australia: Experienced operator with strong competitive position

## Assets in operation

Installed capacity in MW



**~4 GW<sup>1</sup>**  
installed capacity

- Regionally well **diversified portfolio**

**7.9 TWh** power generation<sup>2</sup>

- Extensive experience in technology**



**~190** assets in operation

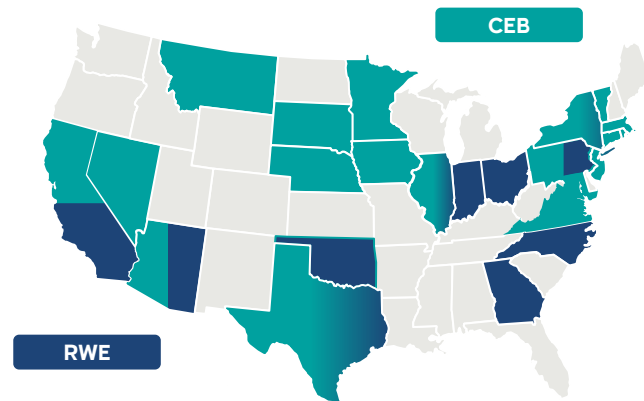
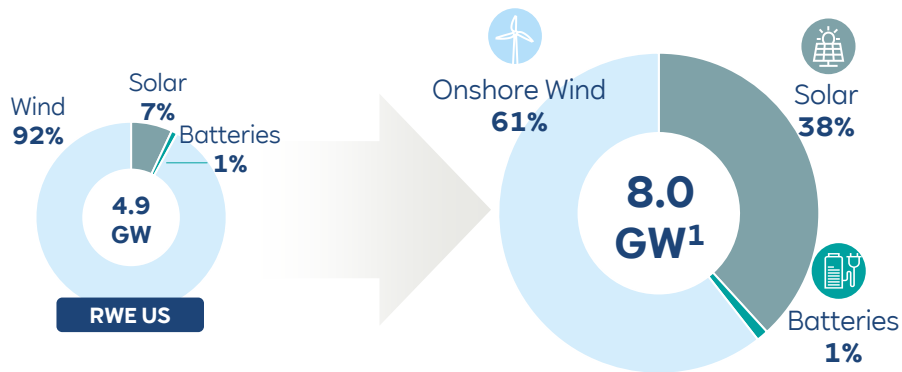
<sup>1</sup> Pro rata view as of 31 March 2023; please note: Australian Solar asset Limondale (249 MW) is not disclosed in the map. | <sup>2</sup> Accounting view as of 31 Dec 2022.





# Onshore Wind/Solar Americas: RWE Clean Energy - emerged from the combination

## RWE's U.S. portfolio significantly stepped up through combination



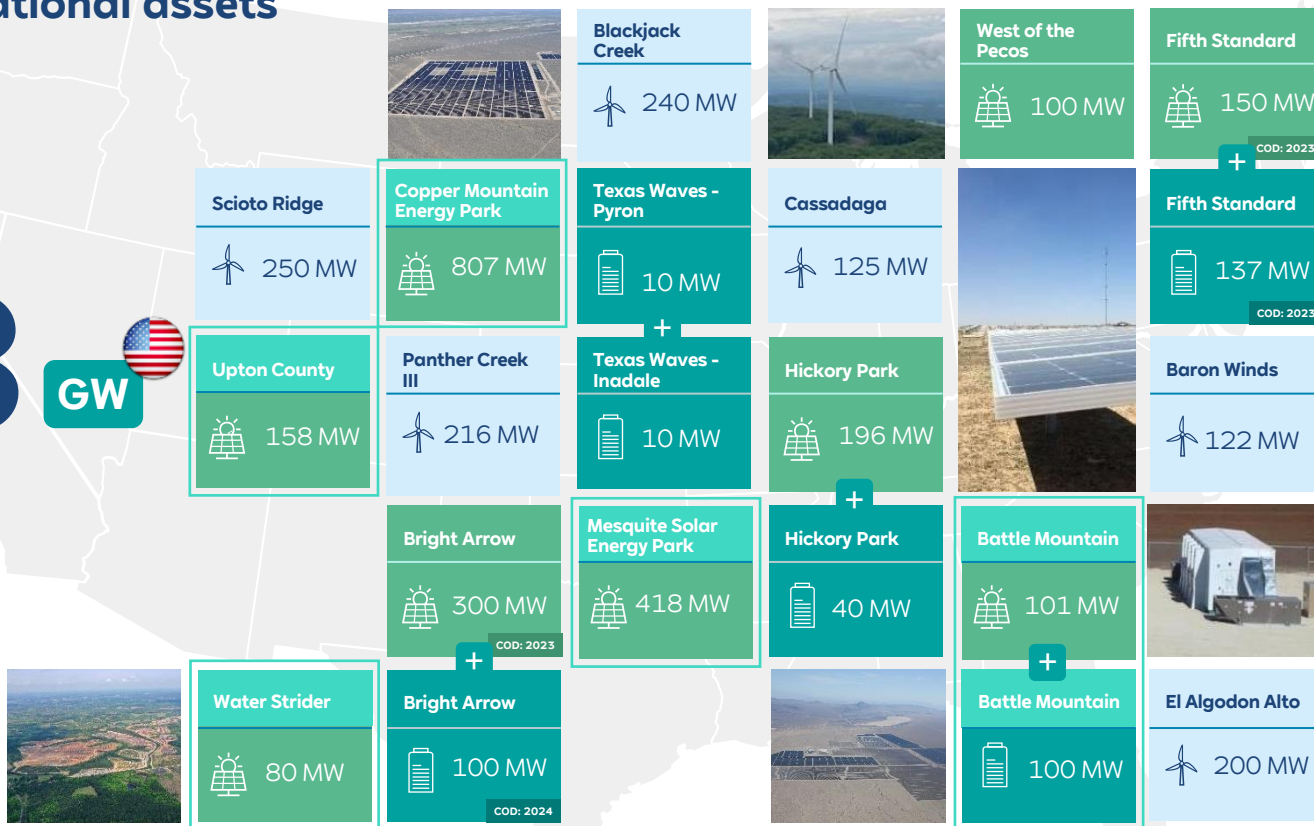
<sup>1</sup> Pro rata view as of 31 March 2023.



# Onshore Wind/Solar Americas:

## Highlights of operational assets

~ 8 GW

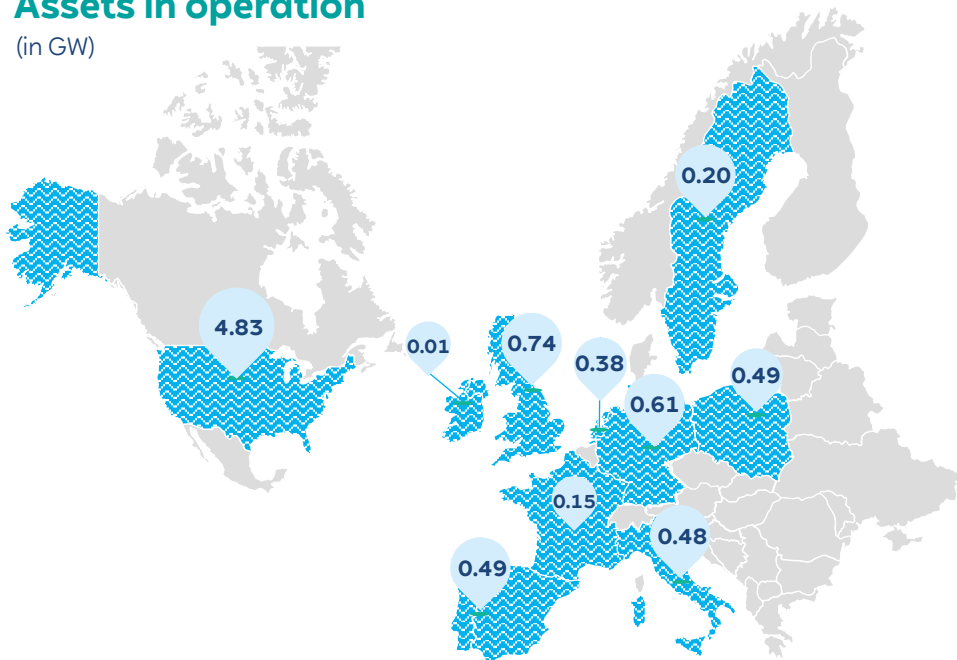




# Onshore Wind total

## Assets in operation

(in GW)



- Regionally well **diversified portfolio with**

**8.4** GW Onshore Wind

globally across Europe and the US

**>0.6** GW of projects under construction

- Industry-leading expertise** in core capabilities, from supply chain management through operational excellence, fostering future growth
- Impressive track record** of developing, constructing and operating highest performing and most efficient sites

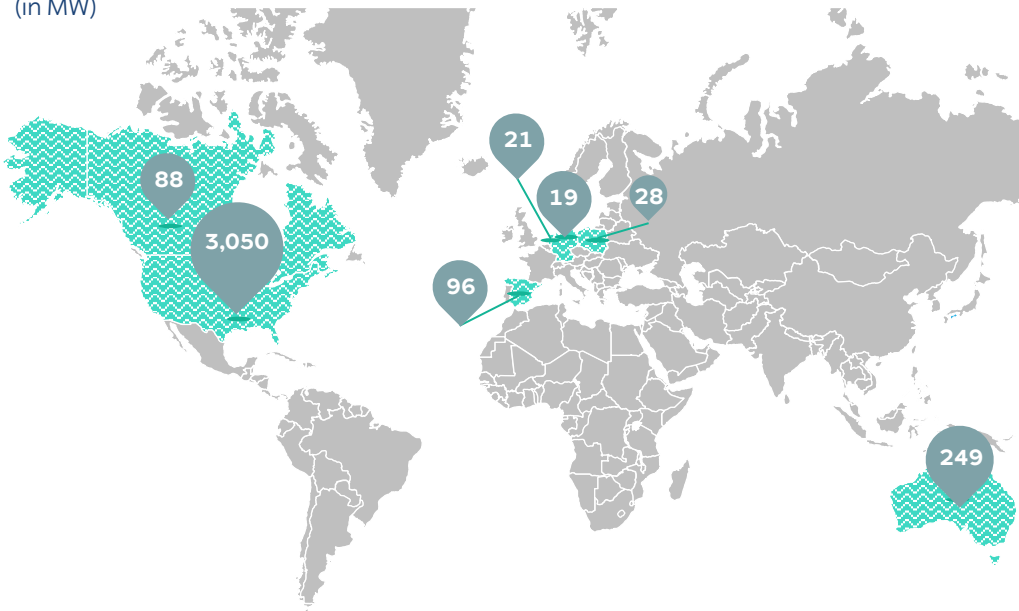
Note: Pro rata view as of 31 March 2023; rounding differences may occur.



# Excellent capabilities in Solar and Storage

## Installed solar capacity

(in MW)



Note: Pro rata view as of 31 March 2023; rounding differences may occur.

- Installed **solar** capacity of **~3.6 GW** and installed **storage** capacity of **0.3 GW**
- Globally **~3.5 GW** of Solar PV and Storage **projects under construction** with a strong footprint in the US
- Scaling up US growth ambitions through acquired pipeline of CEB with **>7 GW** to deliver **500+ MW** p.a.
- Strengthening our EU and UK solar & battery platform by acquiring **JBM Solar** (UK) (**6.1 GWac**) and **AlphaSolar** (PL) (**~3 GWac**)
- Excellent global solar and storage **engineering backbone**
- Our **Storage solutions are tailor-made** covering a wide range of applications ranging from ancillary services to T&D deferral and energy shifting, leveraging our strong technical capabilities



# Onshore Wind assets - operational

illustrative

## Scioto Ridge (USA, Ohio)



- COD: 2021
- RWE share: 100%
- Capacity: 250 MW
- 75 x Siemens Gamesa turbines
- Location: Ohio, Hardin and Logan Counties
- Subsidy scheme: REC/PTC
- Offtake: PPA
- More than 60,000 potential households supplied annually
- RWE's 1st onshore wind project in Ohio

## Zuidwester (The Netherlands, Urk)



- COD: 2016
- RWE share: 100%
- Capacity: 90 MW
- 12 x 7.5 MW Enercon turbines
- Location: Westermeerdijk and Zuidermeerdijk
- Subsidy scheme: FiT (SDE+€120/MWh)
- ~80,000 potential Dutch homes supplied annually
- Q&M provided by EPK Enercon
- Zuidwester ist part of Noordoostpolder, one of Europe's largest wind power projects



# Solar and Storage assets - operational

illustrative

## West of the Pecos (USA, Texas)



- COD: 2019
- RWE share: 100%
- Capacity: 100 MW
- More than 350,000 photovoltaic panels built over a 270-hectare area
- Location: Reeves County, TXS, approx. 75 miles southwest of Midland-Odessa
- Subsidy scheme: ITC
- Offtake: PPA and Firm Hedge
- Q&M provided by RWE

## Hickory Park (USA, Georgia)



- COD: 2022
- RWE share: 100%
- Capacity: 196 MW coupled with a 40 MW 2-hour battery storage system
- Location: Mitchell County, Georgia
- Subsidy scheme: ITC
- Offtake: PPA
- Hickory Park is RWE's largest solar plus storage project in the U.S.
- Offtake: 30-year utility contract
- Solar power plant will interconnect more than 650,000 solar panel
- Hickory Park covers an area of about 728 hectares



# Onshore Wind/Solar assets - operational

illustrative

## Cassadaga (USA, New York)



- COD: 2021
- RWE share: 100%
- Capacity: 125 MW
- 27 x Nordex and 10 Siemens turbines
- Location: Chautauqua County, NY
- Subsidy scheme: REC/PTC
- Offtake: PPA
- ~37,000 potential US homes supplied annually
- RWE's 29th onshore wind farm in the U.S. and represents RWE's second onshore wind project in New York

## Limondale Sun Farm (Australia)



- COD: 2021
- RWE share: 100%
- Capacity: 249 MW
- approx. 872,000 panels used for this project
- Location: New South Wales
- Offtake product: merchant, PPAs and Green Certificates
- One of the largest solar parks in Australia, covering an area of around 900 hectares, 450 football fields
- ~ 105,000 potential households supplied annually



# Solar assets – under construction

illustrative

## Bright Arrow (USA, Texas)



- COD (expected): 2024
- RWE share: 100%
- Capacity: 300 MW + 100 MW battery storage system
- 876,000 photovoltaic panels and 85 central inverters
- Location: 80 miles east of Dallas, Hopkins county, TX
- Subsidy scheme: REC/PTC
- Offtake: merchant

## Stoneridge (USA, Texas)



- COD (expected): 2024
- RWE share: 100%
- Capacity: 200 MW + 100 MW battery storage system
- Location: Milam County, TX



# Having a closer look at our different business pillars



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## Flexible Generation & Batteries

RWE's European core markets require new, low-carbon flexible capacities



## Hydrogen

Hydrogen is quickly gaining traction with projects in our European core markets



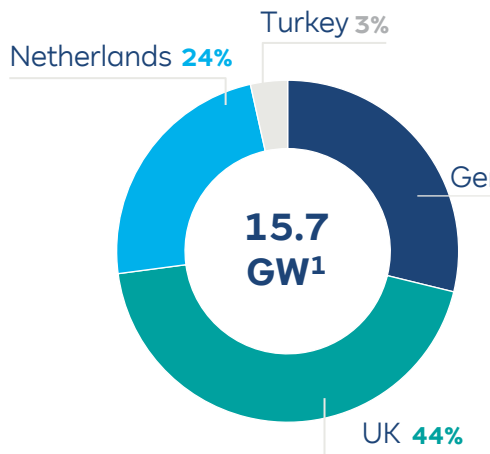
## Commercial Solutions

Decarbonisation of industry drives demand for tailored solutions

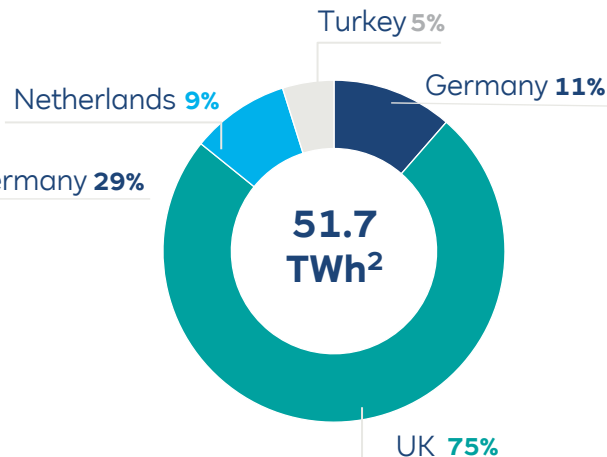


# Gas: Highly efficient and flexible gas assets

### Installed capacity per country



### Power generation per country



**#2** gas fleet in Europe



**31** power plants  
in Germany, UK, Netherlands  
and Turkey

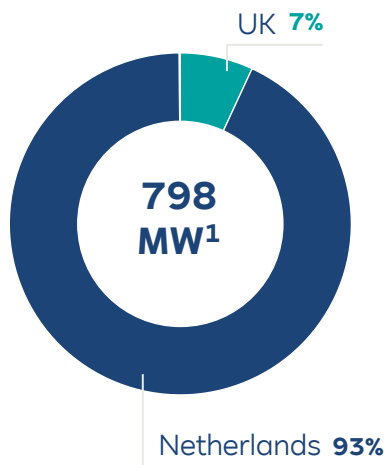


<sup>1</sup> Pro rata view as of 31 March 2023. | <sup>2</sup> Accounting view as of 31 Dec 2022. | Note: Rounding differences may occur.

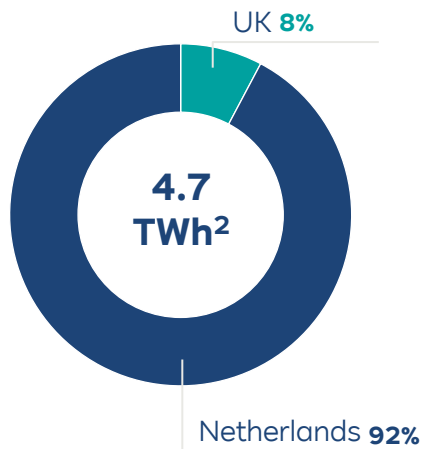


# Biomass: Focused on biomass co-firing

## Installed capacity per country



## Power generation per country



**4 power plants** in  
UK, Netherlands and Germany  
(Neurath BGA (< 1 MW))



### Biomass co-fired power plants

Biomass net capacity:

- Amer (505 MW)
- Eemshaven A+B (237 MW)

### Certificated biomass



<sup>1</sup> Pro rata view as of 31 March 2023. <sup>2</sup> Accounting view as of 31 Dec 2022. | Note: Rounding differences may occur.

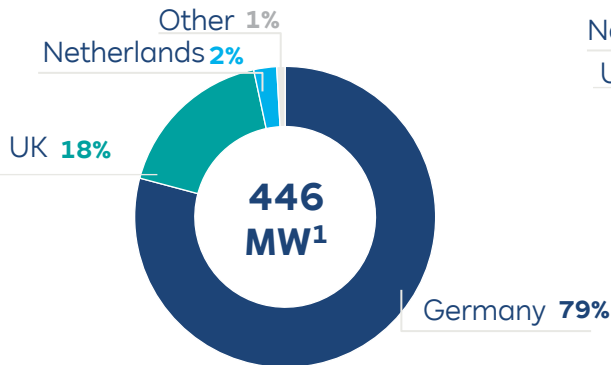


# Hydro & pumped storage: Attractive portfolio with high flexibility

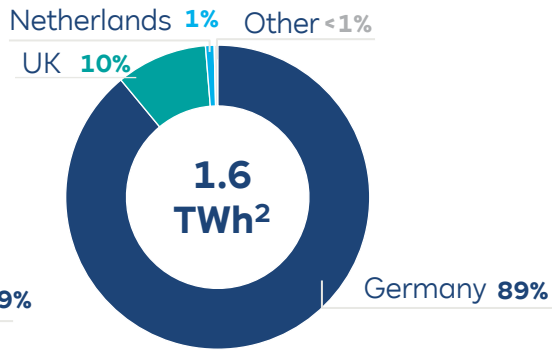


## Hydro

### Installed capacity



### Power generation



## Pumped storage

Own operated power plant

- Koepchenwerk (162 MW)

Contractually secured plants<sup>3</sup>

- SEO Vianden (523 MW)
- Schluchsee (870 MW)

Installed capacity in Germany<sup>4</sup>

**1,555 MW**

<sup>1</sup> Pro rata view as of 31 March 2023. <sup>2</sup> Accounting view as of 31 Dec 2022. <sup>3</sup> Based on long-term use agreements. <sup>4</sup> Pro rata view. | Note: Rounding differences may occur.

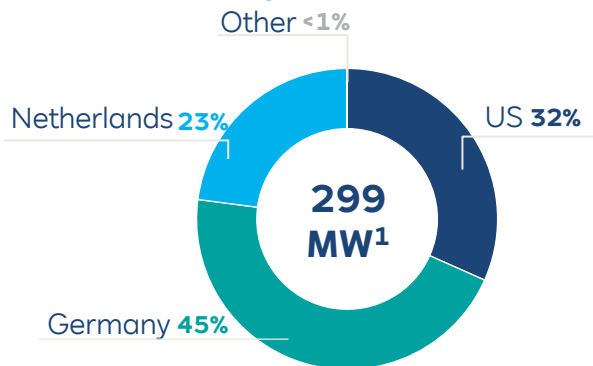


# Batteries: Balancing the system is a growth opportunity



## Batteries

### Installed capacity



Own operated battery storage systems in

- **US, Germany, UK and Ireland**

Growth focus in batteries on co-location

- in particular with wind and solar sites

Additionally **working on further innovative technologies**

- e.g. redox-flow storage systems
- second-life batteries

<sup>1</sup> Pro rata view as of 31 March 2023. | Note: Rounding differences may occur.



# Battery storage assets - operational

illustrative

## Texas Waves - Pyron (USA, Texas)



- COD: 2018
- RWE share: 100%
- Capacity: 2 x 9.9 MW / 5 MW
- A battery system co-located at the Pyron Wind Farm (265 MW)
- Location: near Sweetwater, TXS
- Subsidy scheme: ITC
- Offtake: merchant
- O&M provided by RWE
- Energy storage participates in the frequency regulation market and helps to maintain frequency stability
- In case the frequency drops or increases below certainty threshold, the battery will discharge or charge to support the grid to maintain the grid frequency at 60 Hz

## Lisdrum - County Monaghan (Ireland)



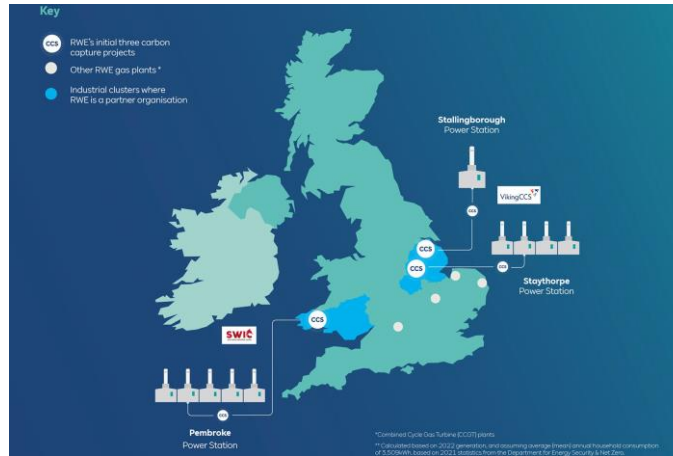
- COD: 2022
- RWE share: 100%
- Capacity: 60 MW
- Second battery storage facility that RWE has brought online in Ireland
- Location: Lisdrumdoagh, (3 km East of Monaghan town)
- Subsidy scheme: Other
- Site provides a short term back-up to help address power outages, and to maintain a more stable and secure electricity supply in Ireland

# Our Carbon Capture projects in the UK

## Our pathway to decarbonisation...

## ...by considering three potential carbon capture projects across the UK<sup>1</sup>

- We are looking at **carbon capture technology** as a viable way to **decarbonise our gas plants** which are located within the vicinity of proposed CO<sub>2</sub> networks or shipping facilities, where the CO<sub>2</sub> could be transferred to safe storage solutions
- We are currently **progressing early development work and preparing information**
- It will allow for **existing plants at Staythorpe and Pembroke**, and a new build Combined Cycle Gas Turbine power station (CCGT) near the Humber, to be submitted into the next stage of the Government's Track-2 Phase-2 of the Cluster Sequencing for Carbon Capture Usage and Storage Deployment process



### Together, these three projects would enable:

- **4.5 GW** of secure, flexible and low carbon energy
- **11 Mt/ year** of CO<sub>2</sub> capture (equivalent of removing 2.2m petrol cars from the road)
- **300+ jobs**

<sup>1</sup> For more information: <https://uk-ireland.rwe.com/rwe-generation-uk/rwes-carbon-capture-projects/>

# Having a closer look at our different business pillars



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## Hydrogen

Hydrogen is quickly gaining traction with projects in our European core markets



## Commercial Solutions

Decarbonisation of industry drives demand for tailored solutions





# RWE has a good starting point along the value chain for green hydrogen

## Competencies of the RWE companies along the green hydrogen value chain

**Renewable Energy Production**



**Electrolyser**



**Logistic (Storage & Transport)**



**Use Case**



**Renewables**

**Renewable Energy Production:** Development, construction, operation and structuring of renewable electricity generation

**Hydrogen generation via offshore electrolyser:** Development, construction and operation

**Flexible Generation**

**Hydrogen generation via electrolyser:** Development, construction and operation

Establish **project partnerships** for the realisation of the first projects

**Commercial solutions**

**Asset optimisation:** flexible use of electrolysers in the electricity market

**Trading and storage:** Overall optimisation of (inter-) national trade and use of RWE gas storage facilities for hydrogen storage

**Reconversion to electricity** e.g. via available gas power plants

# RWE hydrogen project portfolio comprises >30 integrated projects along the entire value chain



**H<sub>2</sub>**

Learn more on our [hydrogen website](#)

- **Development and operation of electrolyzers** in the core markets (DE, NL, UK) and beyond
- **2 GW electrolysis target** by 2030, fueled by growing **project pipeline of >10 GW**
- Dedicated **board member for hydrogen** and growing team of **>300 hydrogen professionals** across markets
- Emerging import and international **trading** business for **green fuels**
  - US gulf coast
  - Chile
  - Namibia
  - Norway

Source: RWE.



# H<sub>2</sub>ercules Hydrogen fast track for Germany

illustrative



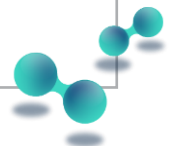
## H<sub>2</sub>ercules

Hydrogen production, storage and import terminals in the north of Germany to be connected with consumers in the west and south



- Plans for up to 1 GW of new electrolyser capacity and 1,500 kilometers of pipeline.
- Importing options through ports in Lower Saxony or grid connected neighboring countries.
- Storage facility in Gronau-Epe (as part of GET H<sub>2</sub>).
- Around 2/3 of predicted H<sub>2</sub> demand in 2030 could be connected.
- New building of at least 3 GW H<sub>2</sub>-ready power plants.
- Already over 20 companies as partners of initiative.

**Project partners (selection)**

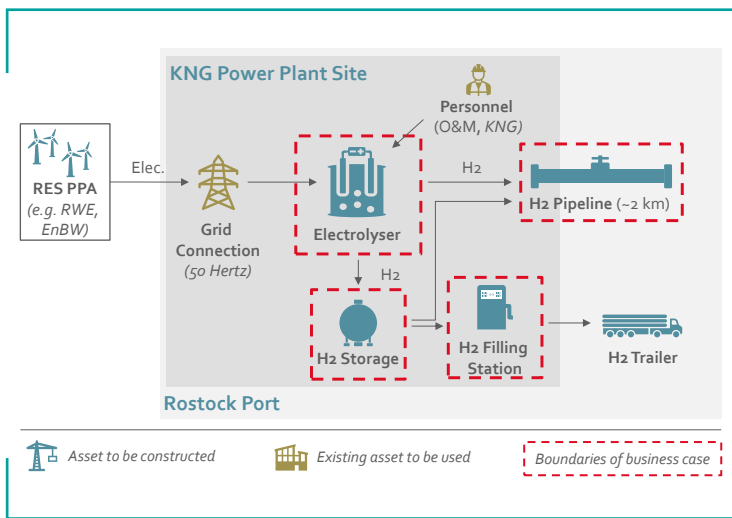


# HyTechHafen Rostock – an initial project in the Energiehafen Rostock Strategy

illustrative

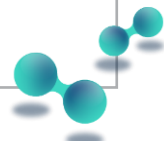


**HyTechHafen Rostock:** Four partners formed the project company “rostock EnergyPort cooperation GmbH”



- The project “HYTechHafen Rostock” aims at the construction of a 100 MW electrolyser, its connection to the Hydrogen Backbone grid, the intermediate storage of hydrogen as well as the construction of a hydrogen filling station which is intended for transport by trailer.
- The project is selected as IPCEI project by the German government and will be part of the IPCEI RHATL wave.
- The commissioning of the electrolyser, the hydrogen grid connection, hydrogen storage, and hydrogen filling station is scheduled for end 2026.

## Project partners (selection)



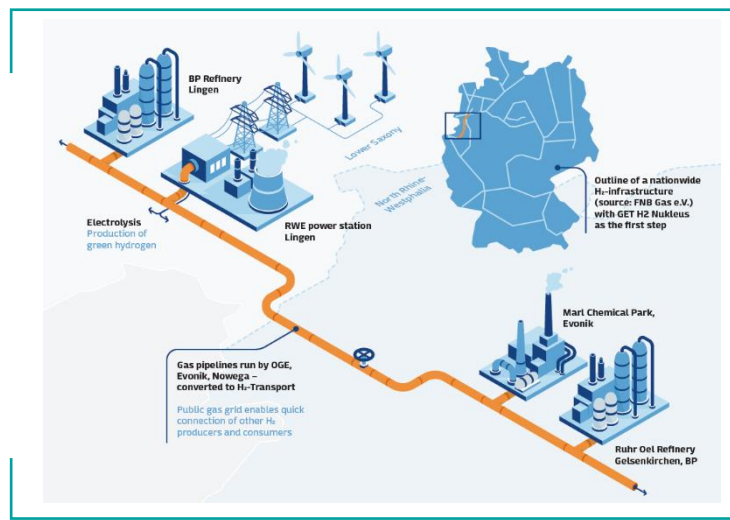


# GET H<sub>2</sub> aims to kick-start the creation of nationwide infrastructure in Germany

illustrative



**GET H<sub>2</sub>**  
An initiative of > 40 industrial and gas companies. In the first sub-project GET H2 Nukleus, RWE plays a key role in the production of green hydrogen at the RWE Lingen site



- The initiative has spawned GET H<sub>2</sub> Nukleus, a pilot project for the construction of the first publicly accessible hydrogen infrastructure involving BP, Evonik, Nowega, OGE and RWE.
- RWE's part consists of building a 100 MW electrolyser and produce green hydrogen at the RWE Lingen power plant site. Scaling potential up to 2 GW.
- The objective is to connect Lingen to the existing hydrogen network in the Ruhr region via a repurposed natural gas pipeline, in order to supply the green hydrogen to refineries and chemical parks.

**Project partners (selection)**

OGE | EVONIK *Leading Beyond Chemistry* | nowega *Wir transportieren Gas.* | bp

# In the UK, RWE is working with partners to develop a hydrogen economy for industries in South Wales

illustrative



## South Wales Industrial Cluster

RWE's Pembroke power station in Milford Haven is part of a large industrial park and can serve as a site for hydrogen production



- RWE's Pembroke gas-fired power station in Milford Haven is situated in one of six major industrial clusters in the UK. Thanks to its proximity to companies in the British steel, chemicals, oil and cement sectors, Pembroke is well suited to function as a future hydrogen production centre.
- The project encompasses the local production, distribution and usage of hydrogen.
- Further subjects of the project consortium's interest are carbon cycle options (e.g. carbon capture during cement production and synthetic fuel production).

### Project partners (selection)



**SOUTH HOOK**  
LNG TERMINAL COMPANY LTD



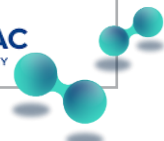
**TATA STEEL**



**Valero**



**TARMAC**  
A CRH COMPANY



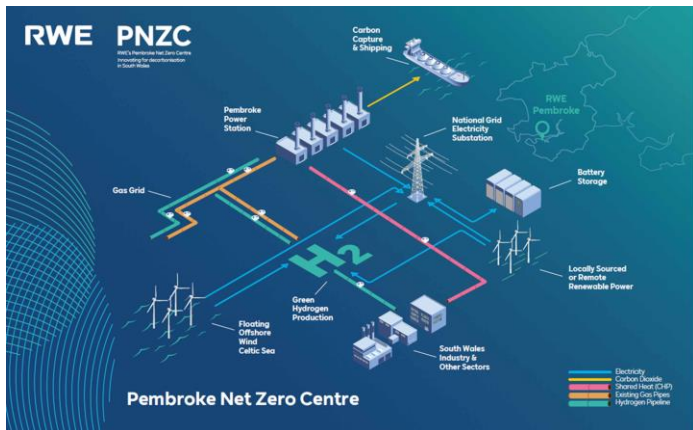


# Pembroke Green Hydrogen Phase 1 – lighthouse project

illustrative

## Pembroke Green Hydrogen Project (Phase 1)

Lighthouse green hydrogen project in SW Wales helping to decarbonise industry and support local hydrogen mobility



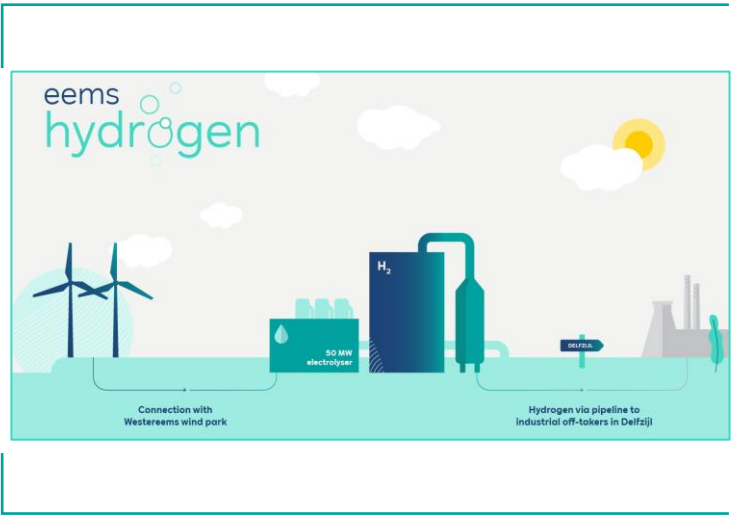
- Phase 1 is for 110 MW of electrolyser capacity.
- Main offtaker will be a nearby industrial user via pipeline, replacing natural gas supply. Smaller offtake for mobility uses planned.
- Plant will be located adjacent to Pembroke CCGT and share some services e.g water treatment plant.
- Grid connection from October 2026, water supply available.
- FID is planned for Q1 2025 and COD Q2 2027.
- Funding will be sought from Government Net Zero Hydrogen Fund and Hydrogen Production Business Model.
- Going out to market for electrolyser supplier and EPC contractor in summer 2023.



# Eemshydrogen plans to produce hydrogen with electricity from RWE onshore wind farm in the Netherlands

illustrative

**Eemshydrogen:** Demonstration of flexible electrolyser operation in line with wind speed-dependent electricity from existing RWE Westereems onshore wind farm



- The facility, rated at 50 MWe, is planned at RWE's power plant location in Eemshaven, Netherlands, to start operation in 2026.
- Synergies with the power station site will be leveraged: a.o. demin water, fire fighting water and sewer.
- Gasunie (TSO) to build hydrogen infrastructure in order to transport to Delfzijl (northern part of the hydrogen backbone).







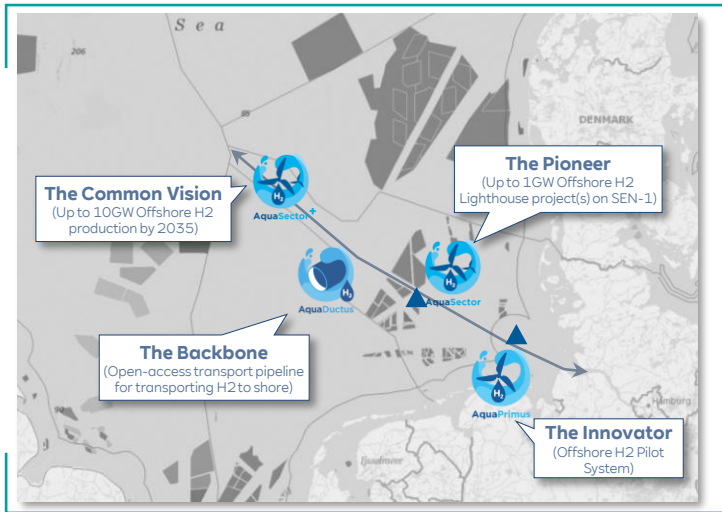
# AquaVentus initiative aims to kick-start Offshore H2 industry in Germany



AquaVentus

## AquaVentus

Initiative of > 100 members across the full H<sub>2</sub> value chain targeting to kick-start Offshore H<sub>2</sub> industry in Germany. RWE is playing a key role in the development and realisation of the AquaPrimus and AquaSector sub-projects



- AquaVentus has the vision to install 10 GW of green hydrogen generation capacity from offshore wind energy in the North Sea by 2035 and establish an associated transport infrastructure.
- The initiative comprises numerous coordinated sub-projects along the value chain, in which agile and highly committed consortia work on the realisation of the vision.
- RWE is playing a leading role in the development and realisation of the sub-projects AquaPrimus and AquaSector.
- AquaPrimus is aiming for the realisation of a pilot project for hydrogen production at sea.
- AquaSector targets to build the world's first multi-hundred MW offshore H<sub>2</sub> project and become a steppingstone for gigawatt scale projects in twenty-thirties.

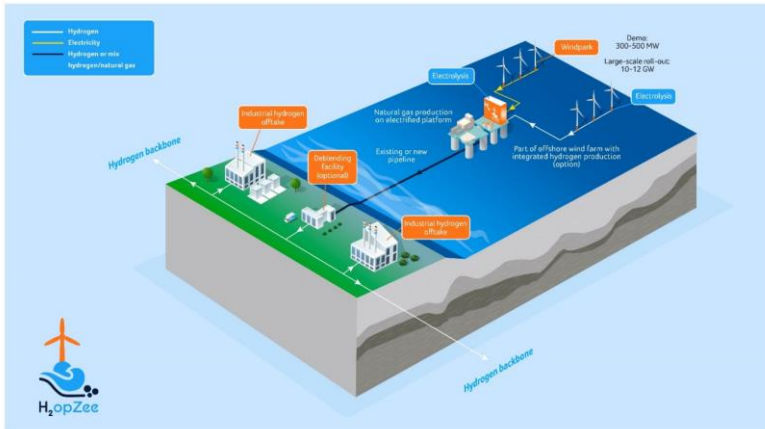


# H2opZee is one of the first large scale Offshore H2 demonstrators in the Netherlands

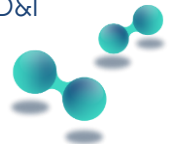


## H2opZee

H2opZee is a consortium-led project between of RWE and Neptune Energy with the aim to install up to 500 MW of offshore hydrogen capacity by 2031, with the possibility of future large-scale (gigawatt scale) expansion



- For the Dutch energy transition, sustainable energy from the North Sea is essential. The H2opZee project intends to demonstrate the feasibility of building a standalone offshore hydrogen production windfarm.
- RWE is developing the project in a 50-50 cooperation with the largest offshore gas producer in the Dutch part of the North Sea, Neptune Energy.
- H2opZee realizes 500 MW of additional hydrogen-out-of-sea capacity using the offshore Hydrogen backbone which is to be operated by the TSO.
- The project is one of the first demonstrators of offshore H<sub>2</sub> production technology at this scale and requires a major RD&I effort.



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## Hydrogen

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## Commercial Solutions

Decarbonisation of industry drives demand for tailored solutions



# Supply & Trading:

## Value creation through fundamental understanding of markets

### Trading volumes in 2022



**888**  
TWh of power



**867 million**  
CO<sub>2</sub> certificates



**452 billion<sup>1</sup>**  
m<sup>3</sup> of gas



**35 million**  
oz. tr. of precious metals

**Leading energy trading house** and **significant gas portfolio** player

**Interface** between the **Group and global wholesale markets** for energy and energy-related raw materials and services

**Europe's largest energy trading floor** at RWE's headquarters (Essen, Germany);

**11** trading offices worldwide

Source: RWEST Risk Governance, March 2022. | <sup>1</sup> Gas traded volume 2022, financial and physical transactions jointly reported.



RWE Group



Market Data



Regulations



RWE  
Technologies

# Supply & Trading:

## Clearly organised in 3 core business areas

### Trading & Origination

- Interface wholesale energy markets all over the world – physical and financial products
- Energy transition investments in commodity-driven assets and companies where we can deliver value from strong trading capability and deep understanding of energy commodity markets



### Commercial Asset Optimisation

- Optimising physical and contractual power assets – from long-term hedging to dispatch decision
- Energy Transition Origination is responsible for the origination of hydrogen projects



### Energy Supply & Services

- Management and optimisation of the Group's Pan-European gas portfolio, gas supply, storage and transport contracts as well as the global LNG portfolio
- Commodity Solutions as fully-fledged service provider for industrial customers and aggregators





# Trading & Origination: Understanding of fundamentals drives trading approach & Energy Transition Investments

**Fundamental analysis (examples)**

- **Power:** demand, conventional power plants, renewable feed-in, cross border flows, weather
- **Gas:** demand, pipeline flows, LNG deliveries, storage levels

- Deep understanding of physical assets
- Fundamental modelling of supply/demand balances

**Quantitative modelling**

- Outright fundamental fair value
- Fuel spreads, time spreads, location spreads and product spreads

- Monitoring of misvaluations in markets
- Assessment of risk/reward of trading opportunities



**Trading strategies**

**Fundamental:** assessment of fundamental fair value

**Relative value:** detection of spread opportunities

**Systematic:** algorithmic trading, monitor money flows

**Origination:** negotiated contracts in illiquid markets

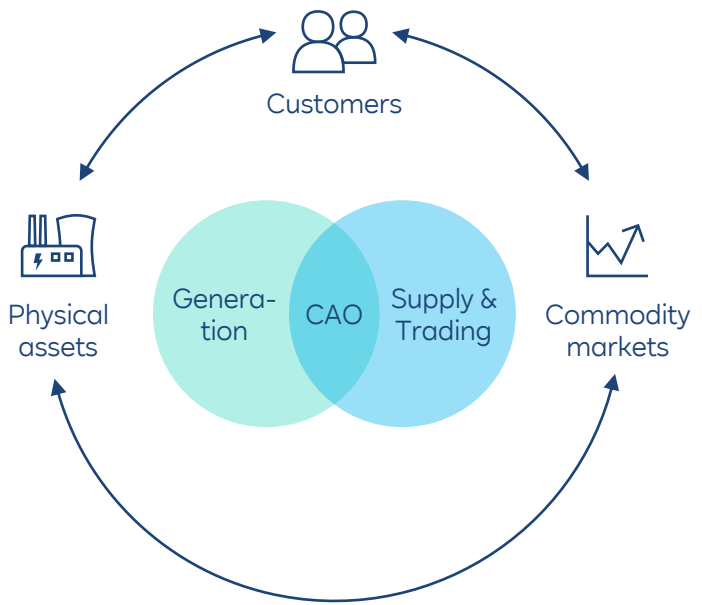
**Energy Transition Investments**

- Focus on private equity-like investments in assets and companies across the energy spectrum that are related to the global energy transition
- Deployed over € 500m in more than 20 transactions across the entire energy value chain, with typical equity investments of up to € 50m









# Commercial Asset Optimisation: The interface between generation & markets

## Business interaction



## Commercial Asset Optimisation

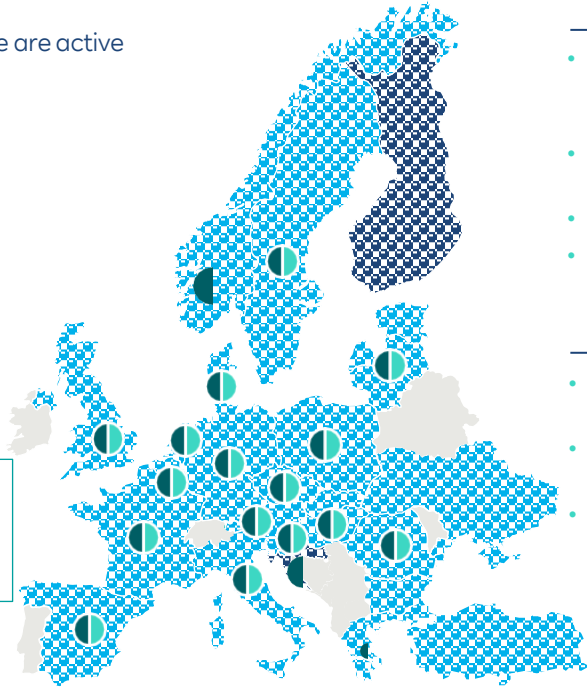
-  Commercial asset management
-  Hedging
-  Operations
-  Renewables
-  Asset partner conventional
-  Sales portfolio management



# Gas & LNG Supply: Major asset backed gas player in Europe

- Countries where we are active
- Not active
- Target markets
- OTC
- Exchanges

**220 TWh/a**  
Total Gas Supply

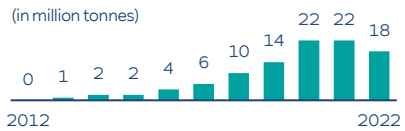


## Large gas portfolio across Europe

- Diversified **physical European gas supply of ~220 TWh/a** across 20+ countries centred around North Western and Central European markets
- Sourced from major international producers, smaller independents and from traded markets
- Booked working gas volume in **gas storages** of about 50 TWh
- ~ 55 GW gas **transportation capacity** at more than 70 European border points and storage connections

## Global LNG activities

- Sizeable global LNG portfolio with a strong customer base in Europe, Asia and the Middle East
- Tailor-made solutions for LNG customers & supply across all major markets
- Chartered 2 FSRUs on behalf of German government and initiation of Elbehafen project as main investor



### 2022 in figures<sup>1</sup>

- **17.8 mt of physical LNG** traded
- **9.99 mt physical delivery to customers<sup>2</sup>**

<sup>1</sup> LNG trading volumes excl. financial trading. | <sup>2</sup> The entire physical volume is sold on downstream by these customers to end users.





# LNG activities:

## A successful growth story

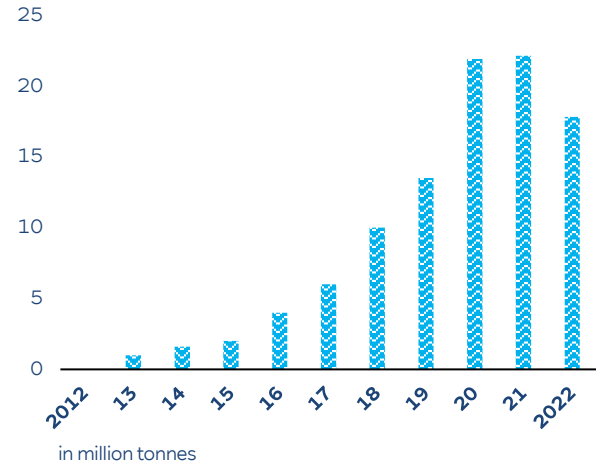


**Pioneer** in developing physical and financially structured transactions, working with our customers to offer tailored indexation and flexibility, along with competitive pricing and reliability.

### Global LNG activities

- Close cooperation with our partners combining innovation and competitive pricing
- Experience in global energy markets to develop tailor-made solutions for our LNG customers
- Risk management and Liquidity solutions through financial markets
- Bespoke LNG pricing on different indexations
- Global presence enabling supply across all major markets
- Chartered 2 FSRUs on behalf of German government and initiation of Elbehafen project as main investor

### LNG physical traded volumes



### 2022 in figures

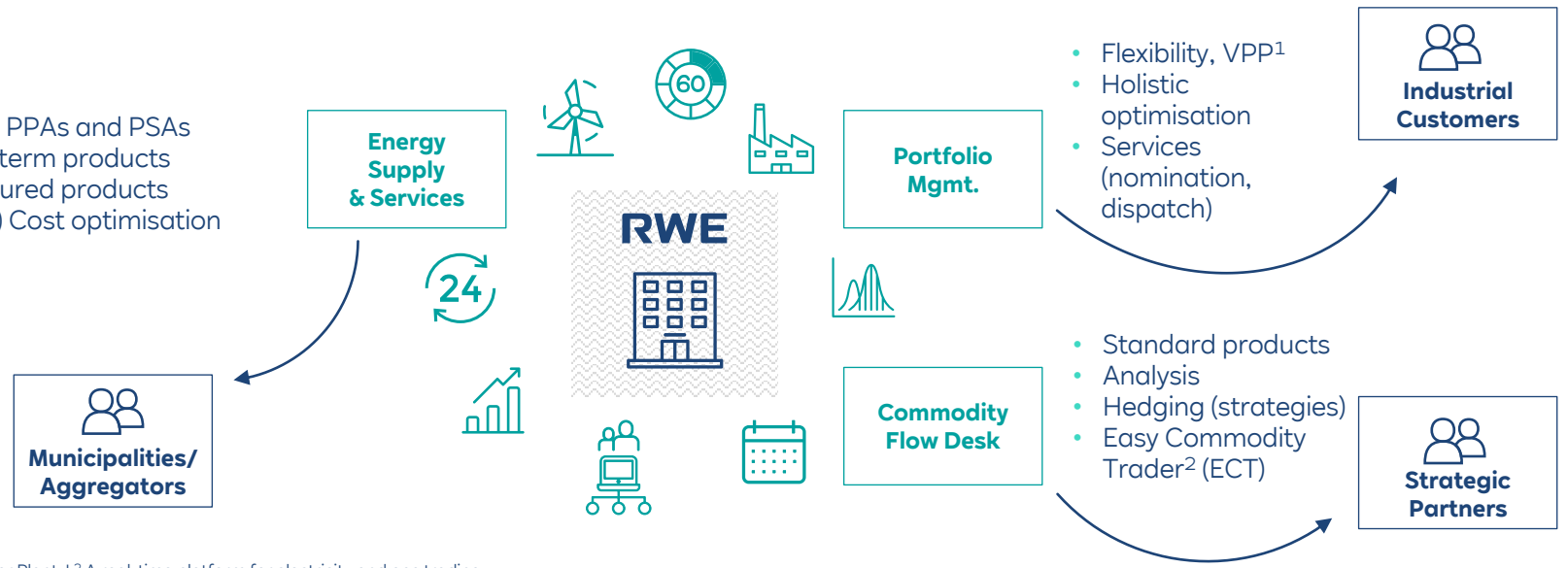
- 17.8 million tonnes of physical LNG traded



# Commodity Solutions: Reliable partner

- **Commodity Solutions** supplies large industrial customers and municipalities/ aggregators in Europe with energy and energy-related services. We offer standard as well as structured products and individual solutions. We create win-wins based on our best in class asset- and portfolio management.

- Green PPAs and PSAs
- Long-term products
- Structured products
- (Grid-) Cost optimisation




<sup>1</sup> Virtual Power Plant. | <sup>2</sup> A real-time platform for electricity and gas trading.



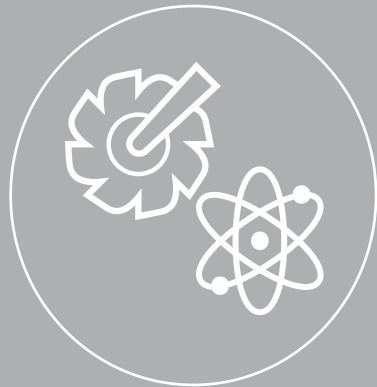
# Gas Storage: Operation and Marketing of underground natural gas storages

## RWE's Storage System Operators (SSO)

 **Germany**

<b>Legal entity</b>	RWE Gas Storage West GmbH
<b>Locations</b>	
<b># of facilities</b>	5 (operating volume of 1.5 bcm <sup>1</sup> )
<b>Type of storages and details</b>	salt caverns
<b>Regulatory</b>	Regulated business according to Directive 2009/73/EC (“Unbundling requirements”)

<sup>1</sup> Billion cubic metres.



# COAL/NUCLEAR



# Lignite:

## Integrated system including mining, refining and power plants

**50 TWh** power generation<sup>1</sup>



**3** major power plant sites in Germany



**8.3 GW** installed capacity<sup>2</sup>



**3** lignite opencast mines



**3** power units from lignite security reserve to operate in wholesale market (total: **0.9 GW**)<sup>3</sup>



**3** refining sites



### Closures by 2030

Responsible and socially acceptable phaseout of coal



### Recultivation

Concept for lignite mines



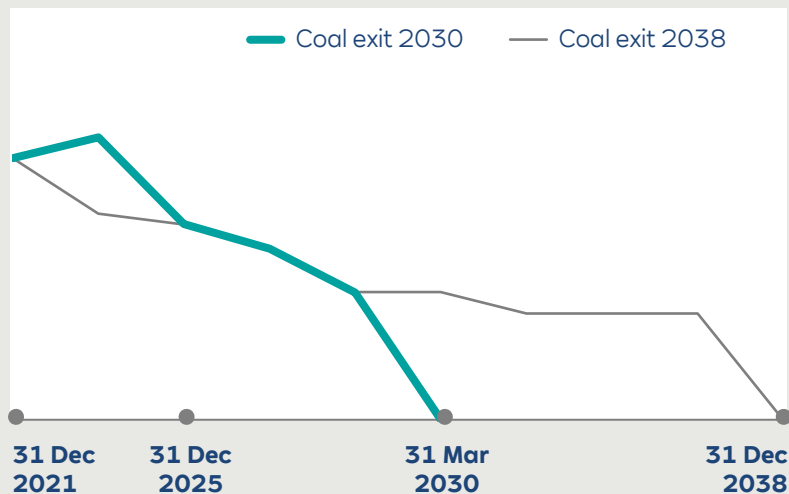
<sup>1</sup> Accounting view as of 31 Dec 2022; including refining plants. | <sup>2</sup> Pro rata view as of 31 March 2023. | <sup>3</sup> Under the German Maintenance of Substitute Power Stations Act entered into force in July 2022, additional non-gas power stations are called upon to cut down on gas-fired power generation incl. three RWE lignite power stations. The law expires in March 2024.



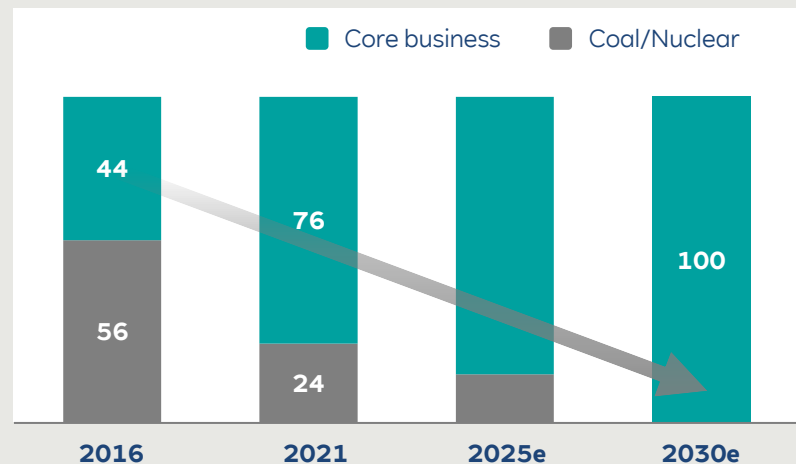
# Lignite & Nuclear:

## Accelerating our decarbonisation path by exiting coal in 2030

### Accelerated coal phaseout path by 8 years capacity development



### Coal/Nuclear share in EBITDA relative share (%)



▶ Accelerated coal phaseout is the basis for 1.5°C compliant pathway.



# Lignite:

## Agreed closure plan for RWE's lignite operations

### Coal phaseout by 2030

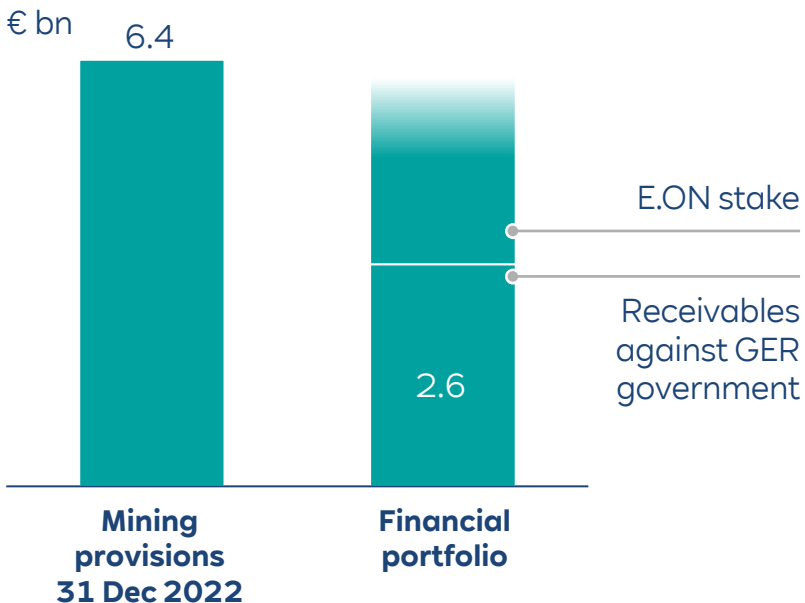
Power plant	Pro rata capacity	Decommissioning date
<b>Neurath C</b>	292 MW	Decommissioning 31 Mar 2024
<b>Neurath D</b>	607 MW	Decommissioning 31 Mar 2024, Government can opt for an additional year
<b>Neurath E</b>	604 MW	Decommissioning 31 Mar 2024, Government can opt for an additional year
<b>Neurath F (BoA 2)</b>	1.060 MW	Decommissioning 31 Mar 2030, transfer to security reserve until 31 Dec 2033 is possible; decision needs to be taken in 2026 at the latest
<b>Neurath G (BoA 3)</b>	1.060 MW	Decommissioning 31 Mar 2030, transfer to security reserve until 31 Dec 2033 is possible; decision needs to be taken in 2026 at the latest
<b>Niederaußem E</b>	295 MW	Decommissioning 31 Mar 2024
<b>Niederaußem F</b>	299 MW	Decommissioning 31 Mar 2024
<b>Niederaußem G</b>	628 MW	Decommissioning 31 Dec 2029, for one unit Niederaußem G or H, transfer to security reserve until 2033 is possible; decision needs to be taken in 2026 at the latest
<b>Niederaußem H</b>	648 MW	Decommissioning 31 Dec 2029, for one unit Niederaußem G or H, transfer to security reserve until 2033 is possible; decision needs to be taken in 2026 at the latest
<b>Niederaußem K (BoA 1)</b>	944 MW	Decommissioning 31 Mar 2030, transfer to security reserve until 31 Dec 2033 is possible; decision needs to be taken in 2026 at the latest
<b>Weisweiler F</b>	321 MW	Decommissioning 1 Jan 2025
<b>Weisweiler G</b>	663 MW	Decommissioning 1 Apr 2028/2029
<b>Weisweiler H</b>	656 MW	Decommissioning 1 Apr 2028/2029



# Lignite:

## Financially ring-fenced coal phaseout liabilities with financial portfolio

### Funding of coal phaseout liabilities



- Provisions for coal phaseout liabilities reflecting accelerated coal phaseout total €6.4bn
- Agreement with German government includes compensation payment of €2.6bn<sup>1</sup> payable via annual instalments until 2030
- Commitment to back amount with adequate financial portfolio. Financial portfolio currently consists of
  - Receivables against German government
  - 15% stake in E.ON (income from financial portfolio recognised in 'financial result')

<sup>1</sup> EU state aid approval pending.





# Lignite: Longstanding experience in recultivation & Structural change



**Biodiversity**  
Diversity of species comparable to high value reference habitat with >3,200 animal species and >1,500 plant species

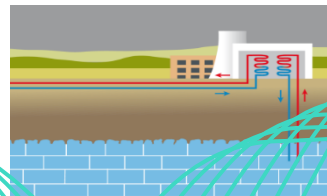
**Forestry recultivation**  
Near-natural forest management  
By mid of the century 1,900 more hectares of forest reforested than cleared



**Renewable energy**  
Wind farm on recultivated former opencast mining sites. Furthermore, the potential use of Agri-PV on recultivated sites is currently being examined together with municipalities

**New technologies ...**  
Existing power plant equipment and infrastructure can be used for other technologies

- Deep Geothermal energy
- H2-ready combined cycle gas turbines



## Recultivation



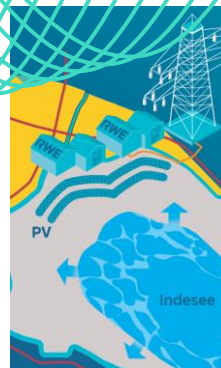
**Agricultural recultivation**  
7 years biological activation of fields by RWE  
Afterwards farmer take over the fields for planting  
Quality of land guaranteed by RWE for 25 years

## Structural change



**Site development**  
Perspektive.Struktur.Wandel GmbH (PSW) is an established company entrusted with the qualification and development of strategically important sites; in cooperation with the federal government and municipalities

## Plant repurposing



**... and opportunities**  
Economical use of fallow land for open-space PV systems including battery storage in the opencast mining landscape



# Nuclear:

## Experience across entire nuclear plant lifecycle with focus on secure and efficient decommissioning

**Nuclear power generation** in Germany **ended** on 15.04.2023



Focus: Secure and efficient **decommissioning** of all RWE nuclear power plants



### Status

RWE Nuclear units in Germany	Net capacity (GW)	End of operations	Spent fuel removal	Decomm. licence	Decommissioning progress	
Emsland	1.3	2023	2027	Pending	Preparation for decommissioning	Post-operational phase
Gundremmingen C	1.3	2021	2026	✓	Advanced	
Gundremmingen B	1.3	2017	✓	✓	Advanced	In decommissioning
Biblis A	1.2	2011	✓	✓	Advanced	
Biblis B	1.2	2011	✓	✓	Advanced	
Mülheim-Kärlich	1.2	1988	✓	✓	Far advanced	
Lingen KWL	0.3	1979	✓	✓	Far advanced	
Gundremmingen A	0.2	1977	✓	✓	Far advanced	Decommissioned
Kahl	0.01	1985	✓	✓	Finished	

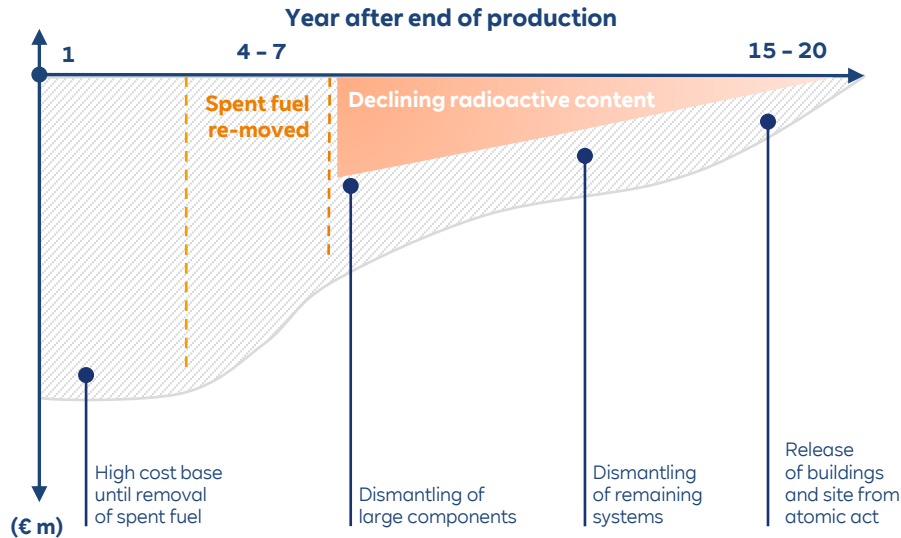


# Nuclear:

## Cash flow profile of provisions driven by timing of individual shutdowns

### Example: Decommissioning cash flow profile (one unit)

illustrative



### Accounting of provisions

Nuclear provisions (31.12.2022)	€5.7bn
Discount rate	2.5%
Escalation rate	2.6%
Sensitivity (+/-10 bps change in real discount rate)	c. -/+€30m

### Utilisation of provisions

- Increased utilisation of provisions due to further shutdowns (€450m – €650m p.a.) from 2023 onwards
- Clear reduction in utilisation of provisions from ~2030 onwards



# Nuclear: Decommissioning steps

illustrative

## Basic site management

Periodic inspection, ongoing supervision and maintenance of systems and buildings

Operation and maintenance of adjusted infrastructure systems

Downsizing/replacement of infrastructure

Final shutdown of systems

## Dismantling

Dismantling of systems and components

Decontamination of buildings

Release of buildings and site

## Materials & waste treatment

Sorting of materials

Decontamination of materials

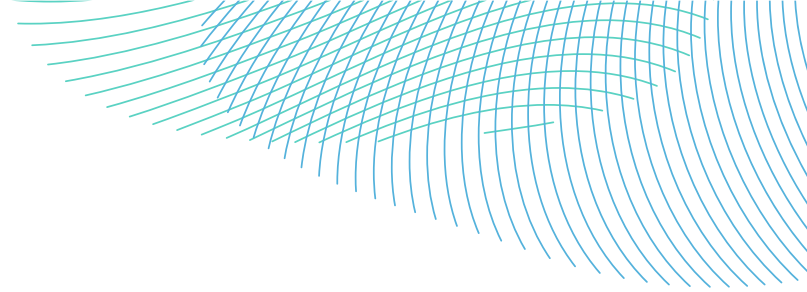
Release of materials

Treatment<sup>1</sup> of radioactive waste

## Responsibility of State

Interim storage & final disposal

<sup>1</sup> For example melting, incineration, compaction, packaging and documentation.



# Appendix

# RWE generation asset list

The RWE logo is displayed in white, bold, uppercase letters on a dark blue background. To the right of the logo, there is a decorative graphic consisting of a grid of thin, light blue lines that curves and fades out towards the right edge of the slide.

**RWE generation asset list as of 31 December 2022**  
**incl. operating portfolio from CEB acquisition**

Note: Rounding differences may occur.

# Glossary

## A

AFIR	Aufbau der Infrastruktur für alternative Kraftstoffe
aFRR	Automatic Frequency restoration reserve
APAC	Asia Pacific

## B

BAT	Best available techniques
Bcm	Billion cubic metre
BM start up	Balance Mechanism start up
Bps	basis points
BREF-LCP	Best Available Techniques Reference – Large Combustion Plants

## C

CAO	Commercial Asset Optimisation
CAPEX	Capital Expenditure
CBAM	Carbon Border Adjustment Mechanism
CCfDs	Carbon Contracts for Difference
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CCUS	Carbon Capture Utilisation and Storage
CFD	Contract for Difference

CHP	Combined Heat and Power
COD	Commercial Operation Date
CO <sub>2</sub> e	Carbon dioxide equivalent
CPI	Consumer Price Index
CPPA	Corporate Power Purchase Agreement
CSP	Concentrating Solar Power

## D

DESNeZ	Department for Energy Security and Net Zero
--------	---

## E

ECT	Easy Commodity Trader
EEG	Renewable Energy Act
EFR	Enhanced Frequency Response
EMR	Energy Market Reform
EMS	Energy Management System
EP	European Parliament
ETS	Emission Trading System
EZK	Ministerie van Economische Zaken en Klimaat (Ministry of Economic Affairs and Climate Policy)

## F

FCR	Frequency containment reserve
FFR	Firm Frequency Response

FID	Final investment decision
FIP	Feed-in premium
FIT	Feed-in tariff
FSRU	Floating Storage and Regasification Unit

## G

GHG	Greenhouse Gas
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## H

HVDC	High Voltage Direct Current
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## I

ICE	Institution of Civil Engineers
IFRS	International Financial Reporting Standards
IPCEI RHATL	Important Projects of Common European Interest; Regional Hubs and Their Links wave
IPPs	Independent Power Producer
IRR	Internal Rate of Return
ITC	Investment Tax Credit

## K

KPIs	Key Performance Indicators
KEPCO	Korean Electric Power Corporation

## L

LCOE	Levelised Cost of Electricity
LOLE	Loss of load expectation
LRF	Linear Reduction Factor

## Country Codes

AL	Albania	BG	Bulgaria	DE	Germany	FR	France	IE	Ireland	LT	Lithuania	MX	Mexico	RO	Romania	TR	Turkey
AT	Austria	CA	Canada	DK	Denmark	GB	Great Britain	IN	India	LU	Luxembourg	NL	Netherlands	RS	Serbia	TW	Taiwan
AU	Australia	CH	Switzerland	EE	Estonia	GR	Greece	IT	Italy	LV	Latvia	NO	Norway	SE	Sweden	UK	United Kingdom
BA	Bosnia Herzegovina	CL	Chile	ES	Spain	HR	Croatia	JP	Japan	ME	Montenegro	PL	Poland	SI	Slovenia	US	United States of America
BE	Belgium	CZ	Czech Republic	FI	Finland	HU	Hungary	KR	South Korea	MK	Macedonia	PT	Portugal	SK	Slovakia		

# Glossary

<b>M</b>		<b>R</b>		<b>V</b>	
MACRS	Modified Accelerated Cost-Recovery System	RD&I	Research, development and innovation	VPP	Virtual Power Plant
MFR	Mandatory Frequency Response	REC	Renewable Energy Certificate		
mFRR	Manual Frequency Restoration Reserve	RED	EU Renewable Energy Directive		
MSR	Market Stability Reserve	REFIT	Renewable Energy Feed-In Tariff		
Mt	Metric tonnes	REGOs	Renewable Energy Guarantees of Origin		
MWp	Megawatt peak	REMA	Review of Electricity Market Arrangements		
<b>N</b>		RES	Renewables		
NWS	National Hydrogen Strategy	RESS	Renewable Electricity Support Scheme		
<b>O</b>		RFNBO	Renewable fuels of non-biological origin, incl. Green hydrogen		
OCGT	Open Cycle Gas Turbine	ROC	Renewable Obligation Certificate		
O&M	Operation and Maintenance	RPS	Renewable Portfolio Standard		
OPEX	Operational expenditure	RR	Replacement Reserve		
OREC	Offshore Renewable Energy Certificate	<b>S</b>			
ORESS	Offshore Wind Renewable Electricity Support Scheme	SDE	Stimulation Renewable Energy		
OTC	Over-the-counter	SDGs	Sustainable Development Goals		
<b>P</b>		SSO	Storage System Operators		
PPA	Power Purchase Agreement	STOR	Short term operating reserve		
PSA	Power Supply Agreement	<b>T</b>			
PTC	Production Tax Credit	T&D	Transmission & Distribution		
PV	Photovoltaic	TSO	Transmission System Operator		
		<b>U</b>			
		UCTE	Union for the Coordination of the Transmission of Electricity		



# Your contacts in Investor Relations

## Important Links

- [Annual and interim reports & statements](#)
- [Investor and analyst conferences](#)
- [IR presentations & factbooks](#)



### ADR programme available

#### Further information on our homepage

[RWE shares/ADR](#)

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+1 201 680-6255 (from outside the US)

1-888-269-2377 (within the US)

## Financial Calendar

- **14 March 2024**  
Annual report for fiscal 2023
- **03 May 2024**  
Annual General Meeting

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