

The role of gas in the European energy system.
Decarbonization strategies of energy companies.



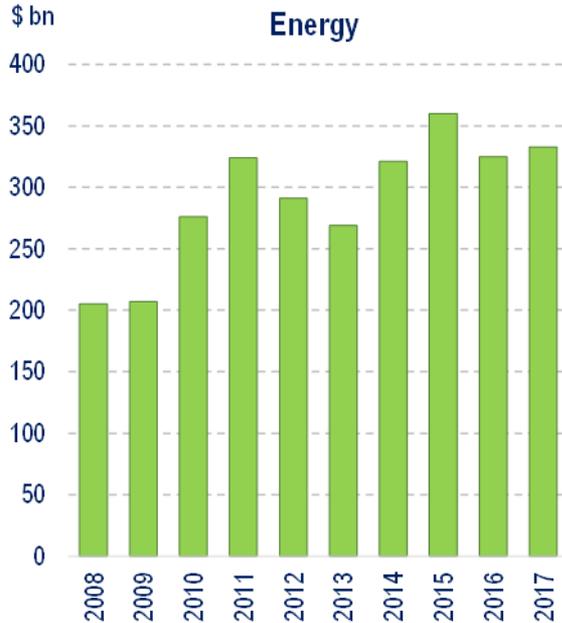
The Paris climate agreement: key points

The historic pact, approved by 195 countries, will take effect from 2020

Temperatures 2100	Finance 2020-2025	Differentiation	Emissions objectives 2050
<ul style="list-style-type: none"> Keep warming "well below 2 degrees Celsius". Continue all efforts to limit the rise in temperatures to 1.5 degrees Celsius" 	<ul style="list-style-type: none"> Rich countries must provide 100 billion dollars from 2020, as a "floor" Amount to be updated by 2025 	<ul style="list-style-type: none"> Developed countries must continue to "take the lead" in the reduction of greenhouse gases Developing nations are encouraged to "enhance their efforts" and move over time to cuts 	<ul style="list-style-type: none"> Aim for greenhouse gases emissions to peak "as soon as possible" From 2050: rapid reductions to achieve a balance between emissions from human activity and the amount that can be captured by "sinks"
Burden-sharing	Review mechanism 2023	Climate damage	
<ul style="list-style-type: none"> Developed countries must provide financial resources to help developing countries Other countries are invited to provide support on a voluntary basis 	<ul style="list-style-type: none"> A review every five years First world review: 2023 Each review will inform countries in "updating and enhancing" their pledges 	<ul style="list-style-type: none"> Vulnerable countries have won recognition of the need for "averting, minimising and addressing" losses suffered due to climate change 	

Global Renewable Energy Development

Global New Investment in Clean Energy



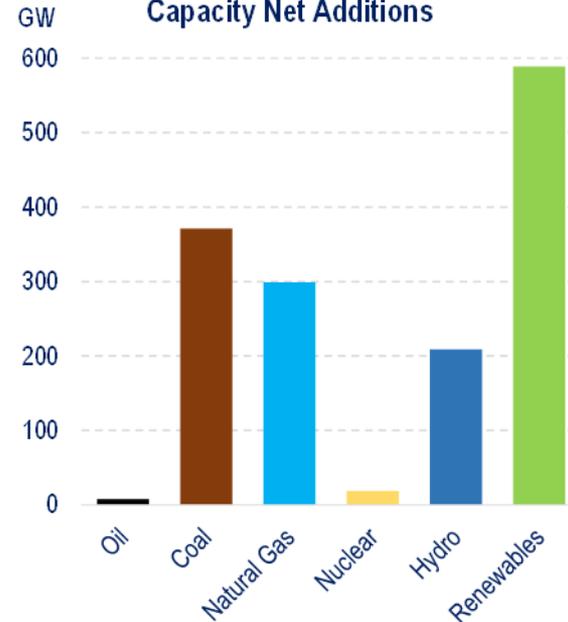
Total amount of investments in renewable energy within the last 10 years exceeded **2.9 trillion US dollars**

Since 2010, net additions of renewable power generation capacities were the biggest among all energy resources and already reached **600 GW**

However, the key challenges of increasing the share of renewables in the power mix has not yet been met:

- Intermittent power generation
- Lack of efficient energy storage

2010-2016 Global Generation Capacity Net Additions



Source: Bloomberg New Energy Finance

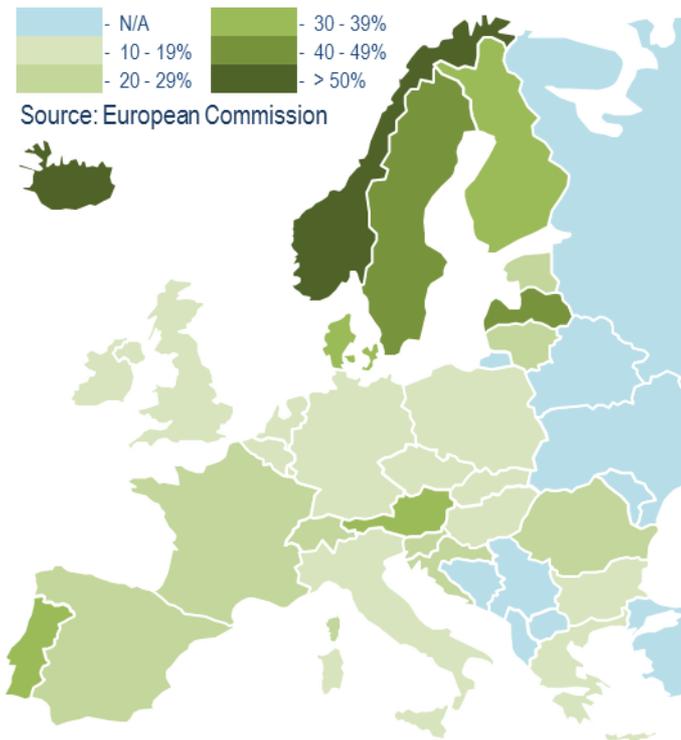
Source: IEA

EU Targets for Share of Renewable Energy in Gross Final Energy Consumption by 2020

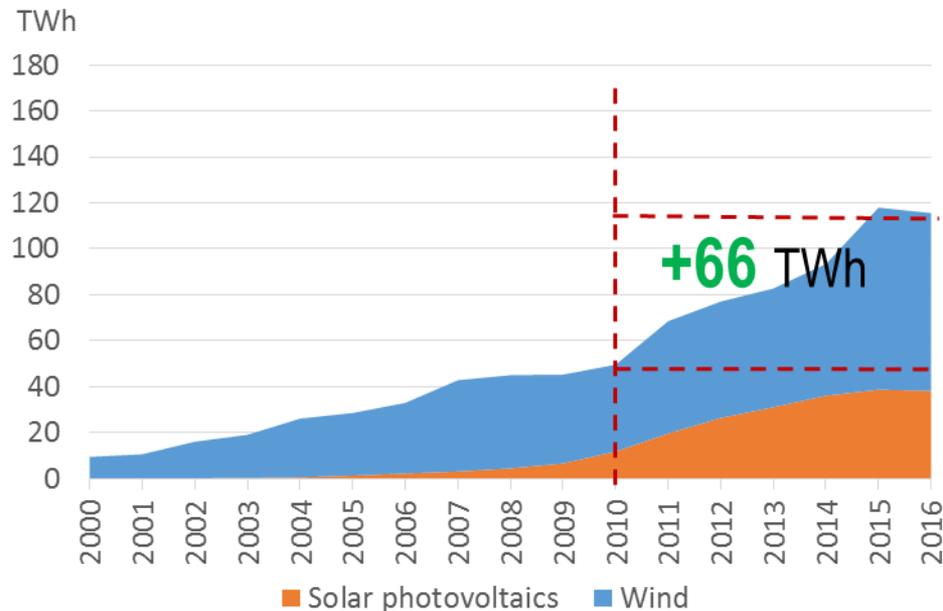
The EU's Renewable Energy Directive sets a mandatory target of 20% of renewable energy sources in the final energy consumption by 2020.

To achieve this target, the EU countries have to achieve their individual targets of RES share in the final energy consumption.

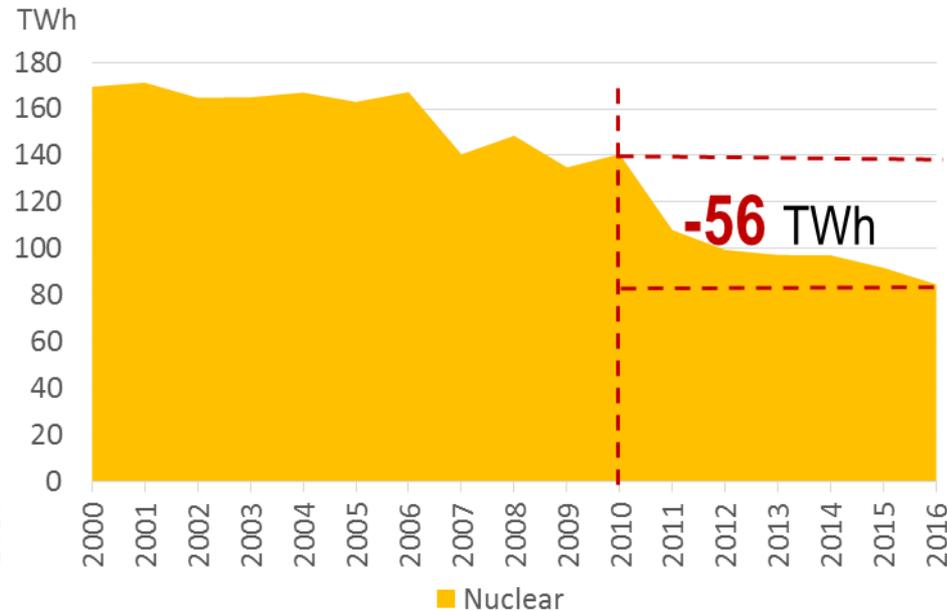
The most ambitious targets set in Iceland and Norway – **72%** and **68%**, respectively.



Electricity output

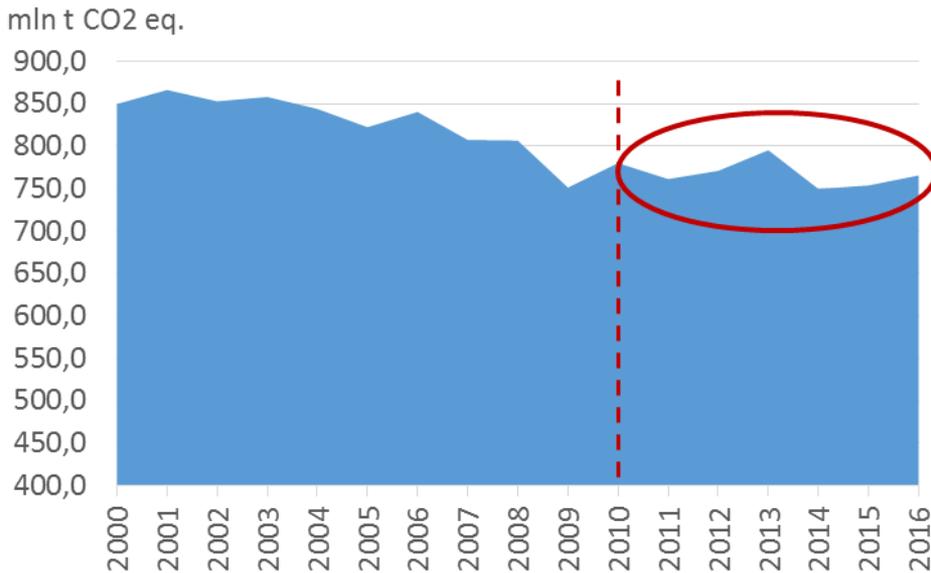


Source: IEA



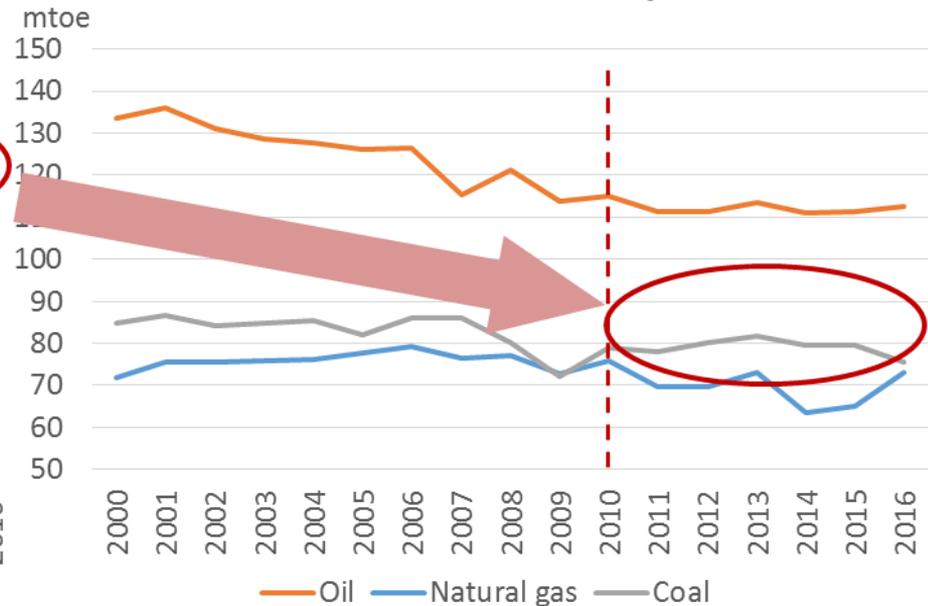
Source: IEA

Carbon Dioxide Emissions



Source: BP Statistics

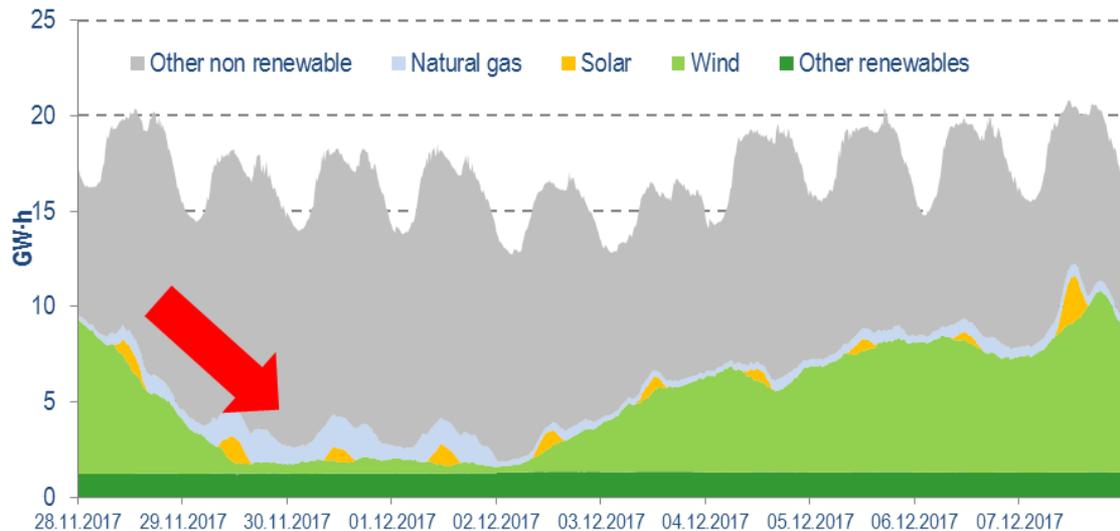
Fossil fuel consumption



Source: IEA

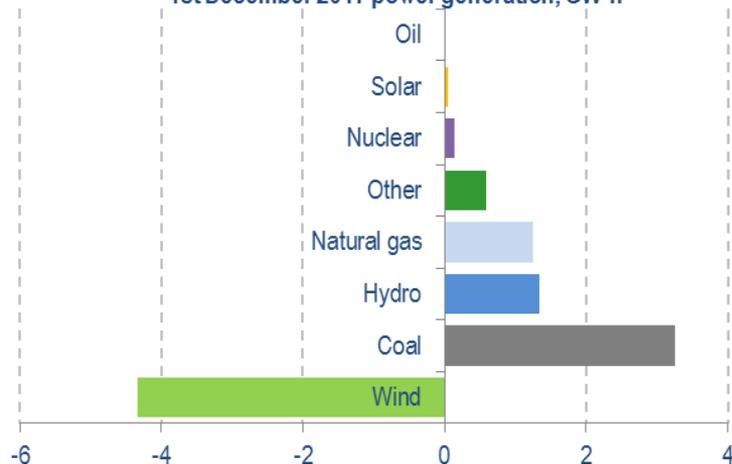
Power Generation in Germany

- 'Dunkelflaute' periods in 2017 and 2018 appear regularly.
- In December 2017 the share of wind and solar energy in the power mix fluctuated between **4,5%** and **32%**.
- On December, 1st 2017 the share of wind and solar energy in the power mix dropped to **4,5 %**, occasionally – **2,2%**.



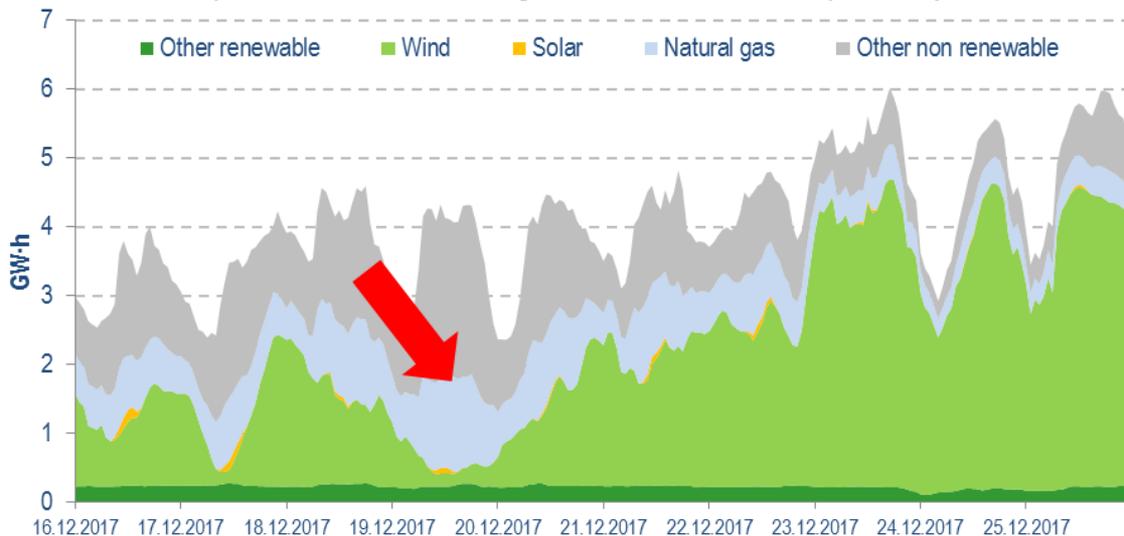
Source: ENTSO-E

Difference between December average and 1st December 2017 power generation, GW·h

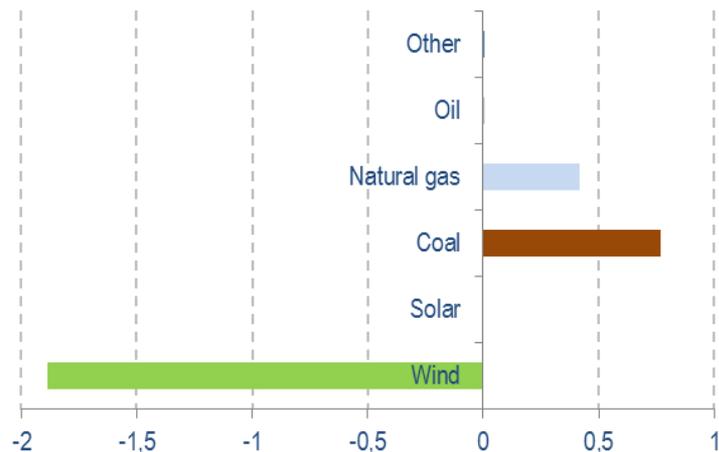


Power Generation in Denmark

- In December 2017 the share of wind and solar energy in the power mix fluctuated between **11%** and **77%**.
- On December, 19th 2017 the share of wind and solar energy in the power mix dropped to **11%**, occasionally – **5,3%**.
- All these periods occurred during winter months, when power system is working in harsh conditions.



Difference between December average and 19th December 2017 power generation, GW-h



Source: ENTSO-E

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Gas Advantages in Power Generation

	Gas 	Coal 	Nuclear 	Hydro 	Renewable 
Low capital costs for power plant construction	✓		✗	✗	
Low operational costs for power generation			✓	✓	✓
Short period for power plant construction	✓		✗		
Low pollutions		✗		✓	✓
Availability of construction sites	✓		✗	✗	✗
Possibility of power system balancing	✓			✓	
Independency of energy production from weather conditions	✓	✓	✓		✗

The Paris Agreement recognizes that countries need to conduct assessments of their vulnerabilities to climate change and undertake adaptation planning processes. Similarly, there is a current need for energy companies to develop a comprehensive understanding of the implications of climate change on their businesses.

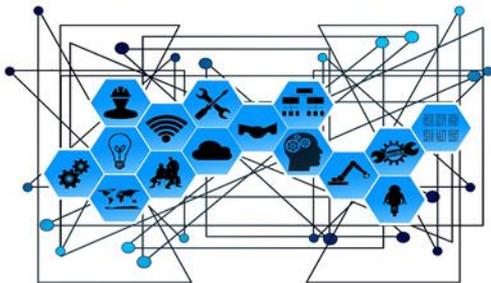
Companies consider their current resources, infrastructure investments, future fossil fuel demand, research and development, and technology in order to identify the reliable development strategy.



Pathways to Decarbonization



Operational efficiency



Development of RES

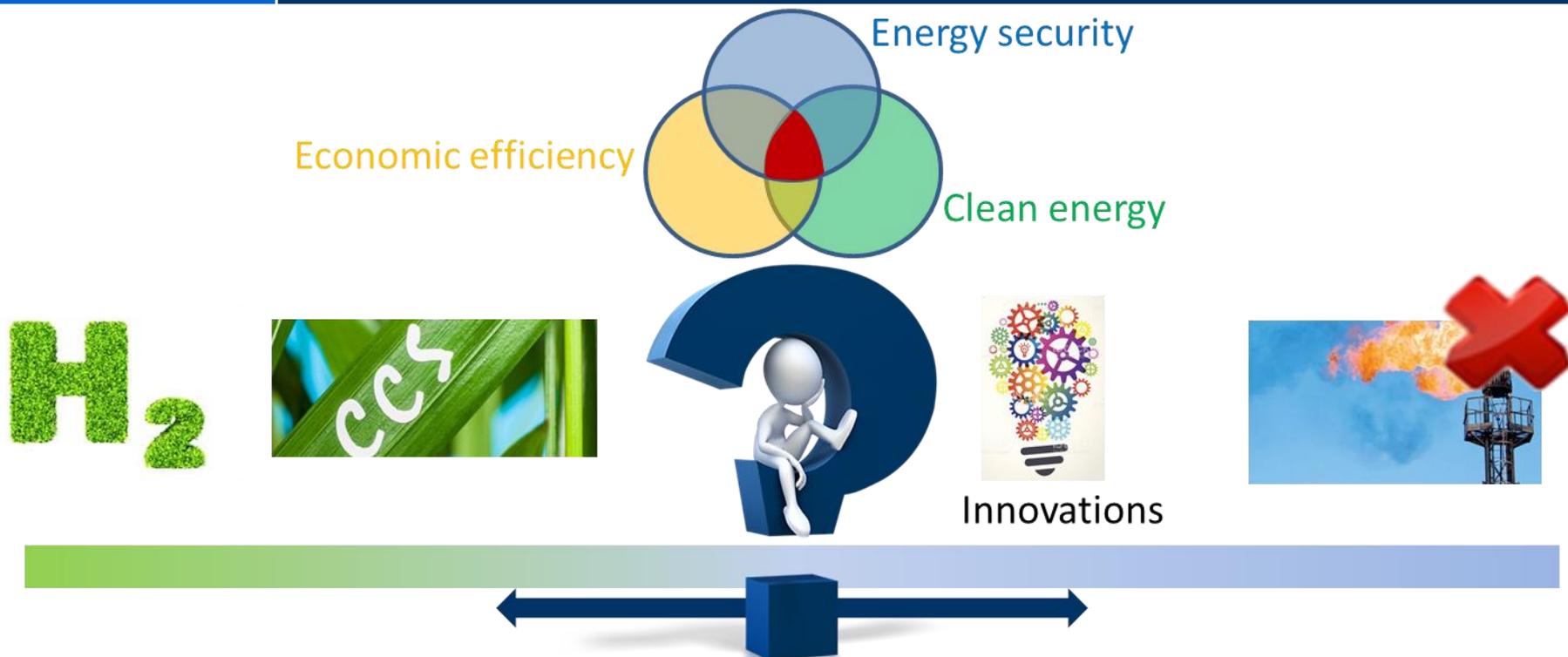


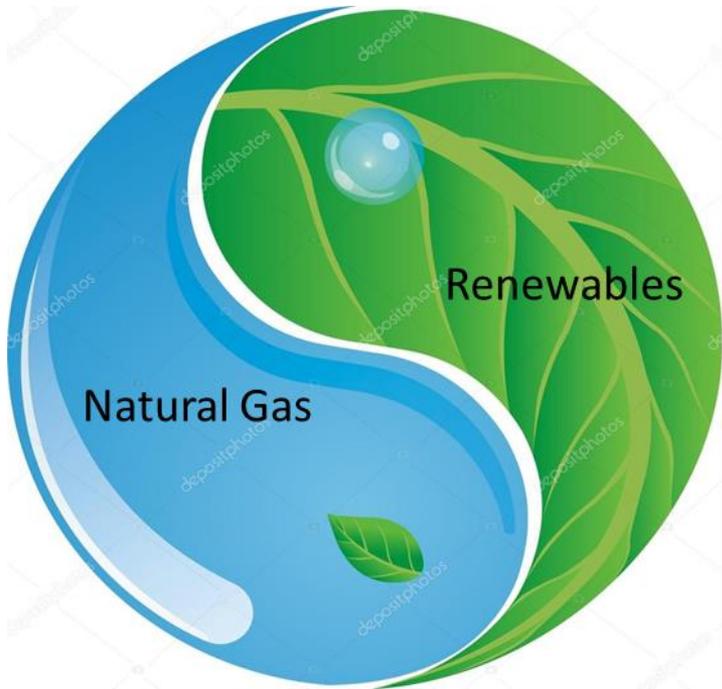
Technology innovations



Pathways to Decarbonization

	Shell	Equinor	Total	BP
Operational efficiency	SmartFields, CCS, Flying Nodes, Shell MMLS Liquefaction technology	Sub-sea compression station, WS Seabed Rig, TAIL, Drill Plan, Cloud Data Storage, CCS	Paziflor, CCS, Subsea-to-shore technology	WATS, Plant Operations Advisor Intelligent system
Development of RES	Airborne Wind energy (AWE) - Kite Power Systems, Bioethanol production	20% of CAPEX in RES by 2030, Hywind, Photovoltaic technology solutions, Biofuel technology	25% of investments in RES by 2022	Hydrogen plant, Solar's Mono2 silicon, Biofuel production
Ventures	Shell Technology Ventures, Engineering companies	Equinor Energy Ventures	Total Energy Ventures	BP Ventures





«Gas can undoubtedly play a very prominent role when it comes to the decarbonisation process of the energy system».

Prof. Dr. Klaus-Dieter Borchardt



Thank You for Attention