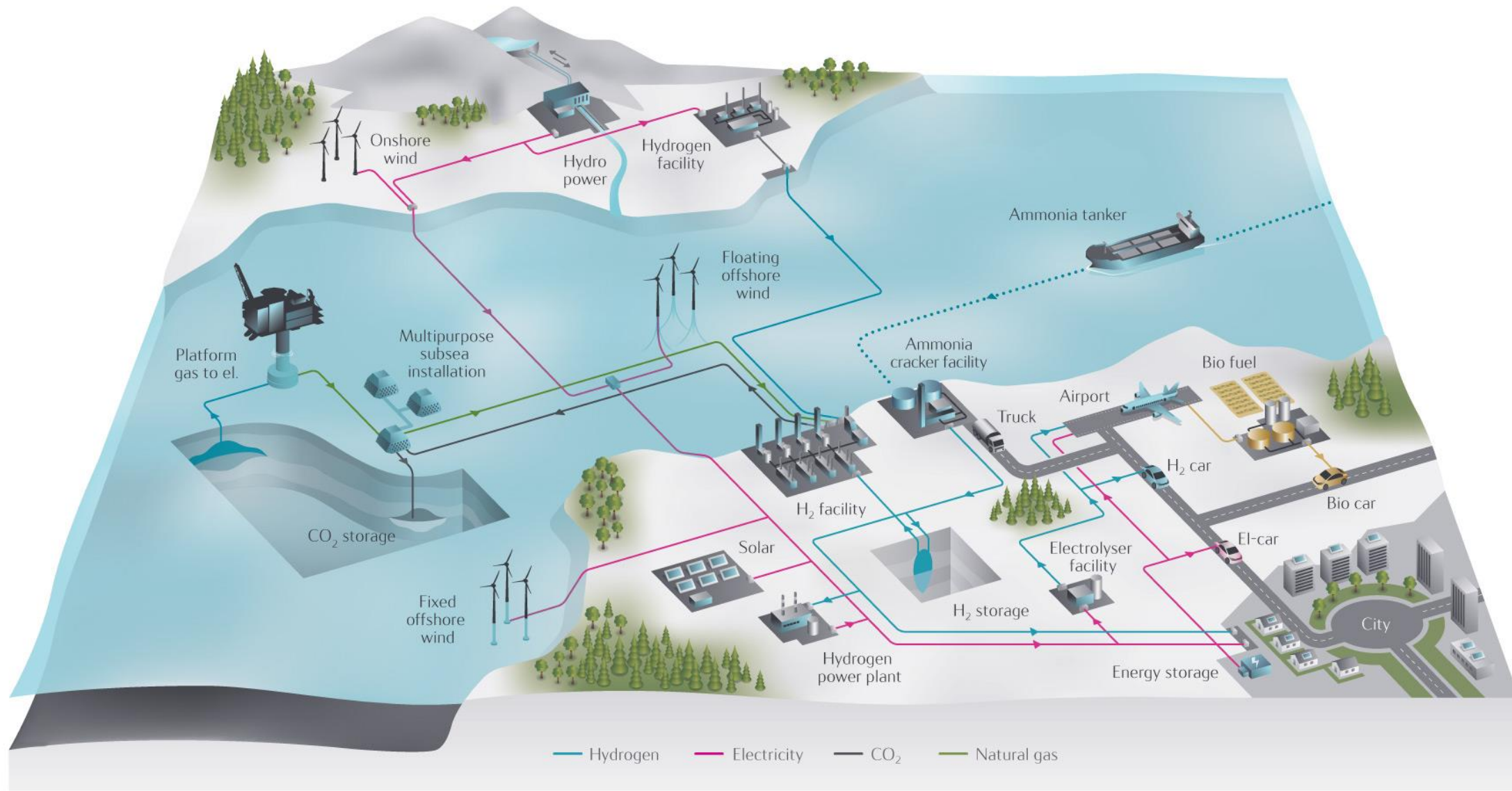


# Low Carbon Solutions

Steinar Eikaas – Equinor



# Gas is a cost efficient enabler

## ... to a carbon neutral energy system



Gas displacing more carbon intense fuels in transport, heating and power

Gas combination with renewables (gas and electricity)

Hydrogen and renewable electricity smartly integrated

# Our approach Clean (Blue) Hydrogen

## Infrastructure Dimension

- Build on the massive existing natural gas network
- Produce hydrogen at large scale from natural gas
- Capture the CO2 in the process and send it to permanent offshore storage

## Commercial Dimension

- Identify markets suitable for switching to hydrogen
- Partner with large customers who are pioneers in pursuing low carbon solutions
- Develop real, tangible and sizable projects
- Approach authorities to design suitable financial support solutions

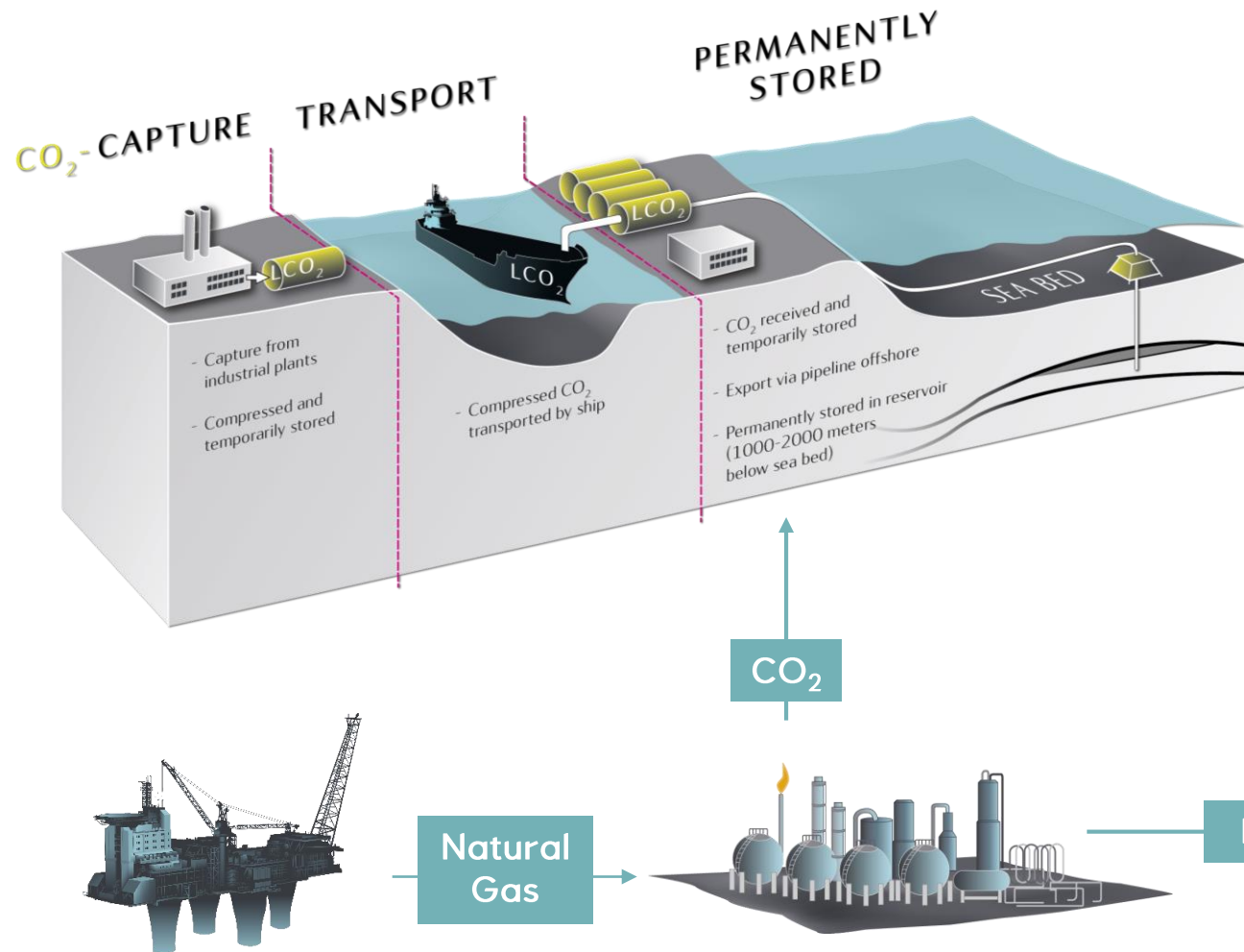
Hydrogen Council



gasunie



# CCS as enabler for hydrogen production



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

Clean Hydrogen



for power generation



for heat



for maritime transport

# Decarbonising Energy Systems

Easy ← complexity to decarbonise → Hard



Transport

Battery (mostly) plus Hydrogen for Heavy Duty

Hydrogen Fuel-Cell Trains

Liquid Hydrogen and Fuel-Cells for long haul Big Ships

Power

Large Battery Systems for Daily Swing (night-to-day)

Hydro-Power as Battery for Small Scale Intermittency

Hydrogen fired CCGTs Clean Back-Up Power for Large Scale Intermittency

Industry

Light Industry powered by Renewable

Heavy Industry powered by Hydrogen from Natural Gas + CCS

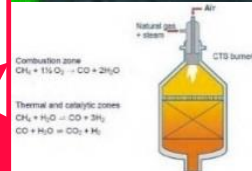
CCS for Industry without other Alternatives

Heat

Heat Pumps For Efficient Use of Electricity in Homes

Hydrogen for Efficient Transfer of Energy from Production to End-Users

Hydrogen for Large Scale Seasonal Storage



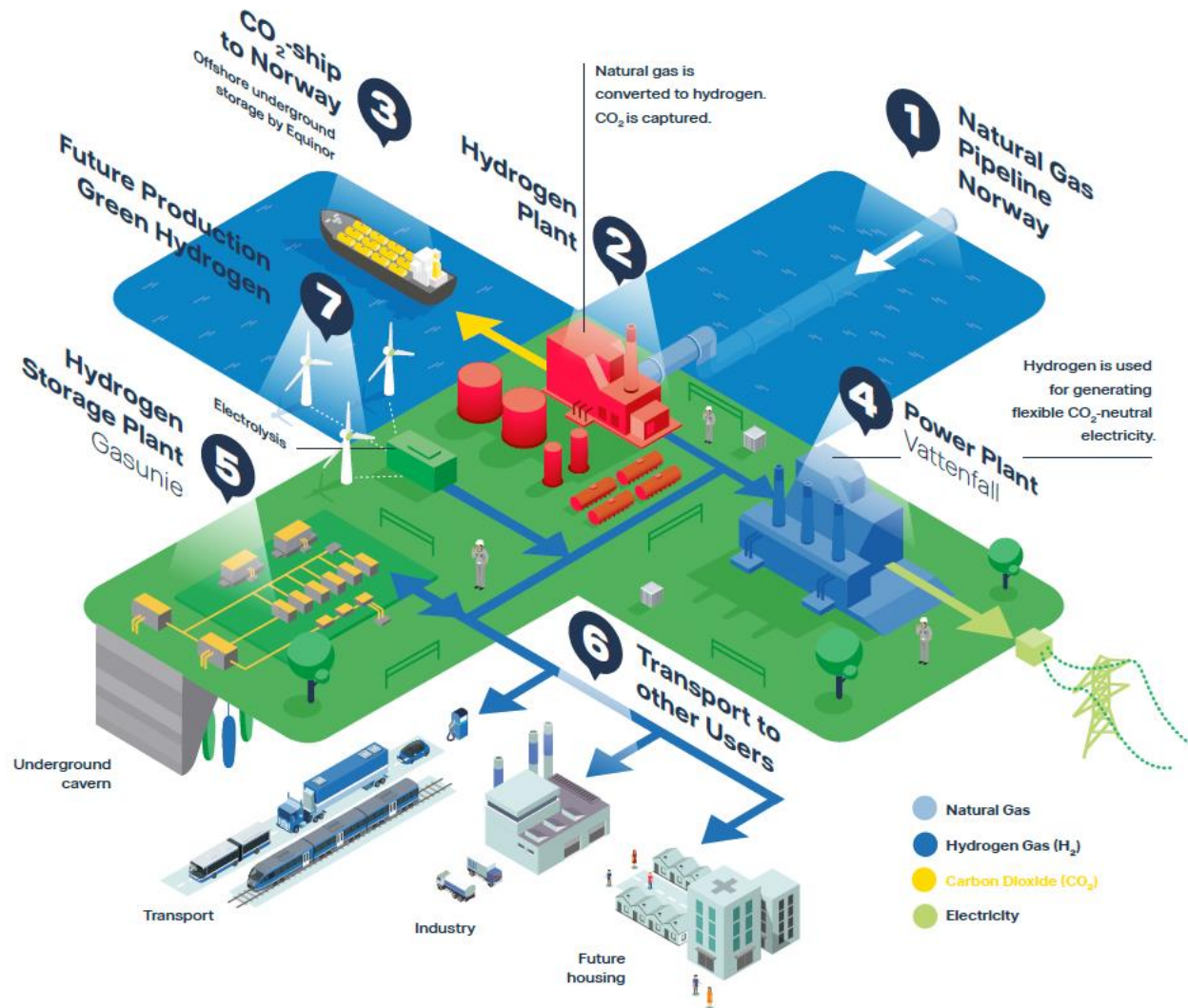
Natural Gas Reforming to Hydrogen with CCS



Multiple technologies to address the challenge



# H2M – Magnum, Netherlands



- Energy: 8-12 TWh
- CO2 emissions reduction of 2 Mton/year
- Utilise existing gas power plants and gas infrastructure
- Switch fuel from natural gas to clean H2
- Clean, flexible electricity as back-up for solar and wind
- Launch large-scale H2 economy

• Partners:

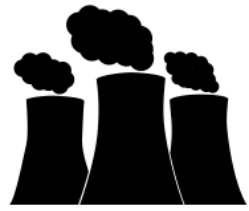


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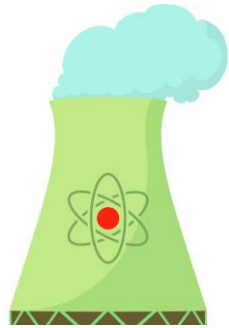
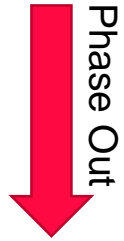


# Demand for Clean and Flexible Power Expected to go up

## Baseload



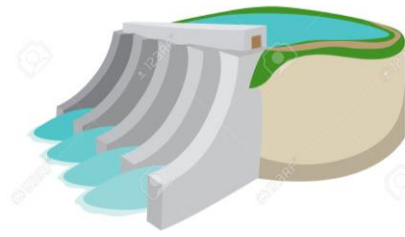
Coal



Nuclear



## Flexible



Hydro



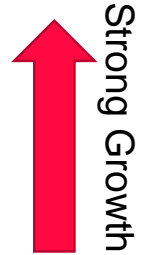
Gas -> Clean Hydrogen



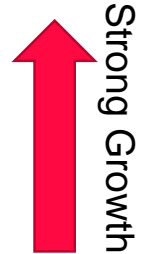
## Intermittent



Wind



Solar



# Perfect fit of Offshore Wind and Hydrogen




360 MW



20.000 x 20ft (2,5 days backup)



440 Mw Unlimited, Clean Backup 



# H21 North of England

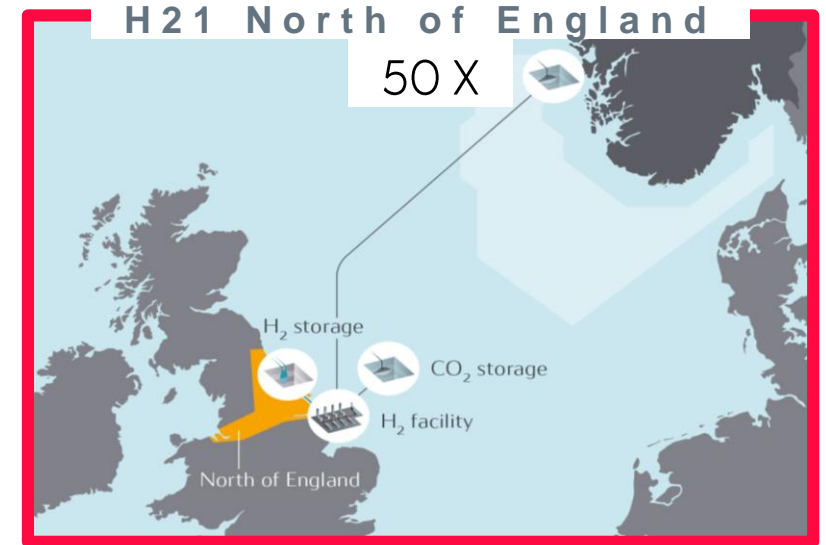


- System approach to **decarbonise residential heating** and distributed gas use— fuel switch from natural gas to hydrogen
- **Large-Scale:** 12.5% of UK population , ~85 TWh
- **17-18 Mtons CO2** reduction per year
- Continued use of **existing infrastructure**
- **SoS:** copes with seasonal (winter) peak demand
- **Offshore CO2 storage** in either UK or Norway
- Facilitating unlimited **system coupling** between gas and electricity
- Launch date: November 23<sup>rd</sup> (London)

# Understanding the Challenge

Natural Gas currently provides Europe with more than 1500 TWh of flexible energy.

**What is 1500 TWh?**



**Vehicle**

20 000 000 000 X



TESLA 75D Li-Batteries

**Battery park**

11 600 000 X



**Hydro**

200 X



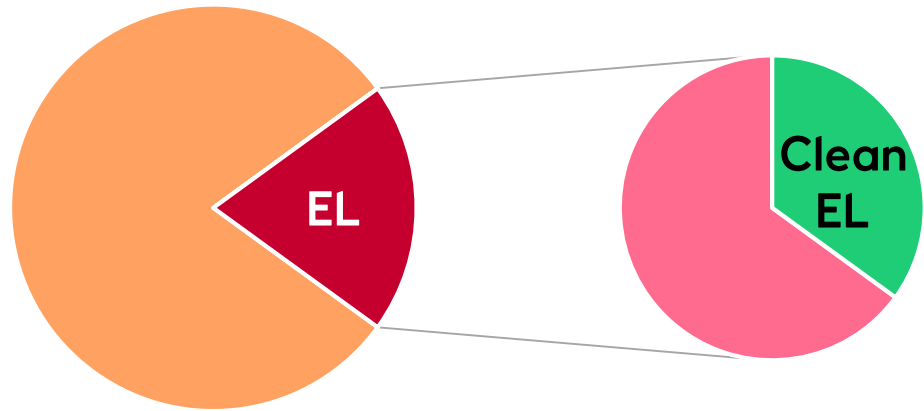
# The Efficiency Challenge of Green Hydrogen

- in the medium term

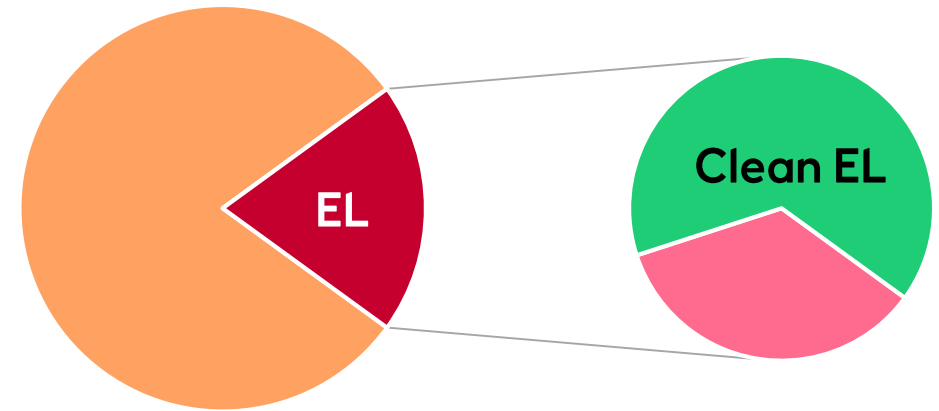


equinor

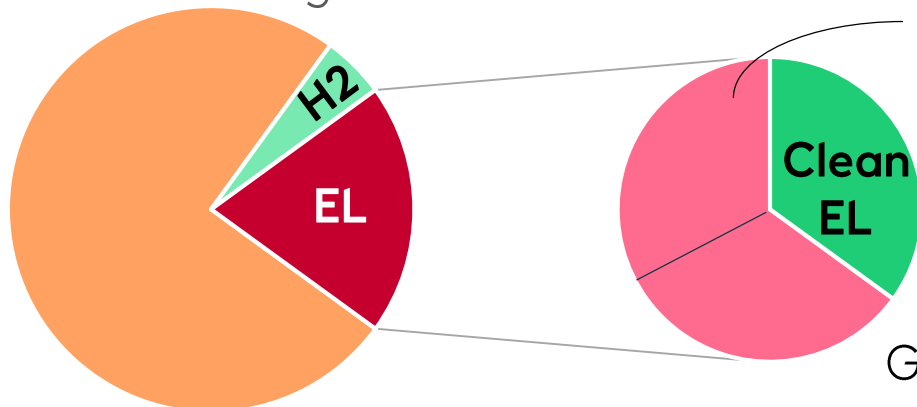
European Energy-Mix 2018



European Energy-Mix 2030



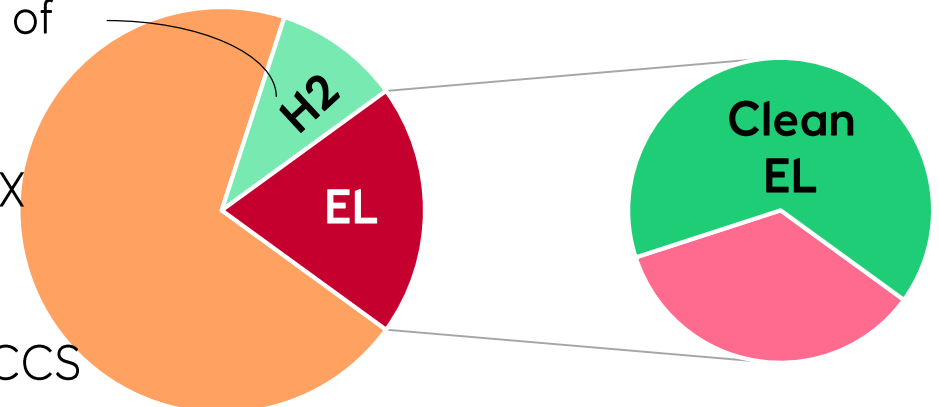
2030: Producing Hydrogen from growth in clean EL



Identical volume of Natural Gas

Identical CAPEX electrolyzers and Gas reformers + CCS

2030: Producing Hydrogen from Natural Gas with CCS



# Key messages



- Decarbonizing Europe towards 2050 is a major challenge.
- Renewable solutions are perfect for the carbon-light sectors.
- Heavy industry, heat and flexible power generation require large-scale solutions on which we need to start working today
- Hydrogen from natural gas with permanent offshore storage of CO2 offers:
  - Low cost – *Gas reforming is the most cost effective hydrogen pathway*
  - Low technical risk - *Proven technology in H2 production and CO2 storage*
  - A clean value chain – *The CO2 is returned to permanent offshore storage*
  - Large scale – *The industry has demonstrated a track-record of mega projects*
- Hydrogen from natural gas with CCS will establish a robust hydrogen infrastructure that green hydrogen can utilize later



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# Low Carbon Solutions

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