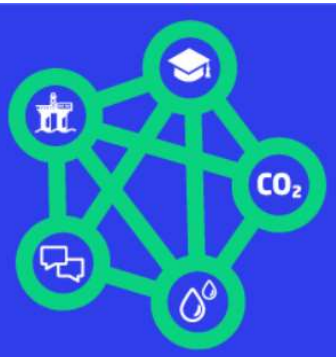
CCS contribution in TotalEnergies' Net Zero Emission Ambition by 2050

Focus on Project Bifrost

29 November 2022 – Kolding, Denmark

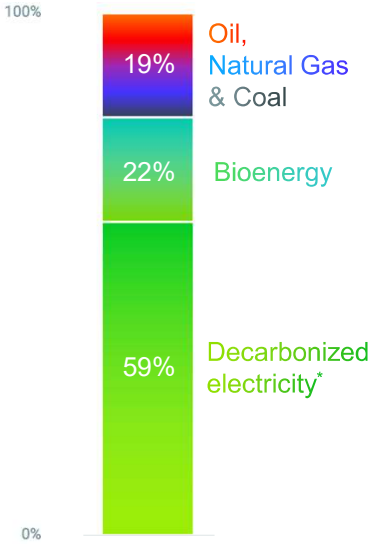
Danish Offshore Technology Conference 2022



R&D for the Offshore Energy Transition

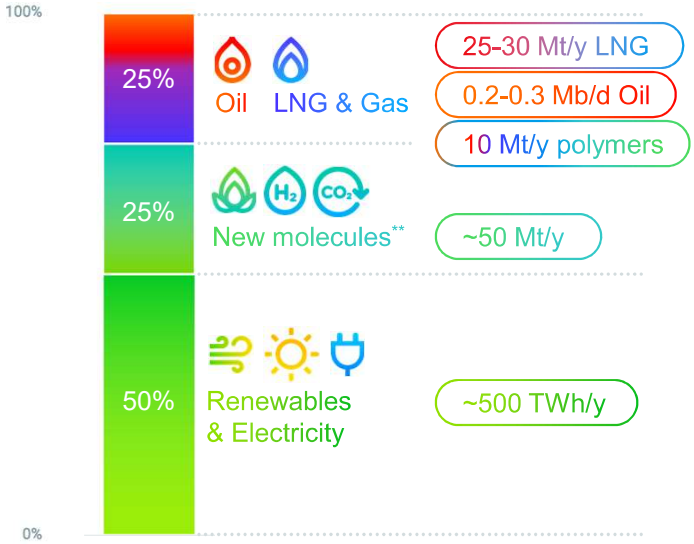
TotalEnergies in 2050: a vision for a Net Zero company

IEA NZE energy mix in 2050



CCS: 7 $GtCO_2e$

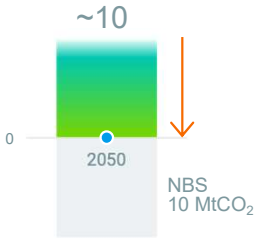
TotalEnergies' 2050 energy production & sales



CCS: 50-100 $MtCO_2e$

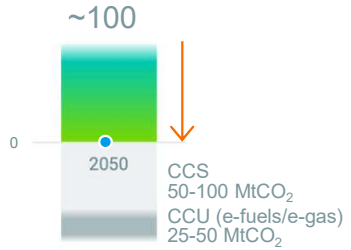
TotalEnergies Net zero Scope 1+2[a]

$MtCO_2e$



TotalEnergies Net zero Scope 3[b]

$MtCO_2e$



Net zero lifecycle carbon intensity[c] -100%

* Hydro, solar, wind and nuclear
** Biofuels, biogas, hydrogen and e-fuels/e-gas

(a) From operated facilities
(b) From energy products used by our customers (GHG Protocol Category 11)
(c) Average carbon intensity of energy products used by our customers worldwide (Scope 1+2+3)

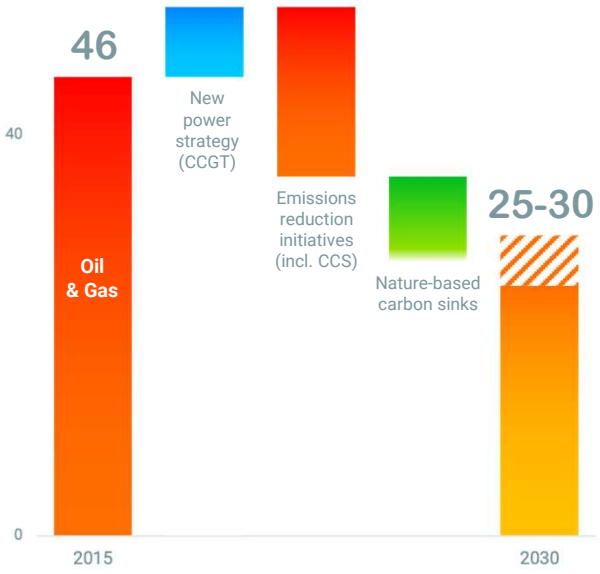
Scope 1+2: mobilization on CO_2 reduction

Using best available technologies

Levers

Scope 1+2 from operated facilities

$MtCO_2e$



Stop routine flaring

→ <0,1 Mm^3/d by 2025

→ Zero routine flaring by 2030

All new projects with closed flare

Reduce non-routine flaring

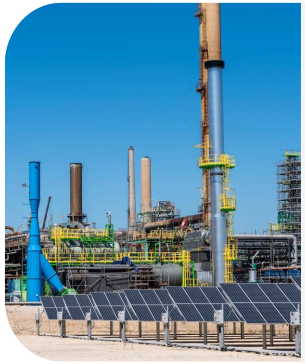
Improve energy efficiency

Reduce fuel gas consumption

Optimize power consumption

→ RC: 450 M$ over 2018-25

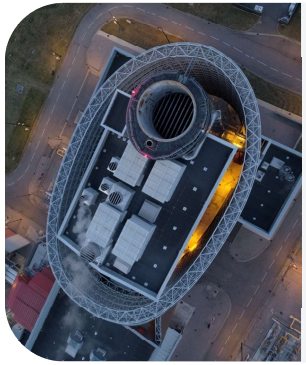
Deploy digital solutions



Green power

Cover all industrial sites' power needs with green electricity in Europe and the US

→ > -2 $MtCO_2/y$ Scope 2 emissions by 2025



Capture and store carbon

Decarbonize all grey H_2 used in our European refineries

→ -3 $MtCO_2/y$ by 2030

Develop carbon transport and storage projects

→ ~10 $MtCO_2/y$ capacity by 2030

North Sea: the place to develop CCS

Denmark as a European CO2 hub

- → EU favorable **regulatory policies**
  - Danish political agreements
- → North sea region **large CO_2 storage potential** (saline aquifer structures and depleted O&G fields)
  - Huge potential in Danish subsoil assessed by GEUS
  - Potential repurposing of existing O&G assets
- → Northern Europe, an area of **concentrated CO_2 emissions**
  - Strategic location of Denmark
- → New players' emergence

Deploying CCS strategy

Reducing emissions and developing profitable business

Incorporating CCS in our assets

- → Avoid emissions in greenfield projects
  - North Field East & South (Qatar)
  - Papua LNG
- → Reduce emissions from existing assets
  - Ichthys (Australia)
    awarded GHG storage assessment permit
  - Cameron LNG (US)
    Hackberry Carbon Sequestration project under development
  - Refineries

Offering Carbon Transport & Storage services

- → Build a profitable, scalable business and reduce Scope 3 emissions by offering CCS solutions to our customers
- → **North Sea core area**
  - Under Construction, **Northern Lights**
  - Under development
    - Focusing on our depleted assets and saline aquifers
    - **Aramis (NL, op.), Bifrost (Denmark, op.), NEP (UK)**
- → Worldwide growth options

2030 target (Company share)	Growing investment to
> 10 Mt/y	~300 M$/y

Investing in CO_2 storage services for our customers

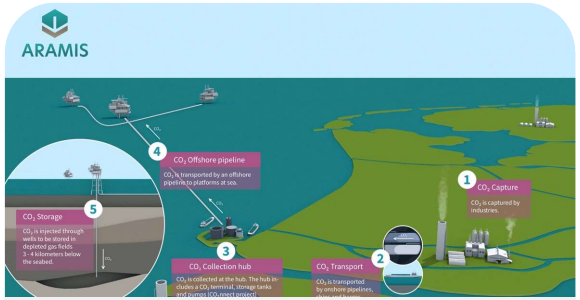
Focus on CO_2 transportation and storage projects

Norway

Northern Lights (TotalEnergies 33%)

→ **Phase 1 (FID 2020)**
Up to **1.5 $MtCO_2/y$** by 2025

→ **Phase 2**
Capacity expansion for European emitters' needs up to **5 $MtCO_2/y$** by 2030

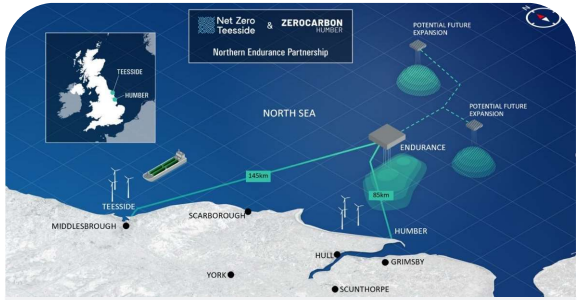


Netherlands

Aramis (TotalEnergies 25%)
CO_2 storage (TotalEnergies 60%, operator)

→ **Aramis project**
- Onshore CO_2 multimodal terminal and transport infrastructure to offshore storage area
- **> 5 $MtCO_2/y$** transport capacity from 2026 (Ph. 1)

→ **Operated storage**: **2.5 $MtCO_2/y$** (Ph. 1) to **8 $MtCO_2/y$** in 2030 based on customer demand



UK

NEP* (TotalEnergies 10%)

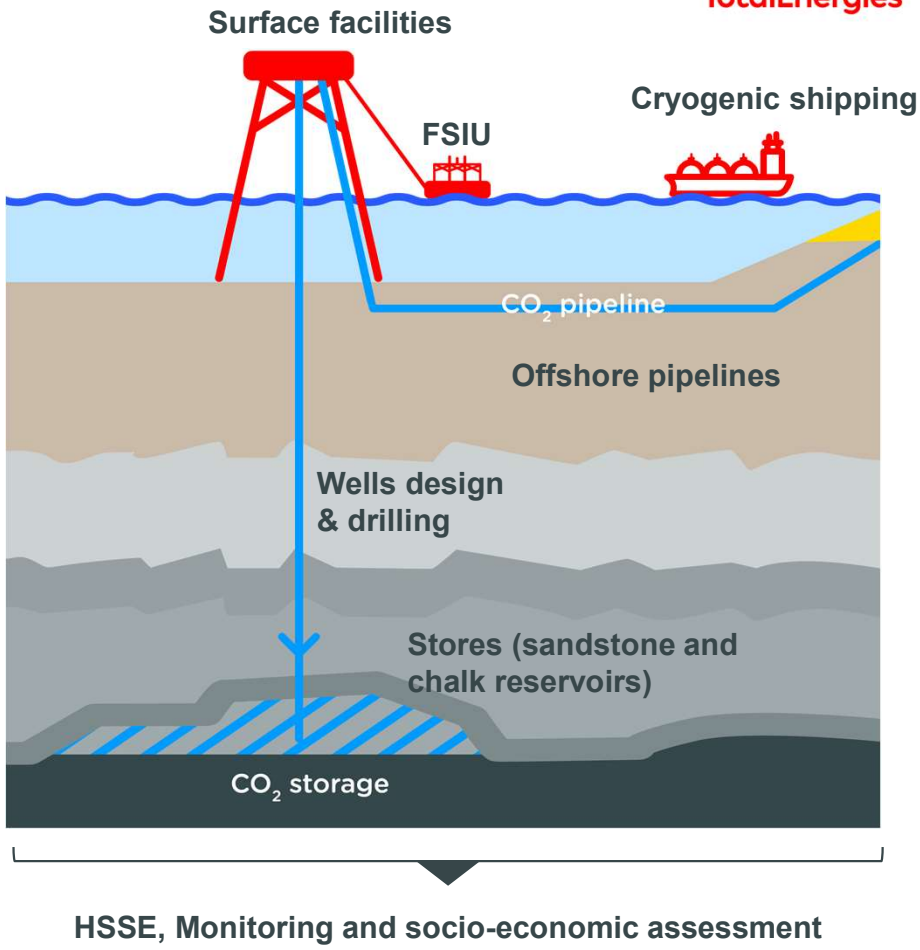
→ Onshore and offshore infrastructure for storage in the Endurance reservoir, a large-scale saline aquifer
- **4 $MtCO_2/y$** by 2026
- > 400 $MtCO_2$ storage capacity

* Northern Endurance Partnership

Bifrost, transportation and storage in the Harald fields

Re-purposing existing O&G assets

- bifrost, 2 year-study funded by **EUDP**
- Study partners:
- Develop safe and permanent CO_2 storage in the Danish North Sea.
  - Potential play opener for storage in chalk
- Perform the groundwork necessary to demonstrate **a robust concept for CO_2 transportation and storage**, re-purposing some existing facilities and developing new activities.



Bifrost, store qualification

Storage capacity	Injectivity	Containment	Main Risks
Evaluation of CO_2 storage capacity	Injection rate and injectivity impairment (Several chemical, biological and mechanical effects can impact the injectivity during CO_2 injection)	Storage site safety (When CO_2 is injected, it may interact with the caprock and decrease its sealing capacity. Other factors such as fault reactivation or fractures may also pose a risk for leakage.)	Cap rock integrity Alteration of fault properties Injectivity loss Well integrity

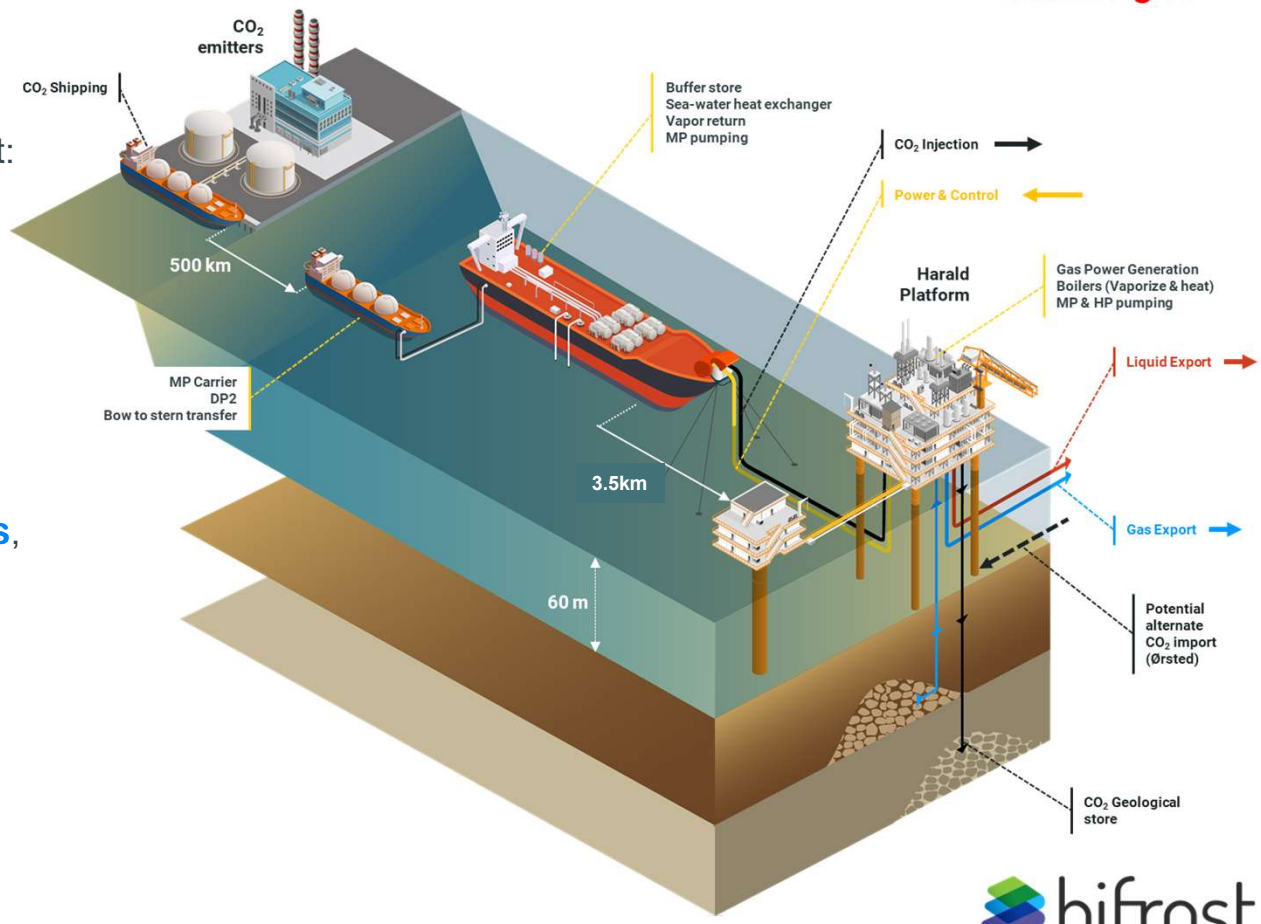
- Joint analysis of geosciences & engineering disciplines and specialties concludes that **safe CO2 storage on Harald West sandstone** field is highly likely.
  - **Strong seal**
  - **Integrity** of legacy wells

- Preliminary studies have not identified any show-stoppers for **CO2 storage in Harald East**. Harald East chalk reservoir is being matured as a complement to the sandstone store & may be the first step to **unlock a significant storage potential offshore Denmark**

- Further modeling, assesments and uncertainties analysis ongoing to qualify a **robust & safe development** for CO_2 permanent storage

Bifrost, offshore development concept maturation

- Feasibility of a fully offshore offloading concept:
  - LCO2 full offshore chain, continuous injection, MP conditioning, cryo spec
  - **Well conversion and completion design**
  - **Injection in depleted fields**
  - Technology maturation with the **identification of technological gaps**, engage vendors and **initiate qualification programs** (wells, flexible lines, process...)
- **Integration** on Harald platform, full chain flow assurance in SIMOPS



Bifrost, repurposing gas pipeline for CO_2 transport

Ørsted

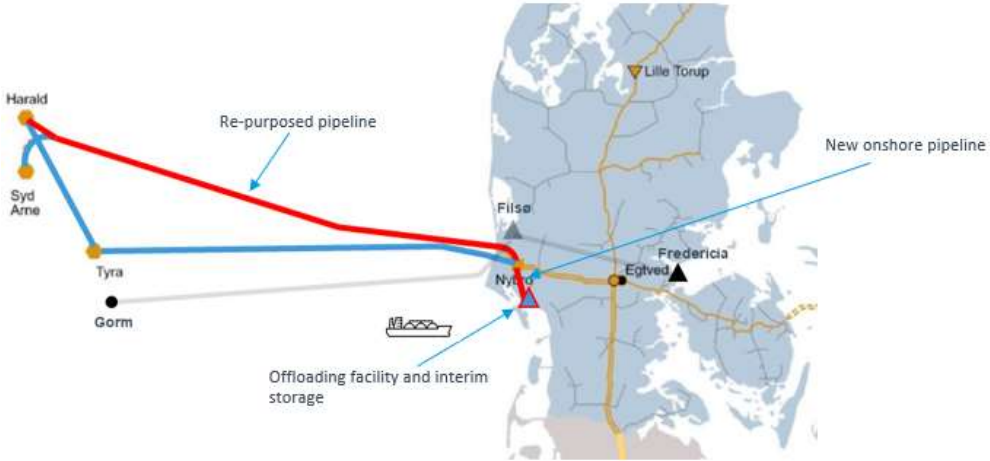
TotalEnergies

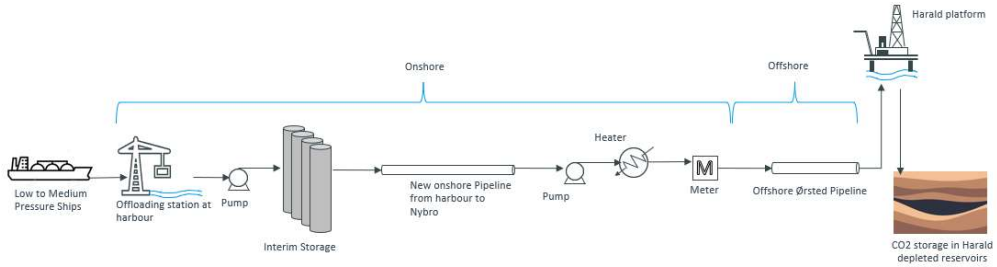
- Re-use of existing pipelines is a **key lever to optimize costs** and **reduce carbon footprint**.

- Preliminary assessment indicates suitability of existing gas pipeline for CO_2 transport
  - Dense phase
  - Dry CO_2 purity (subject to further investigation), in line with cryogenic spec
  - Capacity example: from the operating envelope of the 24” Harald to Nybro pipeline; ~12 Mtpa at 80 barg

- Main technical risks to be further studied:
  - Corrosion
  - Running ductile fracture

- Permitting and regulation for converted pipeline to be further investigated





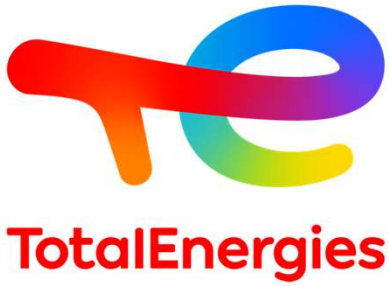
bifrost

Safe permanent storage & public perception

- **Safety, Environment, Societal**
  - Implement **high HSE technical standards** for Bifrost.
  - Define permit and consent register in compliance with regulations in place
  - Perform **Environmental and Societal baseline surveys** (EBS & SBS)

- **Monitoring technologies** being studied
  - A **monitoring digital twin concept** (utilizing an **advanced machine learning method**) will be studied for an application on Harald fields to optimize prediction of CO_2 plume migration
  - A new highly sensitive stationary **specific chemical sensor** is developed to enable **environmentally safe permanent offshore storage operations**.

- **Socio-economic and perception**
  - A **national survey reaching 50,000 Danish households and with over 8,000 respondents** carried out together with dedicated stakeholder interviews to assess the perception & acceptance of CCS in the country
    - In tomorrow's afternoon agenda!



Thank you!
and

Stay tuned, Bifrost website coming out soon!

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