IRIS: Developing an Integrated CCUS Project In Corinth Refinery

IENE WORKSHOP

THE ECONOMICS OF CCUS APPLICATIONS

12th March 2025

Athens

Pathway to Reduce GHG Emission

Decarbonisation of our Activities

- Secured €127mn grants for implementation of CCS on SMR unit (Project IRIS)
- Low-carbon H_2 to reduce Refinery GHG emissions further

- Reduced emissions from power unit efficiencies and recycled H_2
- Ongoing energy conservation initiatives
- 10 MW PVs installed on refinery alongside 6 MW storage. 24 MWh storage system

Decarbonisation of our Products

- ~60 ktpa of low-carbon H_2 to be produced by 2029
- ~25 ktpa of e-methanol to be produced by 2029

- ~200 ktpa biodiesel production capacity from co-processing biogenic feedstock
- 250+ ktpa advanced biofuel production program under assessment

IRIS

Funded by the European Union

Regulatory tools

1 Emissions Trading System

- ✓ Expansion of Scope (maritime, road transport, buildings)
- ✓ Provisions for **CO2 captured and permanently stored**

2 CCS Directive

- ✓ Directive establishes **a legal framework for the environmentally safe geological storage of carbon dioxide (CO2)** to contribute to the fight against climate change

3 Industrial Carbon Management Strategy

- ✓ Scale up CO2 capture, utilization, and storage to align with the EU's 2040 climate target, aiming **for least 250 million tones CO2 injection by 2040 in EEA**
- ✓ **Accelerate carbon storage development across Europe** rather than only on the North and enable a Europe-wide network for CO2
- ✓ Unlocking investment **in carbon capture and storage & de-risk via CfD**
- ✓ Engage with EIB on financing capture and storage
- ✓ Scale up **industrial carbon removals**

4 Net Zero Industry Act

- ✓ Achieve at least **50million tones CO2 injection capacity by 2030** together with related transport modes
- ✓ Create an **EU market for CO2 storage**
- ✓ Accelerating permitting and defining strategic net-zero projects

Aalborg Declaration

- ✓ CCUS an essential technology needed to support the green transition and reach net-zero emissions by 2050.
- ✓ Need for developing a European CCUS market.
- ✓ Collaboration of CCUS projects
- ✓ Efficient infrastructure

5 RED III & Accompanying Delegated Acts

- ✓ RFNBOs **as 1.2% of total energy** supplied at ports
- ✓ **5.5% combined share** of RFNBOs and Annex IX part A by 2030
- ✓ **42% H2/RFNBO** of H2 **in industry** by 2030
- ✓ **Utilization of CO2** & Sustainability Criteria

6 FuelEU & Refuel EU Regulation

- ✓ Introduction of e-fuels in the energy mix
- ✓ **Directly or indirectly** (blending sub-target for SAF, means to achieve maritime GHG reduction pathway to 2050)

7 Gas & Hydrogen Market Package

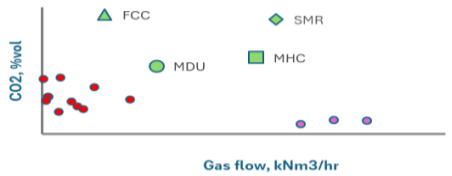
- ✓ **Internal markets** for renewable gas, natural gas and hydrogen
- ✓ Sustainability criteria & **Low Carbon gases**

Design Points & Concerns

1 Emitting points

Multiple emitting points, wide range of flow rates and CO2 concentrations

Move beyond CO2 waste handling



Aim for Blue H2

2 Flue gas vs process side

Maintain H2 & HP Steam Balance

Capture rate & final H2 footprint

Regulatory provisions for H2

Degree of intervention required

CAPEX & OPEX considerations

Existing experience

Post Combustion, Amine Based capture with Highest TRL; Plants in operation

3 LCO2 specs & Conditions

A project specific issue ?

Medium vs Low pressure

Vessel's emissions performance

Cross-contamination and handling of off-spec LCO2

Requirement for robust QA and MRV systems in place

- Medium pressure given the location of potential storage sites; Experience
- Specifications for Medium Pressure

4 Utilization of CO2 - eMeOH

Regulatory framework for fossil CO2 use

RED II/III & FuelEU provisions for RFNBOs

High TRL - few operating plants

Intermittency

CO2/ H2 efficiency

5 Plot plan considerations

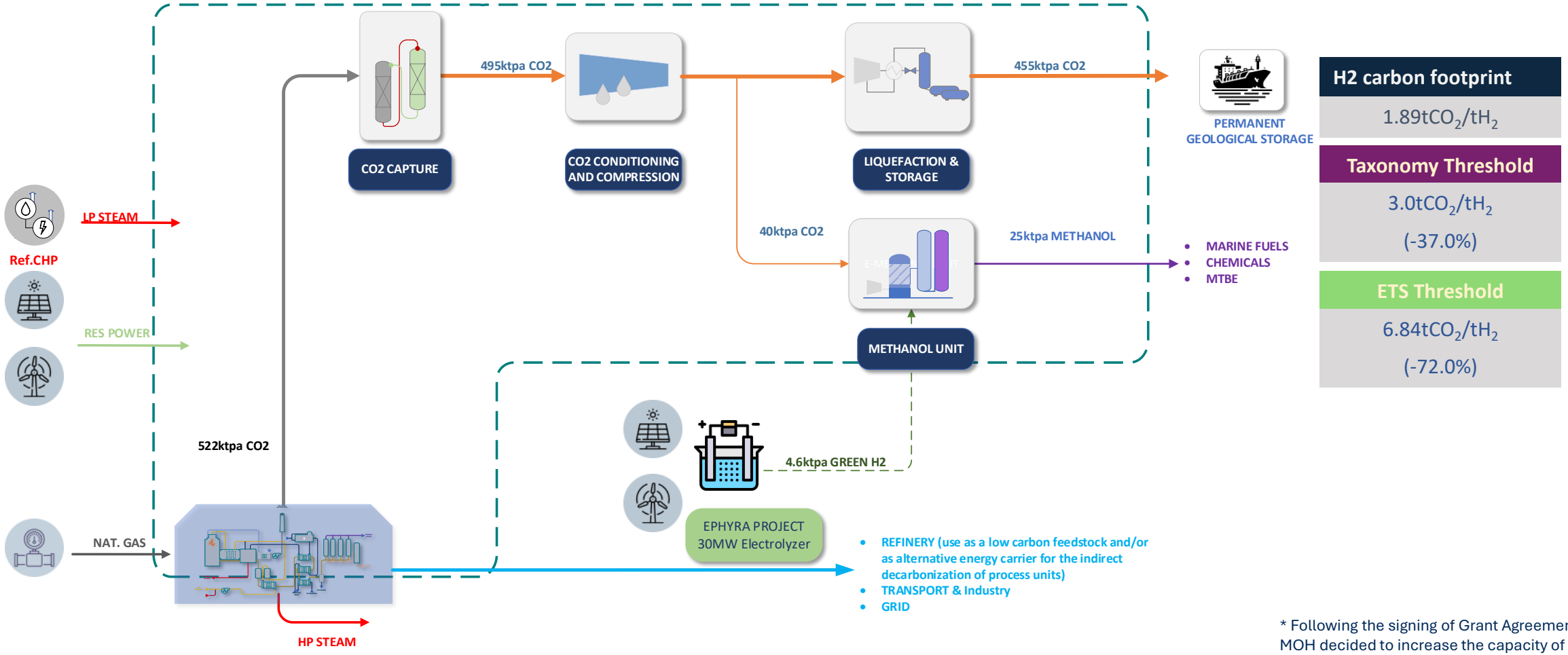
Location of main process equipment (i.e. quencher/ pre-treatment) vs emitting point

Duct piping routing

Heat/ Cooling integration with the refinery

Continuity of operations during construction

IRIS project: 455kt p.a. CO2 removal & 25kt* p.a. e-methanol production



H2 carbon footprint
1.89tCO_2/tH_2
Taxonomy Threshold
3.0tCO_2/tH_2
(-37.0%)
ETS Threshold
6.84tCO_2/tH_2
(-72.0%)

* Following the signing of Grant Agreement MOH decided to increase the capacity of MEOH unit from 10kt to 25lt p.a..

Closing Remarks

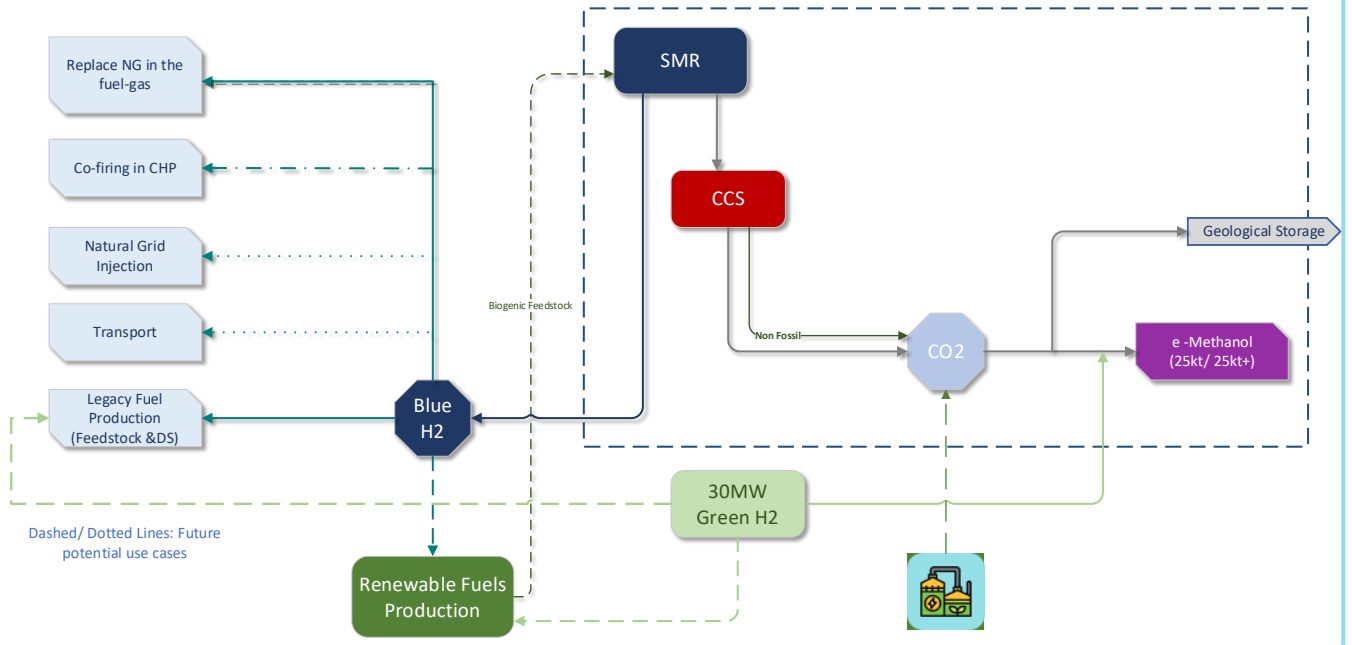
IRIS Serves MOH's main strategic directions

- Increases refinery's resilience by drastically reducing refinery's GHG emissions, both directly and indirectly
- MOH becomes a major Blue Hydrogen producer while expanding the capacity to further decarbonize its operations
- Materializes CO2 circularity via the production of e-Methanol while setting the grounds to become bio-CH4/bio-CO2 off-taker in the future
- Builds on synergies with other projects

… but with challenges

- Complex, multifaceted projects with long development periods; cooperations between parties with differing decarbonization objectives, investment hurdles and tolerances for sharing risks across different projects
- Significant up-front capital investment required, uncertainty of future CO2 prices, storage capacity readiness & marine transport development
- Regulatory framework for the operation of the value chain under development; the ball at the Member States
- Existing technologies in more demanding configurations and new technologies with limited (or even zero) number of commercial plans
- Long lead times affect the maturation between capture & storage projects

Near & Mid-term decarbonization opportunities



Thank you very much!

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