KOdeCO net zero
CCS KNOWLEDGE SHARING WORKSHOP BY THE INNOVATION FUND

Aalborg, Denmark, 28th of November 2023
DECARBONIZING KOROMAČNO CEMENT PLANT
ENABLING ISTRIA TO ALIGN INDUSTRY WITH TOURISM

35% reduction of CO₂ footprint

PHASE 1 - KOdeCO
Fossil fuel phase out
Minimize use of fossil fuel to 5% of energy needs

PHASE 2 - KOdeCO net zero
Carbon Capture and Storage of all CO₂ emissions caused by the process

KOdeCO solar
Development of solar power plant

years of the Koromačno cement plant 1926 - 2026
Location: Koromačno, Croatia

Actual / projected captured CO2: 367,000 t CO2/year

Technology: CO₂ capture adsorption technology

CO₂ Usage/storage model: Offshore sink

Estimated CAPEX (rough estimate): 237 mil. EUR
SYNERGY WITH EXPERIENCED STRONG PARTNERS
RESULT IS INNOVATIVE AND SCALABLE PROJECT WITH HIGH MATURITY

Application to EU InnovFund - 2022 - LSC

Q3 2023 EU IF Results
- FEED and basic engineering
- EIA
- Contract negotiation and finalization
- Permitting and compliance
- Preparation for FID

Q4 2025 Financial Closure
- Site preparation and energy delivery preparation
- EPC execution
- Transportation and storage contract monitoring
- Integration, operational and maintenance plans
- Commissioning

Q4 2028 Entry into operations
- Operations: reporting and continuation of knowledge sharing

PUBLIC FUNDING
- EU InnovFund
- JTF

PRIVATE FUNDING
- Holcim Group

CO2 capture
Wastewater treatment
Shipping
Storage
Communication

PPA & internal Green Energy Projects
Electrical grid extension
Stakeholders

K0deCO net zero project perimeter

Energy supply
KOdeCO cement plant (on-site)
KOdeCO storage facility
K0deCO Net Zero project perimeter

Block 1 – Carbon Capture and liquefaction
Block 2 – Transport and Storage

Koromačno cement plant (on-site)
KOdeCO facility
CO2 capture, liquefaction & transportation
KOdeCO storage facility
Loading arm
KOdeCO sea-going vessel
CO2 Storage in the Mediterranean
Wastewater treatment

EU InnovFund
JTF
Holcim Group

4
JUST TRANSITION TERRITORY
WE ARE PROUD TO SUPPORT OUR COMMUNITY IN THE TRANSITION

Istria and Sisačko-Moslavačka counties are only territories in Croatia identified by Just Transition Fund (JTF) and included in Croatian Integrated Territorial Program.
NORTH EUROPE CREATED OPPORTUNITIES
WE CARE ENABLING SOLUTIONS FOR INDUSTRY IN SOUTH EUROPE

TRANSPORTATION AND STORAGE NORTH - EU COUNTRIES

Reference scenario
2030

Source: CO2Europipe; WP2.2 Report – Development of a large-scale CO2 transport infrastructure in Europe: matching captured volumes ans storage availability

TRANSPORTATION AND STORAGE - KOdeCO net zero

First permanent offshore geological storage in the Mediterranean
Project IFESTOS
Scaling Carbon Capture & Storage in Greece

CCS Knowledge Sharing workshop, EU Innovation Fund
Aalborg, November 28, 2023
Aris Tsikouras, Titan Cement
Value chain

Overview

Carbon Capture
Kamari plant
1.9 mtpy CO₂

Industrial Hub
Elefsina

Sea Transport
via liquid CO₂ vessels

Permanent
Geological Storage
Prinos or other suitable site in the Med

• Pre-combustion
• Post-combustion
• Compression

• CO₂ Pipeline
• Liquefaction unit
• Buffer storage & loading terminal

Other emitters

Expected entry into operation: 2029
Regulatory challenges

✓ Provide open & non-discriminatory access to logistics & storage infrastructure
✓ Ensure unbundled, cost-based, transparent tariffs
✓ Establish Carbon Contracts for Difference
✓ Determine licensing & certification framework
✓ Define technical / safety standards
✓ Enable cross-border transportation
Thank you
IRIS
Innovative low carbon hydrogen and methanol production by large scale carbon capture

CCS Knowledge Sharing workshop by the Innovation Fund – Realising opportunities along the value chain
27-28 November 2023
IRIS | Innovation Fund

IRIS project comprises a novel, heavily integrated point-source CCUS technology solution, applied on its current hydrogen production process and its coupling to a small-scale methanol production unit, which will utilize part of the captured CO₂ as feedstock.

MOH’s innovative project IRIS, seeks to couple the production of ultra-low carbon hydrogen and methanol by integrating point-source carbon capture, applied on its current Steam Methane Reforming unit, electrolytic H₂ production and a catalytic process of high selectivity.

Coordinator: Motor Oil (Hellas) Corinth Refineries S.A.
Location: Agioi Theodoroi, Corinth, Greece
Sector: Refineries
Amount of IF grant: €126,790,000
Duration: 168 months
Volume of CO₂ captured for storage by 2030 (Mtpa): 1.2Mt
Starting date – Ending date: January 2024 – June 2037
Planned date of entry into operation: July 2028

MOH Refinery, Agioi Theodoroi, Corinth, Greece
IRIS constitutes a significant step:

(a) in the decarbonization plan of MOH carbon capture project implemented in the Steam Methane Reforming Unit of the refinery with post-combustion capture technology scheme which allows maximization of the CO\textsubscript{2} captured

> decreases the total carbon footprint of the refinery by 25% (~495,000 t/y of CO\textsubscript{2} captured)
> achieves very high energy integration with the existing refinery operations, further reducing its total energy requirements
> will lay the foundation for the future expansion of the CO\textsubscript{2} capture technology to two more refinery units, that could further decrease the total refinery carbon footprint by 50%

(b) for the production of low CO\textsubscript{2} energy carriers for mobility purposes and other industrial usage

> 55,280 t/y of blue hydrogen produced - ~37% lower than the EU Taxonomy threshold
> 10,000 t/y e- methanol as part of the captured CO\textsubscript{2} will be combined with green hydrogen produced by a 30MW electrolyzer (EPHYRA), materializing the principles of circular economy

(c) to lever the development of the very few CO\textsubscript{2} storage facilities in the Mediterranean Sea

(d) for the creation of a wider ecosystem of projects that promote the development of hydrogen market, namely the EU-backed projects EPHYRA* and TRIERES*

* EPHYRA and TRIERES projects are supported by the Clean Hydrogen Partnership and its members Hydrogen Europe and Hydrogen Europe Research under Grant Agreements No. 101112220 & No. 101112056 respectively
Project OLYMPUS
Milaki Cement Plant Decarbonization
<table>
<thead>
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<th>HERACLES Group</th>
<th>Milaki Cement Plant</th>
</tr>
</thead>
</table>

### Milaki Cement Plant

- **Operating in Evia**
  - Since 1982

- **2 Owned Quarries**
  - Limestone & Schist
  - 50 Years Reserves

- **Bagging Facilities**
  - Ground Cement, Solid Fuels and Raw Solid Fuels

- **Capacities**
  - Clinker: 1,600 kt/a
  - Cement: 1,700 kt/a

- **2 Alternative Fuel Workshops**
  - for Biomass and SRF

- **Bulk Material Yard**
  - 400kt Storage Capacity
Innovation & Differentiation

**Cement & Clinker**
- Cement exports worldwide
- 24/7 simultaneous loading & unloading ability
- Up to 150 kt dead weight capacity

**Oil Well Cement**
- API certified manufacturer of Well Cement for the Oil & Gas Industry (Class G)
- Deliver Oil Well Cement to end customers (Europe, Middle East, Africa, Oceania)
- Bagging facilities specifically designed to meet O&G industry needs

**Solid Fuels**
- Trading of tailor-made SF satisfying customer requirements (ability for a variety of processes e.g. grinding, screening, bagging, mixing)
- Increased flexibility to manage different fuel types for customers

**Aggregates**
- Sales to greek islands through plant port
OLYMPUS Project

2028 Milaki Cement Plant Carbon Capture & Storage

Low Concentration CO₂

Additional Net Carbon Removal

High Concentration CO₂

CO₂ Capture and Liquefaction
by Cryo-processing

Milaki Cement Plant
New set-up: OxyCalciner with carbon shifting

Air Separation Unit
Oxygen Production

41%

CO₂ Liquid Storage

> 920 ktpa CO₂

Storage Site in the Aegean Sea

> 900 ktn of CO₂ GHG emissions avoided

Waste Heat Recovery Units

20%

17%

22%

Liquid CO₂ vessel

CO₂ Loading Berth

Waste Treatment Condensates

>900 ktn of CO₂ GHG emissions avoided
Main benefits

1. Greece enacting a leadership role in climate action, turning the latter to an opportunity for growth and moving the needle on sustainability.

2. Establishing Greece as a friendly operating environment for forward-looking enterprises; thus, reinforcing its investment potential.

3. Not only safeguarding current job positions but also creating new and more specialized ones, especially in regions where underemployment prevails, such as Central Greece.

4. Kick-starting the technology race to a CO₂ circular economy & net zero transition in the cement sector across Europe with Greece being in the spotlight.

5. Serving as a blueprint for the conversion of cement plants both for Greece and the whole Europe towards a sustainable constructions sector with multiple benefits to the environment and the society, but also to the profitability and competitiveness of the Greek and EU cement industry.

6. Contributing to the significant reduction of GHG emissions through net carbon removal and paving the way for green growth, not limited to cement sector, but for the rest of CO₂ intensive industry as well.

7. CO₂ avoidance represents 2% of total Greece’s CO₂ emissions.
BECCS at Växjö Energi, Sweden

Julia Ahlrot, Project leader Växjö Energi AB julia.ahlrot@veab.se
Daniel Eidenskog, Senior Process Engineer Växjö Energi AB, daniel.eidenskog@veab.se
### Växjö Energi, a public owned energy company

<table>
<thead>
<tr>
<th>Founded</th>
<th>Employees</th>
<th>Owner</th>
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<tbody>
<tr>
<td>1887</td>
<td>222</td>
<td>Växjö kommun</td>
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<table>
<thead>
<tr>
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<tr>
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<tr>
<td>Broadband</td>
<td>43 000</td>
<td>435,000 km</td>
</tr>
<tr>
<td>Combined Heat&amp;Power</td>
<td>10 100</td>
<td>46,000 km</td>
</tr>
</tbody>
</table>
Växjö, a municipality in southern Sweden
EXISTING COMBINED HEAT AND POWER AT THE SANDVIK PLANT

100 % Fossil fuel free! Biomass from forest residues
BECCS value chain

260,000 biogenic tonnes/year captured at Sandvik
CLUSTER COOPERATION IN SOUTHERN SWEDEN FOR CARBON LOGISTICS

CNetSS
CARBON NETWORK SOUTH SWEDEN

Subsidized by Swedish Energy Agency
Finansieras av Europeiska unionen
NextGenerationEU
PILOT PROJECT FOR CARBON CAPTURE IN COOPERATION WITH LUND UNIVERSITY

Amine technology
AMP/DMSO

Subsidied by Swedish Energy Agency

Finansieras av Europeiska unionen
NextGenerationEU
Thank you!

Julia Ahlrot, Project leader Växjö Energi AB julia.ahlrot@veab.se
Daniel Eidenskog, Senior Process Engineer Växjö Energi AB, daniel.eidenskog@veab.se
CO₂NTESSA PROJECT
PROJECT BACKGROUND
Cement plant NEXE in Našice accounts for 1/3 of cement production in Croatia – more than 1 million t of cement per year, out of which more than 50% of production is exported to the countries of the region.
PROJECT BACKGROUND

Cement production represents an energy-intensive process with a large amount of CO2 emission as a by-product. More than 70% of CO2 emissions is a result of the chemical process of decomposition of carbonate raw material at >1400°C and Carbon Capture technology represents the only long-term solution for reduction of CO2 emissions.

The production of 1 million tons of cement requires >900 GWh of energy.
CO₂NTESSA PROJECT
CO₂NTESSA PROJECT

Project: CO₂NTESSA
Industry: Cement
Location: Našice/Slavonia/Croatia
Investment: EUR 391.7 mil
Entry into operation: 2029
Category: Carbon Capture and Storage (CCS)
Technology: Thyssenkrupp Polysius® pureoxyfuel Carbon Capture

July 2023: The European Commission (CINEA) proposed to the European Investment Bank (EIB) that, for the CO₂NTESSA project, the allocation of EIB technical assistance (EIB PDA) should be considered.
October 2023: The CO₂NTESSA project is included in the list of strategic investment projects of the Republic of Croatia.
The cement industry is very energy intensive and one of the most significant emitters of CO₂, responsible for around 4% of all emissions at the EU level. The need to decarbonise cement industry is urgent to prevent the risk of locking in CO₂ emissions beyond 2050, when the EU plans to achieve full carbon neutrality.

The CO₂NTESSA project will lead to implementation of an innovative carbon capture technology at NEXE cement plant in Našice, Croatia. Existing plant will be modified based on the Polysius PureOxyfuel technology developed by thyssenkrupp. Based on this, the CO₂NTESSA project will allow capture 739 000 t CO₂/year, making cement production at NEXE close to zero emissions. Moreover, the CO₂NTESSA project will unlock the potential for NEXE to become the first negative emitter of CO₂ in the EU because of use of alternative fuels.

Geologically highly appropriate, onshore storage location Bockovci is located only 38 km away, allowing energy and cost-efficient injection of the captured CO₂ into the saline aquifer. The CO₂NTESSA project will achieve synergy with the GT CCS project which includes renewal of the existing out-of-function pipeline for transport of captured CO₂ from the NEXE cement plant. The GT CCS project is expected to be included into the EU’s list of Projects of Common Interest (PCI), with potential to become a regional hub for CO₂, making the CO₂NTESSA project an important milestone of carbon capture and storage development in Croatia and beyond.

Carbon capture technologies in cement production require massive investments, making high costs the main barrier to wide roll out of carbon capture solutions, so public funding is crucial in reaching energy and climate objectives within the cement industry. **Total investment cost in the CO₂NTESSA project will be EUR 391.7 million, making it one of the largest planned investments in industry in Croatia.** Project CO₂NTESSA enables capturing of CO₂ in more cost-effective way in comparison with similar Carbon Capture projects, securing the long-term competitiveness of cement products abroad.
INNOVATIVENESS OF THE PROJECT
INNOVATIVENESS OF THE PROJECT

A unique, fully rounded, cost-effective CCS project in Southeast Europe. One of few in the EU that has efficient solution for disposal of captured CO₂ by transport pipeline up to location Bockovci-1, where CO₂ will be injected into the deposit-saline aquifer (connection to the project Croatia GT CCS).

1. CO₂NTESSA PROJECT | NEXE | CO₂ CAPTURE
2. GT CCS CROATIA | PLINACRO | TRANSPORT OF CO₂
3. GT CCS CROATIA | CROATIAN HYDROCARBON AGENCY | STORAGE OF CO₂

Point 1-3 distance is app. 38 km (out of which only 8 km of new route)
INNOVATIVENESS OF THE PROJECT

Carbon Capture industrial large-scale project which do not need additional energy-intensive CO₂ purification for further transport and injection/storage of CO₂, as CO₂ purity of app 90% is enough.

Unique completely rounded CCS project in south-east Europe, that includes CO₂ capture, transport of CO₂ by pipeline and injection of CO₂ in saline aquifer Bockovci-1 (on-shore storage) which is only 38 km far from cement plant.

Cost efficiency through significant less CAPEX and OPEX (per tonne of CO₂ avoided) in comparison with similar projects.

NEXE cement plant in Našice becomes a negative CO₂ emitter with capture of >700,000 t CO₂ per year (100% CO₂ emissions from production process) and use of alternative fuels (enables continued substitution of alternative fuels with a substitution coefficient >90%).

Implementation of carbon-neutral and cost-efficient production as guideline for other plants in industry that have low quality raw materials and low level of CO₂ concentration in exhaust gases from production processes (cement plants, power plants, refineries...) as an example of green transition for long-term sustainable operations.
INOVATIVNOST PROJEKTA
INOVATIVNOST PROJEKTA
PROJECT IMPLEMENTATION
PROJECT IMPLEMENTATION

- Detailed and financial engineering: Jan 2024 – Dec 2024
- Engineering, Permitting and Site Preparation: Feb 2024 – Mar 2024
- Procurement of equipment: Dec 2025 – Sep 2027
- Construction Works and Entry into Operation: Mar 2027 – Dec 2028
- First year of operation: 2029
INFORMATION ON PROJECT APPLICATION TO THE INNOVATION FUND

Accelerating the transition to climate neutrality and the production of CO$_2$ neutral cement is planned from 2029.
More information available on:
www.nexe.hr/en/co2ntessa/