



European
Commission

Green Hydrogen opportunities for carbon- intensive and coal regions

Coal Regions in Transition Virtual Week

16 November 2021



A few guidelines before we begin

We will use Slido for Q&A and polling. To submit questions:

Step 1:

Go to [Slido.com](https://www.slido.com)

Step 2:

Enter the code: [GreenHydrogen](#)

Or follow the link on Swapcard

Step 3:

Submit your question, vote on other questions!

Please note this meeting will be recorded

DEFOSSILIZING THE CHEMICAL INDUSTRY

OPPORTUNITIES AND CHALLENGES

Prof. Dr.-Ing. Mathias Seitz

Fraunhofer Institute for Microstructure of Materials and Systems IMWS – Halle/Germany

University of Applied Science Merseburg: Professor for Process and Chemical Reaction Engineering



Challenging structural changes

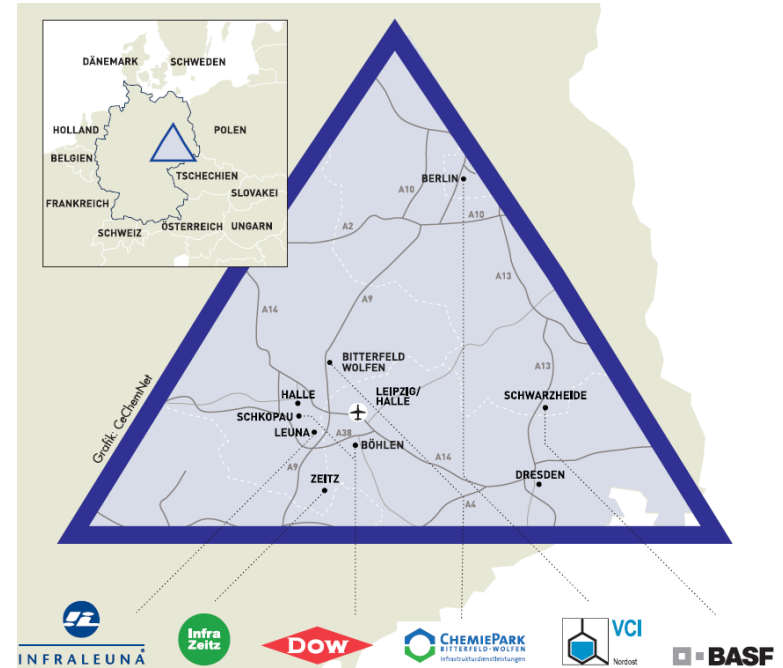
Chemical triangle in central Germany

■ Structural changes

- Link to climate protection, energy transition, **coal phase-out** and reduction of greenhouse gases
- Due the phase-out of lignite-based power generation, the basic materials industry has to assume an anchor function for employment and innovation in the Central German mining region

■ Raw materials change

- One-sided dependence on raw materials (oil and natural gas)
- Energy transition and climate protection require **defossilization** with a drastic reduction in CO₂ emissions
- Substitution of petroleum-based **value chains** with alternatives such as **electricity-based hydrogen (PtX)** and bio-based products

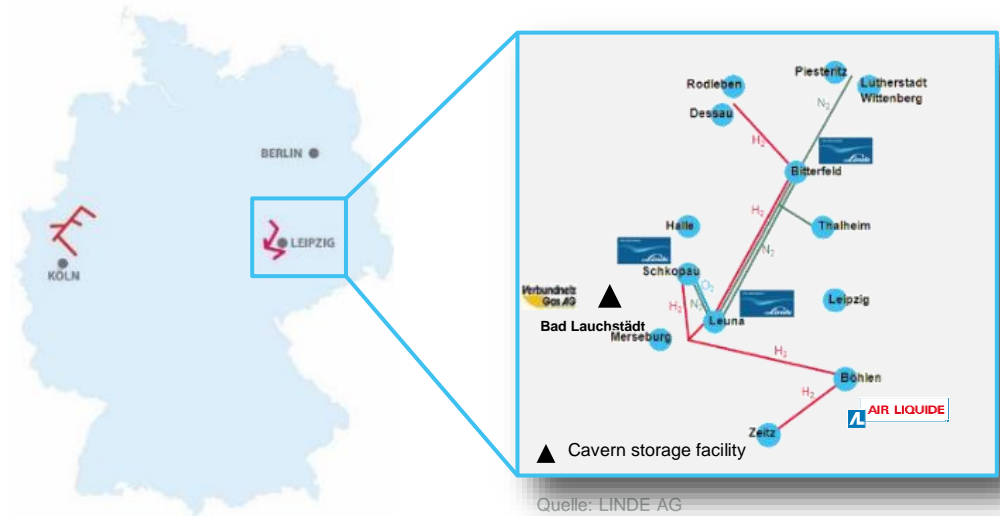


Cracker, refinery, pipeline system and production facilities for basic chemicals, excluding R&D

Green hydrogen for a CO₂ neutral industry

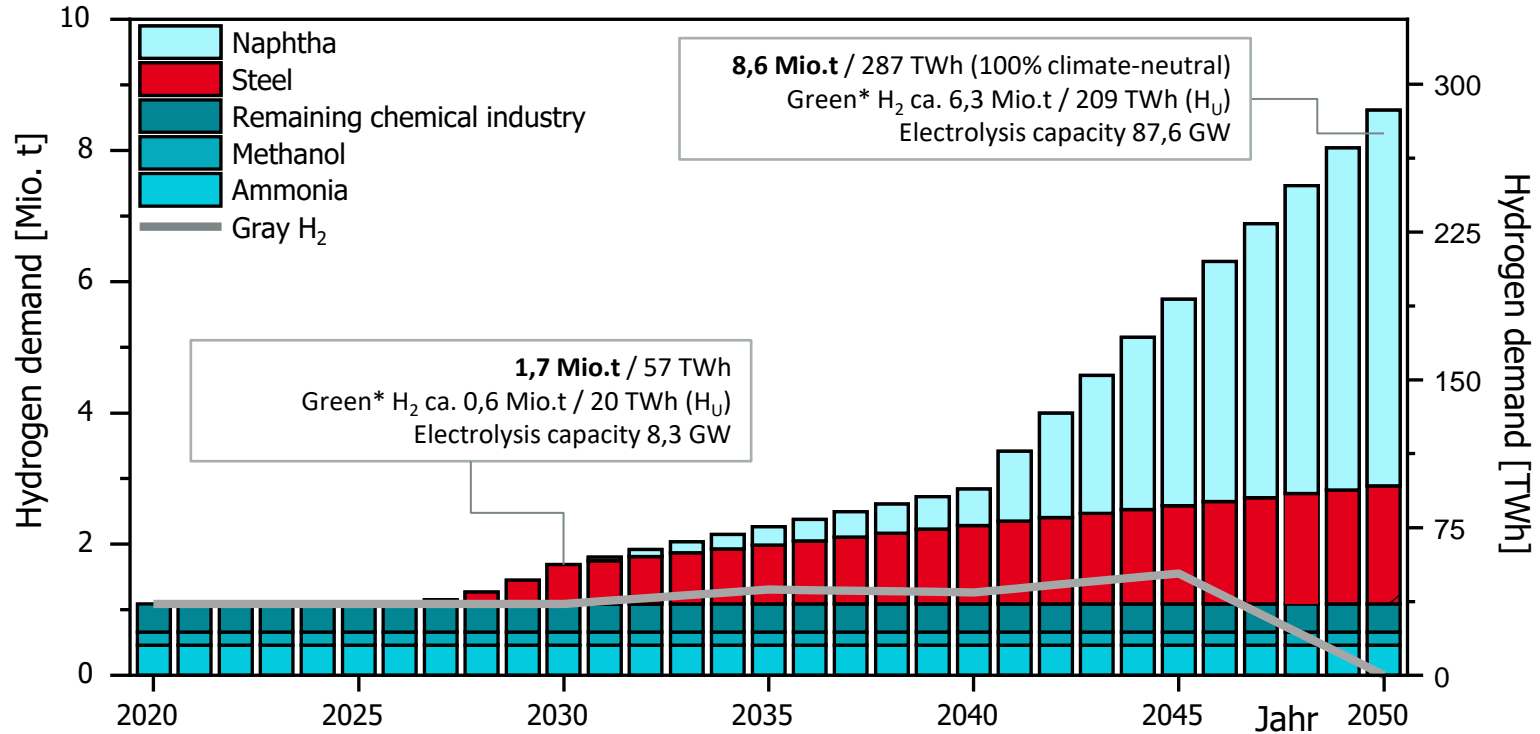
Location Leuna in chemical triangle in central Germany

- H₂ pipeline system and cavern storage facility
- Hydrogen production Linde (gray – steam reformer)
 - 2022: 24 MW green (PEM)
- Two out of five hydrogen liquefiers in Germany
- Raw material alliance Total refinery Leuna and Cracker Böhlen
- Largest methanol plant in Germany (gray – approx. 1 million t / a CO₂)
- Largest ammonia synthesis plant in Germany for fertilizer production
- NEW 2022: industrial biorefinery UPM
- Network basic materials InfraLeuna
- 10,000 employees and € 10 billion sales / a
- ➔ Big opportunity for **electricity-based hydrogen (PtX)**



Market in Germany

Hydrogen demand and the resulting extrapolated electrolysis demand



Assumptions: * green H₂ from electrolysis

Electrolysis capacity NHS (National Hydrogen Strategy): specific energy consumption electrolyser 5 kWh / Nm³ (electrolytic decomposition of water 3.54 kWh / Nm³, efficiency 70% and 4,000 full load hours / a)

Research infrastructures for the market ramp-up of green H₂ technologies

Hydrogen research platforms



ELECTROLYSIS TEST and TRIAL PLATFORM LEUNA

- Electrolysis system tests up to 5 MW
- Various technologies (AEL, PEML, SOEC)
- Hydrogen utilization for downstream processes with **coupling to chemical industry** (Chemical Park Leuna)
- Examples:
 - **MegaLyseurPlus**: Further development 1,25 MW **PEM-Systems**
 - **SynLink**: **Synthetic fuels** with co-electrolysis and CCU from the air
 - **Hy2Chem**: ia. **Methanol synthesis** for further processing in refinery processes (z.B. Total refinery)
- Research operation from 2021



HYDROGEN LAB GÖRLITZ

- Focus on application in **industrial production - decarbonization**
- Test fields for
 - Electrolysis (stacks and systems) on MW scale up to 12 MW
 - Fuel cell systems
 - Storage, transport (pipelines), sensors
- Research operation from mid-2023



HYDROGEN LAB BREMERHAVEN

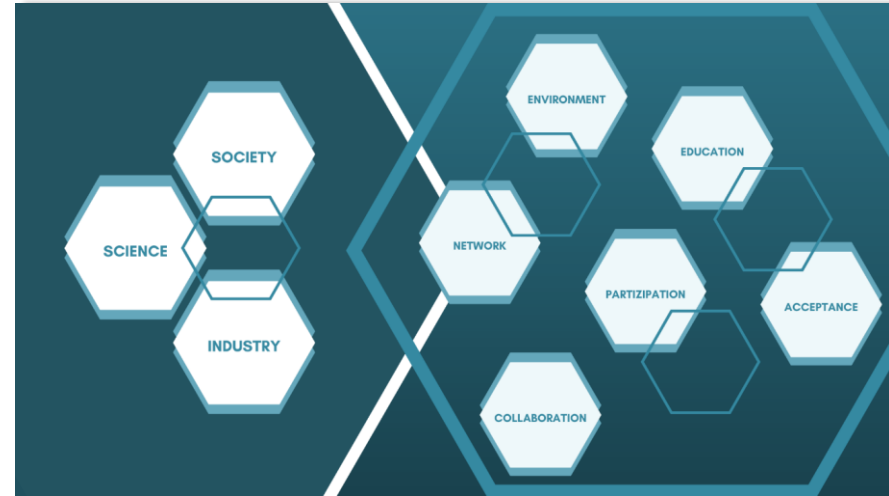
- Dedicated operation of a total of 2 MW electrolysis with coupling of wind energy
- Additional 8 MW test stations planned
- Determination of the **electrical properties** of electrolysers, connection to the virtual medium-voltage network of the **Dynamic Nacelle Testing Laboratory**
- Cross-system optimization of hybrid power plants
- WEA test field in Bremerhaven and Hamburg
- Research operations from mid-2023

Networked trial platforms

Integrated approach

Leaving no one behind

- Various projects that go beyond technology development (e.g. LTZ CBS, HoT, Competence Hub)
 - Technology-oriented structural change in the sectors of chemical industry, bioeconomy, ...
 - Sustainable, coupled and holistic circular economy based on green hydrogen
 - Involvement of regional actors via knowledge transfer (e.g. spin-offs, further education, science communication)
 - Think Tank chemistry 4.0 central German chemical triangle as a lighthouse region
- Integration of the network (e.g. German National Hydrogen Council, HYPOS, DurchH2atmen, chemical parks, SMEs, etc.)



Conclusion

Opportunities and challenges



- Many activities in science and industry in the field of green hydrogen
- However high investment needed, new technologies, missing knowledge on process optimization
- Usage of existing assets necessary – targeted expansion of the region-specific infrastructure
- High job creation potential in circular carbon economy → wide field of activities and technologies
- Need for new business and operator models, skilled employees, sensible regulation, etc.
 - Close cooperation of science, economy and society → bringing research findings into small companies while taking needs of society and industry into account
 - Realize global goals while considering regional characteristics

An intelligent, systemic transformation is essential, taking into account local conditions and involvement of all stakeholders.

Green Hydrogen opportunities for carbon intensive and coal regions

The White Dragon project

Nikolaos Ntavos, Co-founder & Manager

Cluster of Bioeconomy & Environment of Western Macedonia (CluBE)

Ioannis Moraitis, Project Manager H2 & Biomethane

DEPA Commercial S.A.

White Dragon Coordination Team

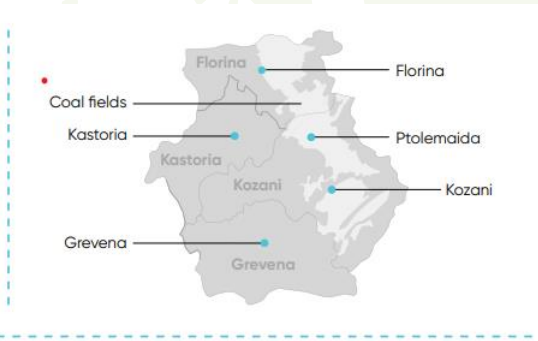
Tuesday 16th of November 2021

*Just Transition Platform Meeting – Coal Regions in Transition virtual week
and Carbon-intensive regions seminars*

Lignite Industry in Western Macedonia

Lignite production and utilization – main features:

- Supplies electricity to Greek interconnected system since 1960, acting for several decades as the Greek energy pillar of economic growth due to the electricity low cost and utilization of domestic energy sources.
- 4 lignite fired power plants of 12 units in operation represented the 40% of thermal units and 20% of the total installed net capacity of the interconnected system in Greece.
- About 100.000 citizens of Kozani, Ptolemaida and Amynteo heated by district heating systems from lignite power plants.



The White Dragon Project

Important Project of Common European Interest HYDROGEN (IPCEI)

- The core of the White Dragon cluster project is based on:
 - the utilization of GW-scale variable renewable electricity, short-term energy hydrogen storage and green combined heat and power (CHP) production through high-temperature fuel cells.
- Furthermore, additional key objectives of paramount importance are foreseen:
 - the development of a high-tech R&D&I hydrogen research center and hub in Greece,
 - the capitalization of the existing energy infrastructure and natural gas pipelines for long-term storage and transportation of green hydrogen with the establishment of an Energy Net Metering Scheme,
 - the implementation of a dedicated hydrogen backbone pipeline in Greece and,
 - the build-up of a national hydrogen mobility sector (distribution/HRS).
- In addition, through TAP, cross-border clean hydrogen transfer will be enabled from Greece to Italy.

Hydrogen
for Climate Action



White Dragon

Important Project of Common European Interest HYDROGEN (IPCEI)

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- A new sustainable production model for the Region of Western Macedonia for the post-coal era
- A low carbon society promoting technical innovation



A Clean Technologies and Green Hydrogen Valley

ΚΟΙΛΑΔΑ ΚΑΘΑΡΩΝ ΤΕΧΝΟΛΟΓΙΩΝ

Συνολικό κόστος επενδύσεων πάνω από 12 δισ. €	Διάρκεια έργων 2022 -2029
Δημιουργία 3 νέων γραμμών παραγωγής 3 νέα εργοστάσια παραγωγής τεχνολογίας	Παραγωγή Υδρογόνου 283.000 τόνοι/έτος
Μονάδα παραγωγής Υδρογόνου από ηλεκτρόλυση 5 GW	Μονάδα συμπαραγωγής ηλεκτρικής ενέργειας και θερμότητας με κυμαινές καύσιμους 0,5 GW
Έγκληση και μεταφορά Υδρογόνου μέσα των αγωγών Φ.Α.	Κατασκευή αποκλειστικού αγωγού Υδρογόνου
Δημιουργία νέων θέσεων εργασίας 18.000 ώρες - 29.500 έμμεσες	Εξοικονόμηση CO ₂ 11,5 εκατ. τόνοι/έτος

White
Dragon

Green
HiPo

H2CAT
Tanks



3 έργα IPCEI στη
Δυτική Μακεδονία

Επιχειρώ | στη Δυτική
Καινοτομώ | Μακεδονία

ΠΕΡΙΦΕΡΕΙΑ ΔΥΤΙΚΗΣ ΜΑΚΕΔΟΝΙΑΣ

White Dragon IPCEI

White Dragon Cluster Project

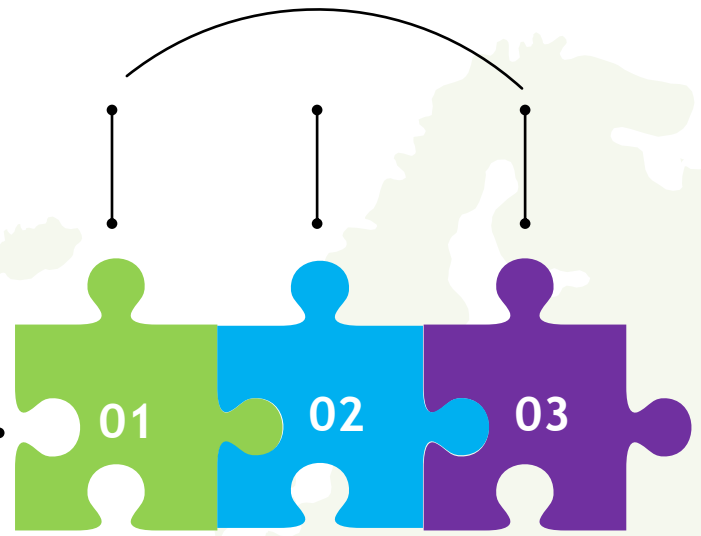
White Dragon (Cluster) is an already integrated project and consists of three sub-projects that are inseparably linked.

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WHITE DRAGON CLUSTER PROJECT
an integrated European Project

White Dragon JV
(implemented by
a full functional
Joint Venture)



White Dragon TAP
(implemented by
Trans-Adriatic-Pipeline AG)

White Dragon DESFA
(implemented by DESFA, the Greek TSO)

White Dragon Cluster Project – Innovations

Primary energy: Variable renewable electricity from the grid
500MW PV directly connected to the electrolyzers

Innovation 1: Integration of different hydrogen technologies into a complete system

PEMEL/AEL/SOEL	4,650 MW
SO Electrolysis (reversible)	350 MW
HTEPEM FC	400 MW
SO FC (reversible)	100 MW
Heating Capacity	500 MW

Innovation 2: Energy Net Metering through Natural Gas Pipelines

Innovation 3: Dedicated 100% hydrogen backbone pipeline

Innovation 4: Cross-border hydrogen transfer through TAP

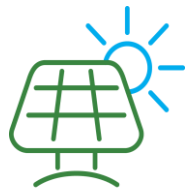
Other uses: Hydrogen transport for large end users (refineries, fertilizer companies and NG CHP plants) and mobility

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Solar energy



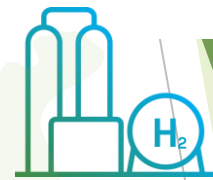
Solar panel



H₂

H₂

H₂



Short-term Storage



DESFA



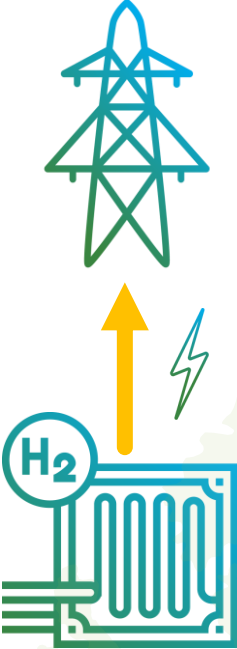
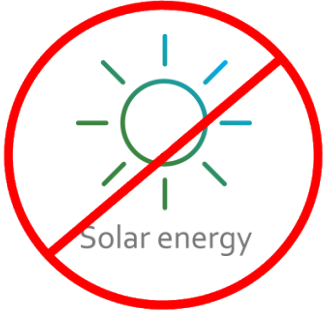
TAP

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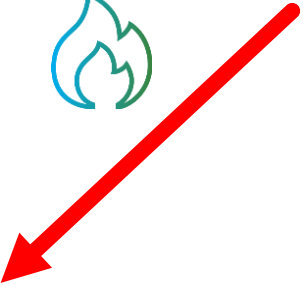
Short-term Storage

H₂

CH₄ / H₂



DESFA NG Pipeline



White Dragon Value Chain

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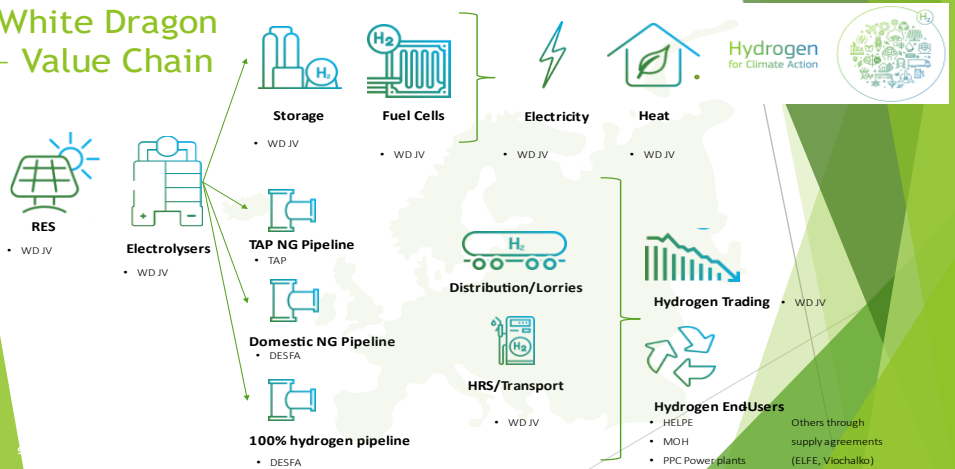


White Dragon is a **lighthouse** pioneering project tackling an aspiring vision;

- Integration of GW-scale variable renewable energy/electricity in the Southeast European energy system.
- Connection of electrolysis and high-temperature fuel cells with energy storage.
- Electricity grid stabilisation and district heating locally.
- Hydrogen and natural gas blending for pipeline transportation.
- Large industrial hydrogen use in a **cohesive first-of-a-kind hydrogen hub**.



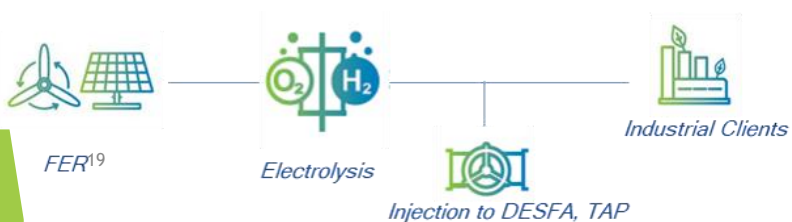
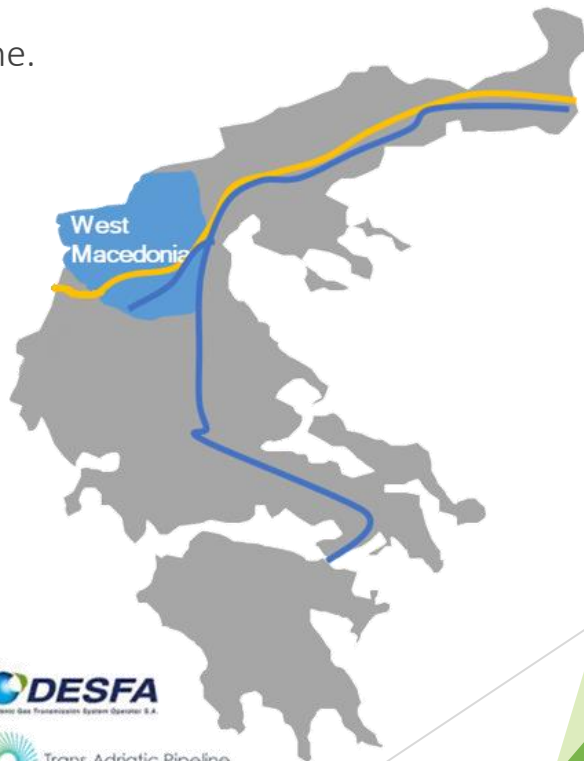
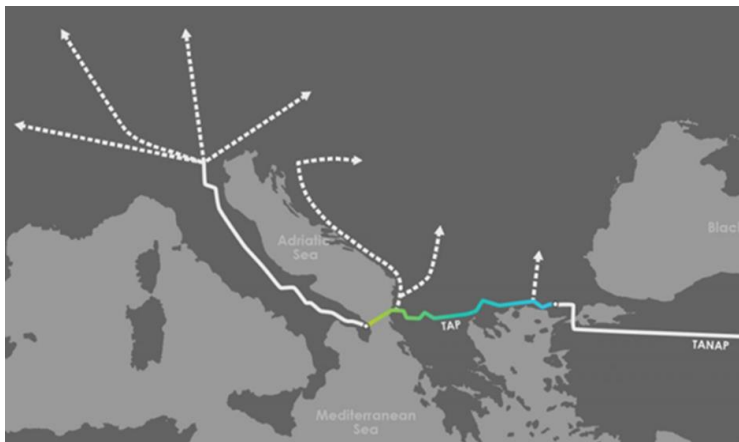
White Dragon - Value Chain



White Dragon Pipelines

- Transforming the existing NG infrastructures for hydrogen injection, transport and storage.
- Development of a dedicated 100% hydrogen pipeline.

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White Dragon - Numbers

<u>Project Duration:</u>	2022 – 2029 (R&D, FID and EET phases)
<u>Hydrogen production:</u>	283,000 tons/year*
<u>Renewable electricity:</u>	1.776 GWh/year**
<u>Renewable heat:</u>	1.929 GWh/year**
<u>CO₂ Savings:</u>	11.5 million tons/year
<u>Jobs created:</u>	9,700 direct jobs and 29,000 indirect***
<u>Hydrogen for other uses:</u>	111,000 to 158,000 tons/year

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* *The renewable hydrogen that will be injected into the pipelines will be around 253,000 tons/year*

** *Calculated for 2030*

*** *During the construction period.*

During operation (from 2030) 2,970 direct jobs and 10,400 indirect

White dragon Benefits (1)

The White Dragon will:

- ✓ Develop the hydrogen economy in Greece and will make the country a pioneer in hydrogen technologies in Southeastern Europe.
- ✓ Be a significant project in the field of hydrogen electricity across Europe (P2P).
- ✓ Install high-tech production lines of fuel cells and electrolyzers in Western Macedonia.
- ✓ Reverse the brain drain by creating jobs of high technological / scientific level.

**Western Macedonia will become a research and development hub
for the European hydrogen industry.**

**Western Macedonia can be a pole of attraction for investments and joint ventures
with strategic industry partners in areas such as aeronautics, defense, automotive, etc.**

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White dragon Benefits (2)

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Blending of hydrogen in the existing gas network is a transitional solution of multiple advantages:

- ❖ *A large reduction in greenhouse gases can be achieved at low systemic costs in the short and medium term.*
- ❖ *It allows the development of hydrogen production capacity and promote a positive business case for the transition to a hydrogen system.*
- ❖ *Provides renewable energy and low carbon energy to consumers currently connected to the gas network.*

An exclusive hydrogen pipeline will be needed to close significant differences in hydrogen supply, potential and hydrogen demand across the country.

The system will also serve to connect the national hydrogen system to neighboring systems, thus providing **security of supply and market integration**.

Hydrogen pipeline networks are the most economical option for transporting hydrogen over long distances, in large quantities, for all possible land routes within Europe and between Europe and potential neighboring export areas.

White Dragon - Partners



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WD
JV

WD

WD TAP

Indirect partner

DESEA

White Dragon Connections



Hellenic Republic
Region of Western Macedonia



Hydrogen
for Climate Action



Supporters

Indirect Partners
from other IPCEIs



Thank you for your attention!

White Dragon Coordination Team

Nikolaos Ntavos, Co-founder & Manager

Cluster of Bioeconomy & Environment of Western Macedonia (CluBE)

Email: n.ntavos@clube.gr

Ioannis Moraitis, Project Manager H₂ & Biomethane

DEPA Commercial S.A.

Email: i.moraitis@depa.gr