THE OXFORD INSTITUTE FOR ENERGY STUDIES

ERCST Roundtable on Climate Change and Sustainable Transition

RIFS POTSDAM

SEMINAR

INCENTIVISING HYDROGEN DEMAND: CRITICAL CHALLENGES AND OPPORTUNITIES

14TH OF MARCH 2024

CONTACT

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VENUE

European Roundtable on Climate Change and Sustainable Transition (ERCST),
Rue Archimède 61,
1000 Brussels,
Belgium

Telephone: +32 468 232 685

PROGRAMME

9.00 **WELCOME COFFEE**

9.15 **SEMINAR OPENING**

Olivier Imbault, *Senior Fellow,* European Roundtable on Climate Change and Sustainable Transition

Bassam Fattouh, *Director,* Oxford Institute for Energy Studies

Rainer Quitzow, *Research Group Leader,* Research Institute for Sustainability

9.30 **HYDROGEN DEMAND: A CRUCIAL ELEMENT FOR THE HYDROGEN RAMP-UP**

Hildegard Bentele, *Member of the European Parliament* (Virtual Input + Q&A)

Stefanie Hiesinger, *Head of Unit - Low Carbon Solutions,* DG CLIMA, European Commission

9.55 **INTRODUCTION TO THE SEMINAR**

Aliaksei Patonia, *Research Fellow,* Oxford Institute for Energy Studies

10.00 **COFFEE AND NETWORKING**

10.15 **SESSION 1: CREATING HYDROGEN DEMAND: DECARBONISING HARD-TO-ABATE SECTORS**

- What are the key sectors that can create initial demand for hydrogen?
- How can hydrogen help to decarbonise these (hard-to-abate) sectors?
- Are there any other alternatives and would they be better (e.g., CCUS)?

CHAIR Aliaksei Patonia, *Research Fellow,* Oxford Institute for Energy Studies

SPEAKERS Bert De Backker, *Policy & Strategy Manager, EAME,* ExxonMobil

Hans Zillig, *Energy Buyer Hydrogen,* ArcelorMittal

Tomasz Włostowski, *Plenipotentiary for the EU Affairs,* Grupa Azoty SA

Kei Fujiwara, *Technical Manager,* Mitsui O.S.K. Lines

12.15 **LUNCH**

13.15 **SESSION 2: CREATING HYDROGEN DEMAND: MARKET DESIGN, LEGISLATION/REGULATION, AND BANKABILITY**

- What approaches can be employed in designing long-term hydrogen contracts to sustain incentives for carbon market hedging?
- Should the RED III sectoral uptake targets be supplemented with additional goals?
- Would an offtaker-neutral or sector-specific approach be more beneficial for targeted EU funds?

CHAIR Olivier Imbault, *Senior Fellow,* European Roundtable on Climate Change and Sustainable Transition

SPEAKERS Timo Bollerhey, *Executive Director,* HINT.CO and *Managing Director,* H2Global

Agnieszka Ason, *Senior Visiting Research Fellow,* Oxford Institute for Energy Studies

Ruud Kempener, *Team Leader - Hydrogen, Financing and International,* DG ENER, European Commission

15.15 **COFFEE AND NETWORKING**

15.30 **SESSION 3: CATALYSING AN INTERNATIONAL HYDROGEN MARKET: LOCAL DEMAND OR INTERNATIONAL OFFTAKE AGREEMENTS?**

- What are the main sources of local and international hydrogen demand in potential hydrogen exporting countries?
- What are the lessons learned so far with mechanisms for creating demand for imports?
- What role can local demand play in paving the way for exports?

CHAIR Laima Eicke, *Research Associate,* Research Institute for Sustainability

SPEAKERS Dorothea Nold, *Senior Markets Officer,* HIF Global

Herbert Beck, *Senior Advisor,* HyIron Green Technologies & former German Ambassador to Namibia

Christoph de Beer, *Principal International Hydrogen Markets,* SASOL

17.30 **CLOSING REMARKS**

Rainer Quitzow, *Research Group Leader,* Research Institute for Sustainability

Olivier Imbault, *Senior Fellow,* European Roundtable on Climate Change and Sustainable Transition

Aliaksei Patonia, *Research Fellow,* Oxford Institute for Energy Studies

DISCUSSANTS

Antoine Hoxha, *Director General,* Fertilizers Europe

Areti Kostaraki, *Senior EU Affairs Manager,* ENGIE

Aymeric Amand, *Policy Officer,* Sandbag

Camille Alleguede, *Market Design Policy Advisor,* Électricité de France (EDF)

Constantine Levoyannis, *Head of EU Affairs,* Nel Hydrogen

Daniel Marenne, *Energy Solutions Architect,* ENGIE

Dominik Komorek, *Chief Expert in Energy Policy Division, EU Economic Department,* Chancellery of the Prime Minister of Poland

Emily Alpers, *Intern,* German Chemical Industry Association (VCI)

Erhan Erdogan, *Policy & Regulation Manager,* Hydrogenious LOHC Technologies

Eric Lamboley, *Associate Director,* Guidehouse (on behalf of H2eart for Europe)

Eunice Ribeiro, *Policy Expert for Hydrogen and Emerging Business,* STX Group

Florian Schmalz, *Policy Advisor for Energy & Climate,* Eurochambres

Florian Zweifel, *European Affairs Officer,* German Steel Association

Floris van Hövell, *Senior EU Affairs Manager,* Shell

François Paquet, *Impact Director,* Renewable Hydrogen Coalition

Gaetana Magnaniello, *Senior Policy Officer - Energy & Climate ,* IOGP Europe

Geert De Cock, *Electricity/ Energy Manager,* Transport & Environment (T&E)

Giacomo Spinola, *EU Policy Advisor,* Edison SpA

Helena Lönnberg, Consultant for Energy, Sustainability & Infrastructure (ES&I), Guidehouse (on behalf of H2eart for Europe)

James Kneebone, *Research Associate,* European University Institute

Jamie Freeman, *Hydrogen Demand Strategy Lead,* Department for Energy Security and Net Zero, UK (DESNZ)

Jaroslav Maroušek, *EU Funds Specialist,* Orlen Unipetrol

Jasmine Barahman, *Climate Policy and EU Affairs Senior Manager,* Fertilizers Europe

Juan Javier Guerrero, *Policy Advisor,* FuelsEurope

Julian Schorpp, *Head of EU Affairs,* thyssenkrupp Steel Europe

Kamila Waciega, *Director, Energy & Infrastructure,* Hydrogen Europe

Lucas Nys, *Consultant, Digital & Creative Communications Hub,* BCW Brussels

Luciana Ribeiro Monteiro, *Sustainability Product Strategy Lead,* Embraer X

Maria Brakatsoula, *Climate and Energy Policy Advisor,* VDMA

Marie Dejonghe, *Researcher,* Ghent University

Mathis Weller, *Policy Officer (National Hydrogen Strategy Division),* German Federal Ministry for Economic Affairs and Climate Action

Melissa Verykios, *President,* Clean Hydrogen Partnership

Michele Casadei, *Greens/EFA Policy Advisor,* European Parliament

Nicolai Romanowski, *Energy Manager,* European Chemical Industry Council (CEFI)

Philipp Tschinke, *Head of Brussels Office,* Salzgitter AG

Rory Macrae, *External Affairs Europe,* Fortescue

Roshin Abraham, *Assistant Manager - Strategy and Decarbonisation,* Mitsui O.S.K. Lines

Ruben Davis, *Policy Officer,* Cleantech for Europe

Sakura Nishioka, *Assistant General Manager (Head of Energy),* Japan Oil, Gas and Metals National Corporation (JOGMEC)

Siobhan McGarry, *Policy Officer, Net Zero Industries, Sustainable and Circular Products,* DG GROW, European Commission

Sven Keysers, *Market Analyst Hydrogen & Derivatives,* Uniper Hydrogen

Theo Paquet, *Regulatory Affairs Manager,* Eneus Energy

Veerle Dossche, *Project Manager, Hydrogen Policy EU,* Agora Industry

Verena Hof, *Political Advisor for Energy Policy, Hydrogen Policy EU,* European Parliament, Office Jens Geier, MEP

Winston O'Young, *Senior Policy & International Relations Officer,* Ministry of Energy and Energy Industries, Trinidad and Tobago

Yana Zabanova, *Research Associate,* Research Institute for Sustainability

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ERCST Roundtable on Climate Change and Sustainable Transition

RIFS POTSDAM

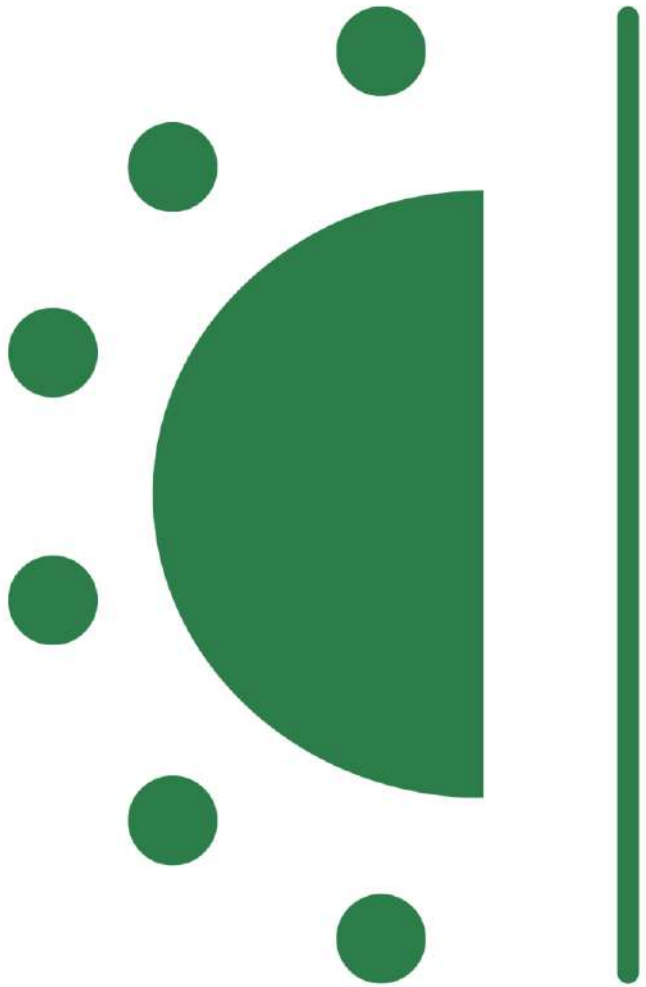
Seminar

INCENTIVISING HYDROGEN DEMAND: CRITICAL CHALLENGES & OPPORTUNITIES

14th of March 2024

European Roundtable on Climate Change and Sustainable Transition (ERCST),

Rue Archimède 61, 1000 Brussels, Belgium



ERCST

Roundtable on
Climate Change and
Sustainable Transition

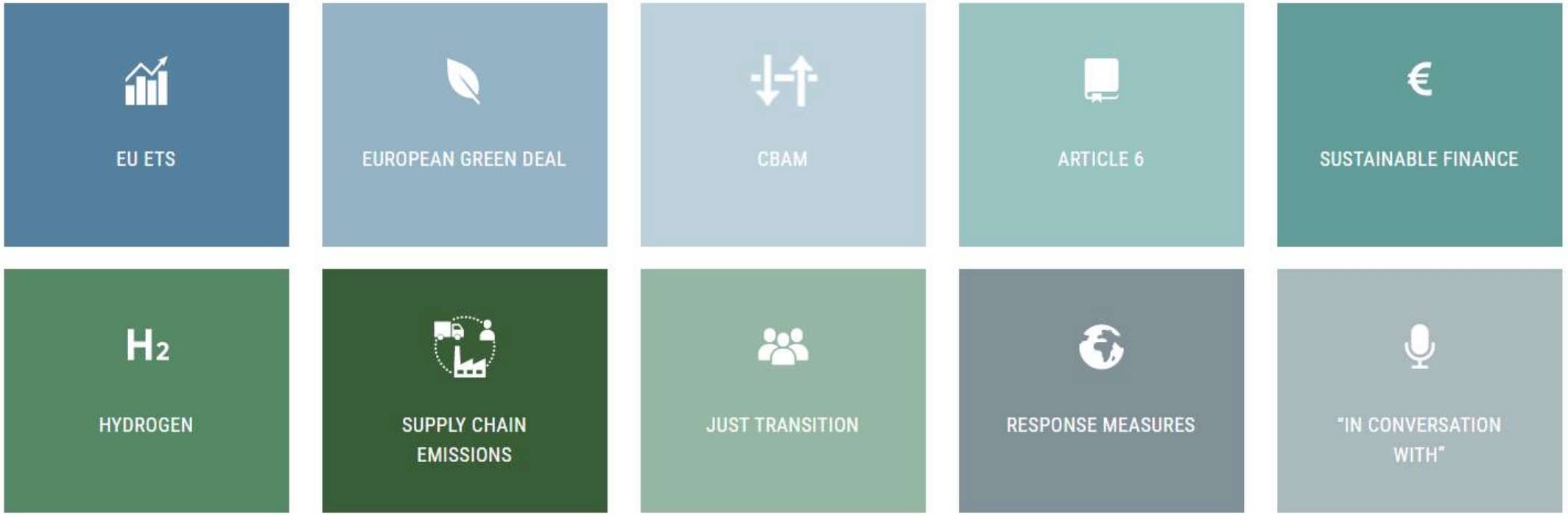
ERCST

European Roundtable on Climate Change and Sustainable Transition

Mission: providing a neutral space where policymakers and regulators can meet stakeholders and discuss climate change policy, including how to manage a sustainable transition to a low-carbon society.

Values: committed to the goals and principles of the Paris Agreement and actively promoting a just, inclusive, and sustainable global transition.

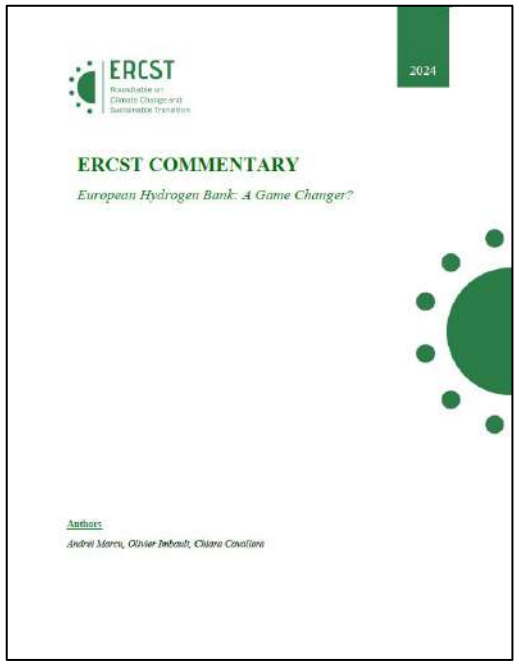
Workstreams

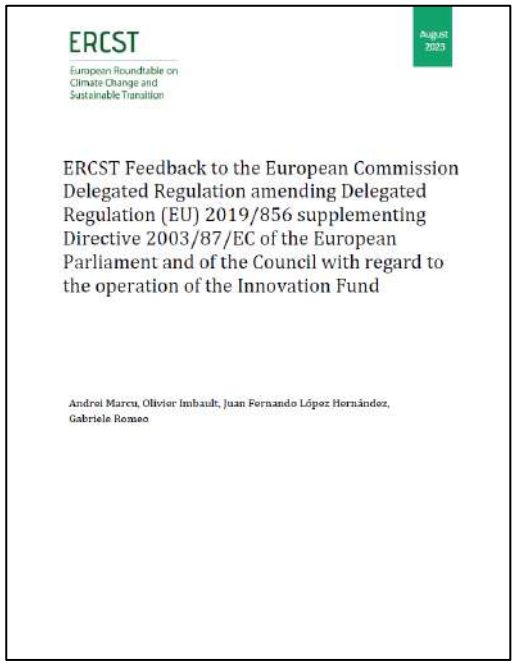


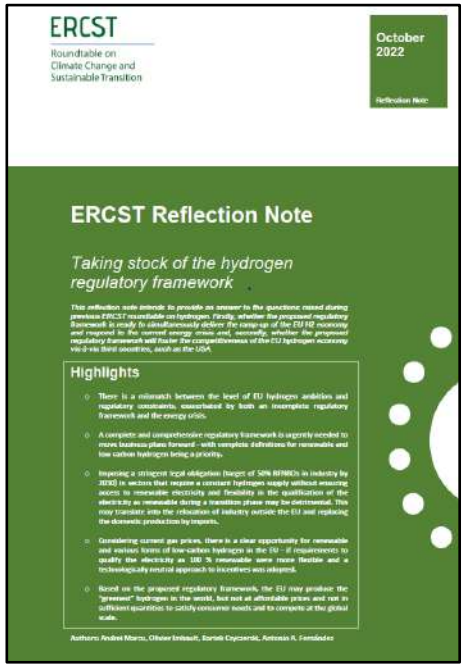
Publications

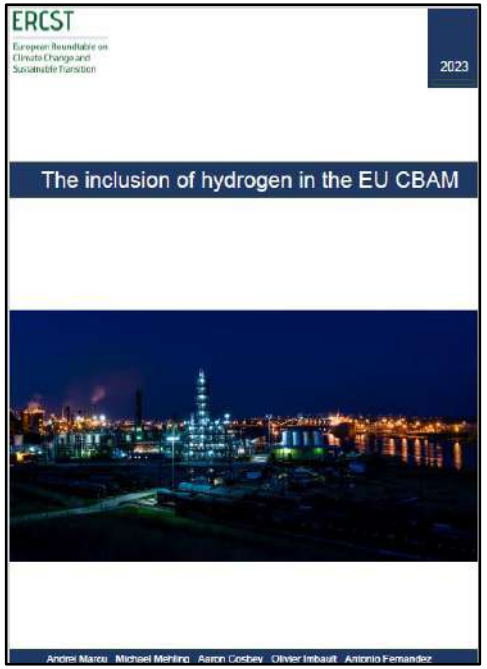
Hydrogen Workstream

- Launched in early 2021
- Established in recognition of hydrogen's Growing significance in decarbonising the EU's major emitting sectors.









Upcoming Publication: 2024 State of the EU Hydrogen Market Report

ERCST
Roundtable on Climate Change and Sustainable Transition

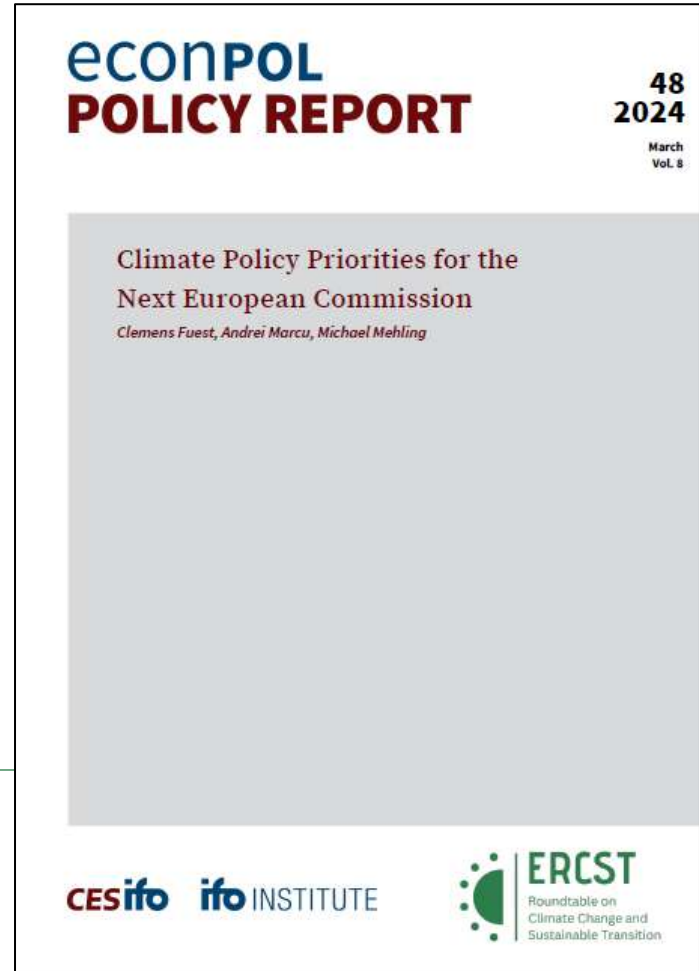
Climate Policy Priorities for the Next European Commission (extracts)

- "Much has changed in the world since the European Green Deal and the Fit for 55 package were conceived"

- "Climate Change increasingly needs to viewed as a matter of Economic, Industrial, and Competition Policy"

- Necessary conditions and components crucial for delivering the 2050 targets in this interlinked environment:
  - Availability and cost of hydrogen.
  - Deployment of CCU, CCS, CDR methods or activities.
  - The necessary rate of electrification.
  - The necessary level of penetration of renewable energy,
  - Inclusive treatment of nuclear, as a zero and low carbon energy solution.

Source: 'Climate Policy Priorities in the Next European Commission' Report



Hydrogen

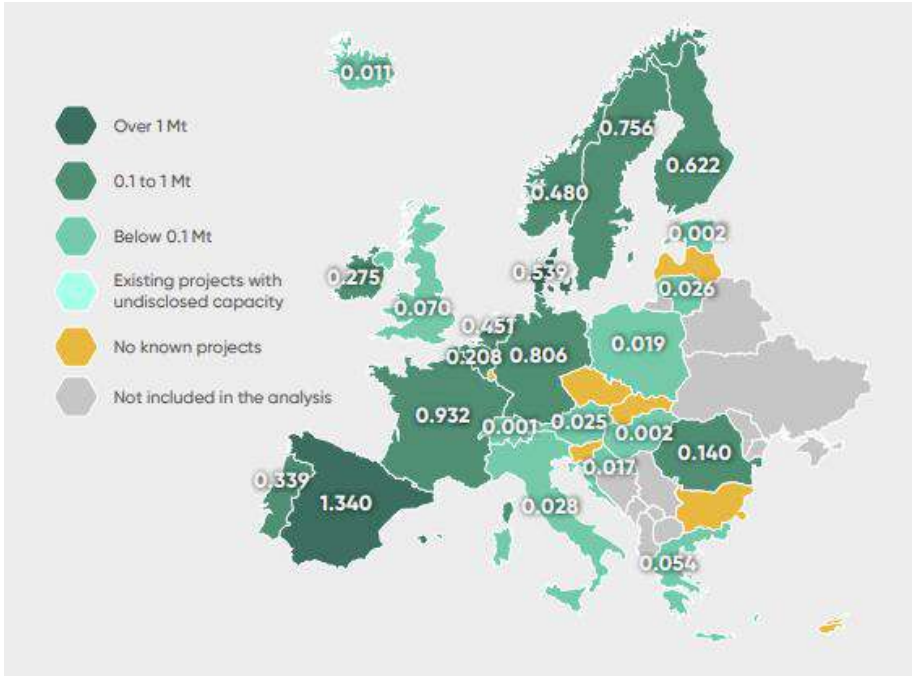
Clean hydrogen as an opportunity

- **2020**: Clean Hydrogen as a key element for decarbonisation
- **2021-2023:** priority to Renewable H2 supported by a series of regulatory elements in the Fit for 55 package
- **2024**: From enthusiasm to scepticism : “Only 7% of world’s hydrogen projects will be completed by 2030… we must create a demand for it” – (Fatih Birol)

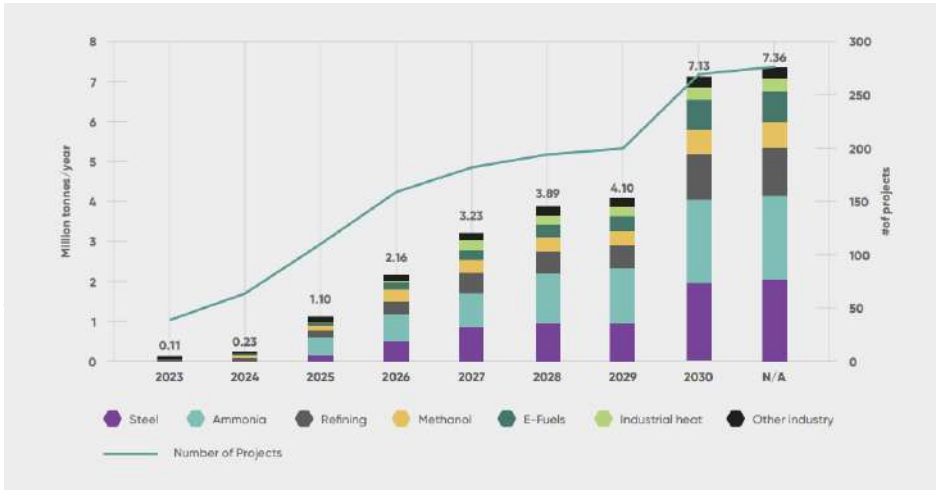
Necessary conditions to create a real demand and build the future “clean hydrogen” market ?

Source: Hydrogen Europe Clean Hydrogen Monitor 2023

Total announced clean hydrogen consumption in industry per country by 2030 in Europe (Mt/year)



Cumulative announced consumption of clean hydrogen in industry by 2030 in Europe (Mt/year and # of projects)



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Thank you!

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THE OXFORD INSTITUTE FOR ENERGY STUDIES

A world leading independent energy research institute

About us: Key research expertise

Energy Transition

- Implications of the energy transition for oil, gas and electricity
- Development of global climate policies
- Regulatory frameworks to enable investments in low-carbon technologies

Hydrogen

- Comparison of alternative production approaches for clean hydrogen and derivatives
- Comparison of approaches to hydrogen transport and storage
- Policy support mechanisms to drive investments in hydrogen infrastructure

Gas

- Global gas and LNG markets, price trends and outlook
- Modelling of long-term scenarios for global gas balances
- Regional analysis with focus on Europe, Russia, Asia, South America and MENA regions

Electricity

- Market design and the integration of renewables into the power sector
- The role of key generation and storage technologies in decarbonising the power sector
- The need for system flexibility and the role of flexible demand and distributed energy resources (DERs)

Carbon Management

- Role of carbon capture and storage in decarbonised economies
- Applicability of CCS in hard-to-abate sectors, such as steel and waste-to-energy
- Policy frameworks to support regional and international carbon management activities

Oil

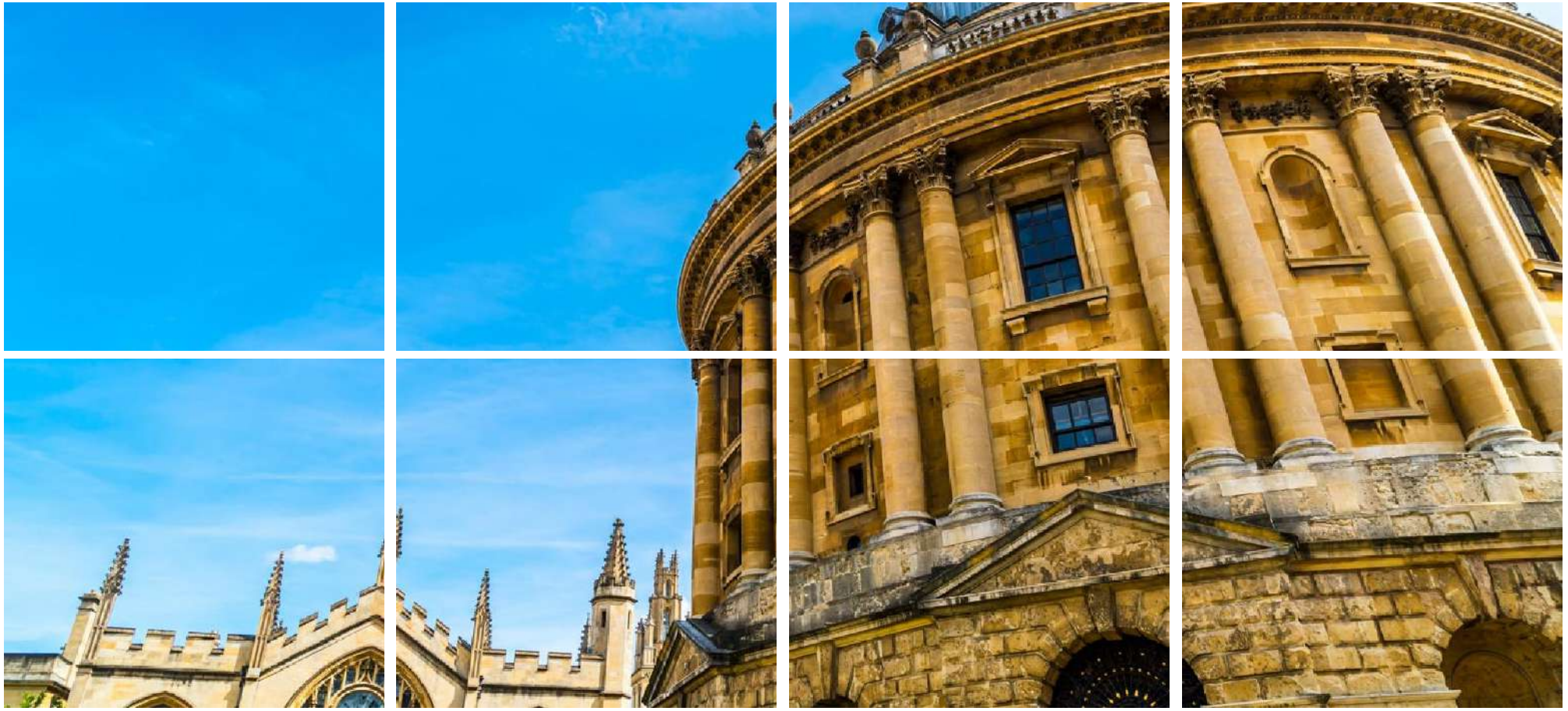
- Global market outlook with balances and price forecasts
- Modelling and scenario analysis OPEC+ policy drivers and dynamics Oil pricing benchmark analysis Geopolitics of oil markets
- Focus on policy, macroeconomic and strategic drivers for oil exporting economies

China

- The energy implications of the macroeconomic and political environment in China
- Short term oil and gas demand and impact for global markets
- The role of hydrocarbons in China's energy transition
- Development of renewables and cleantech in China

Our research on hydrogen: Some key findings to date

- Hydrogen is **in competition with other decarbonisation alternatives**
- The business case for clean hydrogen **currently relies on government policy** to drive decarbonisation
- It is **essential to understand emissions** associated with potential hydrogen investments.
- Hydrogen investments need to consider the **full value chain** and its geopolitics.
- **Transport of hydrogen is expensive** and so should be minimised (at least at the moment).
- **Storage of hydrogen** is an essential part of the value chain and **requires more focus**
- The **development of the clean hydrogen vector is impossible without a reliable and stable demand for decarbonised H_2**



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Research Institute for Sustainability

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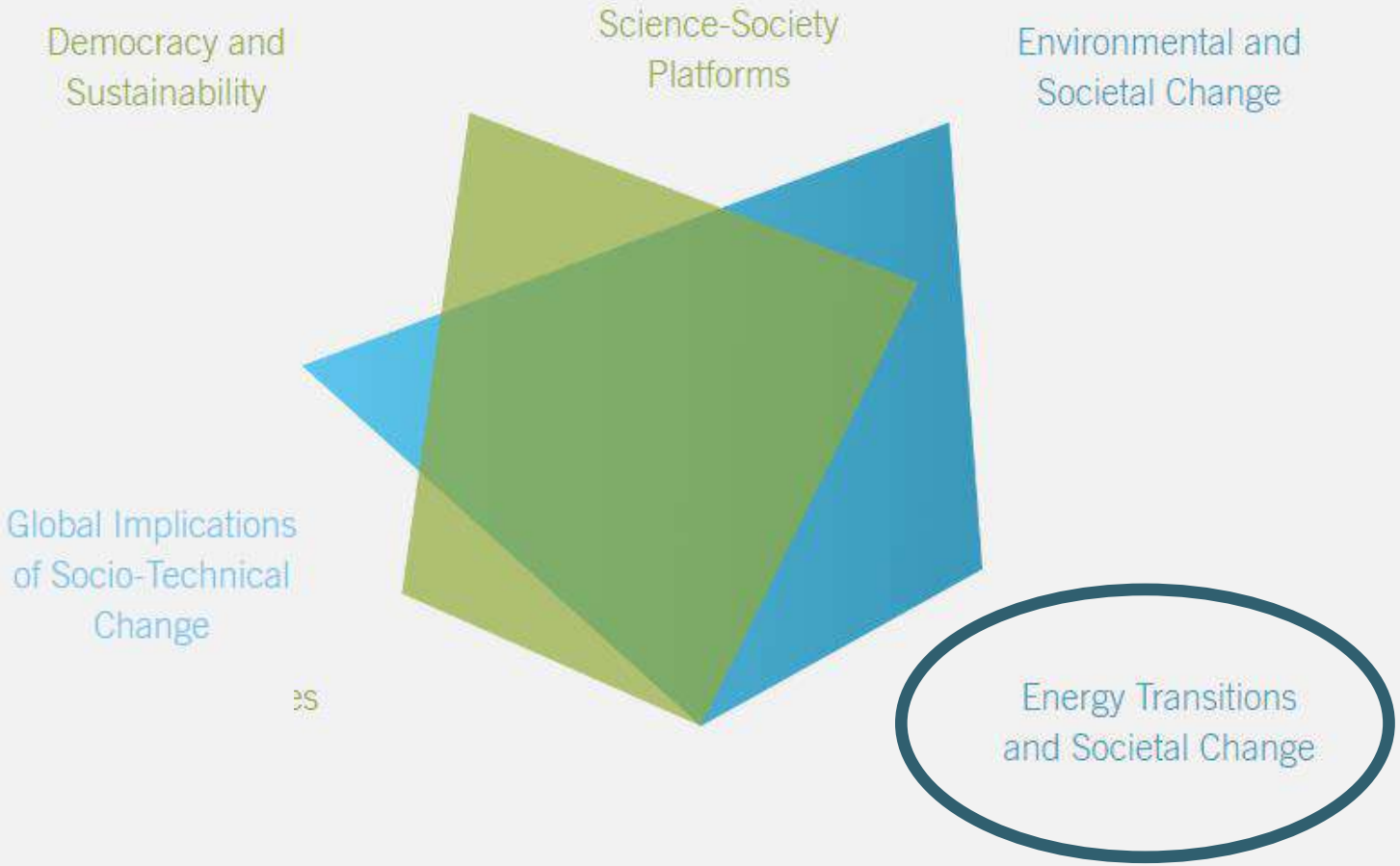
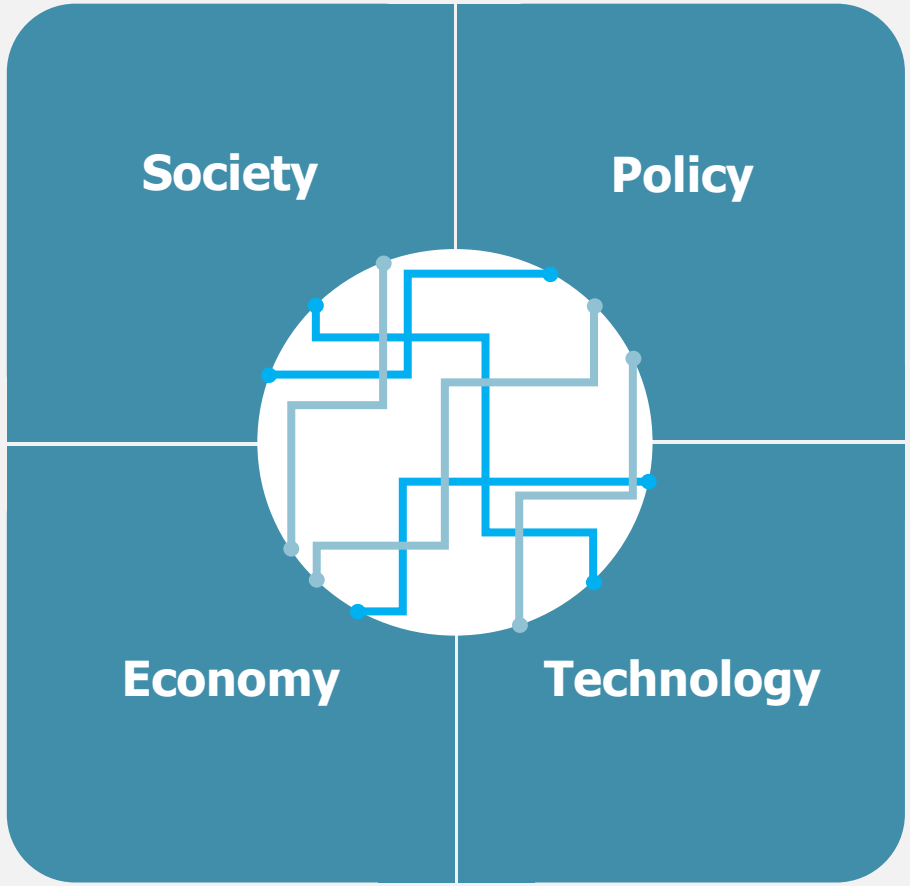
Transformational sustainability research

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

Transformational sustainability research

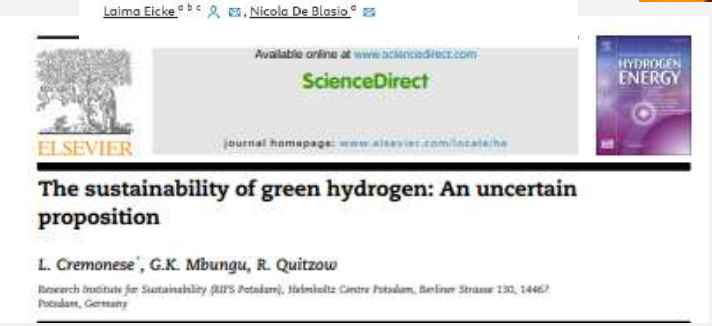


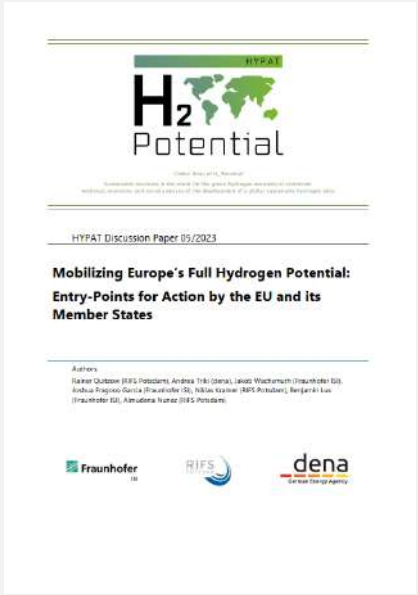


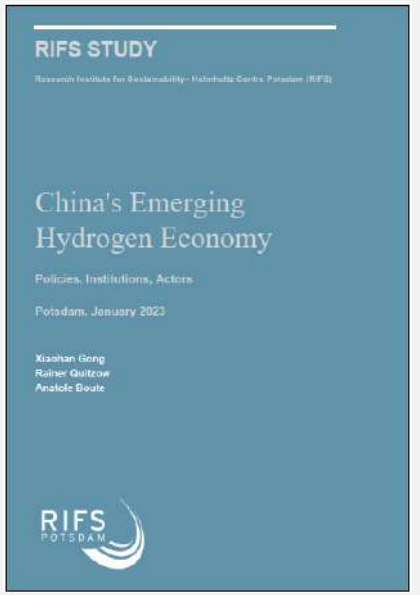
Geopolitics of Transitions in Energy and Industry

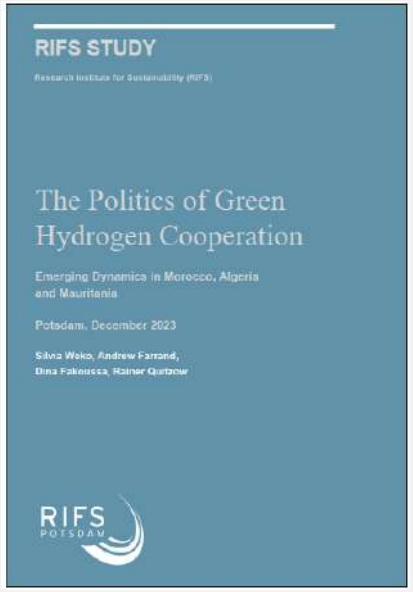
Our hydrogen research in focus

- **Independent research on the politics and policies of an emerging hydrogen economy**
- **Geopolitics and industrial policy perspectives**
- **Academic & policy-oriented publications**



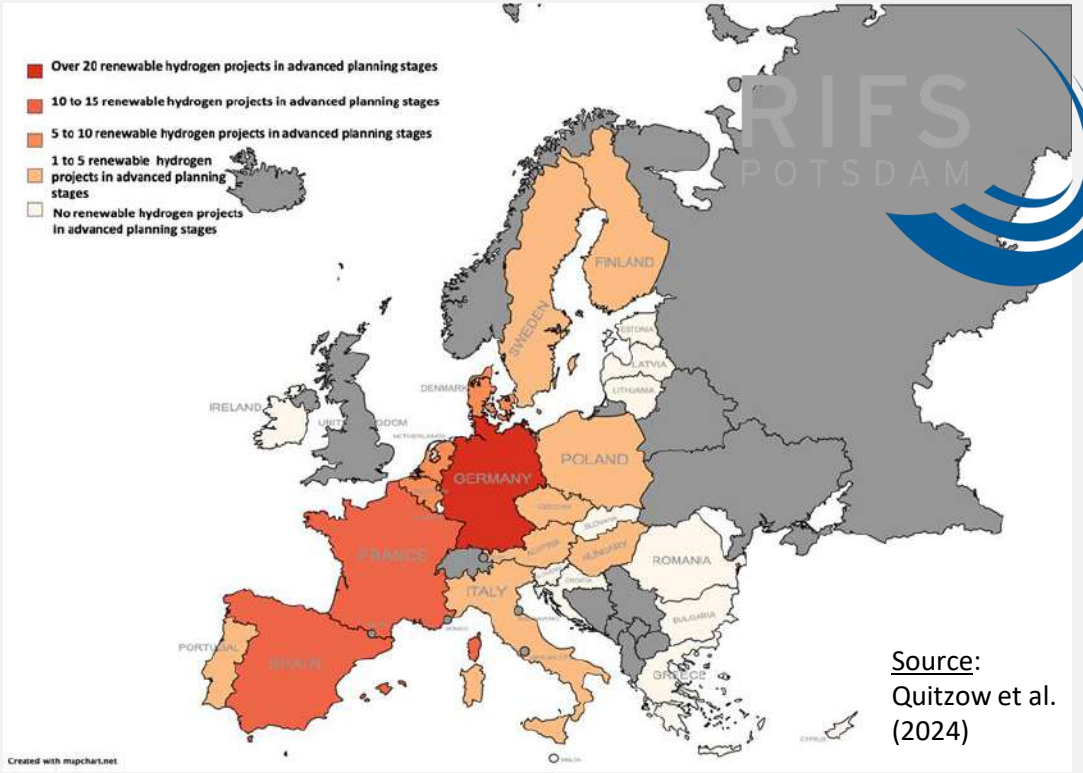




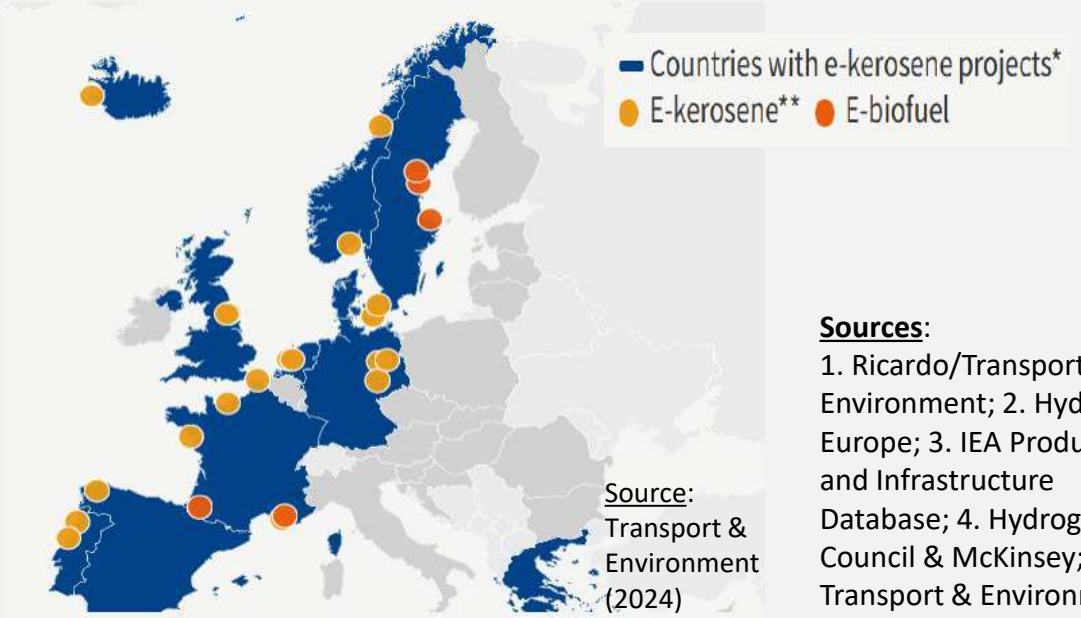


Hydrogen demand in perspective

EU Policy	Estimated demand
RED RFNBO target – transport	≈1 Mt
RED RFNBO target – industry	≈3.5 Mt
Total	**≈4.5 Mt[1]**
Green Hydrogen Capacity	
Operational	228 MW[2] / ≈0.03 Mt
FID or under construction	3 GW[3] / ≈ 0.3 Mt
Announced capacity	10 Mt
EU Policy	**Estimated demand**
REFuelEU target – e-kerosene	**≈0.6 Mt[5]**
E-Kerosene Capacity	
Operational	0
FID or under construction	0
Announced capacity	1.7 Mt[5]



Source: Quitzow et al. (2024)



Source: Transport & Environment (2024)

Sources:
1. Ricardo/Transport & Environment; 2. Hydrogen Europe; 3. IEA Production and Infrastructure Database; 4. Hydrogen Council & McKinsey; 5. Transport & Environment

HYDROGEN DEMAND: A CRUCIAL ELEMENT FOR THE HYDROGEN RAMP-UP

- **Hildegard Bentele**, ***Member of the European Parliament,*** Group of the European People's Party (Christian Democrats)

- **Stefanie Hiesinger**, ***Head of Unit - Low Carbon Solutions,*** DG CLIMA, European Commission

Introduction to the seminar

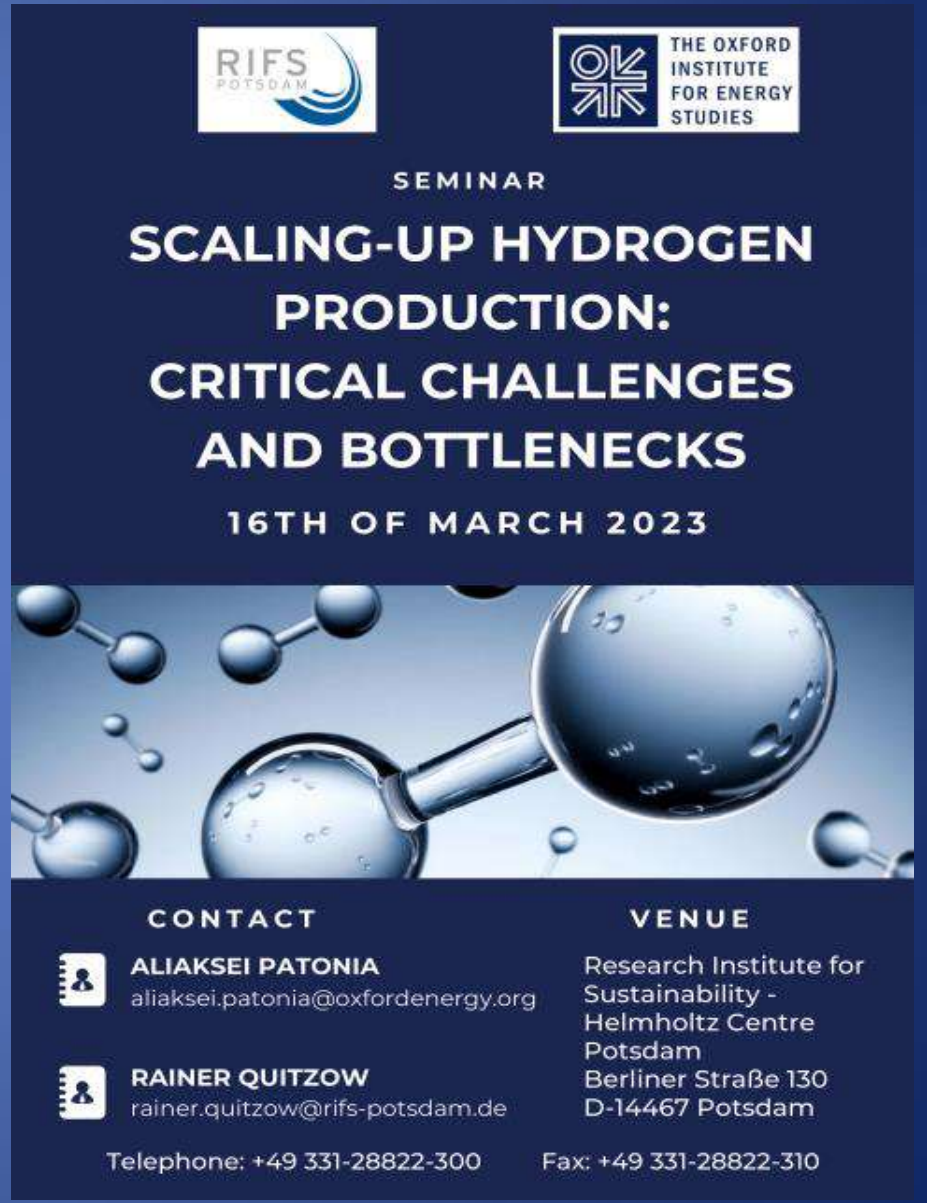
INCENTIVISING HYDROGEN DEMAND: CRITICAL CHALLENGES & OPPORTUNITIES

Aliaksei Patonia

Research Fellow, Oxford Institute for Energy Studies

Background

- This semiar is a continuation of last year's joint efforts of OIES and RIFS
- The seminar is hosted by ERCST – our new partner with extensive expertise in European policy analysis
- Last year's seminar focused on the supply side. It aimed to identify the main challenges and bottlenechs of clean hydrogen production
- Last year's seminar was held at RIFS in Potsdam – one of Germany's key research sites
- This year's event is organised in Brussels – the heart of Europe's policymaking



Context

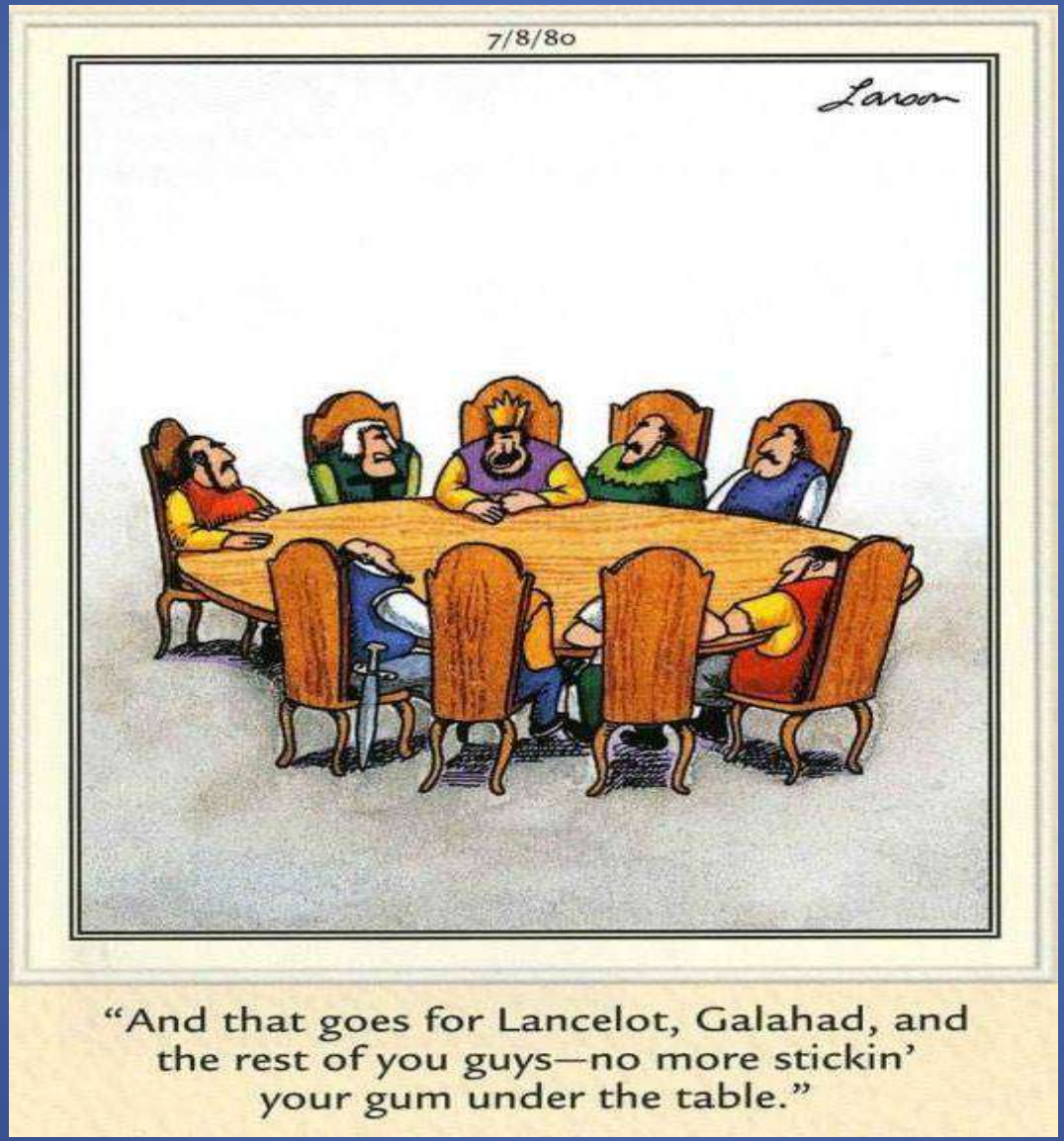
- A lot has been said about the importance of hydrogen for a net-zero carbon future
- However, it is still not clear if hydrogen will play the role it is expected to play
- At the moment, most of the global attention has been paid to hydrogen **production**
- Insufficient **attention** is drawn **to hydrogen storage and delivery**
- Even **less attention** is being **paid to hydrogen demand**
- However, it is clear that creating a **stable and sustainable demand for clean hydrogen** is **essential for a viable H_2 economy**

Uncertainties

- Is hydrogen the best decarbonisation solution for all the hard-to-abate sectors?
- Is hydrogen going to address all the challenges of carbon emissions?
- How can we secure a stable and sustainable long-term demand for clean hydrogen?
- What are the key challenges associated with the ramp-up of stable demand for clean hydrogen?
- What are the key enablers of hydrogen demand?

Roundtable format

17 speakers



>30 discussants

2 coffee breaks for discussions and networking

…and lunch

Programme

10:15	**Session 1:** **Creating hydrogen demand: Decarbonising hard-to-abate sectors** • What are the key sectors that can create initial demand for hydrogen? • How can hydrogen help to decarbonise these (hard-to-abate) sectors? • Are there any other alternatives and would they be better (e.g., CCUS)?	Aliaksei Patonia, *Research Fellow,* Oxford Institute for Energy Studies Bert De Backker, *Policy & Strategy Manager, EAME,* ExxonMobil Hans Zillig, *Energy Buyer Hydrogen,* ArcelorMittal Tomasz Włostowski, *Plenipotentiary for the EU Affairs,* Grupa Azoty SA Kei Fujiwara, *Technical Manager,* Mitsui O.S.K. Lines
12.15	Lunch	

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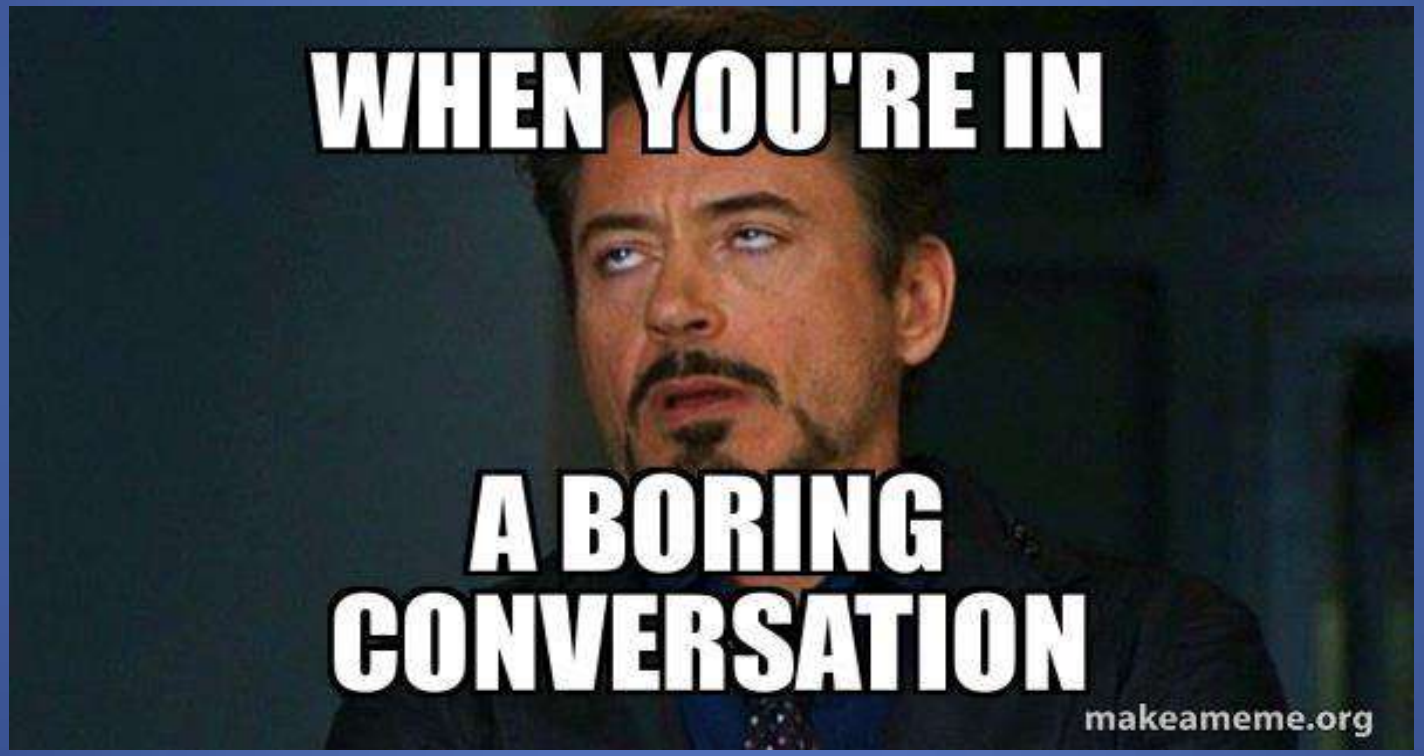
13:15	**Session 2:** **Creating hydrogen demand: Market design, legislation/regulation, and bankability** • What approaches can be employed in designing long-term hydrogen contracts to sustain incentives for carbon market hedging? • Should the RED III sectoral uptake targets be supplemented with additional goals? • Would an offtaker-neutral or sector-specific approach be more beneficial for targeted EU funds?	Olivier Imbault, *Senior Fellow,* European Roundtable on Climate Change and Sustainable Transition Timo Bollerhey, *Executive Director,* HINT.CO and *Managing Director,* H2Global Agnieszka Ason, *Senior Visiting Research Fellow,* Oxford Institute for Energy Studies Ruud Kempener, *Team Leader - Hydrogen, Financing and International,* DG ENER, European Commission
15.15	Coffee and networking	

Programme

15:30	**Session 3:** **Catalysing an international hydrogen market: local demand or international offtake agreements?** • What are the main sources of local and international hydrogen demand in potential hydrogen exporting countries? • What are the lessons learned so far with mechanisms for creating demand for imports? • What role can local demand play in paving the way for exports?	Laima Eicke, *Research Associate,* Research Institute for Sustainability Dorothea Nold, *Senior Markets Officer,* HIF Global Herbert Beck, *Senior Advisor,* HyIron Green Technologies & former German Ambassador to Namibia Christoph de Beer, *Principal International Hydrogen Markets,* SASOL
17.30	**Closing remarks**	

Let’s use this opportunity to discuss/ argue/ investigate



Active participation is encouraged!

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ERCST Roundtable on Climate Change and Sustainable Transition

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SESSION 1: CREATING HYDROGEN DEMAND: DECARBONISING HARD-TO-ABATE SECTORS

- **Bert De Backker,** ***Policy & Strategy Manager,*** EAME, ExxonMobil
- **Hans Zillig,** ***Energy Buyer Hydrogen,*** ArcelorMittal
- **Tomasz Włostowski,** ***Plenipotentiary for the EU Affairs,*** Grupa Azoty SA
- **Kei Fujiwara,** ***Technical Manager,*** Mitsui O.S.K. Lines

Low Carbon Solutions

Accelerating the world's path to net zero

Hydrogen's role in the transition of the PetroChemical industry

Bert De Backker

Policy Manager EAME - Low Carbon Solutions

ExxonMobil

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Finding your pathway through the energy transition

ExxonMobil Low Carbon Solutions, founded in 2021, leverages our decades of experience in carbon capture and storage, hydrogen production and advanced biofuels to develop a growing portfolio of low-carbon solutions.

Tomorrow’s solutions tailored along today’s energy systems

ExxonMobil

The PetroChemical sector challenge

Very high temperature processes

- Require gas firing, no current electrification technology
- Very large amounts of energy (100’s MW/installation)

Residual gas production

- Inherent to conversion processes
- Fuel replacement with Green H2 no solution

Large H2 feedstock users

- ExxonMobil globally produces/consumes >1 mta H2

Our conclusion

- Core of the solution = Blue H2: cost, residual gas use, scale, reliability
- Potential role for Green H2 with the right policy support
- Technology development remains key

Current generation burner firing 80-85 vol. % Hydrogen

“Proof of Concept” burner 100% Hydrogen

ExxonMobil and Zeeco drive emissions reduction with next-generation ultra-low NOx, 100% hydrogen ready burners

SPRING, TX (February 20, 2024) – ExxonMobil and Zeeco, Inc. today announced a strategic alliance to market the ZEECO® FREE JET® Gen 3™ – next-generation ultra-low NOx, 100% hydrogen ready burner. The new burner can significantly lower emissions for **industrial manufacturers** as they explore fuel switching from natural gas to hydrogen, which could be supplied from ExxonMobil’s planned Baytown low-carbon **hydrogen** project.

ExxonMobil Low Carbon Hydrogen

Hydrogen supply | Low carbon solutions (exxonmobil.com)

What is needed to enable Low Carbon Hydrogen EU investment ?

Maritime Sector Decarbonization

14-Mar-2024

Kei Fujiwara / Technical Manager
Energy, Decarbonization & Offshore Business
MOL (Europe Africa) Ltd.

MOL 商船三井

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Table of Contents

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1 MOL at a glance

MOL Group Fleets
799 vessels

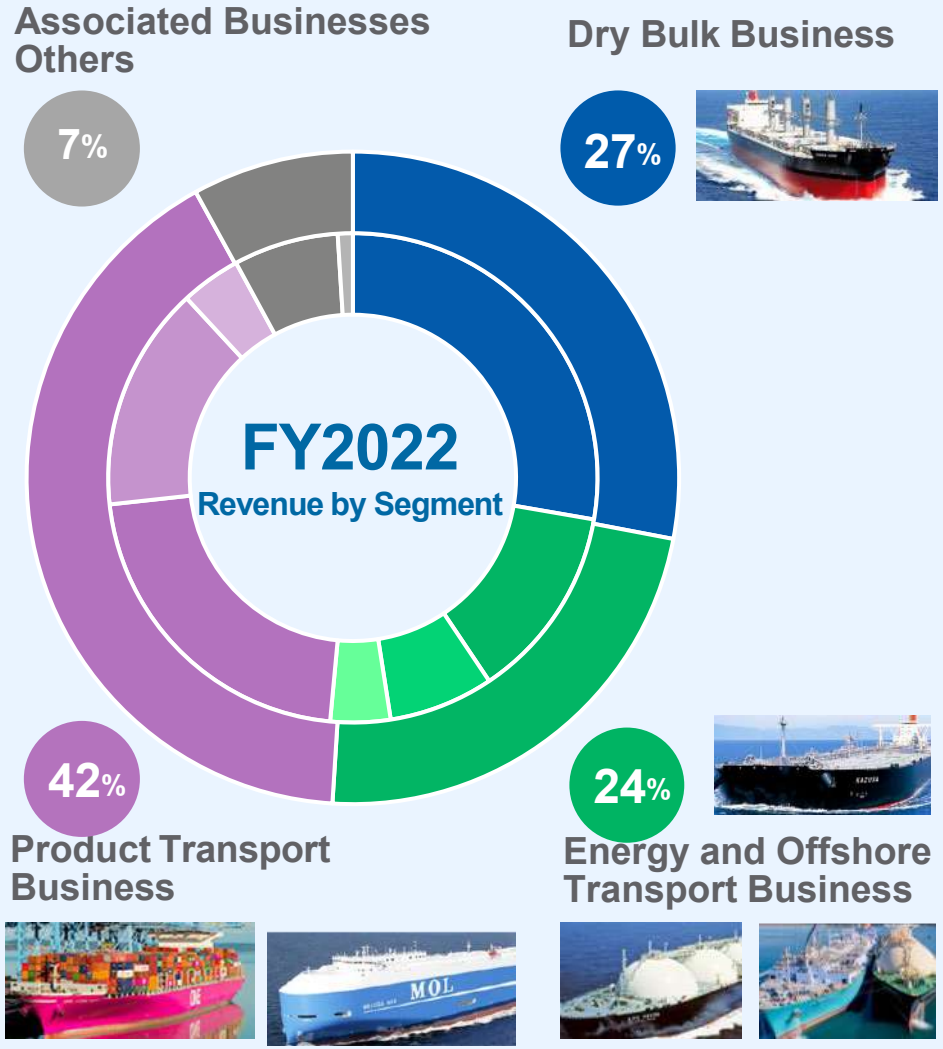
# of Countries MOL Group Bases
44

Revenues
JPY 1612 billion
USD 12.1 billion

# of MOL Group Employee
8,748

# of Group Companies
509

Ordinary profit
JPY811.5 billion
USD 6.1 billion



133 yen＝1USD (Apr 2023)

＊The dividend from ONE is USD 4.7 billion

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2 Background - Maritime Sector Decarbonization

Maritime Sector accounts for approximately 2%[1] of global energy related CO_2 emissions and is recognized as a hard to abate sector.

- IMO GHG Strategy revised at MEPC 80 in July 2023:
  - 2030 – at least 20%, striving 30% reduction, compared to 2008
  - 2040 – at least 70%, striving 80% reduction, compared to 2008
  - 2050 – net-zero
- Regulation Drivers in Maritime Sector:
  - EEDI (Energy Efficiency Design Index): since 2013, requirement for new-built ship
  - EEXI (Energy Efficiency Existing Ship Index): since 2023, requirement for existing ship
  - CII (Carbon Intensity Indicator): since 2023, rating annually based on the actual emission data
  - EU-ETS: since 2024, applied to maritime sector
  - FuelEU Maritime: since 2025, requirement for GHG intensity for the fuels
- Additional IMO Rules (to be discussed at MEPC 81 in Mar 2023):
  - GHG intensity fuel standard
  - Carbon Pricing

1. International Energy Agency - International Shipping – Analysis - IEA

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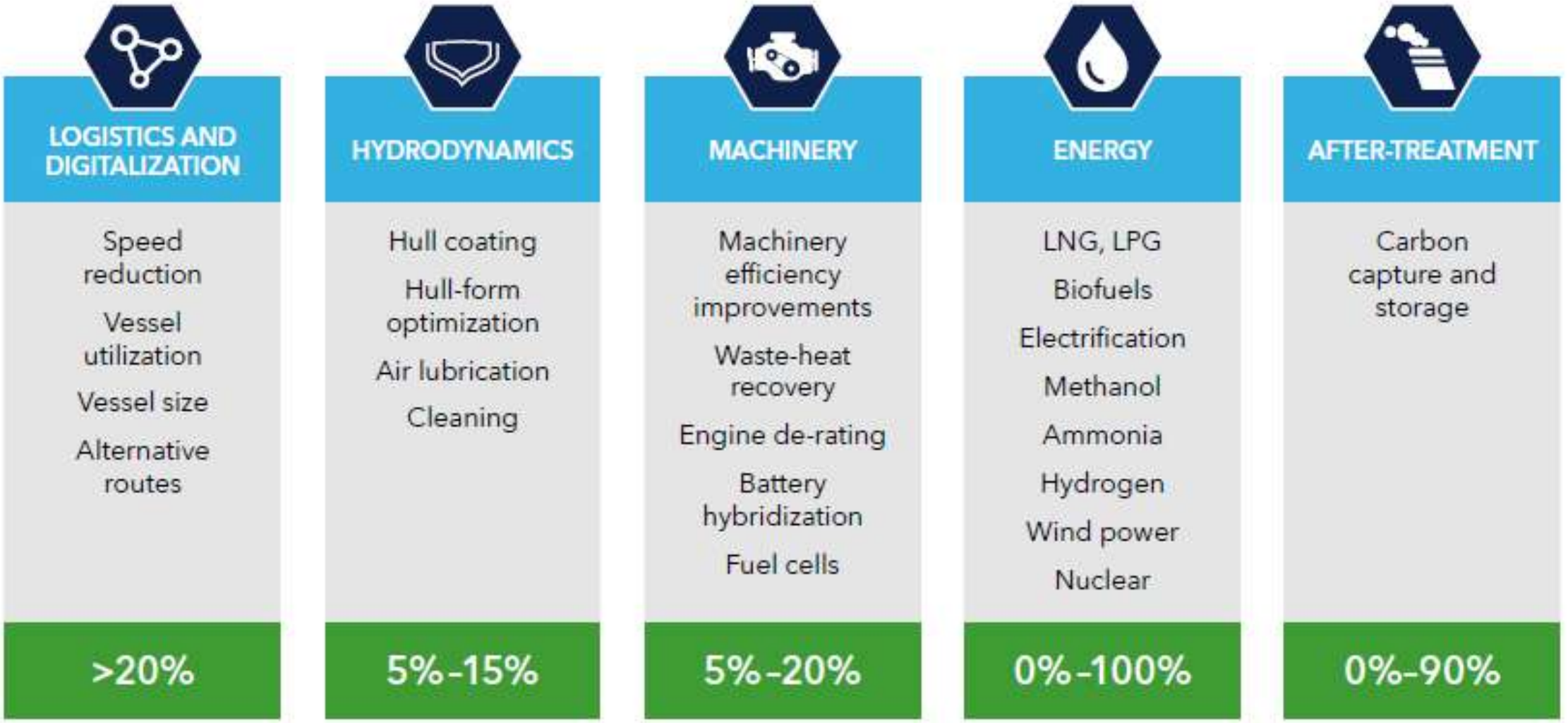
3 Possible Solutions



Source: DNV, Energy Transition Outlook 2023, Maritime Forecast to 2050

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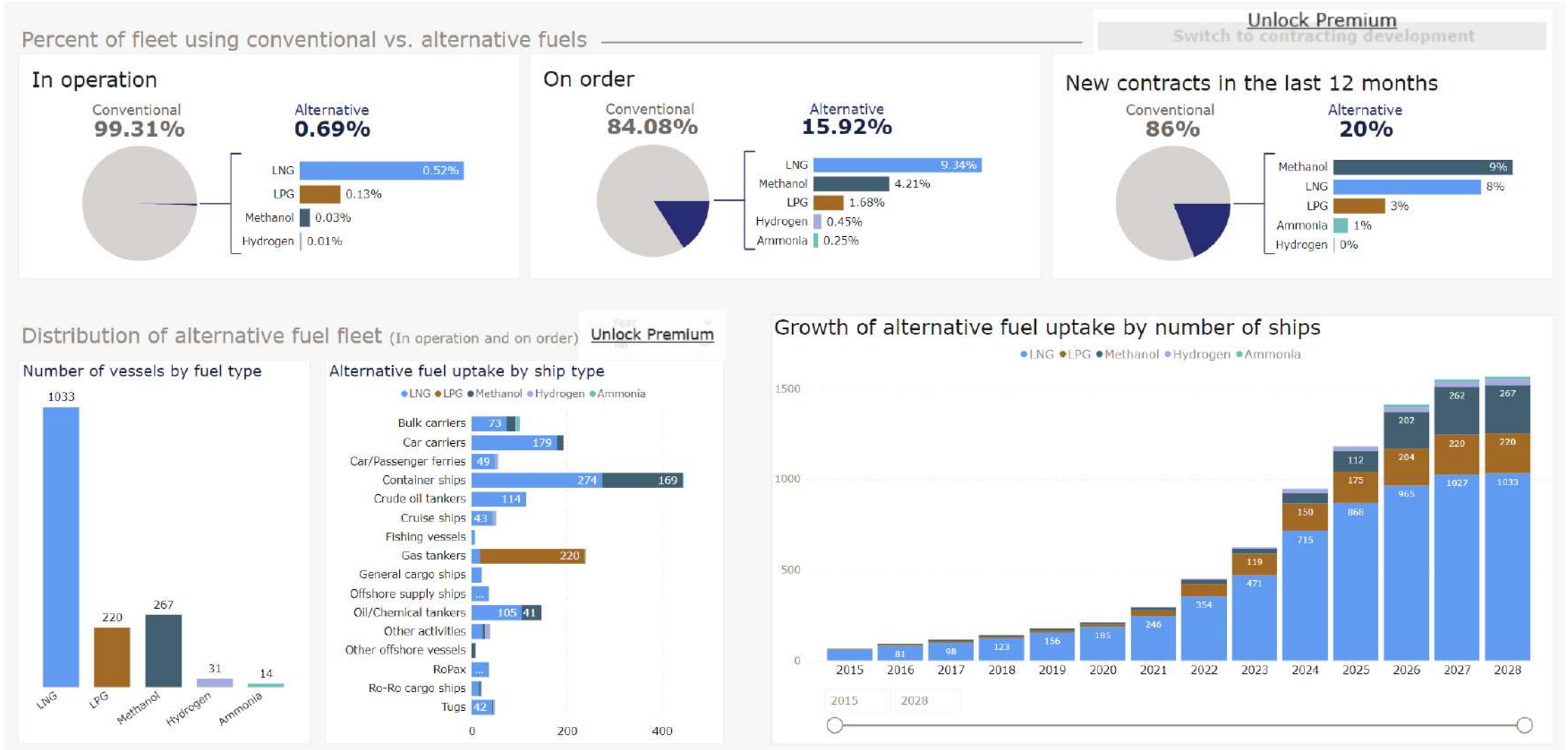
4 H2 Demand Prospect – Current and Near Future Alternative Fuels



Source: DNV, Alternative Fuels Insight

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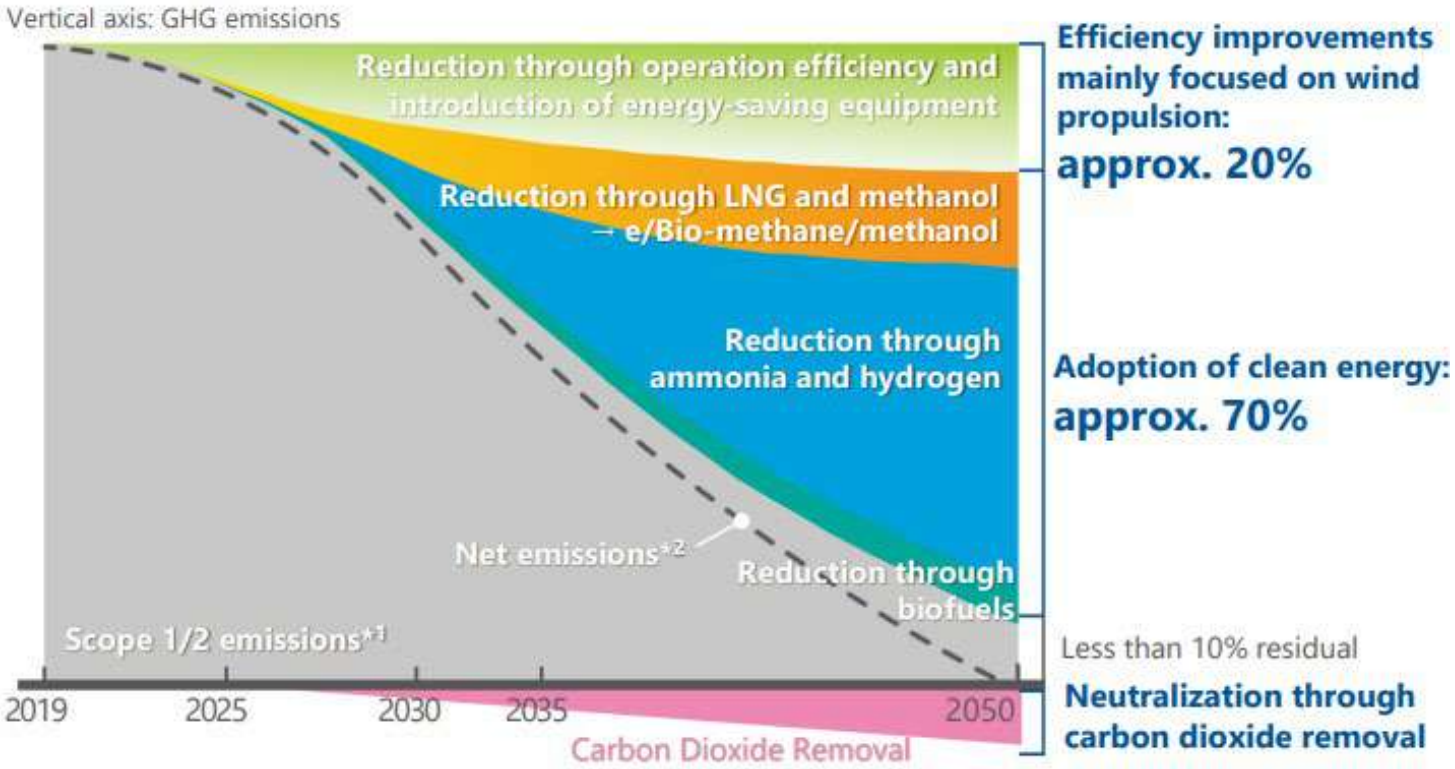
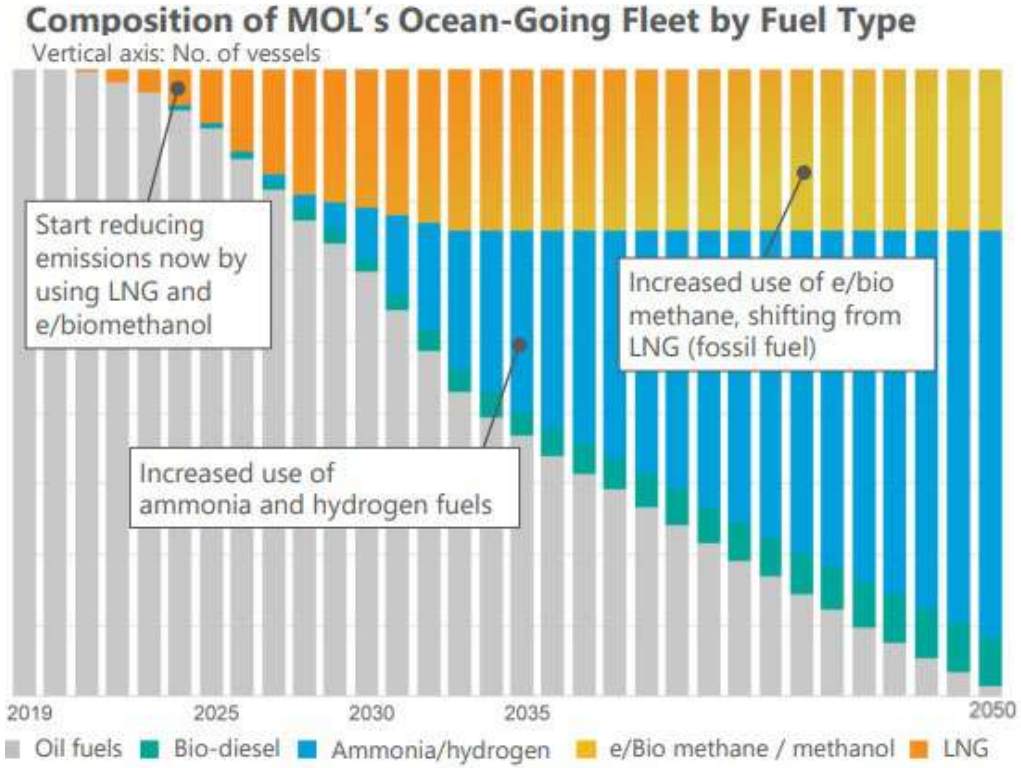
4 H2 demand prospects - MOL Group Pathway to Net Zero

- Proactive Industry leader in actively decarbonizing group operations with a clear pathway to net zero emissions.
- Quantative KPIs in relation to alternative fuel-powered vessels: 2030 LNG/Methanol fueled vessels = 90, 2035 Net Zero Vessels = 130.
- Phasing out of heavy oil a shifting to alternative marine fuels including Ammonia, Hydrogen and battery through development at present day.





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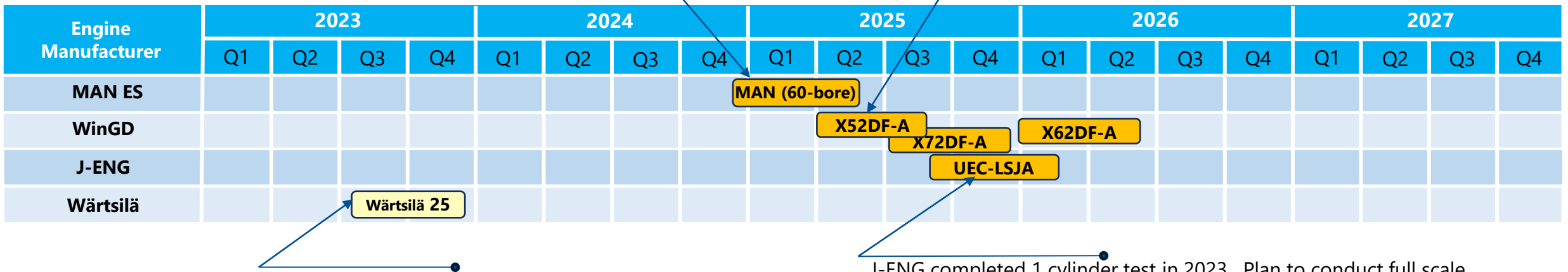
4 H2 Demand Prospect - Ammonia DF Engine Development Status

MAN has successfully completed 1 cylinder combustion tests in 2023. Plan to deliver the 1st ammonia fueled engine (60-bore size) delivery within 2024.
(source: MAN public information)

WinGD plans to conduct all tests in 2024, then plan to deliver the engines in 2025.
(source: WIN GD Technical Seminar in Japan – Nov 2023)



Wärtsilä has already released a smaller size (1.7-3.4 MW), medium-speed, modular 4-stroke marine engine ammonia dual fuel.
(source: Wärtsilä website)

J-ENG completed 1 cylinder test in 2023. Plan to conduct full scale test for about half year in 2025 and complete in Sep-2025.
(source: J-ENG website)

- MAN and J-ENG have successfully completed firing tests with satisfactory results. Concerns regarding N2O content in the exhaust were addressed effectively through engine tuning.
- In the industry, there are about 10 or more projects for designing ships equipped with ammonia-fueled engines. HAZID studies have been conducted or are planned to ensure safety and efficiency. As each classification society oversee multiple projects, the designs are refined through the exchange of mutual feedback.
- Above shows the 1st product released to the commercial. Mass production will start after several years onboard tests.

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5 MOL's activities related to H2 – LH2/Ammonia/LOHC transportation

- With other two Japanese shipping company, NYK and KL, MOL cooperates to develop larger size LH2 carrier built by KHI.
- Teams up with Woodside, HD KSOE and Hyundai Glovis to study transport of LH2.

- Ammonia cargo (LPG/Ammonia cargo) and LOHC cargo (chemical tanker) are technically available.
- MOL is developing larger size Ammonia carrier with ammonia fuel engine.

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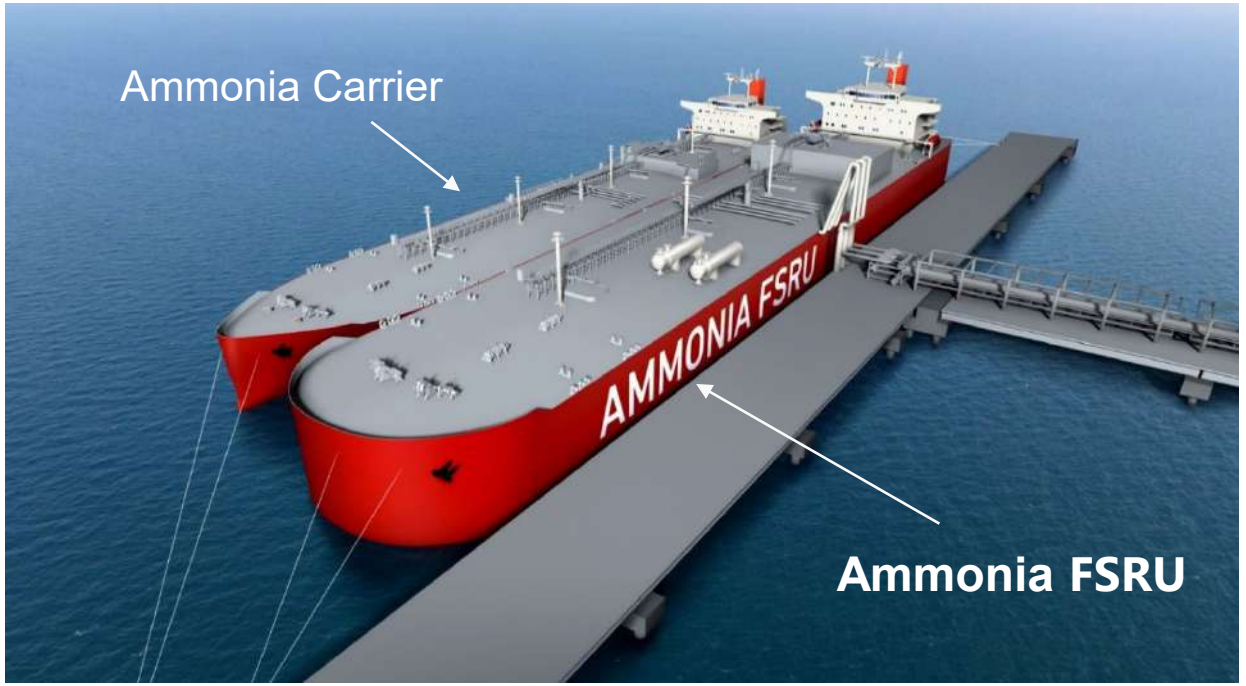
5 MOL's activities related to H2 – Concept Design for Ammonia FSRU

VLGC class (87,000m3) Ammonia FSRU

- Co-developed by MHI and MOL
- Sufficient capacity to receive Ammonia from MGC / LGC / VLGC sized Ammonia carrier
- Regas capacity for Ammonia co-firing or Hydrogen generation plant (cracking)
- Azimuth Thruster & Bow Thruster fitted in case of emergency departure
- Reliquefaction Plant equipped
- Ammonia fueled or cold ironing to achieve zero CO2 emission from FSRU (option).
- Unloading to Ammonia bunkering vessel (option)



NH3 Ammonia Carrier and FSRU
(image)

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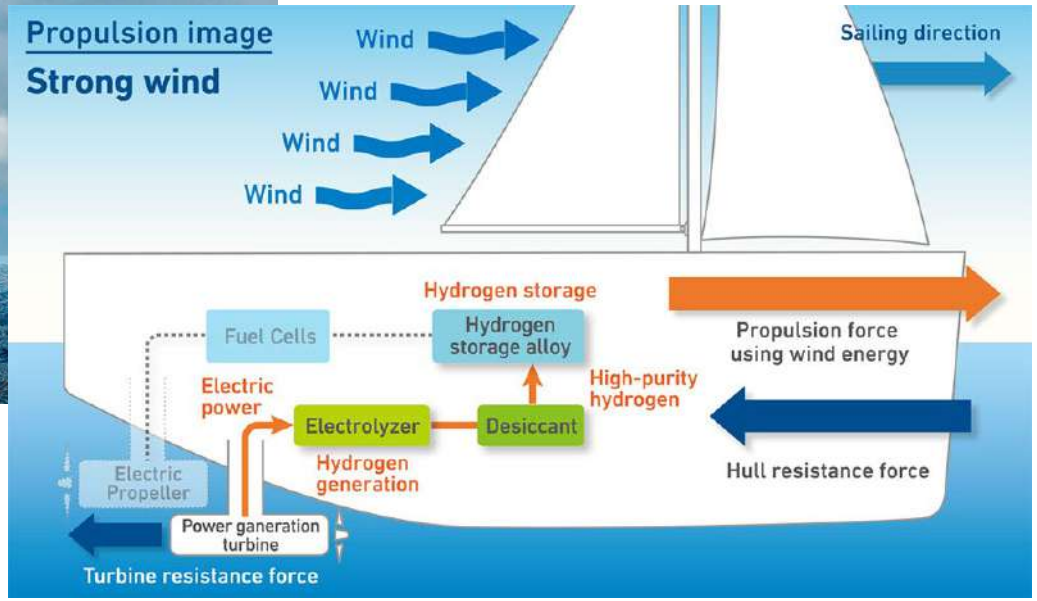
5 MOL's activities related to H2 – Wind Hunter Project



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MOL
商船三井

SESSION 2: CREATING HYDROGEN DEMAND: MARKET DESIGN, LEGISLATION/REGULATION, AND BANKABILITY

- **Timo Bollerhey, Executive Director, *HINT.CO and Managing Director,*** H2Global
- **Agnieszka Ason, *Senior Visiting Research Fellow,*** Oxford Institute for Energy Studies
- **Ruud Kempener, *Team Leader - Hydrogen, Financing and International,*** DG ENER, European Commission

Shaping the global **energy transition.**

Background | Instrument

Timo Bollerhey, February 2024

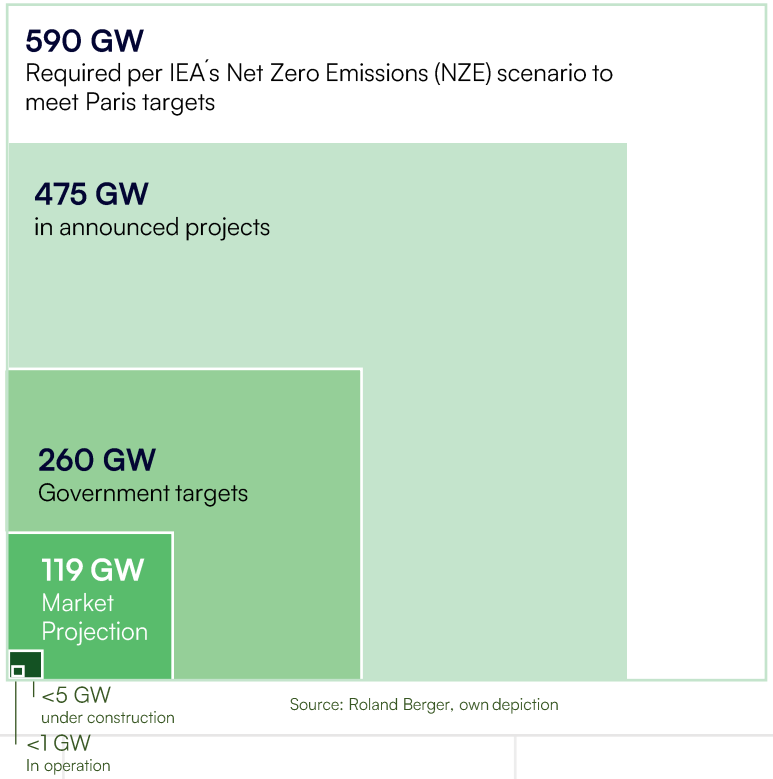
H2Global

The Clean Hydrogen Opportunity

H2Global

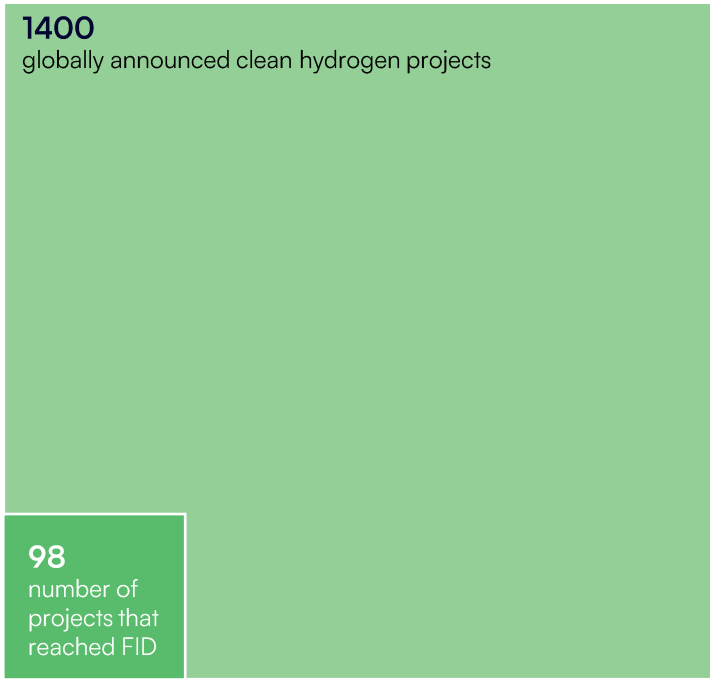
Clean Hydrogen: Ambitions vs. Reality (2023)

Cumulative global installed electrolyzer capacity through 2030



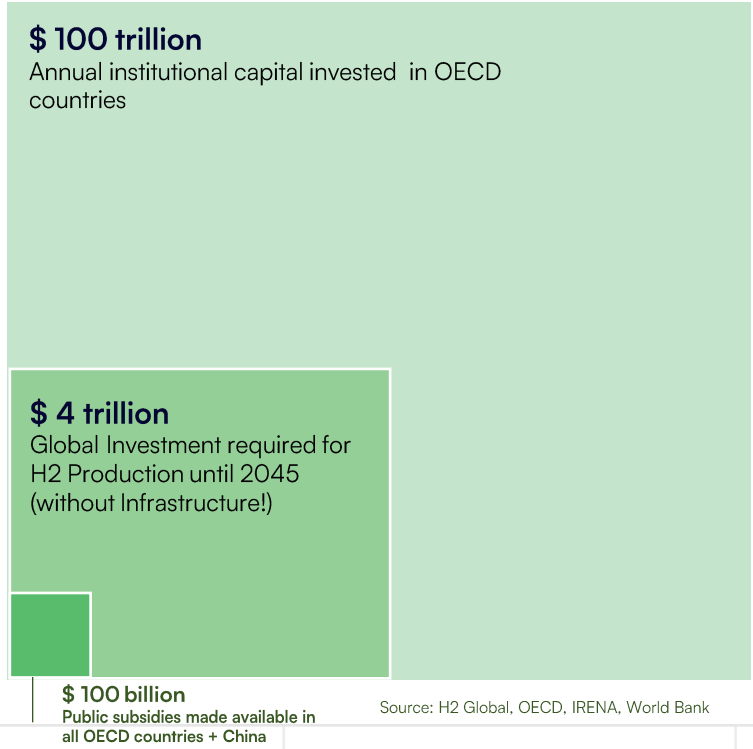
Source: Roland Berger, own depiction

Clean hydrogen projects



Source: H2 Global, Hydrogen Council

Investment Required vs. Public Funding and Institutional Capital available



Source: H2 Global, OECD, IRENA, World Bank

H2Global

The Clean Hydrogen Market Myth

Functioning Market Requirements

- Price Transparency
- Liquidity
- Legal Security / Rules based
- Barrier Free

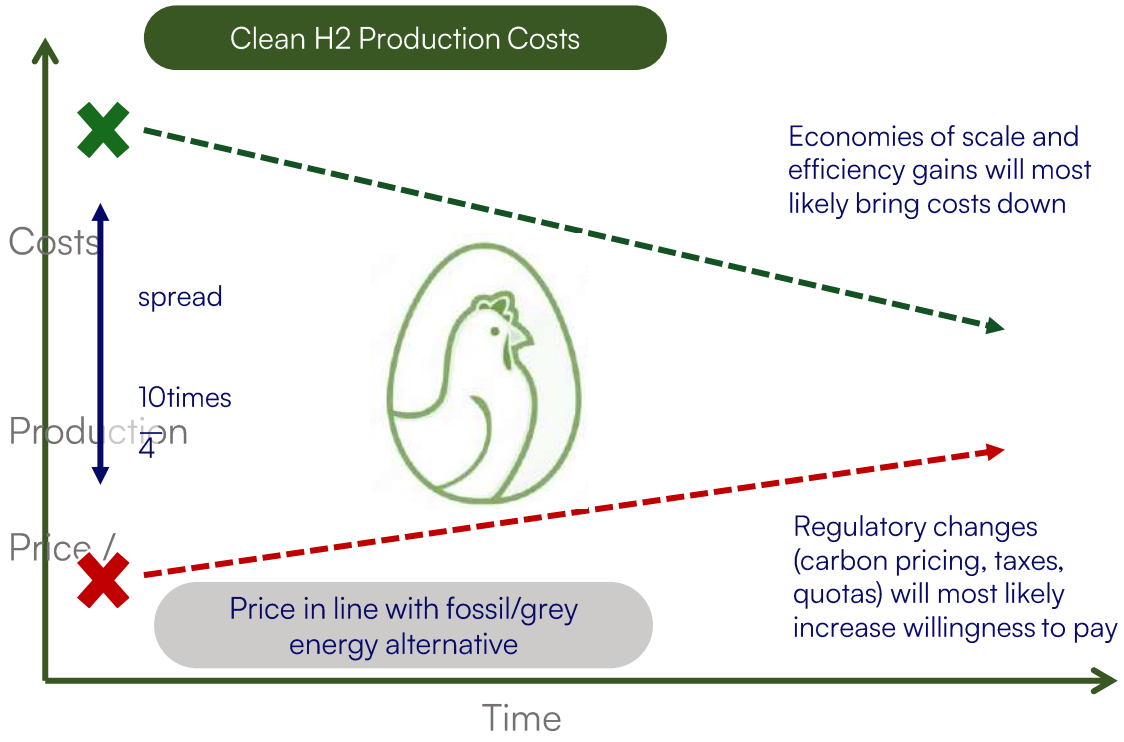
The Hydrogen Market Reality

- Tap in the dark: No pricing signal on supply or demand side, hence no market price
- Indexes only on „assumption base“
- Very limited number of transactions, large volumes only
- Over the Counter (OtC) and „point-to point“ only
- Standards and Certification schemes hardly in place
- Insecurity in terms of recognition and methodologies
- High entry barriers

Before talking about **Market Ramp-Up** we need to talk about **Market-Creation** in the first place

H2Global

Green Commodities' "Offtake-Conundrum"



SUPPLY

- Despite several announcements there are **no long-term and cost-covering offtake**
- Without offtake there is **no Final Investment Decision** (FID)
- Expected **decrease of production costs** delays FID further

DEMAND

- Without regulatory stimulus**, there is no/limited willingness to pay a "green premium"**
- Without supply security at price-comparable conditions, there is **no demand uptake**

H2Global

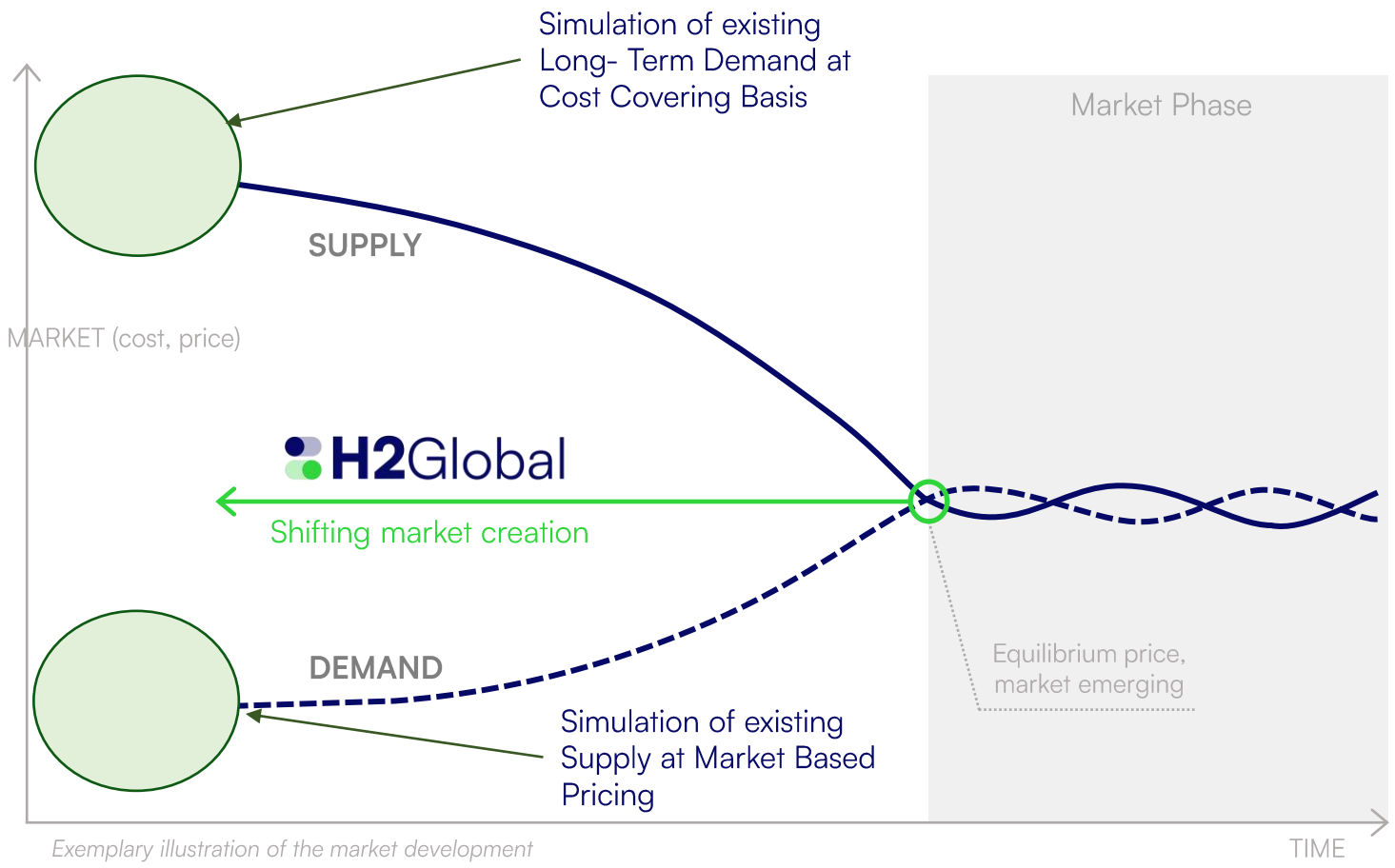
The H2Global Mechanism

H2Global

Market simulation has a catalytic effect and shifts market creation forward

Simulate to Create

Immediate creation of **simulated market** on **supply** and **demand side.**



Exemplary illustration of the market development

H2Global

H2Global's mechanism promotes timely and effective market ramp-up of green commodities such as clean hydrogen

Key elements

Bridging

Creating business cases and investment security.

Shifting the timing of market creation by promoting the market ramp-up until a viable low-carbon market has developed.

Defined System

Long-term purchase agreements over 10 years.

Clear definition of max. funding volume, products, geography and (sustainability) criteria by funding body.

Cost of Difference

Financial compensation of Cost of Difference.

Set up of an intermediary — the **H**ydrogen **Int**ermediary **Co**mpany.

Hintco

Competition-based

Double-auction: Market-based bidding procedures on the supply and demand side.

Minimization of the price difference to be compensated by public funds.

H2Global

Competition-based auctions for the purchase and resale of clean hydrogen and its derivatives through the intermediary Hintco

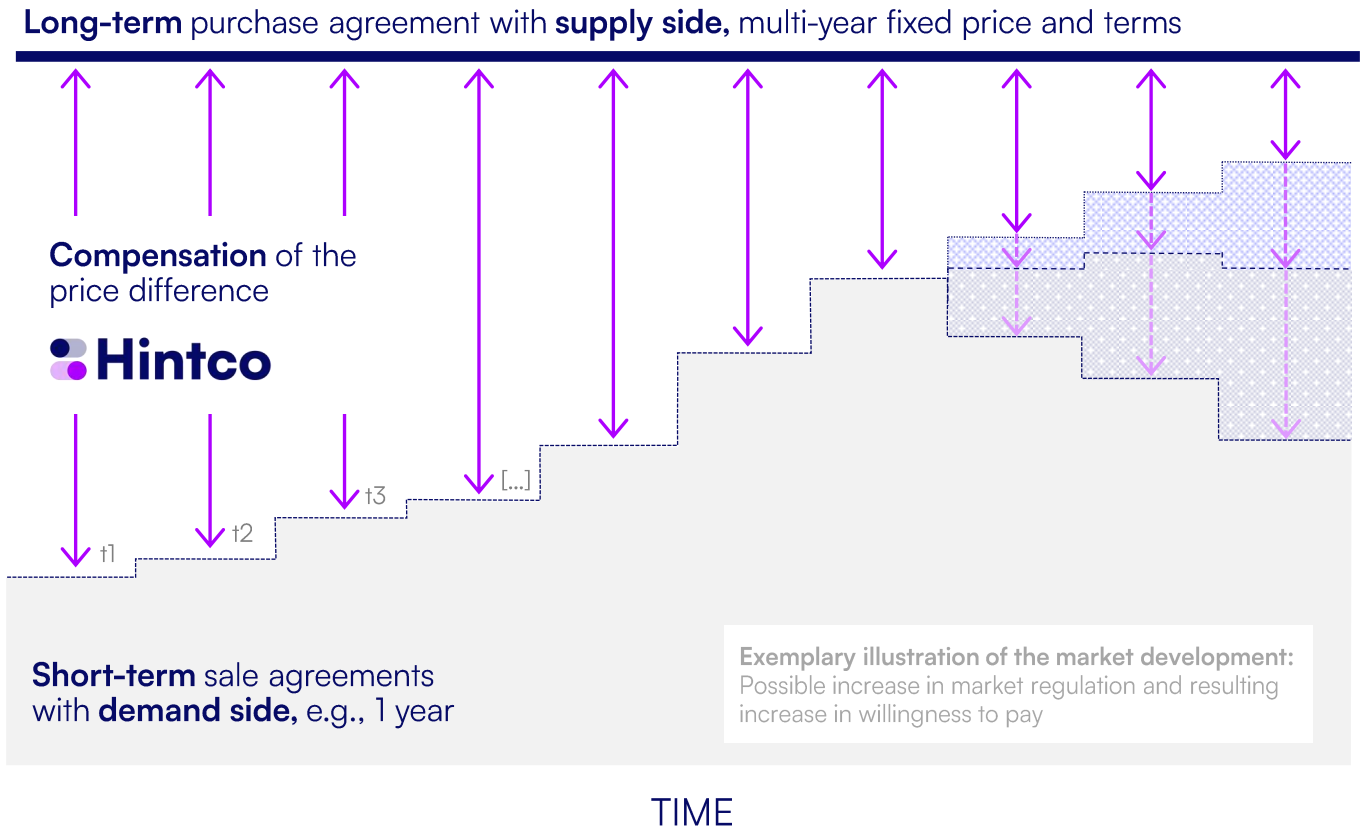
H2Global

The H2Global market-driven compensation mechanism ensures the most efficient use of funds for maximum impact

Core value of H2Globals auction design:

H2Global auctions **uncover supplier** and **offtake pricing dynamics.**

To create **liquidity** and support market development, **short-term** and **broad-based price signals** are **decisive.**



H2Global

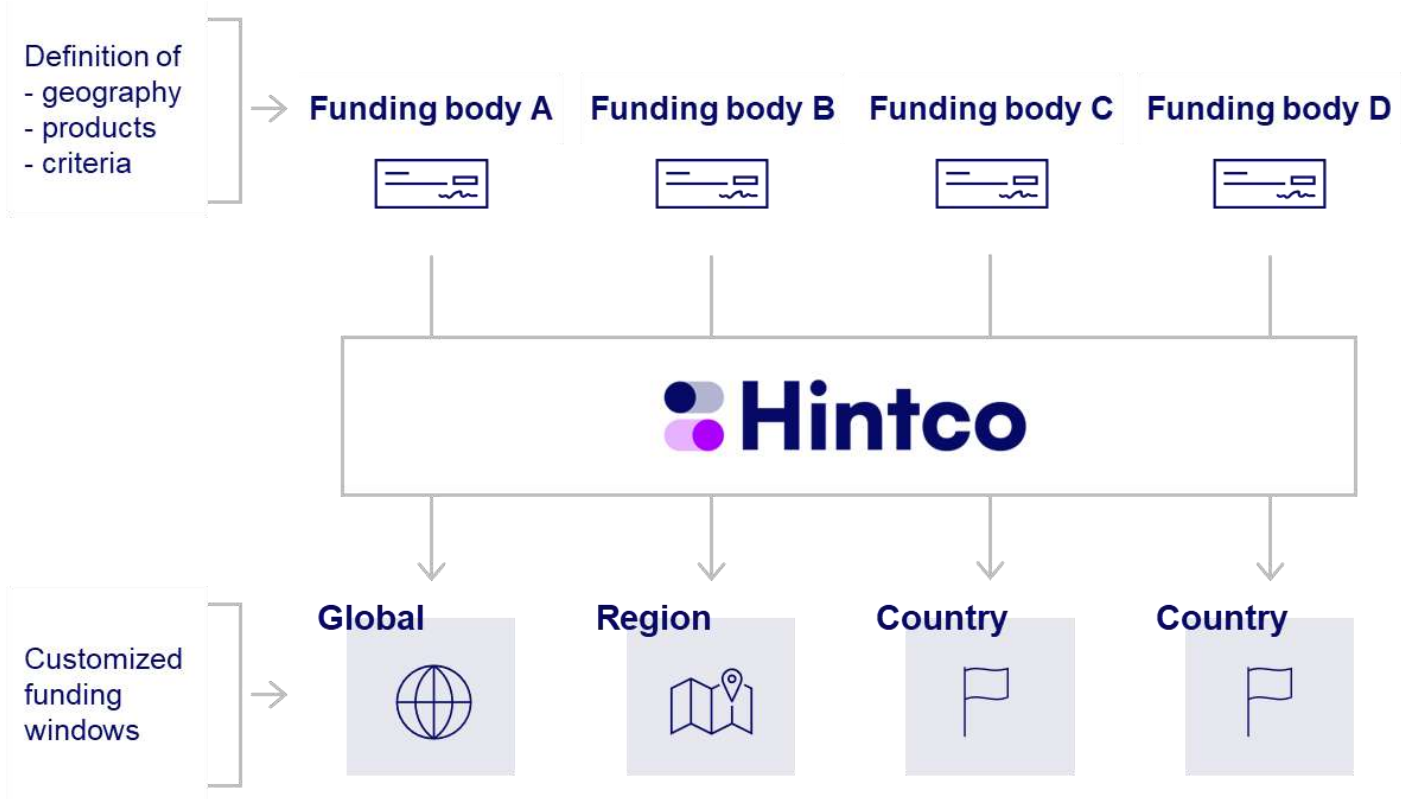
The flexible instrument empowers governments to shape the global hydrogen market through customized funding windows

Customized regarding:

- Geography (global, regions, countries)
- H2 product selection
- Product and sustainability criteria

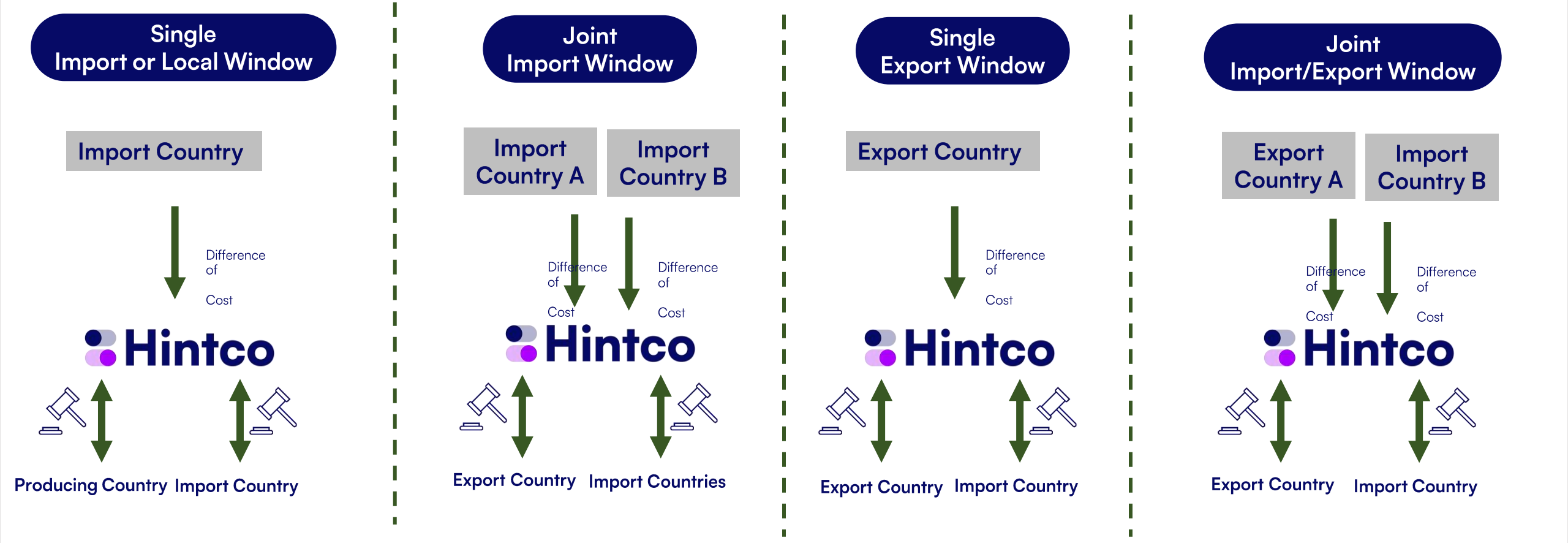
Adaptable to targets:

- Price optimization
- Promotion of green technology
- Energy policy
- Decarbonization of specific sectors
- Development policy



H2Global

Exporters and importers of clean hydrogen can all make use of H2Global's funding windows



H2Global

H2Global's concept is attracting worldwide interest...

*Engaged in discussions at various levels

Canada
H2Global Joint Funding Window

USA, DoE
Knowledge exchange on H2Global approach

Europe
Import Leg of European Hydrogen Bank

Germany
€6.13bn multiple tenders

Netherlands
€0.3bn H2Global Joint Funding Window

Norway*

Belgium*

Luxembourg*

Austria*

Colombia*

South Africa*

Namibia*

Chile*

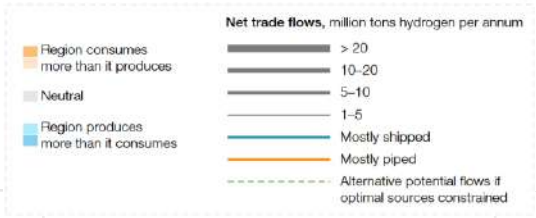
Korea, H2KOREA
Knowledge exchange on H2Global approach

Japan, METI
Knowledge exchange on H2Global approach

Australia
H2Global Joint Funding Window

Saudi Arabia
Knowledge exchange on H2Global approach

UAE
H2Global Joint Funding Window



Major flows of hydrogen and derivatives, million tons hydrogen equivalent in 2050 (Hydrogen Council, McKinsey & Company 2022)

H2Global

The H2Global Set-Up

Independent, non-profit

H2Global

An independent non-profit foundation with a for-profit intermediary is well suited for new market development

H2Global Foundation

- 100% independent from governments
- >65 funders representing the entire hydrogen value chain
- Funders globally distributed
- Governance by elected board of trustees

Hintco

- 100% owned by H2Global Foundation
- Independent from industry

H2Global Stiftung

"Firewall" between donors engaged in the foundation and Hintco prevents conflict of interest

Donors from the private sector across Europe and the world

Independent H2Global Stiftung holds 100% ownership of Hintco

Hintco

€€€

Governments, Philanthropy

Funding body, grant authorities

Funds the price gap

H2Global

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H2Global

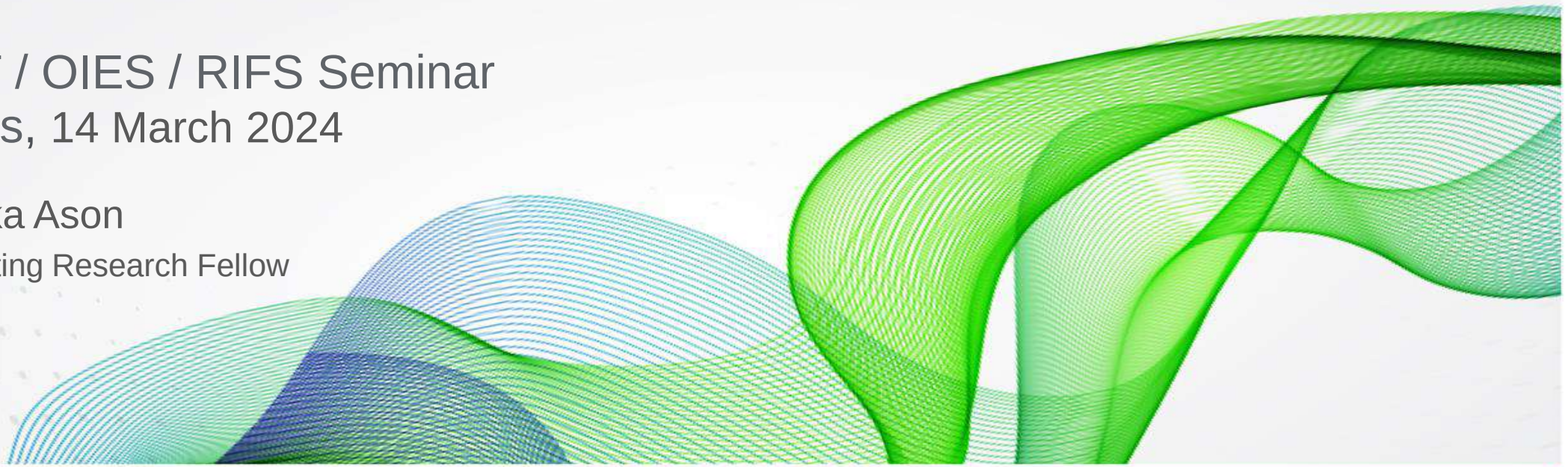
THE OXFORD INSTITUTE FOR ENERGY STUDIES

Incentivising Hydrogen Demand:

Critical Challenges and Opportunities

ERCST / OIES / RIFS Seminar
Brussels, 14 March 2024

Agnieszka Ason
Senior Visiting Research Fellow
OIES



Discussion points

The role of

- regulation,
- the market, and
- long-term contracts

in stimulating hydrogen demand.

Stimulating hydrogen demand through regulation / the market

- The EU has been leading the way in **using regulation to stimulate hydrogen demand.**
- The relevant policy measures have been adopted, or are planned, **both at the EU level and by the EU Member States**. Standardised certification (e.g. CertifHy) and grant support to end users (e.g. to cover the cost premium of fuel cell technologies) are examples of such measures.
- Originally used on the production side, Contracts for Difference (CfDs) and CfD-like instruments are increasingly relevant in the context of stimulating hydrogen demand.
- In a parallel development, but often dependent on regulatory measures, **key market players are taking the lead in developing the hydrogen business.**
- The availability and status of **support schemes in different markets may be subject to change**, which needs to be factored into the investment risk.
- **Long-term contracts are becoming crucial** as a link between hydrogen supply and demand.

The early stage of low-carbon long-term hydrogen contracting

- “Long-term hydrogen contracts”
  - State-level cooperation agreements (hydrogen diplomacy)
  - Pre-contractual arrangements (mainly MoUs)
  - Binding agreements – very few of them

- **Momentum is building for hydrogen offtake agreements**

Hydrogen offtake agreements

Example: Hydrogen Sale and Purchase Agreement (H2 SPA)

Key contract terms

- Contract duration
- Price
- Quantity
- Transportation
- Quality specification

- Contract adjustment
- Force majeure
- Dispute resolution
- Contract termination

Reference points

- **Long-term energy contracts** (LNG SPAs, GSAs, PPAs, etc.)
- **Industry experience** (gas/LNG, ammonia trade, offshore wind investments, etc.)
- **Research** into new low-carbon business and contracting models

Stimulating hydrogen demand through contract design

- Cost-competitive price for hydrogen; scope for price adjustment
- Flexible volume adjustment options and delivery terms
- Security of deliveries (liability for delivery failures; “deliver-or-pay”)
- Structuring liability regime for off-specification deliveries
- Risk allocation in the event of market and regulatory changes
- Efficient dispute resolution and contract termination options
- **Key challenge: balancing the expectations of buyers and sellers**

Managing regulatory uncertainty

The relevant clauses include:

Contract renegotiation clauses

It is hereby agreed that in the event of any major physical or financial change in circumstances … either party may serve notice on the other requiring the terms of this [contract] to be re-negotiated with effect from the date on which such notice shall be served. The parties shall immediately seek to agree amended terms reflecting such change in circumstances and if agreement is not reached within a period of six months from the date of the notice the matter shall be referred to an Arbitrator (whose decision shall be binding on both parties and who shall so far as possible be an expert in the area of dispute between the parties)…

'Meet and discuss', change of circumstances, hardship, similar clauses

In the event that circumstances arise which were not foreseen at the outside of this Agreement, the Seller and the Buyer agree to meet and discuss such circumstances in good faith, with a view of taking actions appropriate to alleviate or eliminate such circumstances or the effects thereof.

Price review clauses

Within 6 months after the beginning of every consecutive 10 Contract Years, commencing on the 10th anniversary of the Commercial Start Date, either Buyer or Seller may request a review of the Contract Price whereupon the Parties shall meet and discuss the matter in good faith with a view to agreeing what Price Adjustment (if any) is required.

Conclusions

- At present, **hydrogen demand is mainly stimulated by regulation**.
- In the future, hydrogen demand creation **will be increasingly market driven**.
- Until at least 2030, most hydrogen projects will rely on government support measures.
- **The risk of regulatory change** needs to be factored into project fundamentals and can become a source of disputes.
- **Long-term contract design can help support hydrogen demand**, especially if priority is given to terms that promote flexibility and serve as a hedge against regulatory uncertainty.

Thank you!

E-mail: agnieszka.ason@oxfordenergy.org

OIES Energy Transition Research: https://www.oxfordenergy.org/energy-transition-research-initiative/

OIES Hydrogen Publications: https://www.oxfordenergy.org/publication-category/hydrogen/

THE OXFORD INSTITUTE FOR ENERGY STUDIES

ERCST Roundtable on Climate Change and Sustainable Transition

RIFS POTSDAM

SESSION 3: CATALYSING AN INTERNATIONAL HYDROGEN MARKET: LOCAL DEMAND OR INTERNATIONAL OFFTAKE AGREEMENTS?

- **Dorothea Nold,** ***Senior Markets Officer,*** HIF Global
- **Herbert Beck,** ***Senior Advisor,*** Hylron Green Technologies & **former German Ambassador to Namibia**
- **Christoph de Beer,** ***Principal International Hydrogen Markets,*** SASOL

HIF eFuels project pipeline around the world

Dorothea Nold

Senior Markets Officer

HIF EMEA

March 2024

Wind in abundance?

Strong winds throughout the year: Capacity factor ~70%
(Average 2022 in Germany[1]: ~20%)

1 Fraunhofer ISE (2023) Öffentliche Nettostromerzeugung in Deutschland im Jahr 2022

HIF Global

We are fueling the world with renewable energy!

HIF LATAM

- Magallanes, Chile
  - Haru Oni demo-plant operational
  - First phase 140 kt_{MeOH}/a
  - 6 following phases 1.3 Mt_{MeOH}/a each
- 500 kt_{MeOH}/a in Uruguay
- EU and Asian market

HIF USA

- 3 phases planned
- Each phase 1.4 Mt_{MeOH}/a
- US and EU market

HIF Asia Pacific

- First phase 185 kt_{MeOH}/a
- 3 following phases 1.3 Mt_{MeOH}/a each
- Australian and Asian market

HIF EMEA

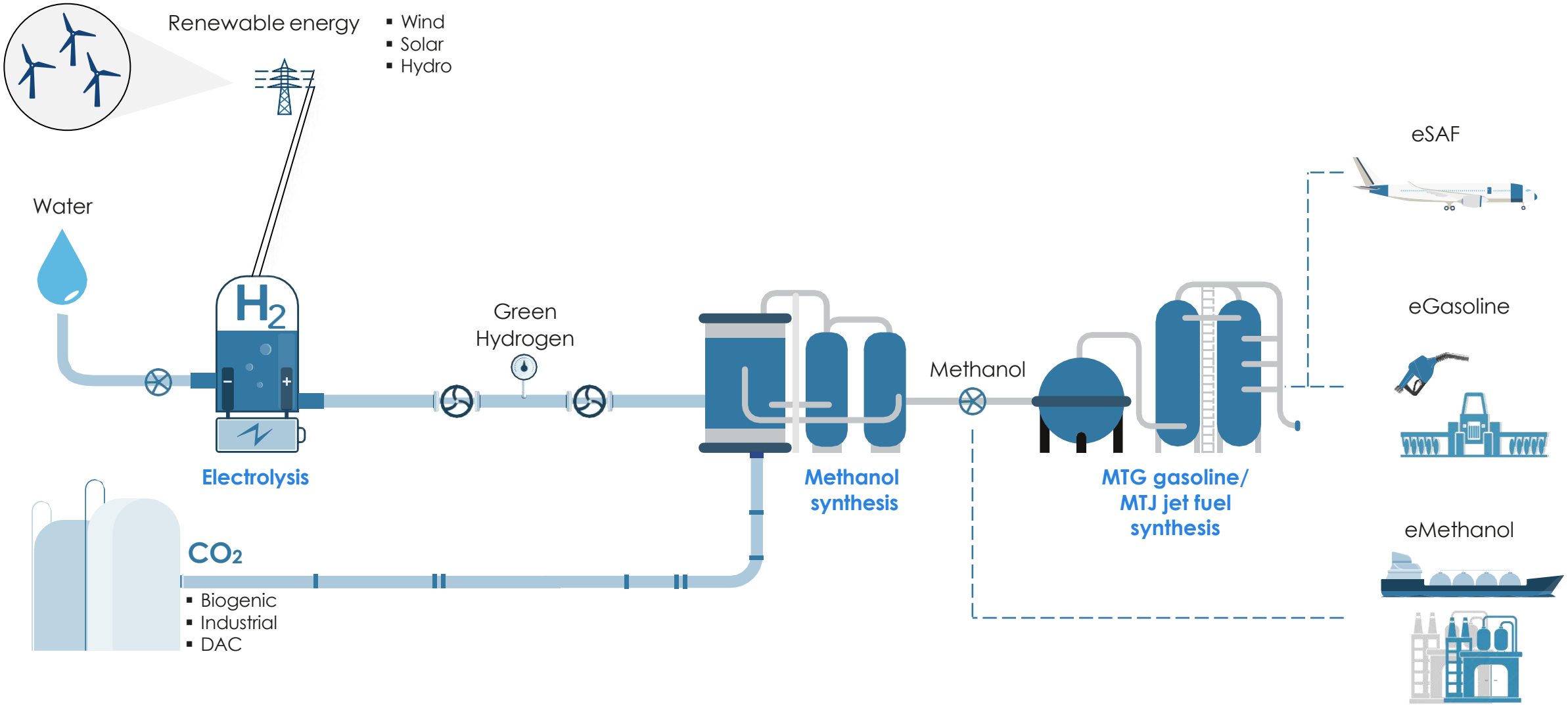
- Commercial office
- Development of eFuels projects in EMEA region
- Headquarter of the HIF Global innovation team

Equity partners

AME, Porsche, EIG, Baker Hughes, Gemstone Investments

HIF's eFuel Production Process: Simple & Proven

Methanol synthesis: maximizing flexibility, optionality and resilience



Diverse eFuels applications

Haru Oni demonstration plant, Chile

First eFuels produced in December 2022

Key stats

Wind turbine capacity	3.4 MW
Electrolyzer capacity	1.2 MW
eMethanol production	350 t/a
eGasoline production	130.000 l/a

World class team

HIF Global as owner and lead developer

Offtaker of the product

Provides MtG technology

Joint R&D in eLPG

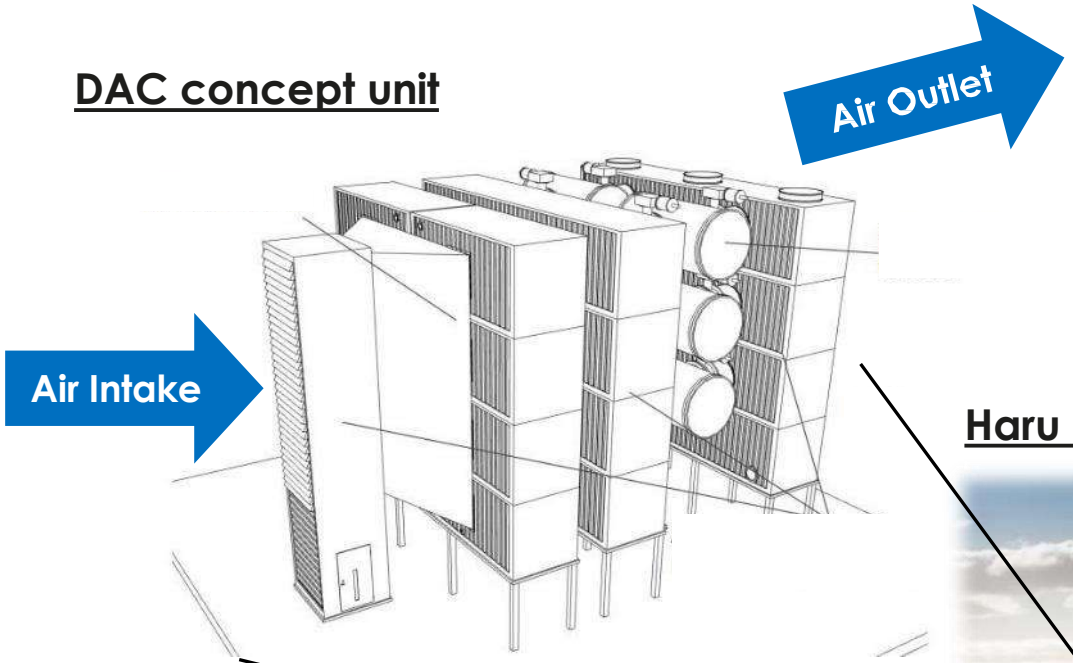
Technology provider and integrator

Partner for wind power gen. and H_2 production

Infrastructure service provider

Extending Haru Oni in Chile with Direct Air Capture (DAC)

DAC concept unit



Haru Oni demonstration plant

Key stats

- ✓ 2024 installation at HIF Haru Oni
- ✓ Up to 600 tons per year of captured CO_2
- ✓ On-top output: water

World class team

VOLKSWAGEN AKTIENGESELLSCHAFT

HIF

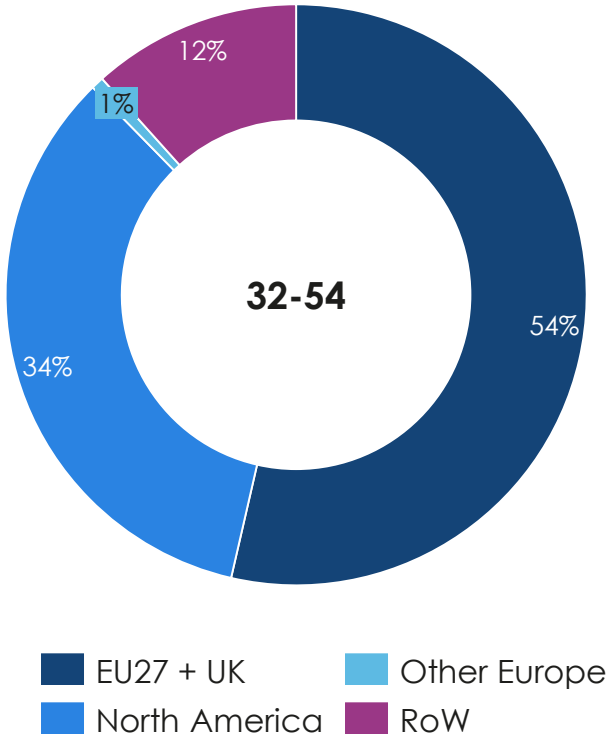
PORSCHE

MAN Energy Solutions

Where will demand in 2030 comes from?

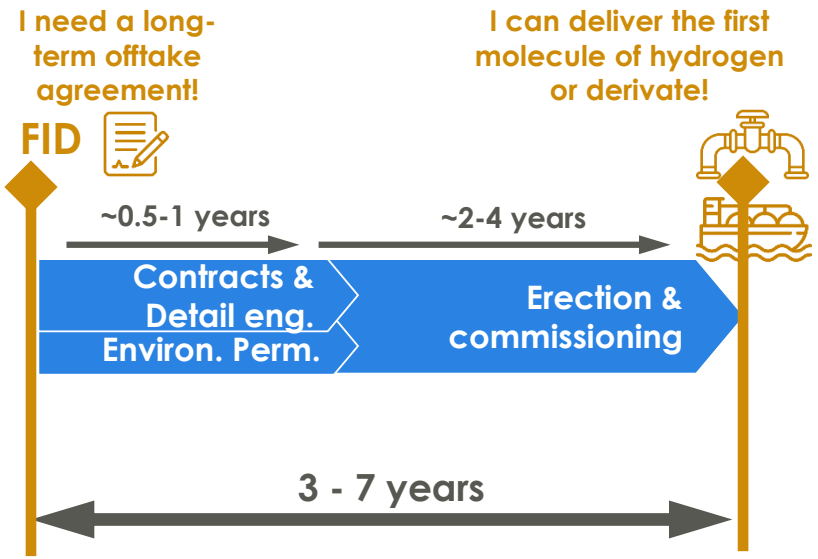
A mixture of regulatory mandates and voluntary commitments

Total sustainable fuels demand by region, 2030[1], Mtpa MeOHeq and % breakdown



- ✓ **Chile** …wants to reduce its national CO2 emissions
- ✓ **DHL, IKEA** …want to reduce CO2 emissions in their logistics fleet
- ✓ **Maritime and aviation** …are "forced" by regulation to contribute to reducing emission (EU, IMO, ICAO)
- ✓ **Customers** …demand effective CO2 reductions, such as in plastics (i.e. Lego)

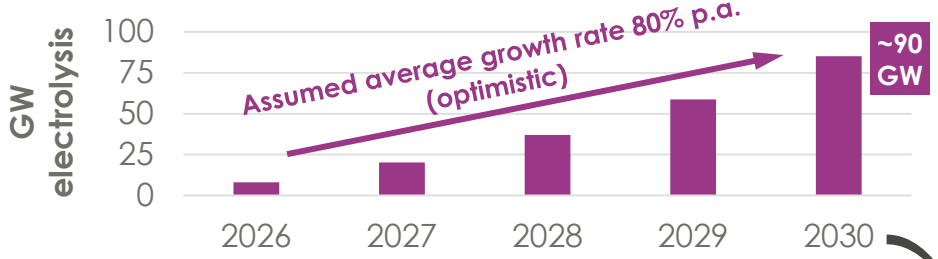
Long term offtake agreements are the key requirement to enable project execution



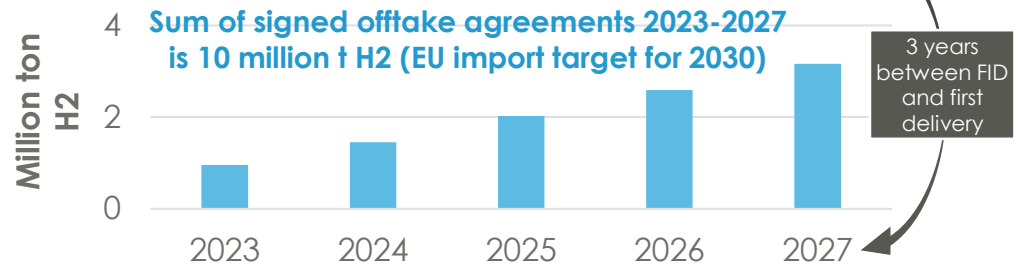
Today (2023) we need sufficient market demand (= willingness to sign long term offtake agreements) to enable first hydrogen supply in 2026

Scenario for project ramp-up for hydrogen import into the EU

Required projects in operation for import into the EU



Long term offtake agreements signed for H2 and its derivatives



Let's assume 50% is imported as eMethanol: **Long term offtake agreements signed for eMethanol**

Conversion losses from H2 to eMethanol, or re-conversion to H2 (if needed) not taken into account in this simple calculation. The actual eMethanol import demand would be higher.

EU Regulation for eFuels acts as stumbling block to global eFuels project development

CO2 restrictions

- x **Industrial CO2** outside EU cannot be used
- x **Biogenic CO2** is scarce globally & EU sustainability standards are critical
- x **Direct Air Capture (DAC)** is commercially not available yet

Subsidy restrictitions

- x EU bans subsidies for renewable electricity, effectively **excluding all H2 and eFuels produced in the US under the I.R.A. from EU markets.**

Certification restrictions

- x EU market certification takes place when plant is in operation, with yearly recertification risk.
- x High risk of non-compliance for the next 20 Years, with changing EU regulation.

EU regulation will declare most of the world's green fuels as grey

eFuels from third countries using the technically identical plant concept with the same GHG emission factor will not be accepted as "green" by the EU due to differing national regulations.

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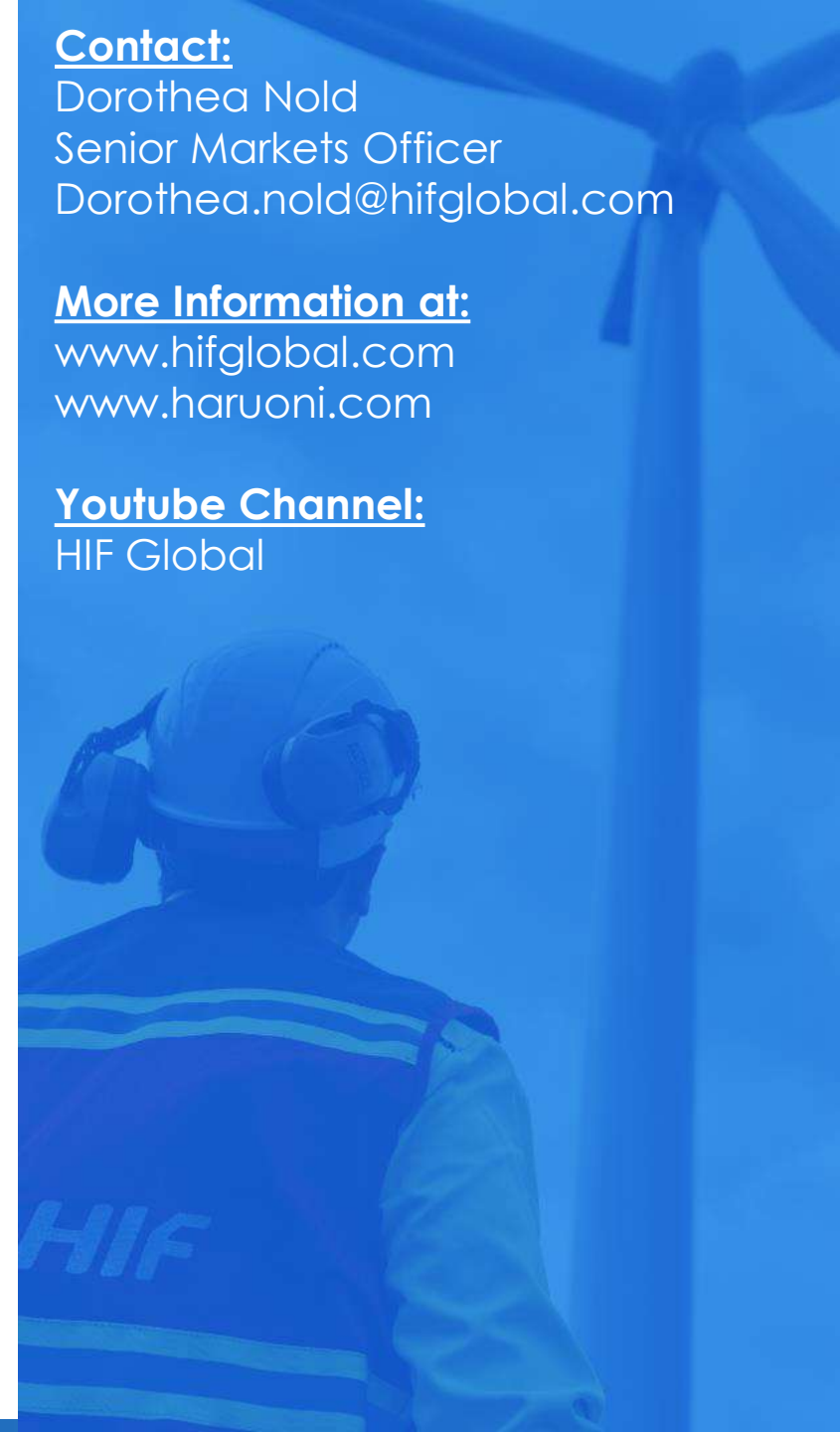
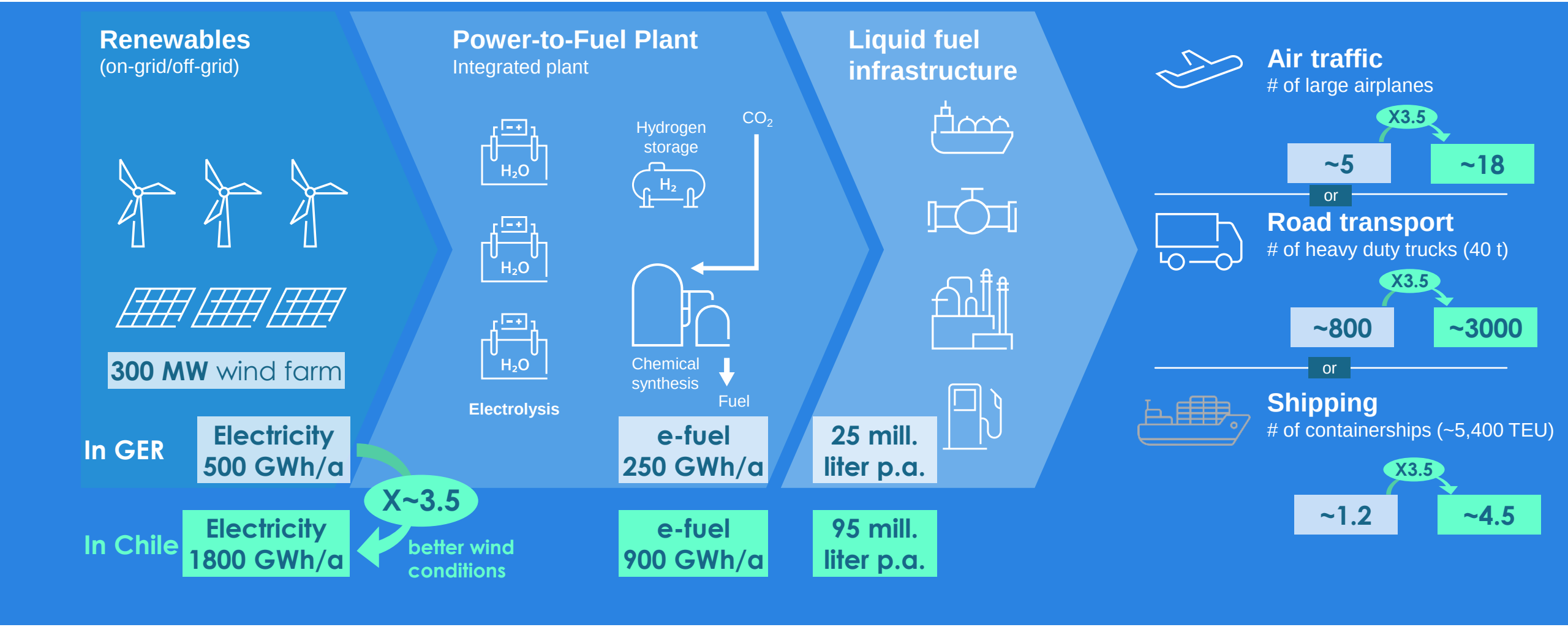
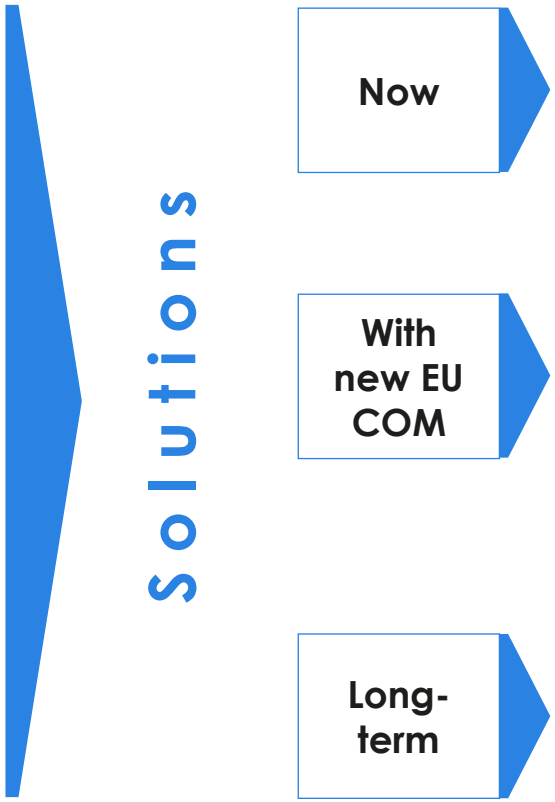


Imports needed to ensure widespread availability of affordable green fuels



How to adapt EU rules and regulations to achieve its ambitious H2 import targets?



Now

H2/RFNBO Certification schemes to be recognised NOW

With new EU COM

Adopt NEW Delegated Acts on Art. 27 and 28 of Renewable Energy Directive III

- grandfathering for 15 Years after COD
- pragmatic approach to CO2 usage and cross-border trade of CCU-based fuels

Long-term

Enact a new „H2 and Derivates Import Law“

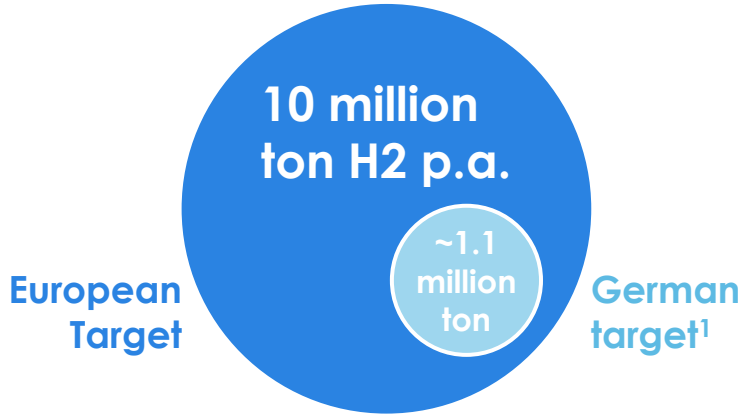
*70% capacity factor, e.g. with onshore wind in Chile & Electrolyzer plant spec power demand of 55 kWh/kg assumed

How much electrolyzer capacity is needed?

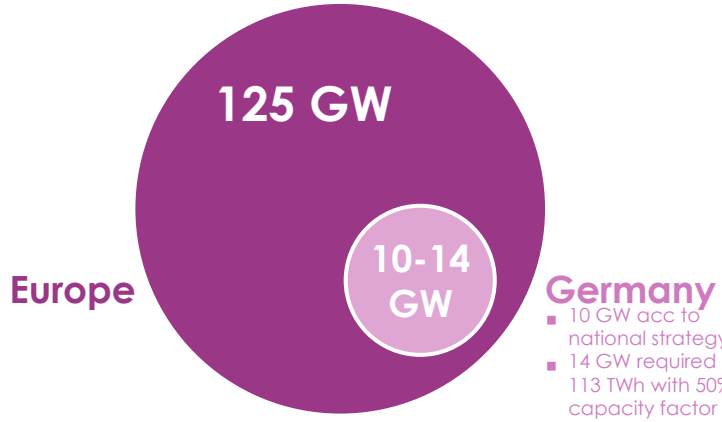
20 Mio tons green H2: Scenario 2030 acc to EU Strategy

Estimated electrolyzer projects size for Europe/Germany

Domestic
generation of renewable hydrogen 2030

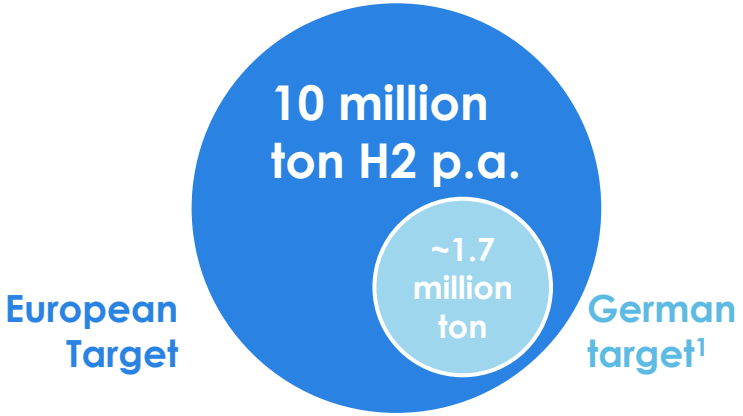


50% capacity factor, e.g. with offshore wind[2]



- 10 GW acc to national strategy
- 14 GW required for 113 TWh with 50% capacity factor

Import
of renewable hydrogen and derivatives 2030

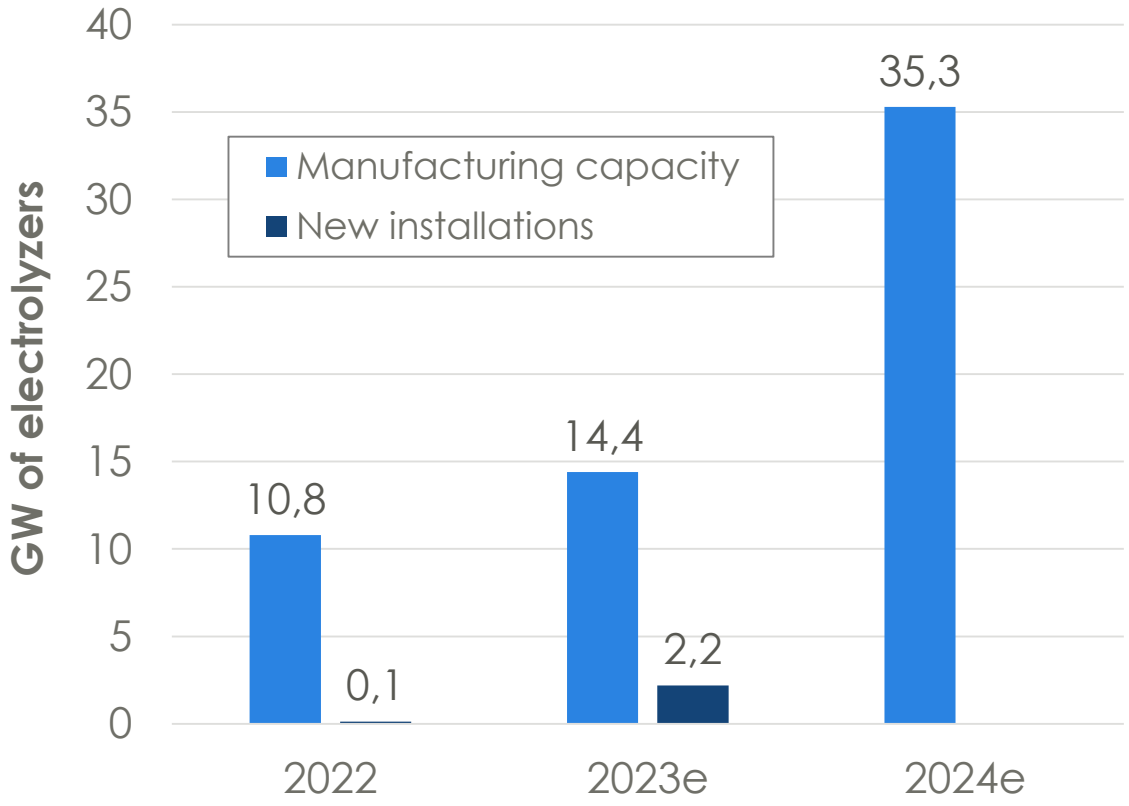


70% capacity factor, e.g. with onshore wind in Chile[2]

1 German national hydrogen strategy: 95-130 TWh in 2030, therof 45-90 TWh import of hydrogen and its derivatives; million ton calculated based on the averaged values | 2 Electrolyzer plant spec power demand of 55 kWh/kg assumed

Is electrolyzer manufacturing capacity the bottleneck?

Global electrolyzer installations and announced manufacturing capacities (~30% of the capacities are in Europe)



- The **existing manufacturing capacities are not being utilized**
- The existing manufacturers already announced **135 GW of capacity for 2030**, despite today's lack of contract awards
- Every year **new manufacturers** come along with new technologies & products, and they announce new capacities

Global new installations according to IEA (https://www.iea.org/energy-system/low-emission-fuels/electrolysers); Announced global electrolyzer manufacturing capacity according to IEA (https://www.iea.org/data-and-statistics/charts/announced-electrolyser-manufacturing-capacity-by-region-and-manufacturing-capacity-needed-in-the-net-zero-scenario-2021-2030)

H_2 Fe HyIron

FIRST OF ITS KIND

HYIRON – GREEN IRON FROM NAMIBIA

First of its kind

Introduction

Iron production at zero CO_2 emissions is an important goal in the fight against climate change. With 9% of global CO_2 emissions, there is a need for rapid adaptation of the iron production processes. The rapid and positive development in the efficiency of renewable energy generation and the pricing of CO_2 emissions has created a positive tipping point: Iron from net-zero production is competitive!

HyIron has the goal of establishing a new technology concept for the production of green iron worldwide. Therewith generation capacities of renewable energy are made usable and a key industry can be supplied with important raw materials and energy. All of this sustainably and within the framework of new energy partnerships.

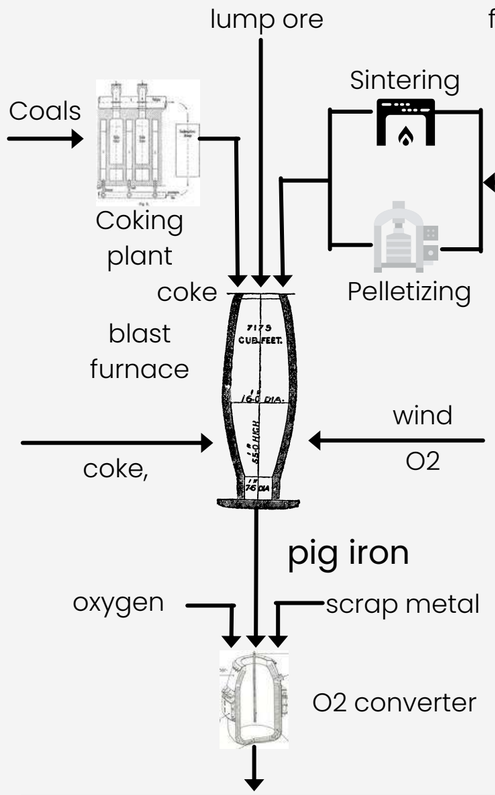
Why green iron?

The green iron market

Many of the world's leading companies are committed to sourcing “green” primary products. Green iron and green steel are two of these basic products. In secondary production, the production of iron and steel from scrap, there are some projects, such as H2GreenSteel, which plan to offer low-CO2 emission iron and steel soon. On the primary production side, the production of iron and steel from iron ore, there are currently few or no projects known that can offer green iron within the next 3-4 years. At the same time, demand is increasing.

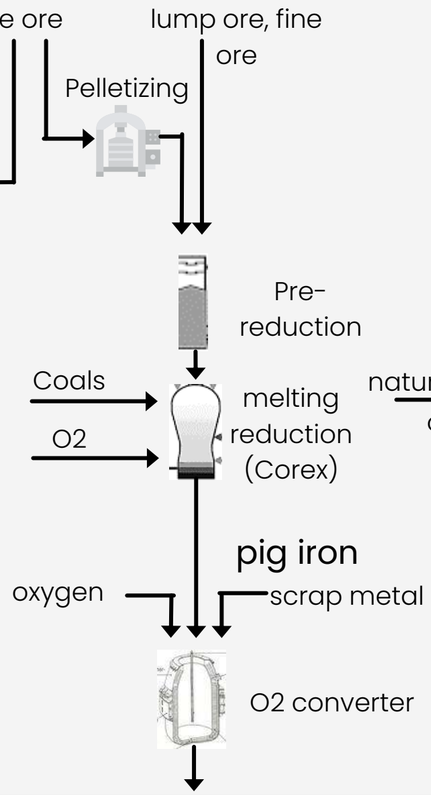
Iron & Steel Production - Overview

Traditional Procedure based on carbons

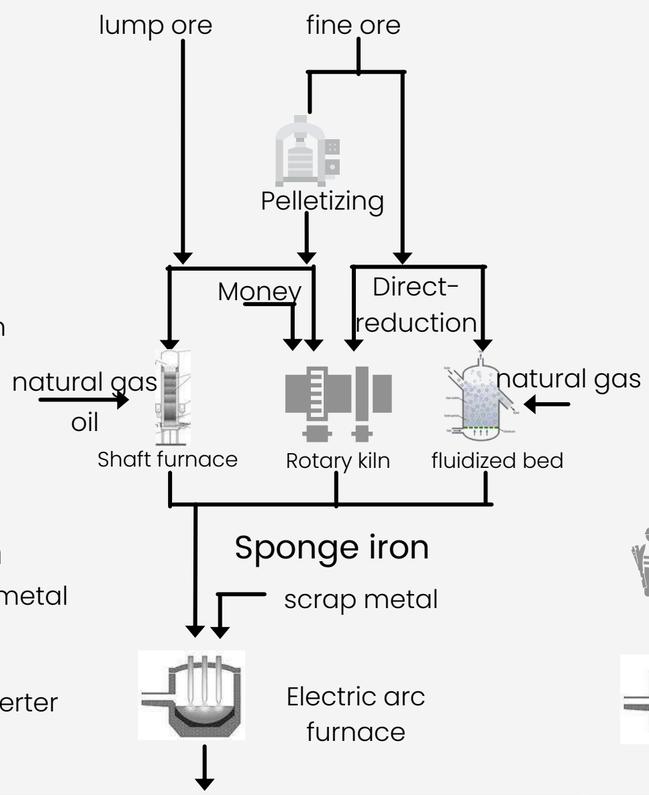


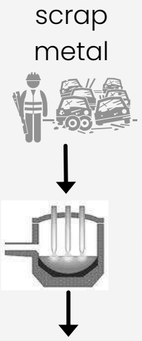
recycling

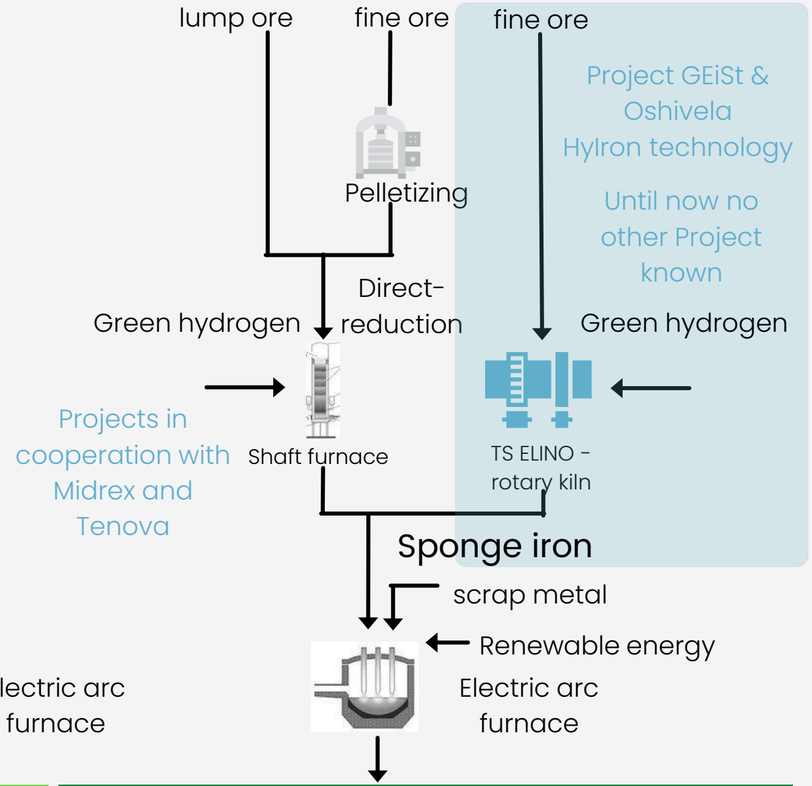
(Secondary production)



Greens Hydrogen-







An average of 1.8 tons of CO2 emissions per ton of steel

Steel with low emissions

Steel with "Net Zero" emissions

About 1.32 billion tons in 2020

About 105 million tons in 2020

About 430 million tons in 2020

Until now no industrial production

Primary production :

Iron from Iron ore

reducing agent

Traditional : Iron reduction with Carbon vs. HyIron : Iron direct reduction with hydrogen

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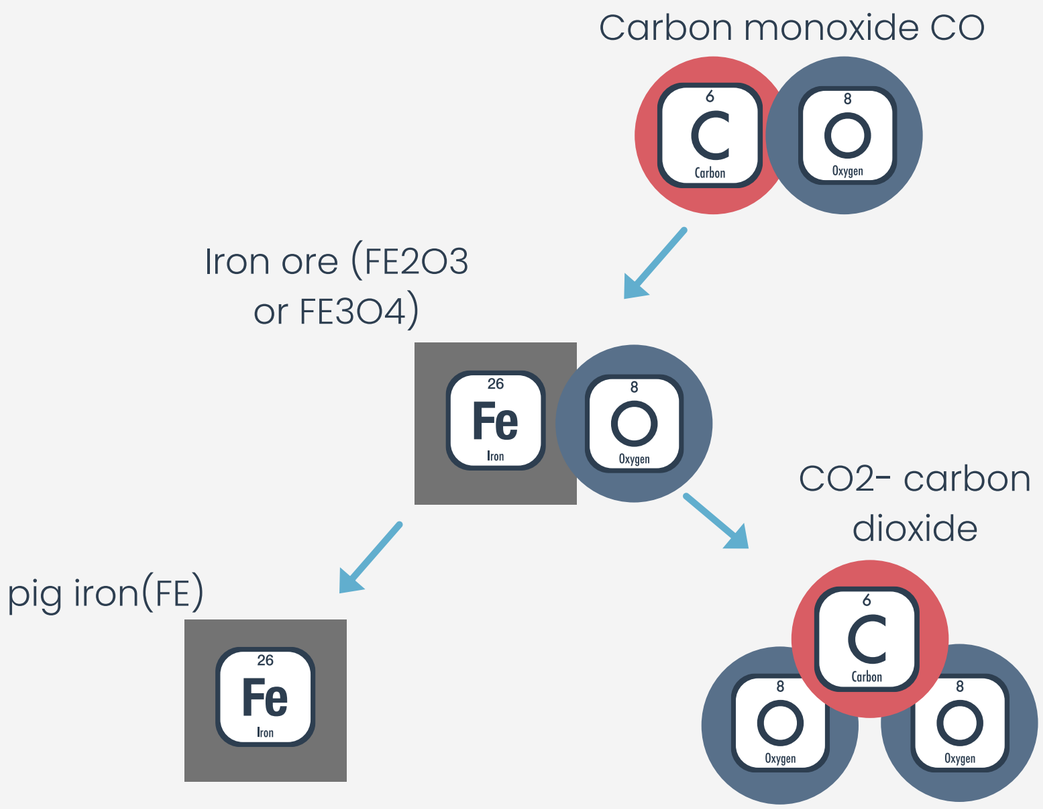
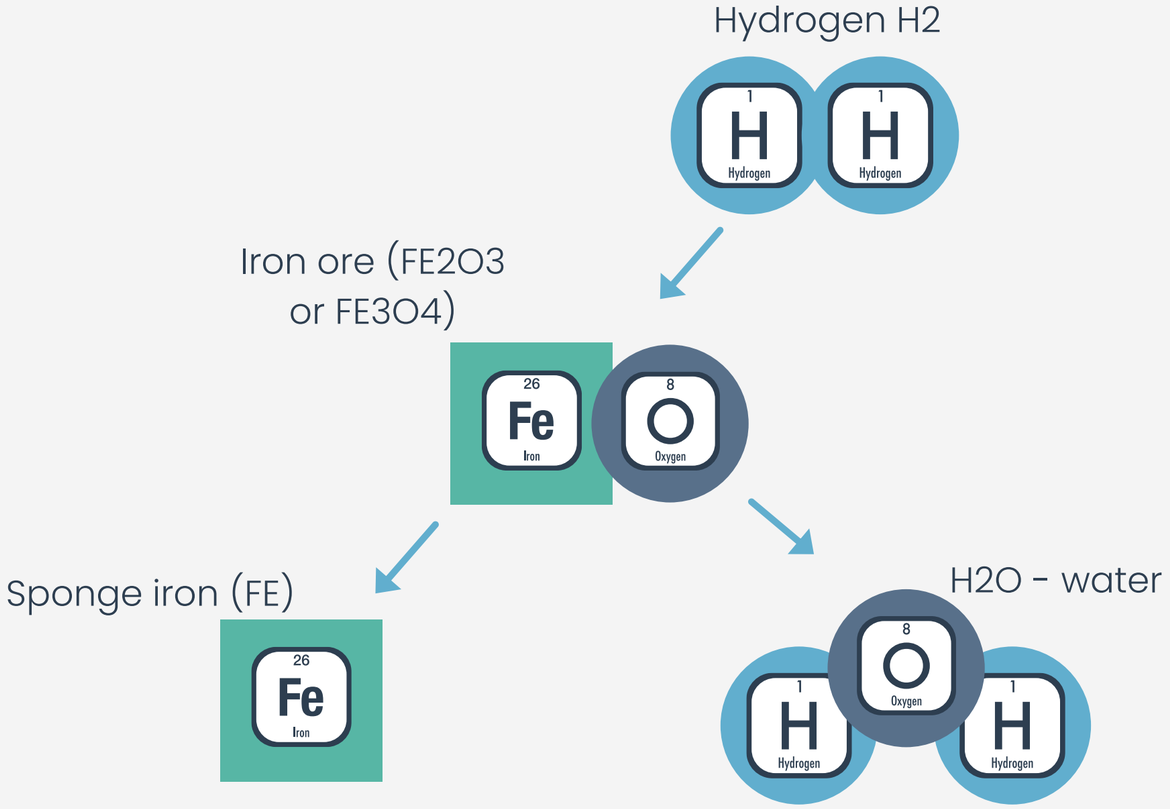
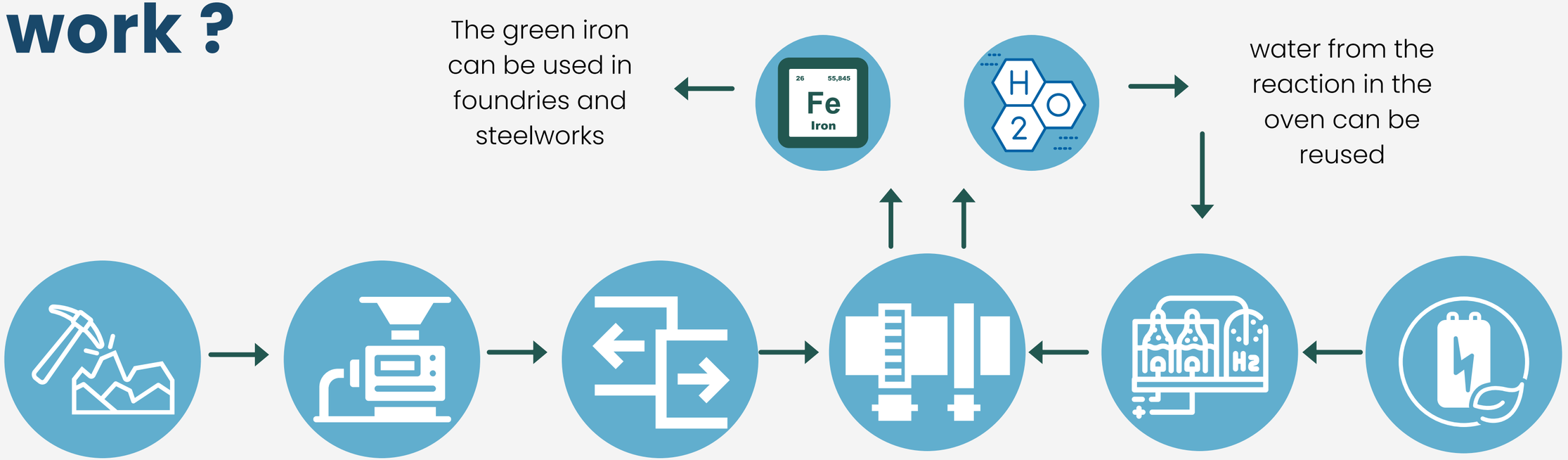


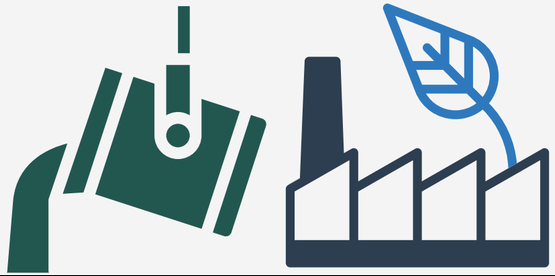


How does it work ?

Overview



Product application ?

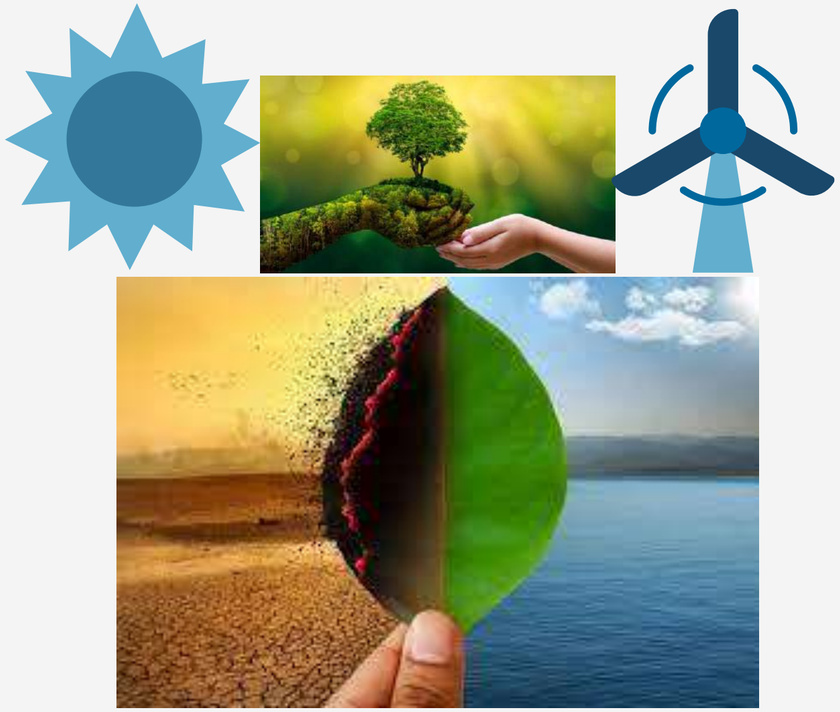


Use in or for:		For:	Examples :

Foundries:		• Cast products for:
		  • Automotive parts
		  • Casings (compressors, electric motors etc..)....
			

Steelworks:		• Iron for the construction industry • Aviation, cars etc. • One of the most used materials worldwide	
Storage & transport of green energy / hydrogen - HyIron & Iron Fuel		• Because the HyIron process can be reversed, hydrogen can be recovered from the sponge iron after transport	

Project Oshivela Phase 1 - 3

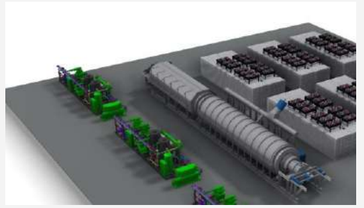


Expansion stages Oshivela :	Energy requirement :	Resulting CO2 savings :
First Production stage : 5 T/H – 3000 hours per year. Annual Production: 15000T	Approximately 25 MW	• Approx.: 27,000 tons of CO2 cut down • This corresponds to approximately 0.75% of the total annual CO2 emissions of Namibia
Second Production stage : 25 T/H – 8000 Hours per year (including energy storage) Annual Production : 200,000T	Approximately 255 MW	• Approx.: 360,000 tons of CO2 cut down • This corresponds to approximately 10% of the total annual CO2 emissions of Namibia
Third Production stage : *250 T/H – 8000 hours per year* *Annual Production :* */2,000,000T*	*Approximately 2600 MW*	• *Approx.: 3,600,000 tons of CO2 cut down* • *Around 88 % of Namibia's annual CO2 emissions*

Etc...

development

2019 – 2024



2019

First very positive results in direct reduction of iron ore with hydrogen in the rotary kiln in 2019 at the laboratory of project partner TS Elino

2020

Founding of the joint venture CO2Grab GmbH Forming of the Collaborative project GEiSt

First works on the project Shiyela in Namibia.

2021

Project start GEiSt in Lingen

First Sampling in Namibia

Application Project Oshivela

2022

Construction start in Lingen

Handing over BMWK funding notice – project Oshivela in Windhoek

Concretization Joint projects with Thyssen Krupp, Salzgitter AG, BAM, RWTH Aachen etc.

2023

Renaming of the joint venture to Hyiron GmbH

Start of production in Lingen

Groundbreaking at the Oshivela Project in Namibia

2024

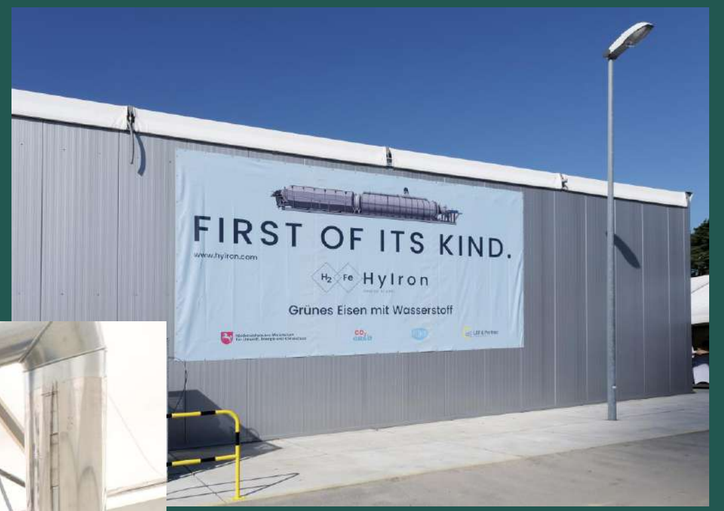
Project starts to further evaluation of energy partnerships / partnerships Green Iron Worldwide

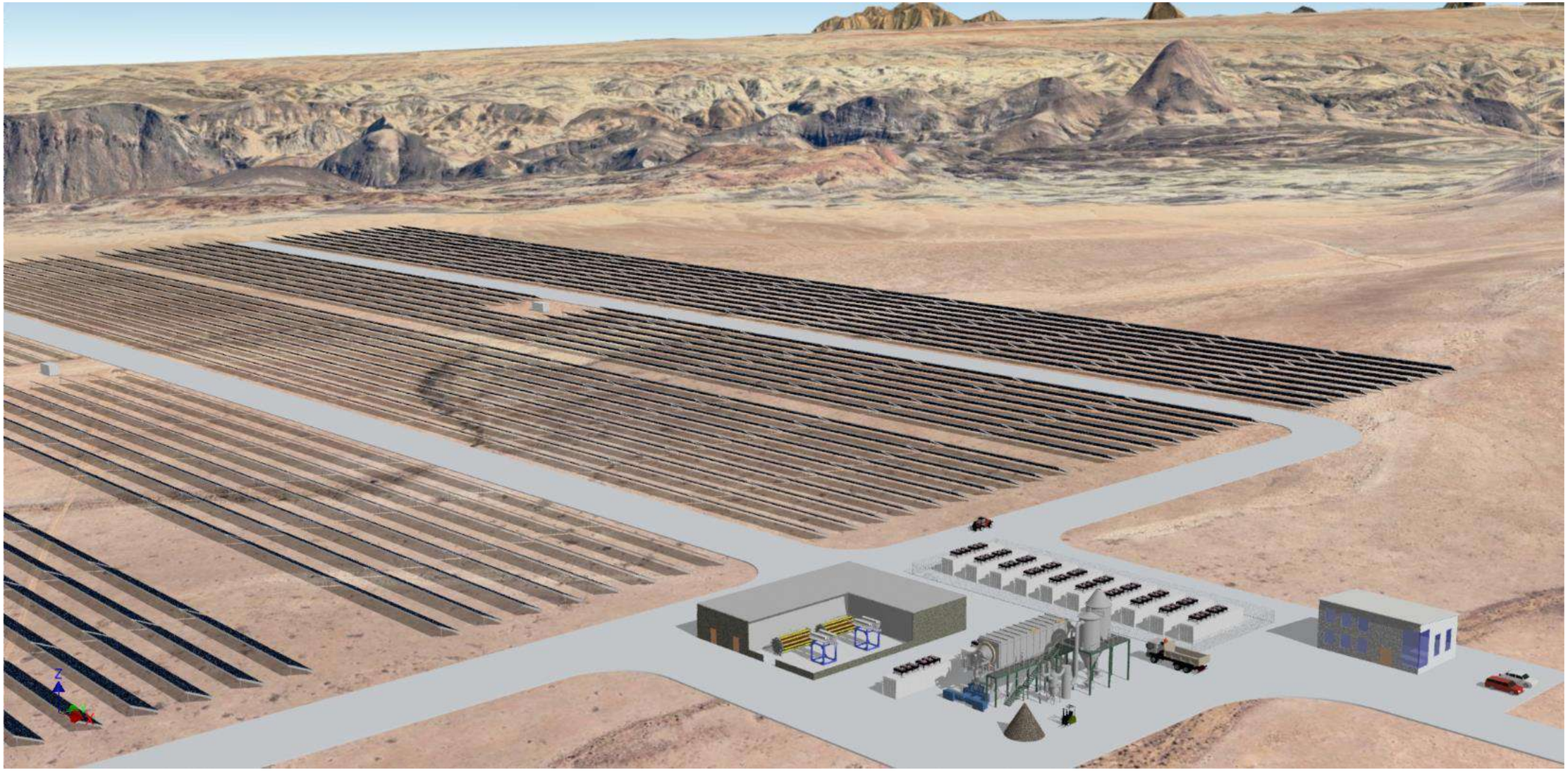
Construction work in Namibia

Commissioning Industrial pilot Oshivela in Namibia

Project GeiSt

In Lingen, Germany





Coking Coal vs. Hydrogen

Energy Costs Comparison / Hyiron vs. Blast Furnace	Hyiron in Namibia	Electric Arc Furnace in Europe	Green Iron (Hyiron Nam + Steelworks Europe)	Blast Furnace
Energy Requirement per ton of Sponge Iron in KWH	3800	664	4464	4502
Thereof Electricity in KWH	3800	533	4333	79
Thereof from Fossil Fuels in KWH (here in coking cole)	0	131	146	4423
Price per KWh Coking Coles		0,032 €		0,032 €
Price per KWh Green Power (EU und Nam)	0,02 €	0,10 €		0,10 €
Direkt Costs Energy	76,00 €	53,31 €	129,31 €	148,459 €
Price per Ton of CO2		60,00 €		60,00 €
Price CO2 Emmissions (1,7 Tons CO2 per ton of Iron)		3,02 €		102,00 €
Energy costs per ton of Iron	76,00 €	56,33 €	129,31 €	250,46 €

END, the beginning,…

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Thank you!