

# Decarbonization and Power2X / eFuels : Insights and Facts

SIEMENS  
ENERGY

Conference Tallin 2.October 2024



Engelbert Schrapp,  
Principal Corporate Account Manager,  
Siemens Energy

# Decarbonization and Power2X / eFuels : Insights and Facts

## Introduction

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Siemens Energy at a glance

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Introduction of Power2X / eFuels

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Liquid Wind / Flagship projects : make more out of your biogenic CO<sub>2</sub>

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Conclusion – Q&A

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## Profile



Dipl. Ing. (FH)  
Schrapp Engelbert

Principal CAM Strategic Power2X Projects  
Coach Account Management Nordics  
Siemens Energy

### Current responsibility/focus areas

- Since 07/2010 Corporate Account Manager (CAM) for Stora Enso
- Since 02/2012 certified Corporate Account Manager
- Additionally, since 07/2015 Coach Account Management Nordics (SE, NO, FI, DK, EE, LV)
- Nominated as 12/2018 Principal Corporate Account Manager
- Additionally, since 04/2020 Principal Corporate Account Manager for Strategic Power2X, eFuel Projects

### Professional experience

- Automation and Control Engineer, Project Manager / Project Director, Voith Paper, 1990 – 1995
- General Manager Global Sales EMSR, Voith Paper, 1995 – 2001
- Sales Director Asia Pacific, Siemens AG / Siemens Ltd. China, 2001 – 2010
- Int. P&P Mega-Projects, 2004 and 2008-2010 located in Shanghai
- 2008-2010 Implementation and GM of Head of Asia Pacific P&P Hub in China/Shanghai

### Education

- Electrician “Gesellenbrief”, 1984 (Apprenticeship 1980 -1984)
- Electrical Engineering, Technical Informatics “Dipl. Ing. (FH) Elektrotechnik”, 1990
- Business Degree “Technischer Betriebswirt IHK”, 1996

### Additional Information

- Married, two kids 28 and 27 years old
- Hobby's: Outings, Cycling, Reading, Wood Working
- Living since 2010 in Stockholm/Sweden



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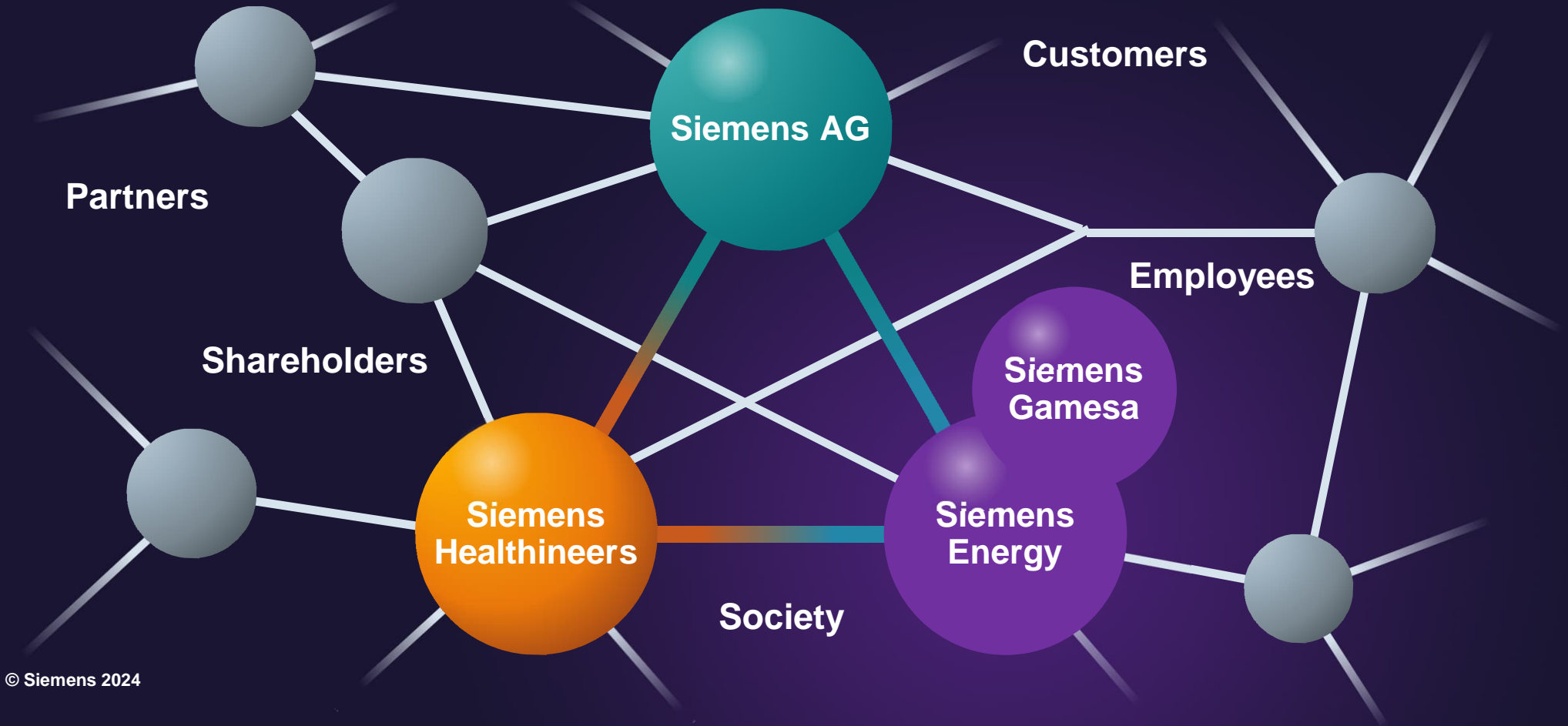
# The Siemens Ecosystem

≈ 410,000

Employees

≈ €165 bn

Orders



Siemens Energy is a  
**global leader in the  
energy business**

**~ 1/6**

of global electricity generation  
is based on our technology.

**98,000**

employees work as a team  
to energize society.<sup>1</sup>

We are present in

**> 90** countries.

We invest around

**€1 bn** annually in  
research and development.

<sup>1</sup> Number of employees as of June 30, 2023

<sup>2</sup> October 2024





# Our financial performance in Fiscal Year 2023<sup>1</sup>

Revenue

**€31.1bn**

Europe, C.I.S., Middle East, Africa: €14.8bn  
(of which Germany: €2.5bn)<sup>2</sup>

Americas: €10.0bn  
(of which USA: €5.8bn)<sup>2</sup>

Asia, Australia: €6.4bn  
(of which China: €1.5bn)<sup>2</sup>

Orders

**€50.4bn**

Order backlog

**€112bn**

Basic earnings per share

**€(5.47)**

Profit before  
Special Items

**€(2,776)m**

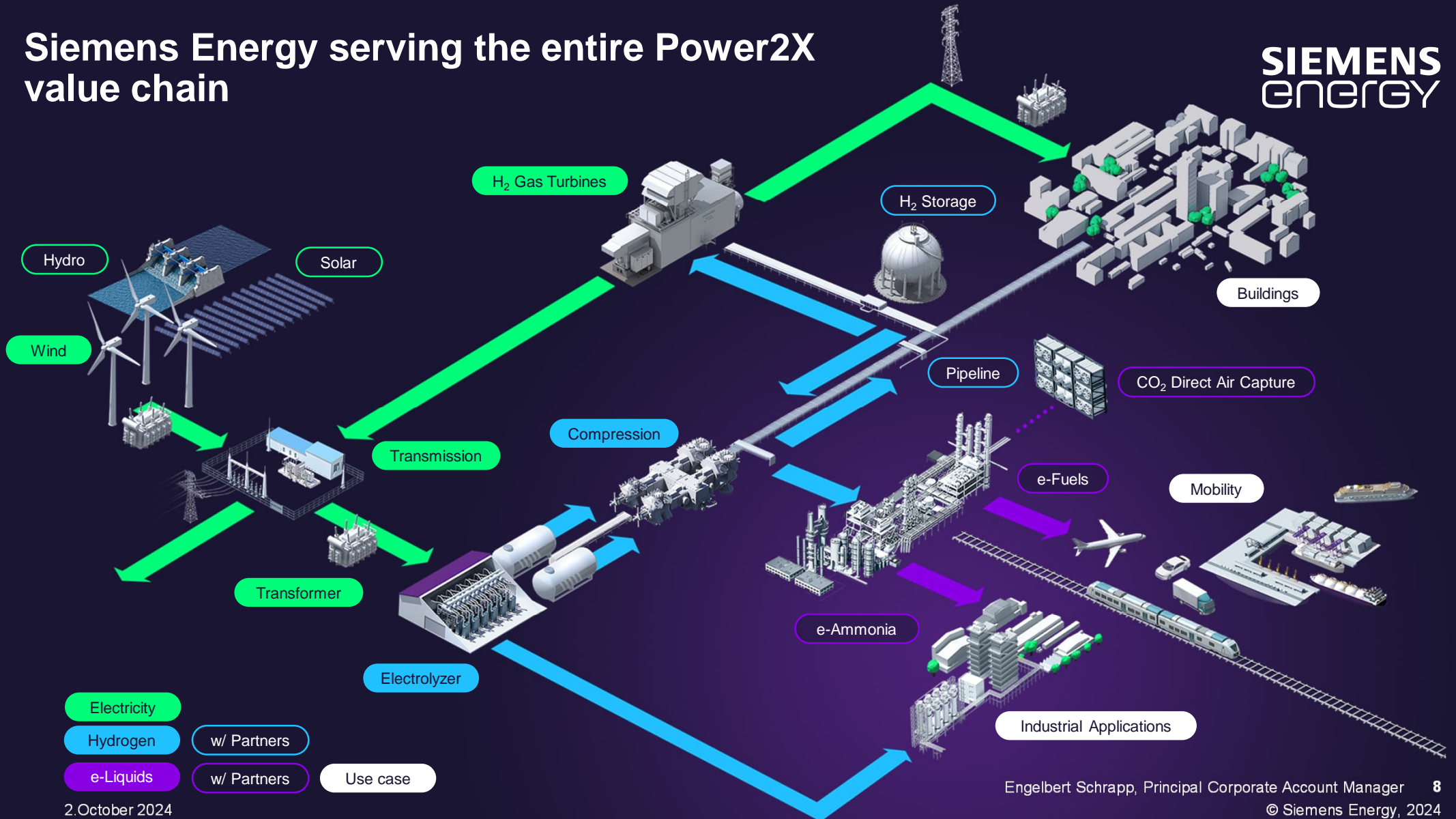
Profit margin  
before Special Items

**(8.9)%**

1) According Annual Report 2023  
(FY 2024 ending 30. September)

# Siemens Energy serving the entire Power2X value chain

**SIEMENS**  
energy



- Electricity
- Hydrogen
- e-Liquids
- w/ Partners
- w/ Partners
- Use case

2. October 2024



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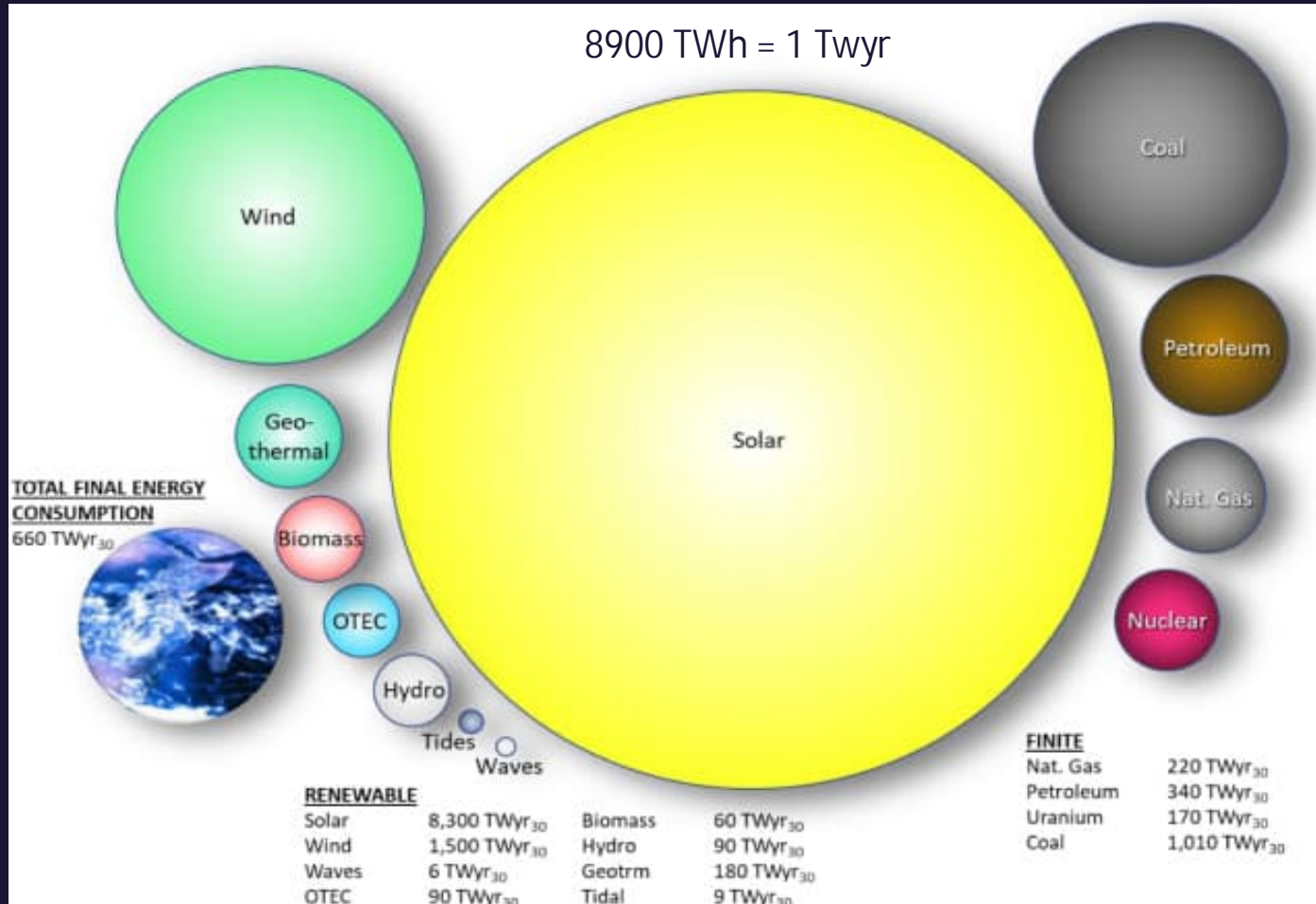
Liquid Wind / Flagship projects : make more out of your biogenic CO<sub>2</sub>

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# The Good News: It's enough Renewable Energy out there: We "just" need to harvest it



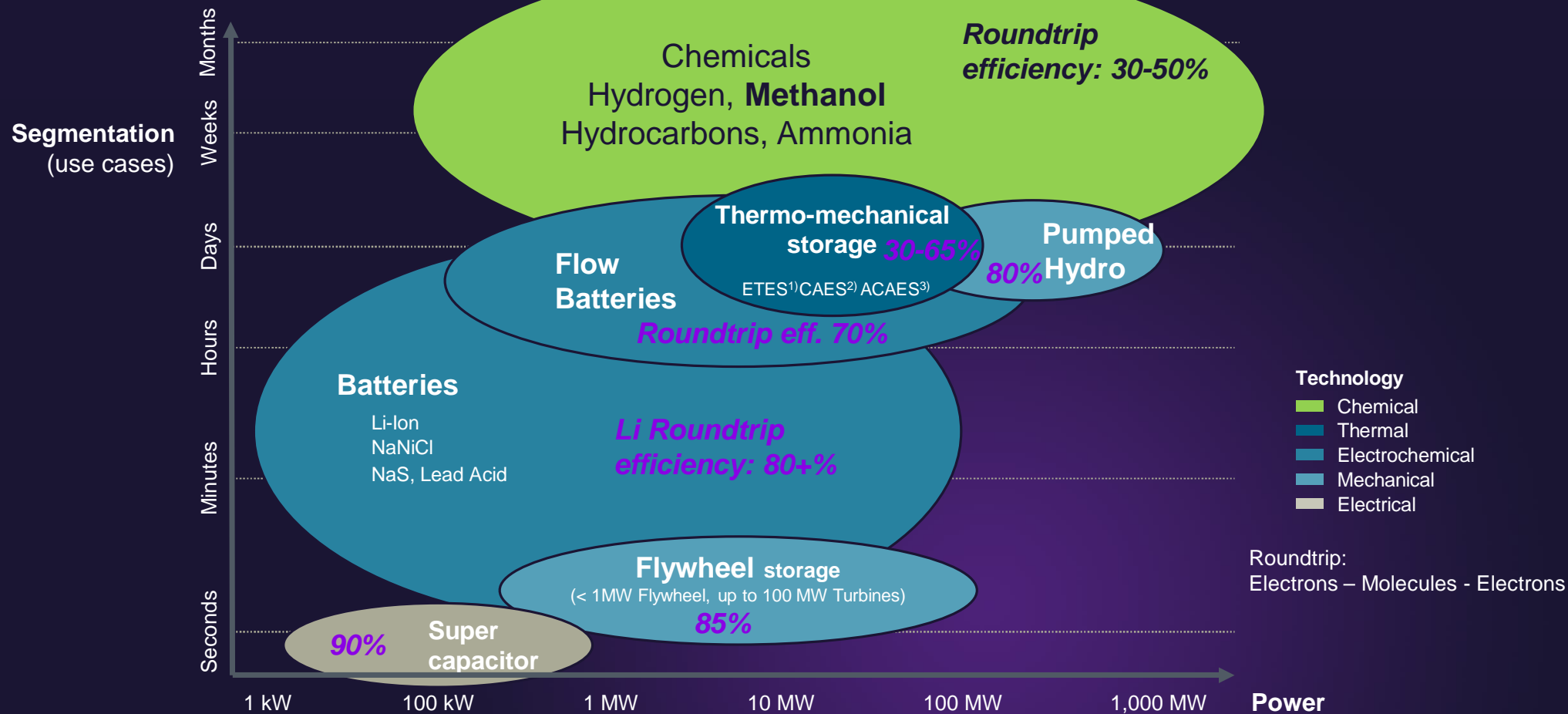
The area of the circles represents *reasonably* assured recoverable energy reserves from both finite and renewable resources over the next 30 years. These areas can be compared with total demand (earth image) over that same period

PVs can meet 100% of extant global primary energy demand more than 12x over, wind 2x over even after reasonable constraints posed by land use and conversion efficiency.

- Under a fully electrified future scenario, solar power could meet global energy demand 27x over, and wind 5x over.

Source: *The Planet, The International Energy Agency SHC Programme Solar Update, 2015*

# The “Bad” News: How to make Renewables 24/7 available ?



<sup>1)</sup> Electro-Thermal Energy Storage

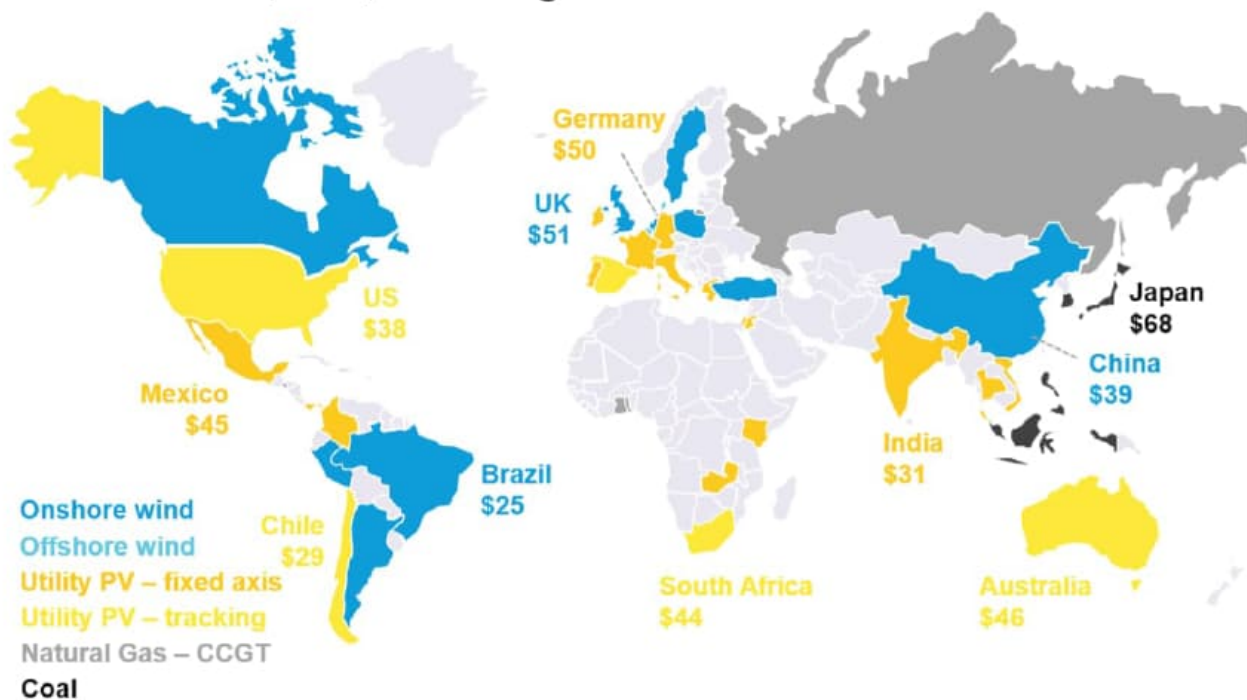
<sup>2)</sup> Compressed Air Energy Storage

<sup>3)</sup> Adiabatic Compressed Air Energy Storage



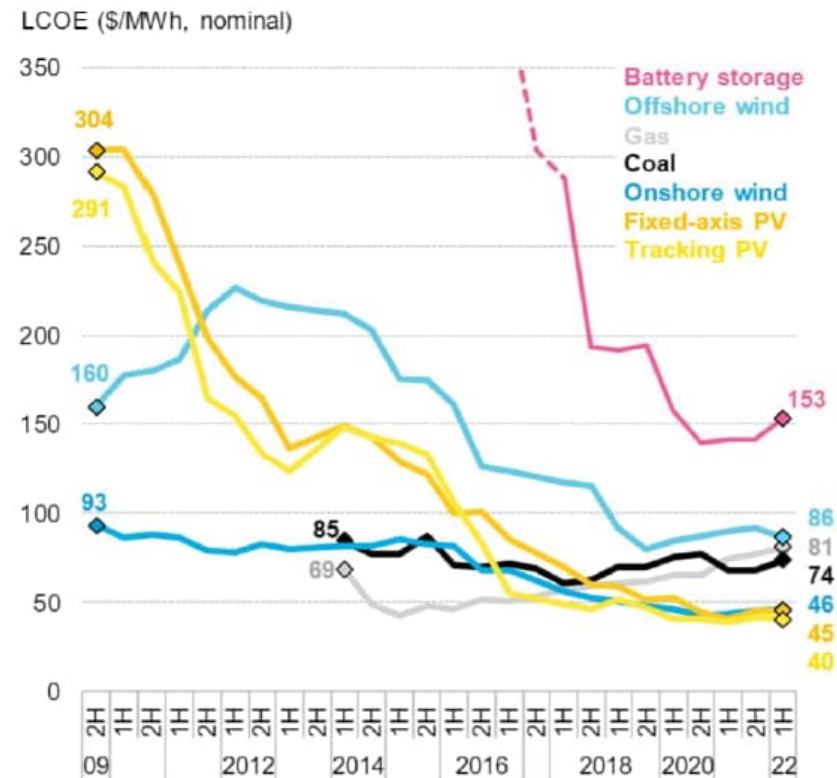
# Today: Renewables are the cheapest source of Bulk Electricity in countries representing 2/3 of the world population and 90% of the electricity generation

Cheapest source of bulk generation, 1H 2022  
New-build solar, wind, coal and gas

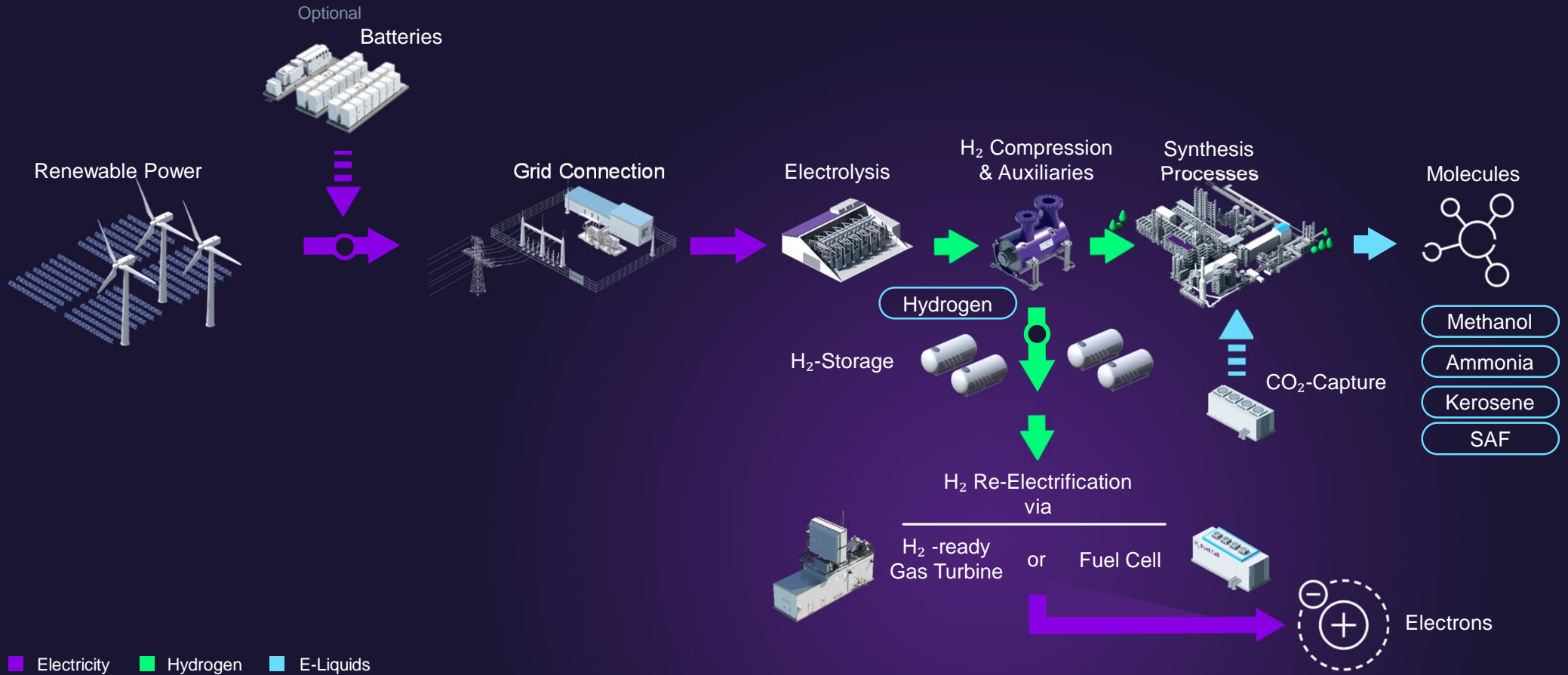


Source: BloombergNEF, costs in \$/MWh

Global levelized cost of electricity benchmarks



# Power2X and eFuel Landscape

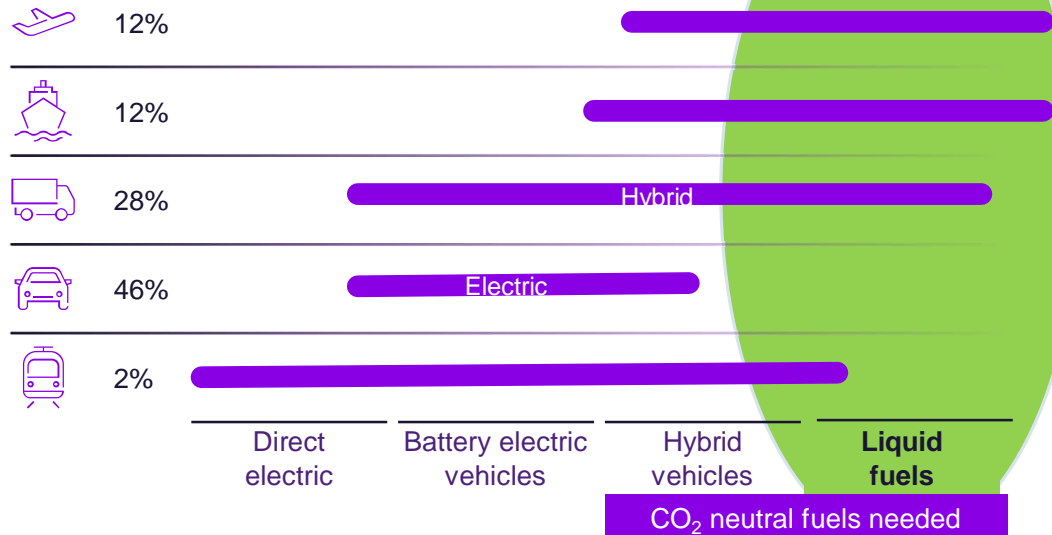


# The decarbonization of Transportation requires biogenic CO<sub>2</sub> for eFuels with high energy density

**Challenge:** The decarbonization of the transportation sector (23% of global greenhouse gas emissions)

## Pathways for decarbonization

Global transportation energy, 2012<sup>1</sup>



## Reasoning

Electric cars are preferred for individual transport – but would require car users to adjust their expectations for travel distances and charging times.<sup>2</sup>

Due to battery capacity limits (very high cost, additional weight – even in the long term), battery only vehicles are not a realistic option for the other transportation modes.<sup>2</sup>

eFuels will be the dominating source of transportation energy in Europe<sup>1</sup> (e.g., still a share of 87% in 2030, 84% in 2050)

<sup>1</sup> European Commission (2016) – EU Reference Scenario 2016, Trends to 2050

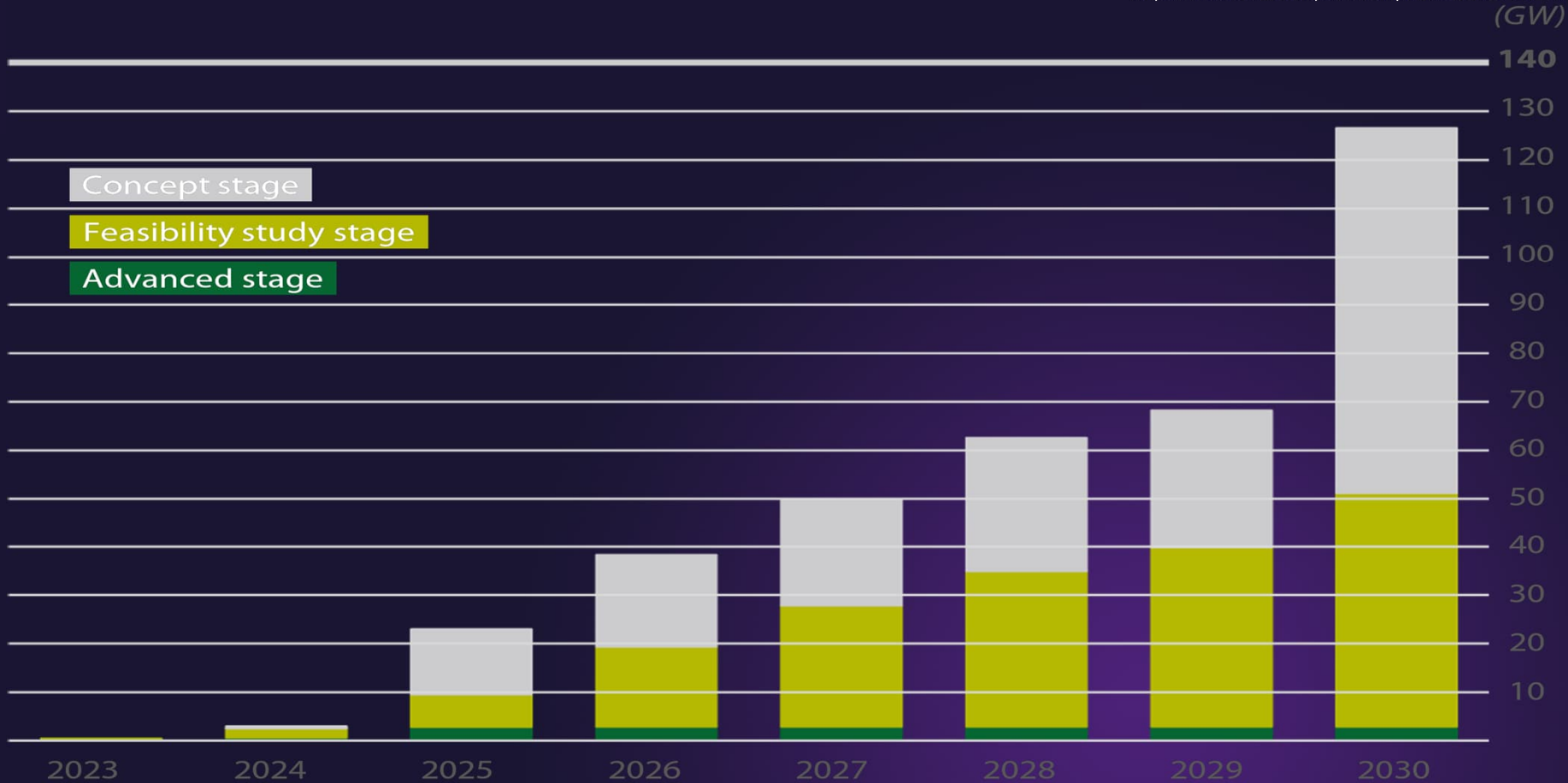
<sup>2</sup> Umweltbundesamt (2016) – Erarbeitung einer fachlichen Strategie zur Energieversorgung des Verkehrs bis zum Jahr 2050, 72/2016



# European Hydrogen Strategy meets Reality :

EU Renewable Energy Directive = RED II and RED III Delegation Act, e.g. a neutral summary can be found under:

<https://www.eca.europa.eu/en/publications?ref=SR-2024-11>

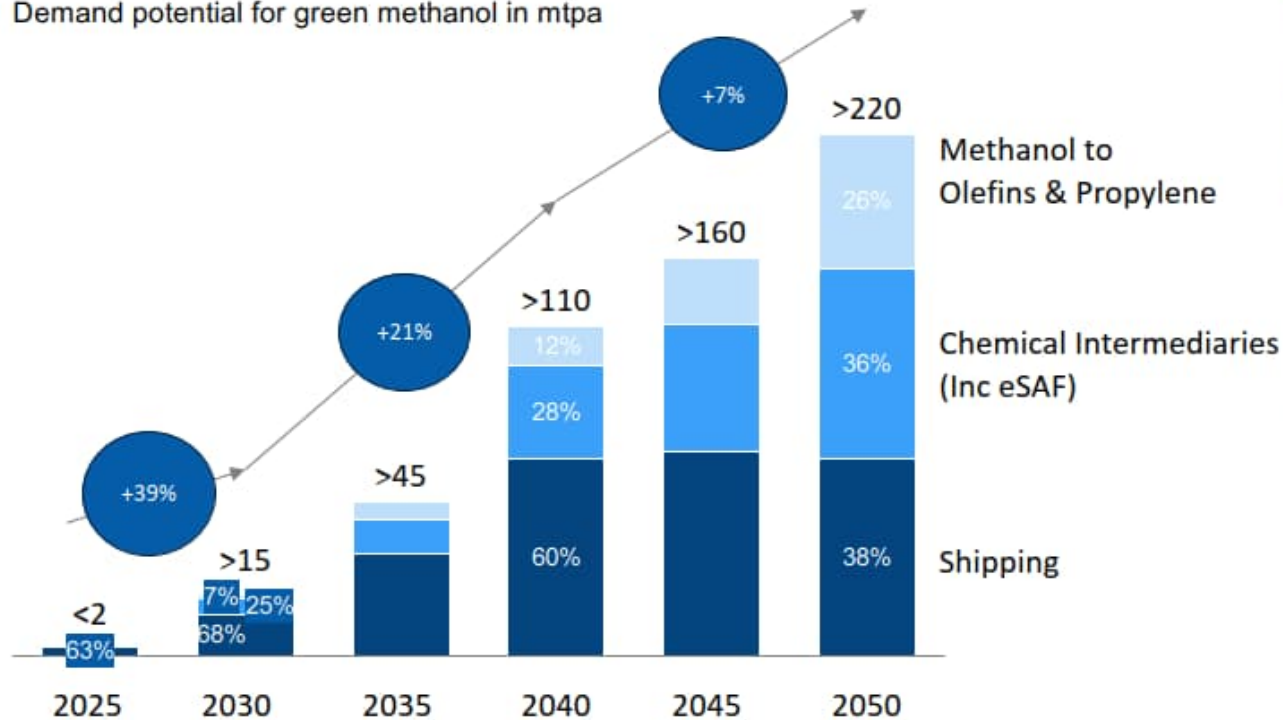


Note: Advanced stage includes projects that are operational, or where the stage is "under construction", or for which a final investment decision has been taken.

Source: ECA, based on data from the International Energy Agency

# Customer Drivers and Plans: Demand Potential for eMethanol

Demand potential for green methanol in mtpa



## Drivers

The eMethanol market is shaped by rules that encourage industries to use cleaner, non-carbon fuels and materials, especially in the EU. Current eMethanol prices are high which impacts its uptake into the market, but with the expected price drop, its market uptake will increase dramatically

- 1) Methanol to Olefin & Propylene, these technologies are not yet fully matured but are essential for the petrochemical industry to become more ecofriendly, alongside recycling. The main take off period is expected from 2040.
- 2) Chemical intermediaries, EU is currently leading the way with strong regulation that incentivises these lower Co2 feedstock, i.e. eMethanol that is helping improve the investment / business case for these technologies. It is expected that as the technology matures from nascent to mainstream roll out, the proportional volume requirements for eMethanol will balloon. We can include eSAF
- 3) Shipping, an increasing order book of dual fuel vessels capable of running on methanol, allows for shipping companies to reduce their emissions and penalty charges that will be levelled on them from both Fuel EU Maritime & also in time the expected emission cap from the IMO.

# Strong growth in green hydrogen production drives cost competitiveness

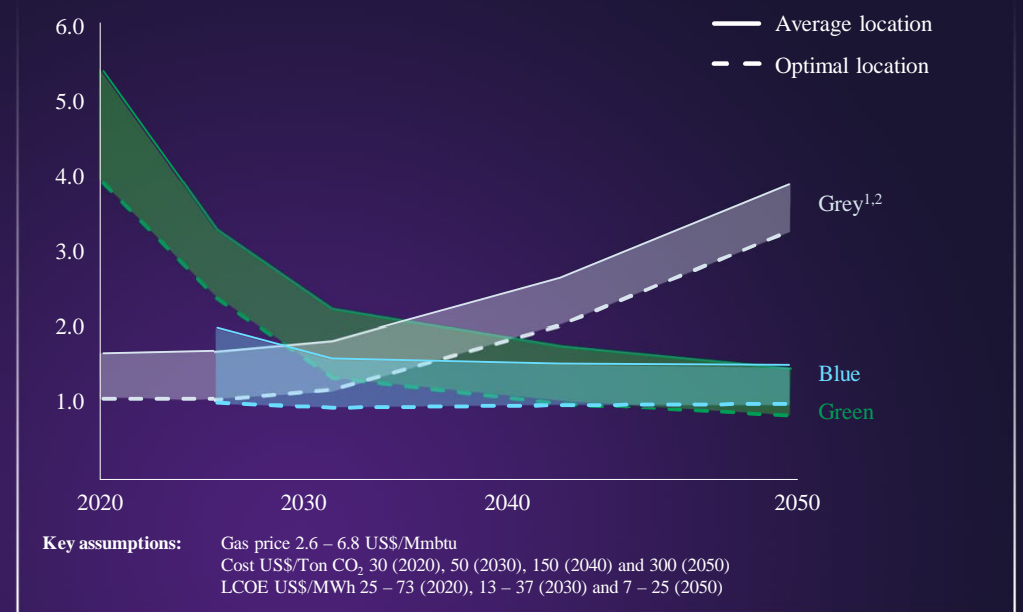
## Announced clean hydrogen capacity through 2030

**Production capacity**  
Mt p.a.



## Hydrogen production pathways, including carbon costs







**Production cost of hydrogen**  
US\$/kg



**Source:** Hydrogen Council, McKinsey “Hydrogen insights report 2021” | 1 Includes projects at preliminary studies or at press announcement stage | 2 Includes projects that are at the feasibility study or front-end engineering and design stage or where a final investment decision (FID) has been taken, under construction, commissioned or operational | 3 Project & Investment tracker, as of Oct 2023, McKinsey Sustainable Energy Systems



# Storage options for compressed hydrogen gas

						
	Tube	Manifold Cylinder Pack	Tube Trailer	Multi Element Gas Container	Cylinder Tank	Geological Storage
H <sub>2</sub>	1 kg	17 kg	300 kg	300 kg	450 kg	Thousands of tonnes
Gross weight	80 kg	1,500 kg	30,000 kg	25,000 kg	50,000 kg	-
Pressure	200 bar	300 bar	300 bar	300 bar	25 bar	60-200 bar
Capital cost	€ <1 k	€ 8.5 k	€ 275 k	€ 260 k	Typical range € 500-700/ kg	Typical range € 500-700/ kg

## Pressure Vessel Types

- Type 1** A traditional all-metal bottle made of steel used for storing liquid and gases for industrial processes. Cheap to produce, but heavy
- Type 2** An additional layer of carbon fibre reinforcement is added round a steel inner tank and shares the load with the metal. This gives it added strength and reduces weight, but makes it more expensive than Type 1
- Type 3** A carbon-fibre composite vessel, with a steel or aluminium vessel inside. The carbon fibre outer vessel takes the load. With more carbon fibre involved, costs are higher than Type 2, but higher pressures can be achieved
- Type 4** A vessel made of all carbon fibre, with an inner liner of polyamide or polyethylene plastic. Characteristics are a much lower weight and very high strength. Comparatively expensive, because of the volume of carbon fibre

# European Hydrogen Backbone – EHB Pipelines

## European Hydrogen Backbone Maps | EHB European Hydrogen Backbone



### Legend

#### Transmission

- Conversion of existing infrastructure Mix
- New

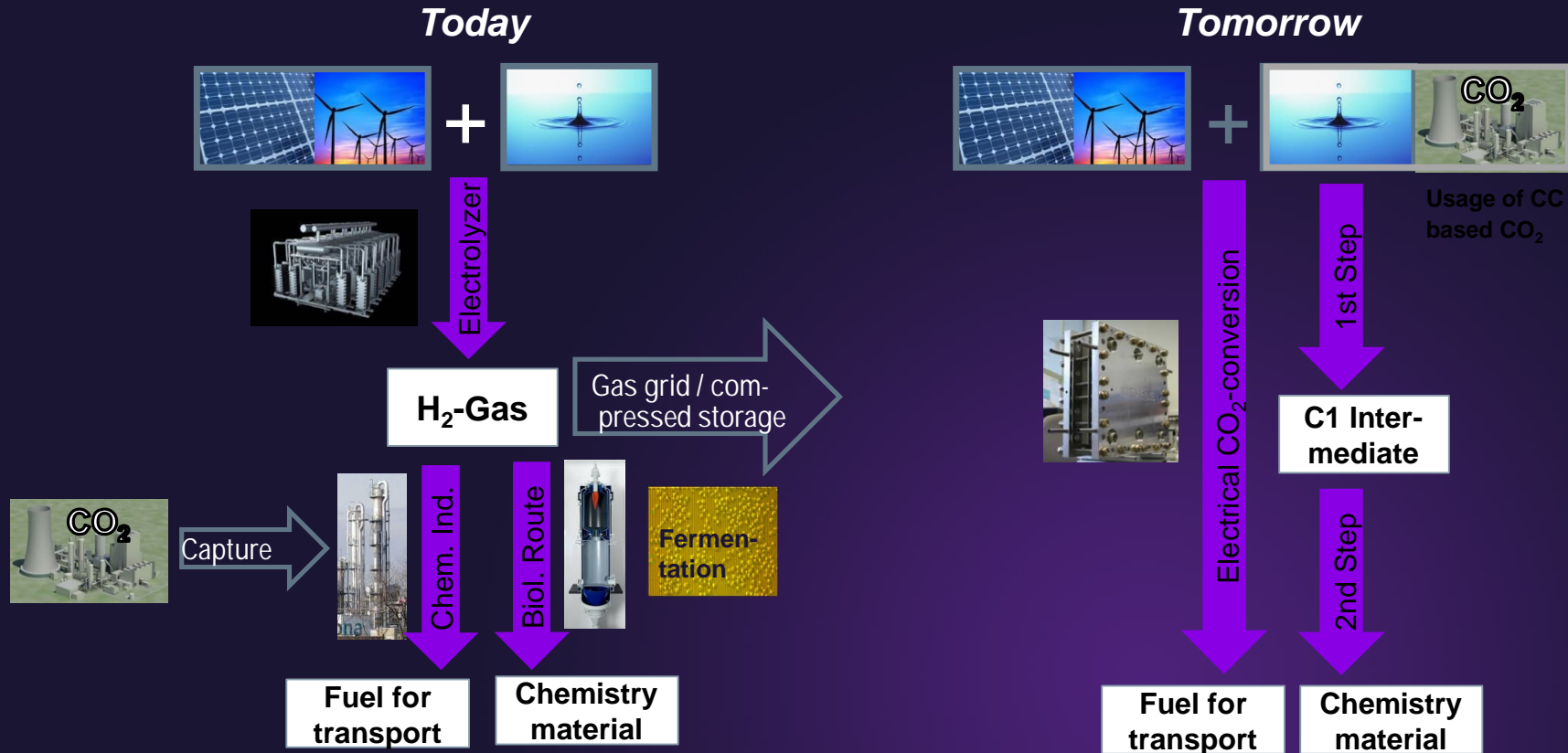


Terminals and ports



Enertrag PtX-Projects

# We need to Research Alternative Electrochemical Pathways to Green Hydrocarbons to learn which is the Best



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Liquid Wind develops and finances commercial-scale facilities to convert biogenic carbon dioxide emissions into green electrofuel for sustainable shipping.

<https://www.liquidwind.com/>



TOPSOE



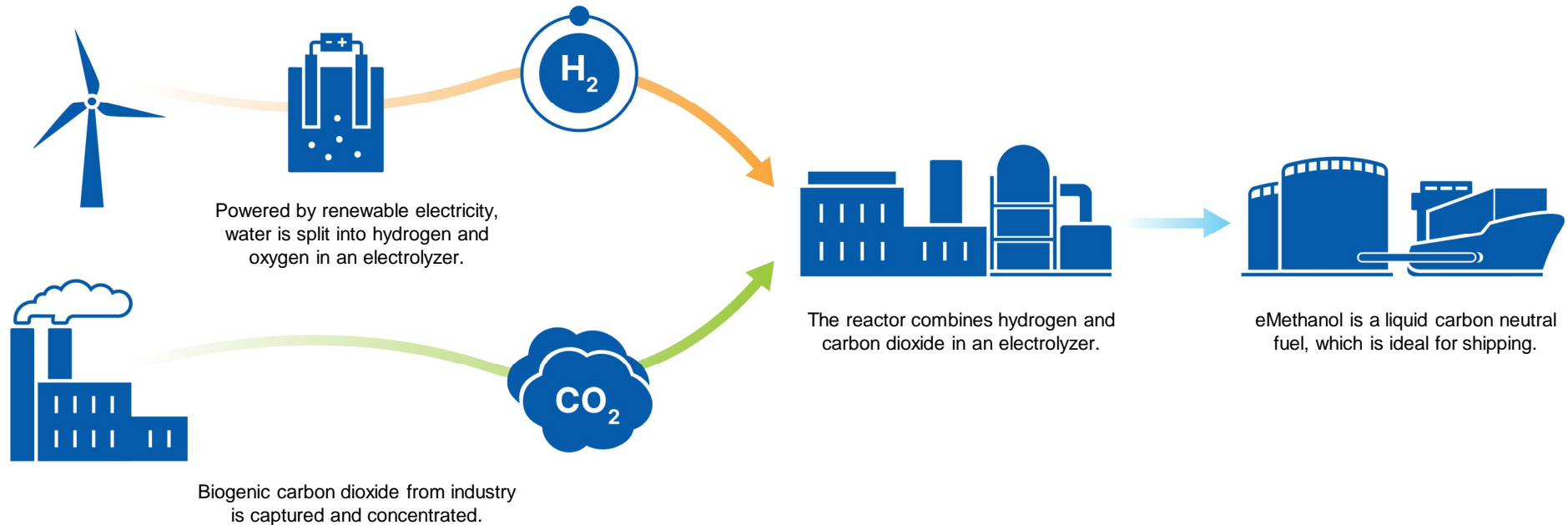
Info@LiquidWind.se



LiquidWind.se

# Electrofuel production process

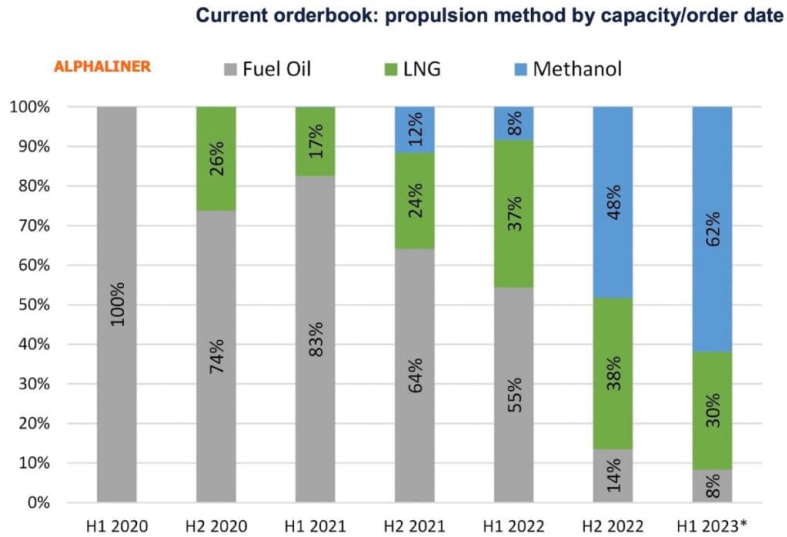
- We capture **biogenic CO<sub>2</sub>** and combine it with **hydrogen** made from green electricity.
- And produce **eMethanol**, a carbon neutral liquid electrofuel ideal for shipping.





# Green Container Shipping – “all the way to zero” has started

## Maersk’s orderbook changing to sustainable fuel



\* at 24/02/2023. Based on current orderbook; does not include vessels ordered since 2020 and delivered.



Link: Methanol boxship orders growing more rapidly than all other fuel types - Splash247

7 Mill. t/y eMethanol today \*

70  
Flagships \*\*

30 Mill. t/y eMethanol by 2030

300  
Flagships \*\*

\* according the actual ordered/existing dual fuel ships in 2024

\*\* each Standard Flagship with 100.000 t/year CO2 neutral eMethanol

2.October 2024

# Site requirements for 100,000t/a eMethanol production



## CO2 flow

- ❑ 160,000 ton captured CO2/year (biogenic)
- ❑ > 8% CO<sub>2</sub> flue gas concentration



## Electricity capacity

- ❑ 170 MW grid connection
- ❑ 1.2 TWh/year green electricity



## Heating and cooling

- ❑ Steam: 30 MW @ >9 & 4 bar
- ❑ Feed water: 10 t/h
- ❑ Cooling water: 80 MW@ 20 >> 40 °C
- ❑ Cooling water: 30 MW@ 40 >> 90 °C



## Land and logistic

- ❑ ~7-8 acres for facility / app. 3 hectares
- ❑ Area for methanol storage
- ❑ Possibility of methanol transport



## Other site benefits

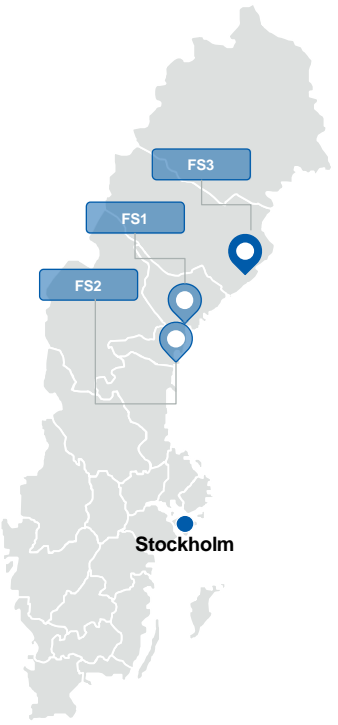
- ❑ Access to water treatment
- ❑ Access to demineralized water (30 t/h)
- ❑ Need for off-gases
- ❑ Need for heavy alcohols
- ❑ Need for pure oxygen
- ❑ Need for residual heat



# FlagshipTHREE, Umeå (Sweden)



# FlagshipTWO, Sundsvall (Sweden)

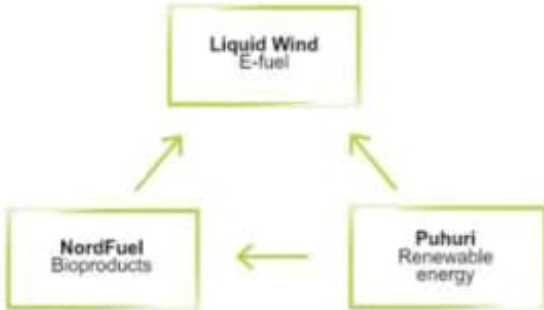


Notes:  
1. Known as Mark-och miljödömsstolen (MMD) in Swedish

## FlagshipFOUR, Haapavesi (Finland)

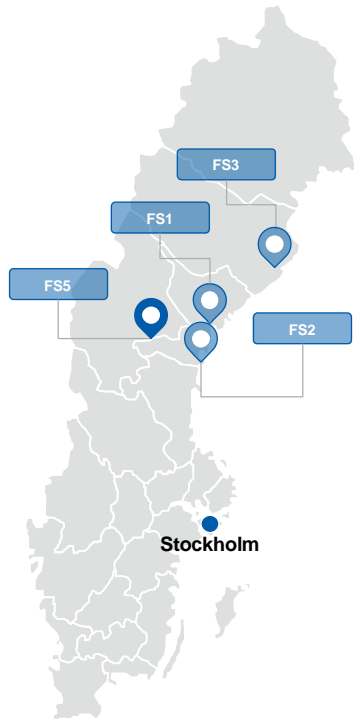


FlagshipFOUR Pre-Feed started 12/2024  
2 x 100.000 eMethanol/year

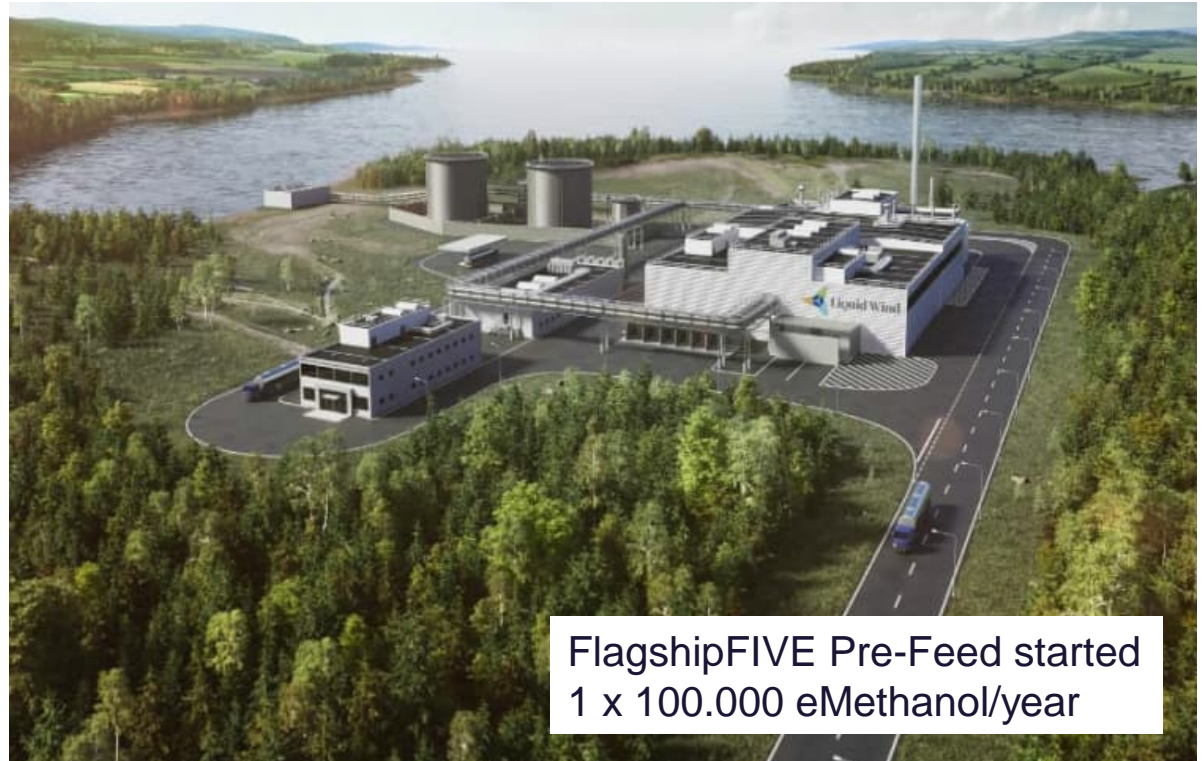




# FlagshipFIVE, Östersund (Sweden)



Liquid Wind and Uniper announce the signing of a strategic partnership agreement to further accelerate the development of eFuel facilities to produce fossil-free eMethanol



FlagshipFIVE Pre-Feed started  
1 x 100.000 eMethanol/year

Notes:  
1. Known as Mark-och miljödömsstolen (MMD) in Swedish

# Liquid Wind's Road Map for the Flagships:

FS2

Sundsvall  
energi

- Exclusivity secured with Sundsvall Energi
- Korstaverket power plant in north Sweden
- 112 ktpa eMethanol capacity
- Environmental permit application submitted
- AFRY conducting FEED study
- Biogenic CO<sub>2</sub> and grid access via host
- FID in 2024, COD by 2027

FS3

UMEÅ ENERGI

- Exclusivity secured with Umea Energi
- Dava cogeneration plant in north Sweden
- 112 ktpa eMethanol capacity
- Biogenic CO<sub>2</sub> and grid access via host
- FID in 2025, COD by 2027

Commercial Discussions for FS4 – FS10 are Advancing						
	Location		Capacity (ktpa)	Development Status	FID	COD
<b>FS4</b>	Haapavesi	+	224	Pre-FEED study set for December 2023	2025	2028
<b>FS5</b>	Sweden		112	Pre-FEED study set for October 2023	2026	2028
<b>FS6</b>			224	Pre-FEED study set for October 2024	2026	2028
<b>FS7</b>			112	Feasibility study ongoing	2026	2029
<b>FS8</b>		+	448	Feasibility study ongoing	2027	2029
<b>FS9</b>			224	Feasibility study ongoing	2027	2029
<b>FS10</b>			112	Feasibility study to be initiated	2027	2029

Long term strategy by Liquid Wind

Final Investment Decisions: 10 x Flagships with 1.5 Mill. Tones eMethanol per year up to 2027

22.02.24: Opening Design Center for Flagships LW and OEMs

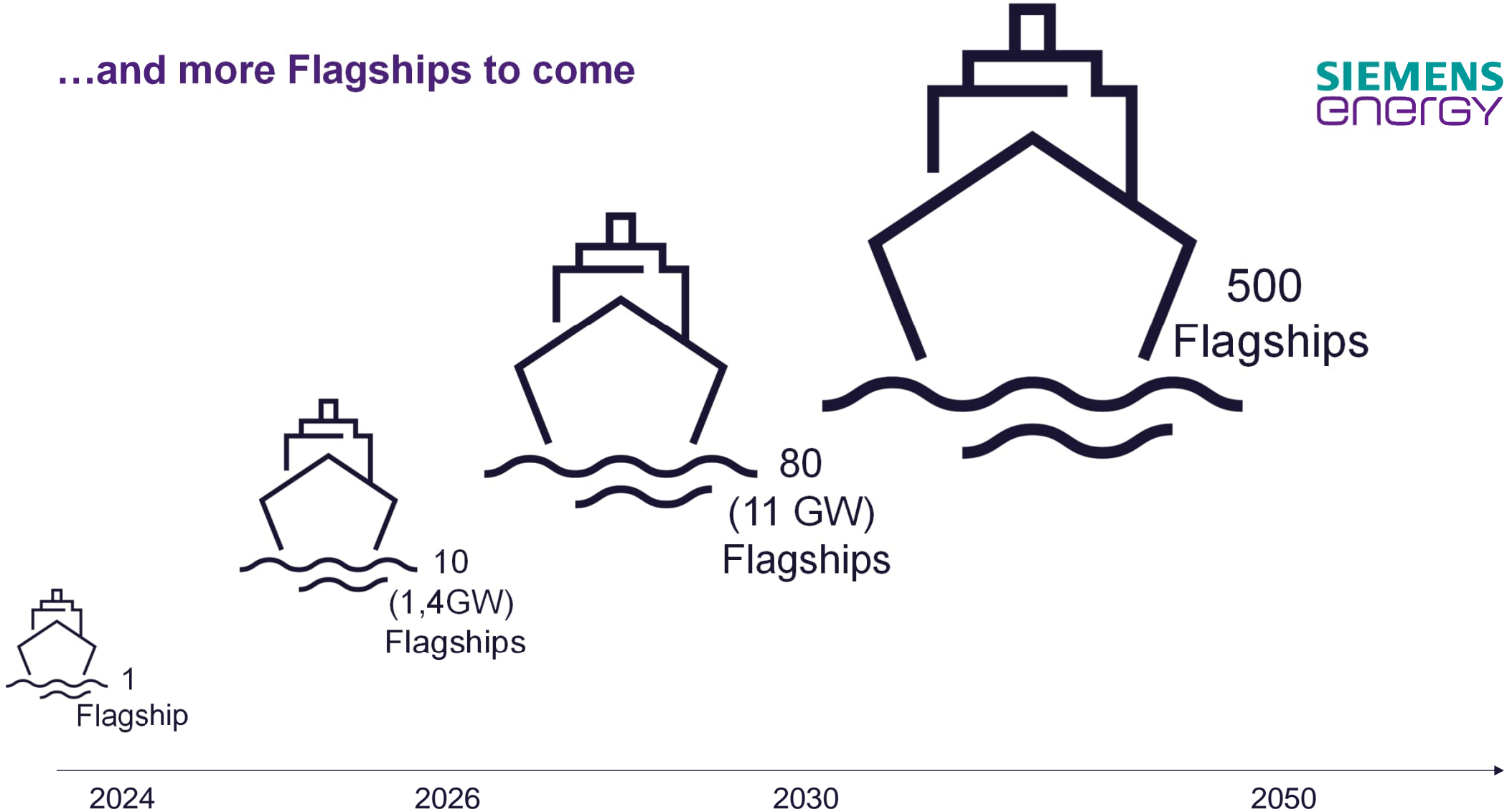
Siemens Energy as the main OEM for Electrolyzer, Compression, EAD

2.October 2024

Engelbert Schrapp, Principal Corporate Account Manager 31  
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# ...and more Flagships to come



# What is the price tag on green shipped consumers products?

## Running ships on 100% green hydrogen would add just cents to most consumer goods

Added costs from China to Europe



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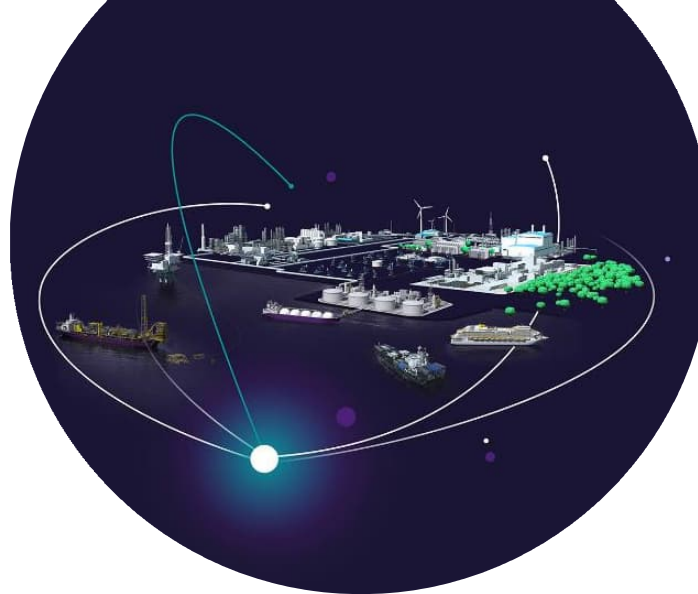
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**Conclusion – Q&A**

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# Contact

**SIEMENS**  
ENERGY



## Schrapp, Engelbert

Principal Corporate Account Manager eFuel & Power2X Projects  
Principal Corporate Account Manager Liquid Wind  
Coach Account Management Nordics

SIEMENS AB  
Evenemangsgatan 21  
SE-171 06 Solna (Stockholm), Sweden  
Sweden

- Mobile +46 (70) 7281218
- Mail to: [engelbert.schrapp@siemens-energy.com](mailto:engelbert.schrapp@siemens-energy.com)



Engelbert