

Decarbonization through technology

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November, 2023



Decarbonization through technology

- 1** **The Energy Transition**
- 2** **Power 2X**
- 3** **Green Energy Certification**
- 4** **Grid Stabilization**
- 5** **Heat Pumps**
- 6** **Digital powerlines**



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1 The Energy Transition

2 Power 2X

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5 Heat Pumps

6 Digital powerlines



The energy transition demands an energetic approach



Five actions we're taking to drive change across the whole energy system

Expanding renewables

+670 GW global wind energy capacity extension until 2027

Transforming conventional power

-65% CO₂ by gas-fired combined cycle PPs compared to coal-fired PPs

Strengthening electrical grids

\$630 billion annual investments in power grids until 2030

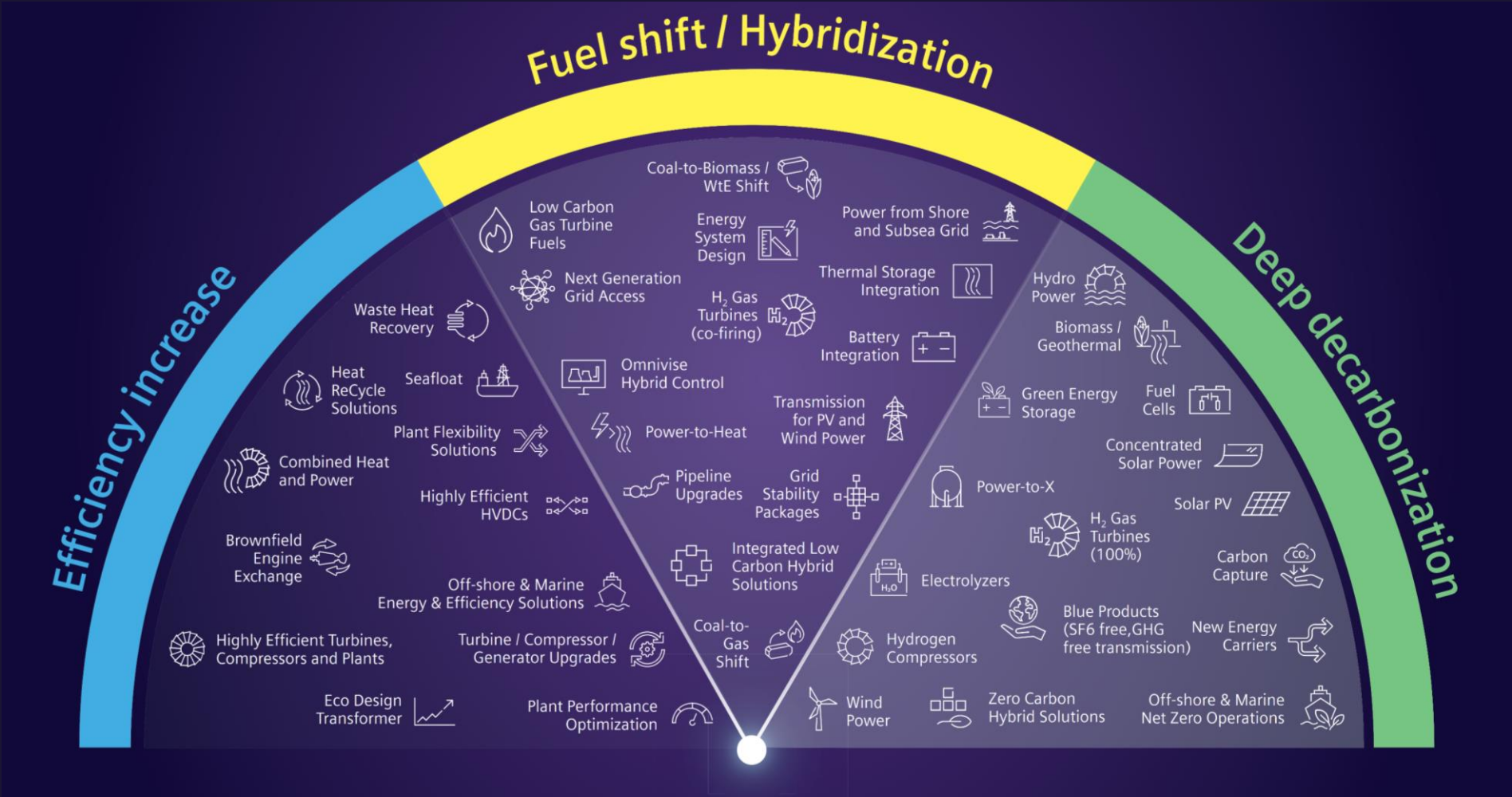
Driving industrial decarbonization

5 Gigatons of CO₂ need to be saved per year in the industrial sector

Securing the supply chain and necessary minerals

+50% minerals required to build a new power generation unit compared to 2010

Following and developing various technology options – our technology radar

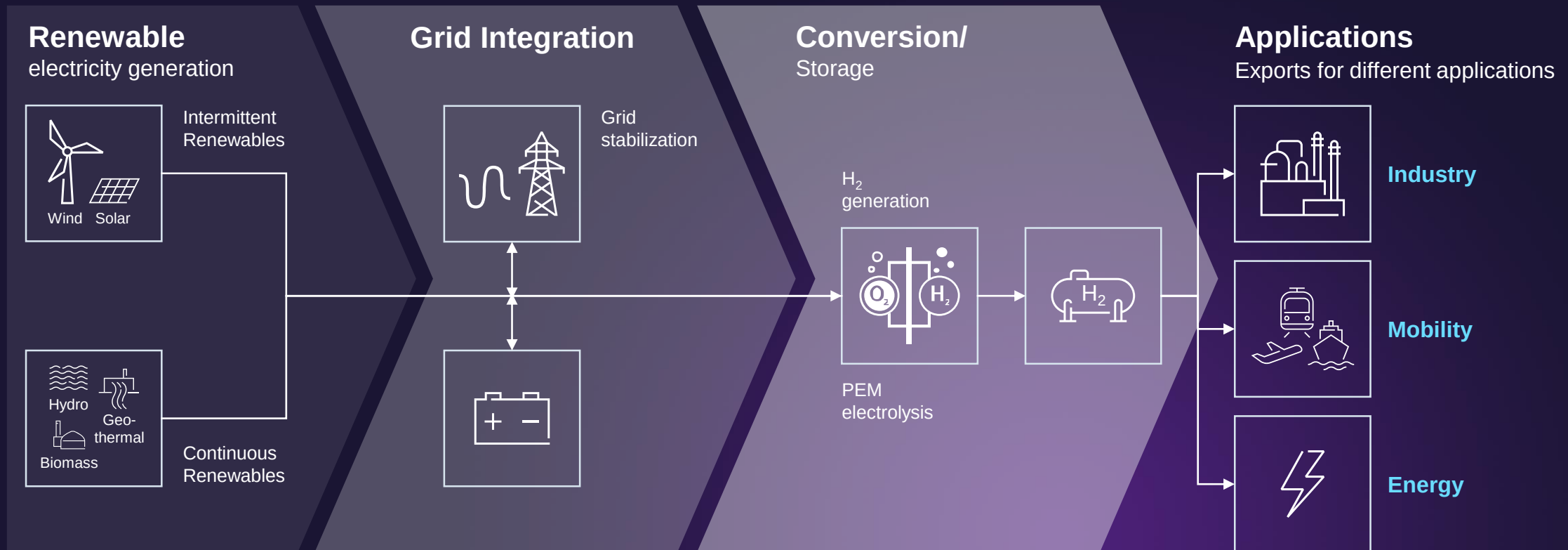


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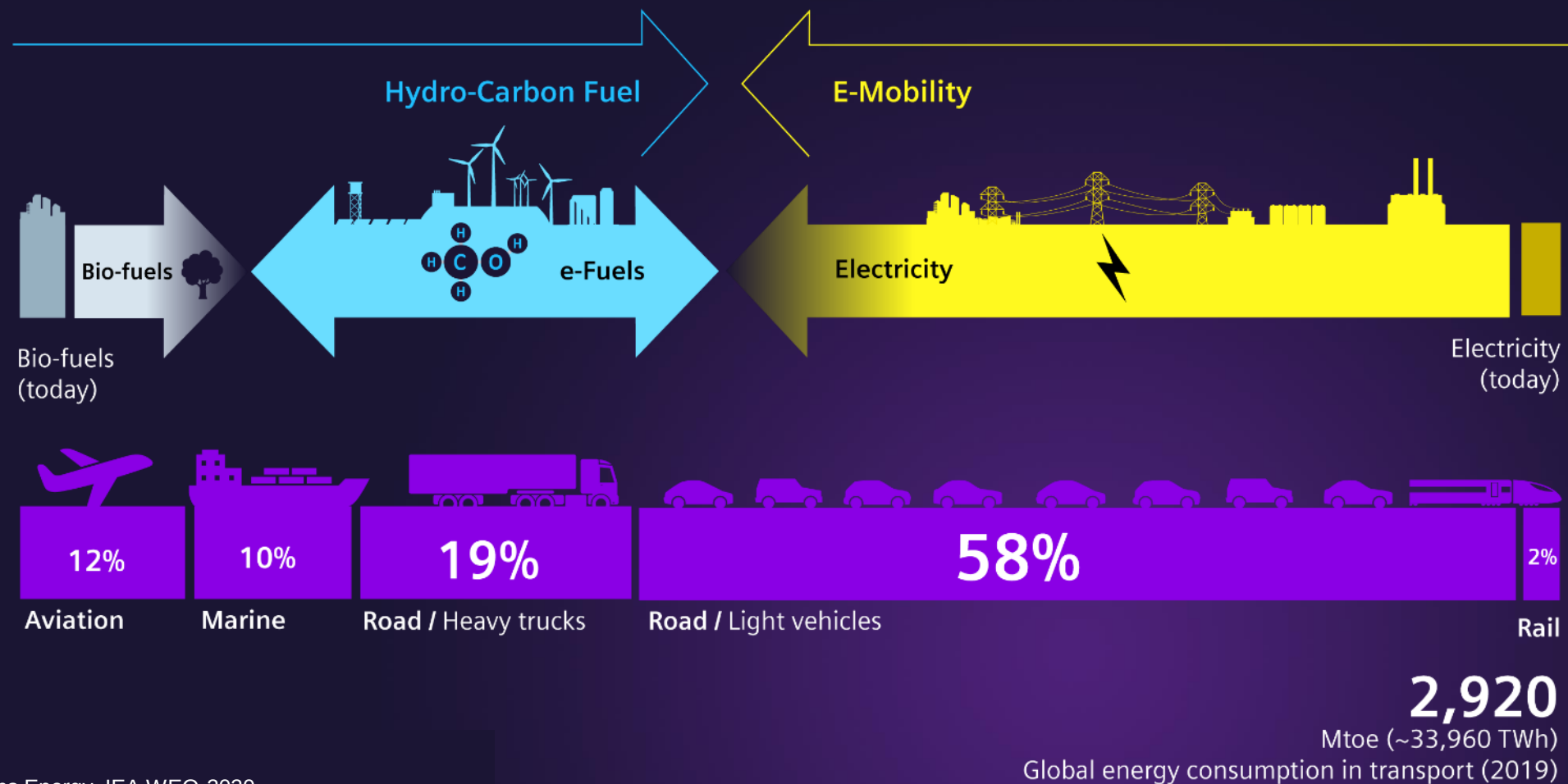
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Hydrogen from renewables enables large scale, long term storage and sector coupling



E-fuels required to reduce CO₂ emissions related to transport



Source: Siemens Energy, IEA WEO-2020

Chemical Processes Power-to-Fuel pathways

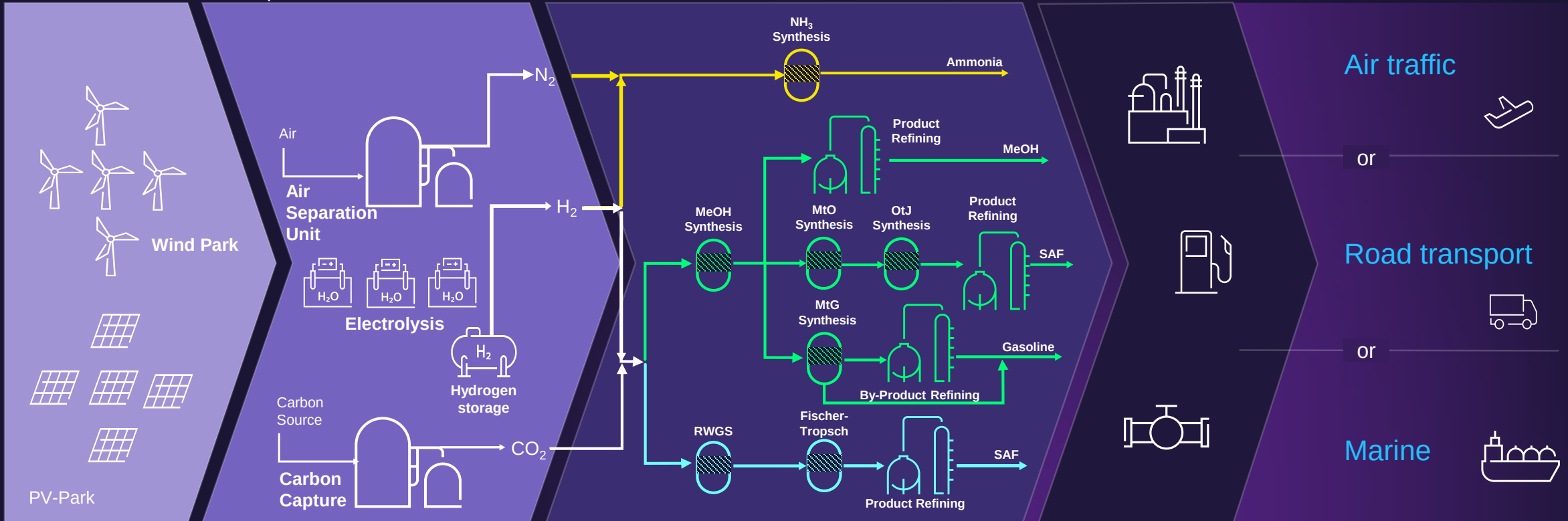
Renewables
(on-grid/off-grid)

Syngas generation

Electrolysis, Carbon capture and
Air separation

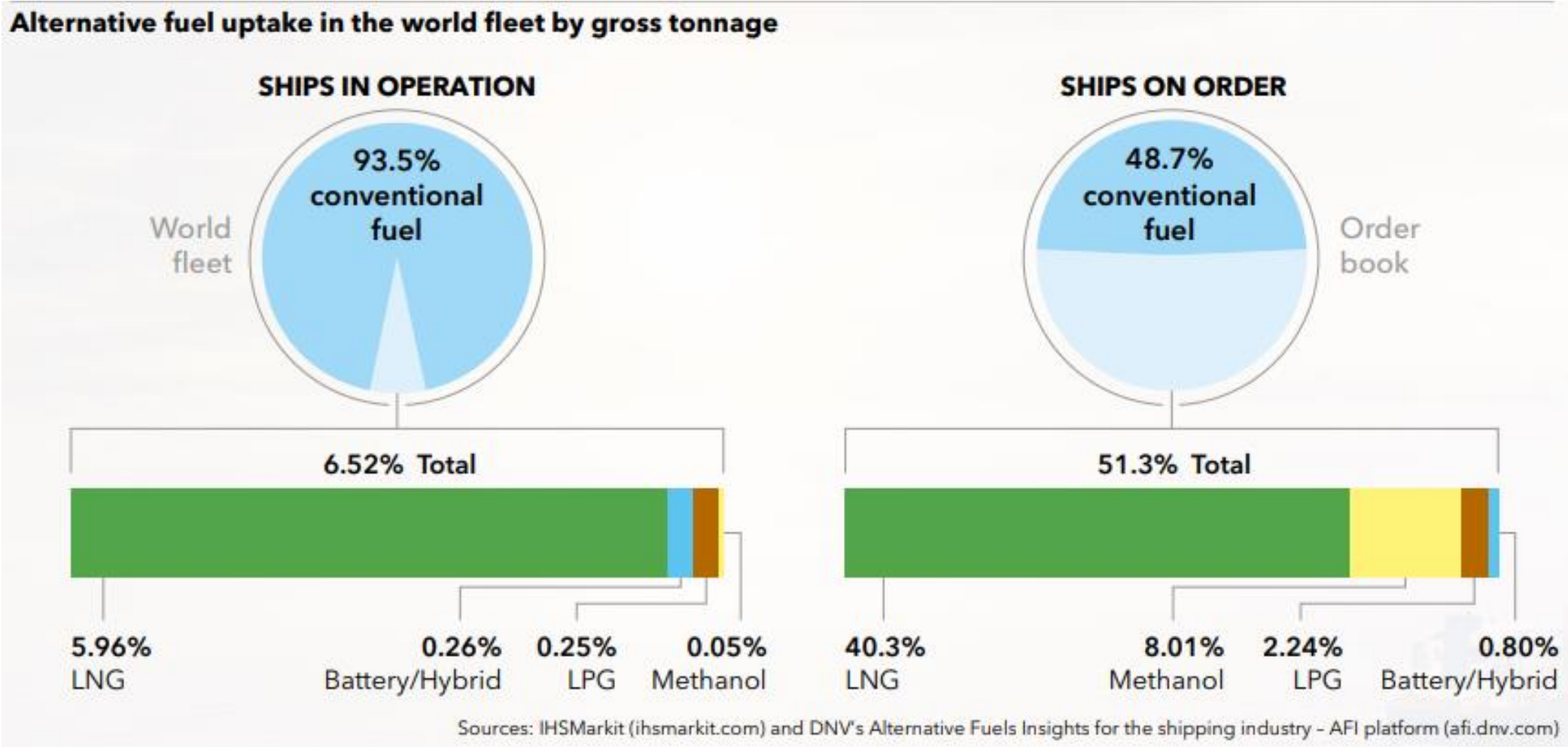
Chemical Processes

**Liquid fuel
infrastructure**



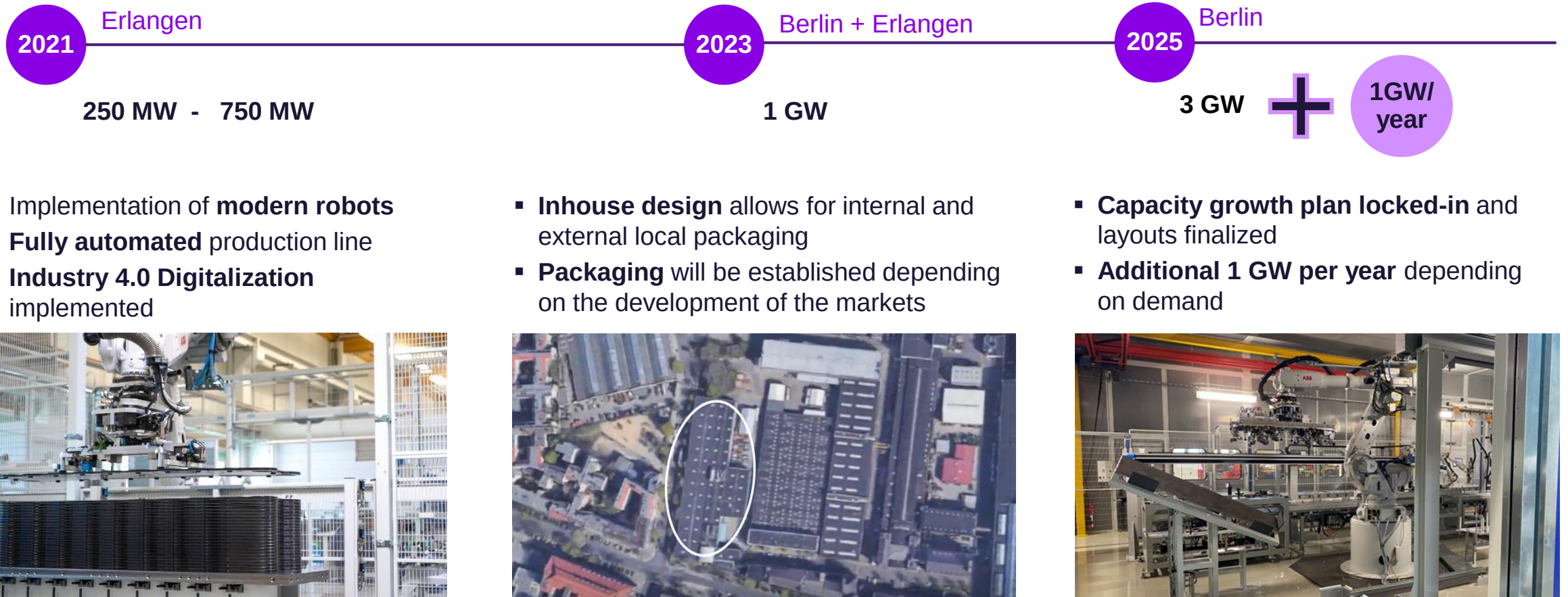
MtO Methanol to Olefins
OtJ Olefins to Jet Fuel
MtG Methanol to Gasoline
RWGS Reverse Water-Gas Shift reaction
SAF Sustainable Aviation Fuel

Decarbonization routes of maritime transportation



Ready to deliver large-scale electrolysis systems + capacity increase in Germany is locked and loaded

SIEMENS
ENERGY



Silyzer 300

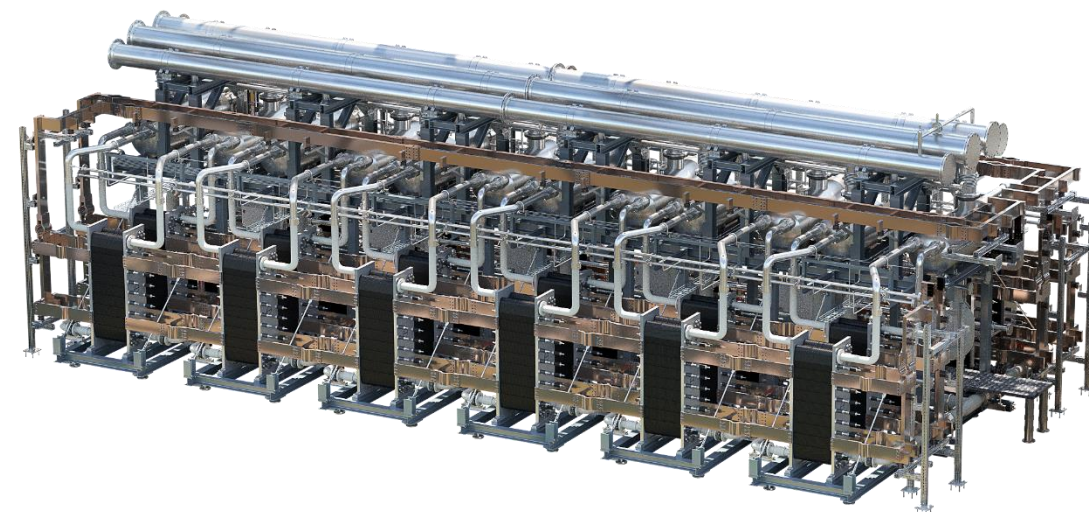
Fact Sheet

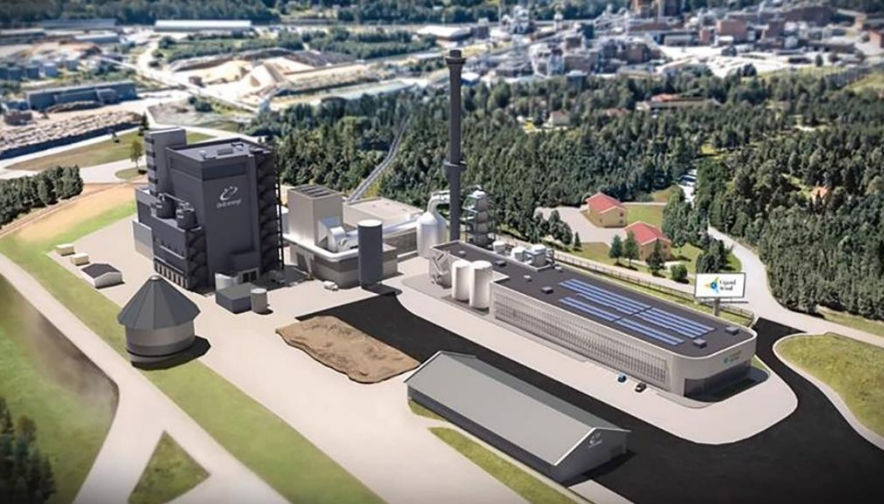


	Hydrogen production	335 kg/h
	Plant efficiency (HHV¹)	>75.5%
	Power demand	17.5 MW
	Start-up time	<1 min, enabled for PFRS ²
	Dynamics in range	10%/s in 0 – 100%
	Minimal load	40% single stack
	Dimension full stack array	15.0 x 7.5 x 3.7 m
	Electrolysis system building	35.5 x 15.5 x 9.0 m
	Plant availability	~95%
	Demin water consumption	10 l/kg H ₂
	Dry gas quality³	99.9999%
	Delivery pressure	Customized

¹ Plant efficiency includes rectifier, transformer, transformer cooling and gas cooling

² Primary Frequency Response Service | ³ With DeOxo | ⁴ Operating Hours





70 MW

power demand based
on Silyzer 300

50.000 tones

of e-Methanol per year from 2025

10 more plants

by 2030

FlagshipONE

Largest commercial product plant for
CO₂ neutral e-Methanol for marine use

SIEMENS
ENERGY

Project

- Customer: FlagshipONE
- Investor: Ørsted
- Country: Sweden
- Installation: expected 2025
- Product: Silyzer 300

Use cases



Hydrogen for e-Methanol
Decarbonize the world's shipping industry

Challenge

- Europe's largest commercial e-Methanol product facility
- Blueprint: Liquid Wind plans 10 facilities by 2030
- FlagshipTWO electrolyzers capacity of 140 MW planned

Solutions

- 4x PEM Silyzer 300
- Plant wide electrification and automation system, digitalization solutions (digital twins), power distribution and compressor systems
- E-Methanol from hydrogen and biogenic carbon dioxide



HARU ONI PILOT PROJECT

First integrated plant for climate-neutral e-fuel production from wind and water

SIEMENS
ENERGY

750,000 liters

of e-methanol per year from 2023
(130,000 liters of e-gasoline)

>55 m liters

e-fuel per year planned from 2025

>550 m liters

e-fuel per year
planned from 2027



Project

Customer: HIF (Highly Innovative Fuels)
Off-taker: Porsche AG
Country: Chile, Patagonia
Installation: 2022
Product: Power-to-methanol solution
based on SE Electrolyzer

Challenge

- Huge wind energy potential in Magallanes
 - Existing industry and port infrastructure
- Perfect conditions to export green energy from Chile to the world

Use cases



E-Fuel for Porsche cars

Potential for adding Kerosene or Diesel production in future phases

Methanol for ship motors

Solutions

- Production of e-gasoline and e-methanol at one of the best spots worldwide for wind energy
- Co-developer Siemens Energy realizing the system integration from wind energy to e-fuel production
- International Partners like Porsche and AME



up to **20 MW**
based on Silyzer 300¹

335 kg
of green hydrogen per hour

2,680 kg
of green oxygen per hour

TRAILBLAZER PROJECT OBERHAUSEN

Green hydrogen for Air Liquide pipeline infrastructure



Project

Partners: Air Liquide
Country: Germany
Installation: 2023
Commissioning: 2023
Product: Silyzer 300

Potential

- Connect hydrogen production to both existing hydrogen and oxygen pipelines
- First step: up to 20 MW capacity
- Potential to expand to 30 MW total planned capacity

¹ plant incl. additional auxiliaries such as compression for hydrogen and oxygen

Funded by the German Federal Ministry of Economic Affairs and Energy

Use cases



Hydrogen for the Industry



Hydrogen for mobility

Solutions

- Operation of a full 24-stack array Silyzer 300
- Electrolyzer will be integrated into existing local hydrogen and oxygen pipeline infrastructure of Air Liquide
- First electrolyzer to be built in the framework of the partnership between Air Liquide and Siemens Energy
- One of the largest renewable hydrogen and oxygen production plants of Germany

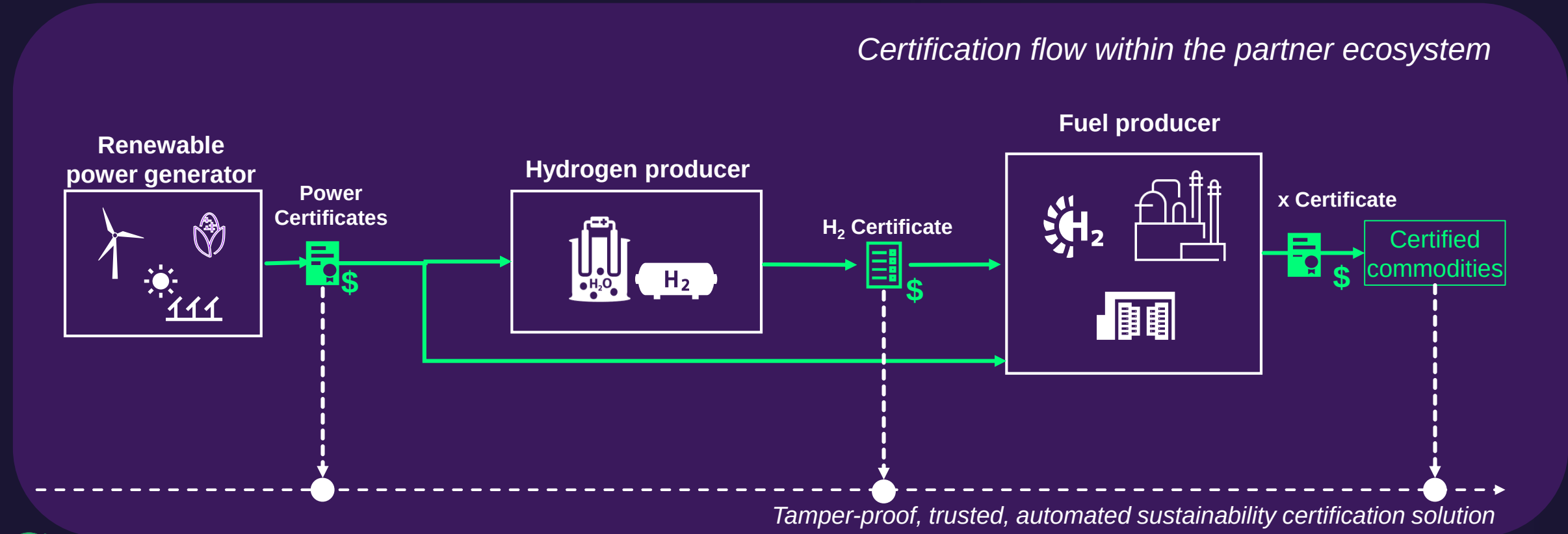
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Clean Energy Certification proofing green origin is a prerequisite to make e-fuels as a tradable commodity

Certification flow within the partner ecosystem



-  Certification Issuing
-  Certification transfer
-  Certification devaluation



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Moneypoint Power Station, Ireland providing a stable grid in the era of renewables



Ireland's great grid stabilizer

Maximum inertia with synchronous condenser and
additional masses provided by flywheel solution

Inertia of

4.000 MWsec

Flywheel

130 tons

Rotor

66 tons

Rotation at

3.000 rpm

- Contribution of short-circuit power
- Voltage support
- Short-term overload capacity
- Inertia to the transmission system

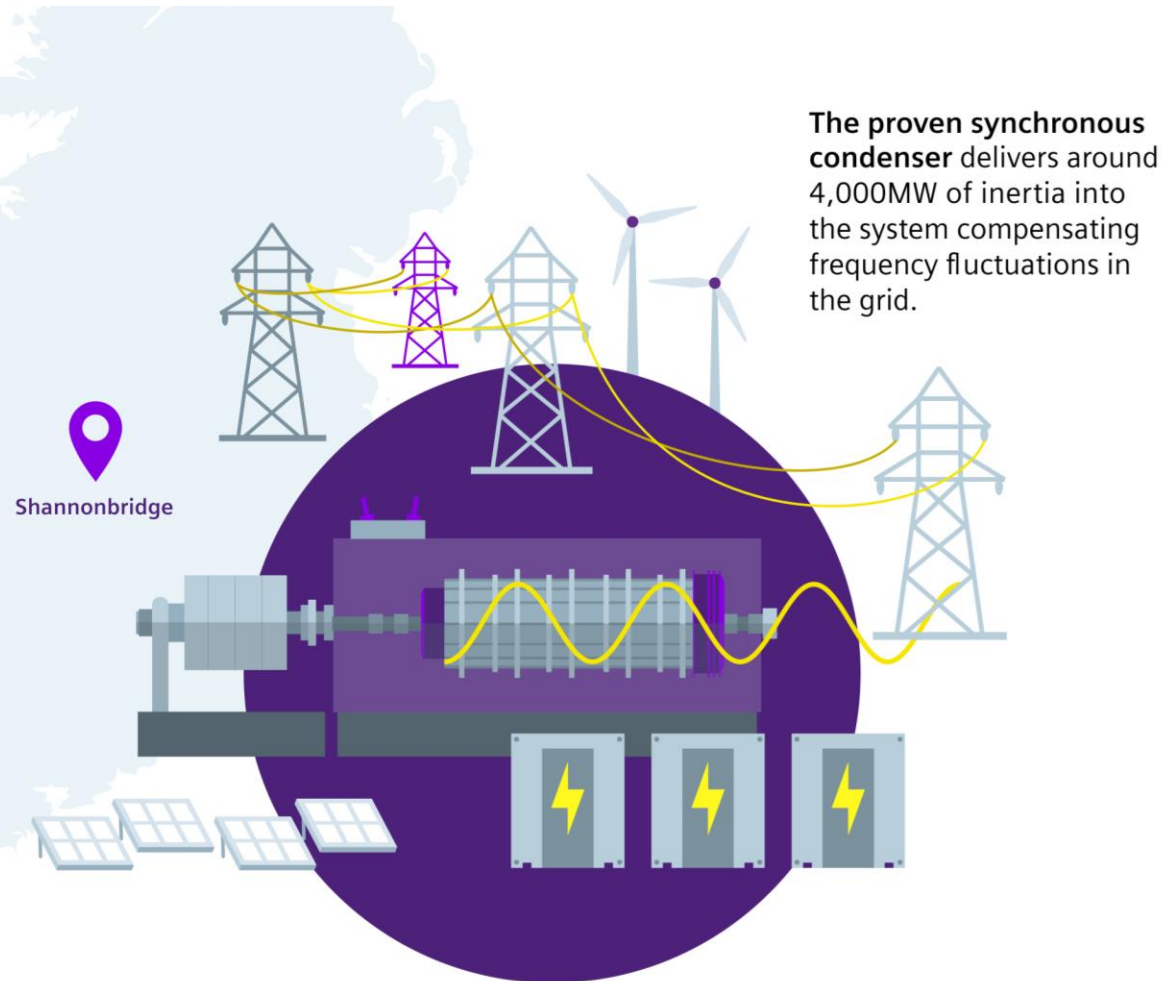


Renewable energy is not enough – it's key to stabilize the grid and expand storage

World-first hybrid grid stabilization plant at Shannonbridge, Ireland

Innovative energy solutions are coming together: large-scale battery energy storage and synchronous condenser technology will be combined to stabilize the grid and to make better use of renewable energy.

Battery systems store excess electricity and with a capacity of around 160MWh it could supply 9,500 households per day.



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Industrial scale heat pumps from Siemens Energy Address both district heating and industry applications



Two complementary product lines ...



SHP-STC-XX W/S

High Temperature Heat Pump

12 – 70 MW_{th}, Up to 150 °C (hot water OR steam up to 3.7 bara)

1st reference: Potsdamer Platz

- 8 MW thermal output
- Customer: Vattenfall Wärme Berlin
- Expected PAC 08/2023



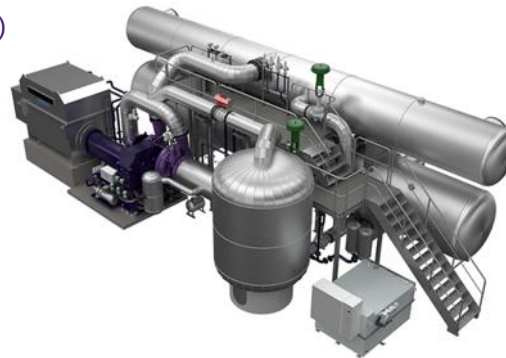
SHP-C600 / C750

Based on PROVEN design (since 1980s)

15 – 45 MW_{th}, up to > 100 °C (hot water)

Latest reference: Reallabor GKM

- 20 MW thermal output
- Customer: GKM Mannheim
- Expected PAC 10/2023



... to serve the needs of our customers



Heat supply

~12 – 70 MW_{th} per unit



Temperatures

up to **150°C** directly from heat pump



Environment friendly work medium

low **GWP¹** and **ODP²**



Various drive concepts

Electrical or mechanical



Combination with steam compression

→ **higher temperatures** and
pressures > 3.7 bara (process steam
production up to 55 bara, 270°C)



Scope of supply

Component up to turnkey supply

¹ GWP = Global Warming Potential

² ODP = Ozone Depletion Potential

³ PAC = Provisional Acceptance Certificate

MVV with GKM using a large-scale heat pump for first steps towards green district heating

CO₂ > 10,000 tons CO₂/a savings



Customer Challenge/Driver

Decrease the use of coal at GKM power plant by installation of a heat pump using the river as energy source. The new heat pump is the first step towards the goal of green district heating. MVV and the City of Mannheim is targeting to become CO₂ neutral in the district heating production by 2030.



Portfolio Elements

Low temperature heat pump SHP-C600 from Finspang (20 MW_{th}) enabling temperature levels up to 99 °C, compressor with gear, electrical motor, heat exchangers, storage tank & control system



Scope

Delivery of a complete heat pump SHP-C600 including full installation and commissioning



Customer Benefit

- Decrease the use of coal
- Use the river Rhine as heat source
- Provide 50 GWh/a heat for the district heating network
- More than 10,000 t of CO₂ emissions savings per year versus heat from a gas boiler at 2,500 full operating hours



PROJECT TYPE

Heat & Green
Municipalities



Combined heat
and power



Heat pumps



Efficiency



CO₂-savings

Decarbonization through technology

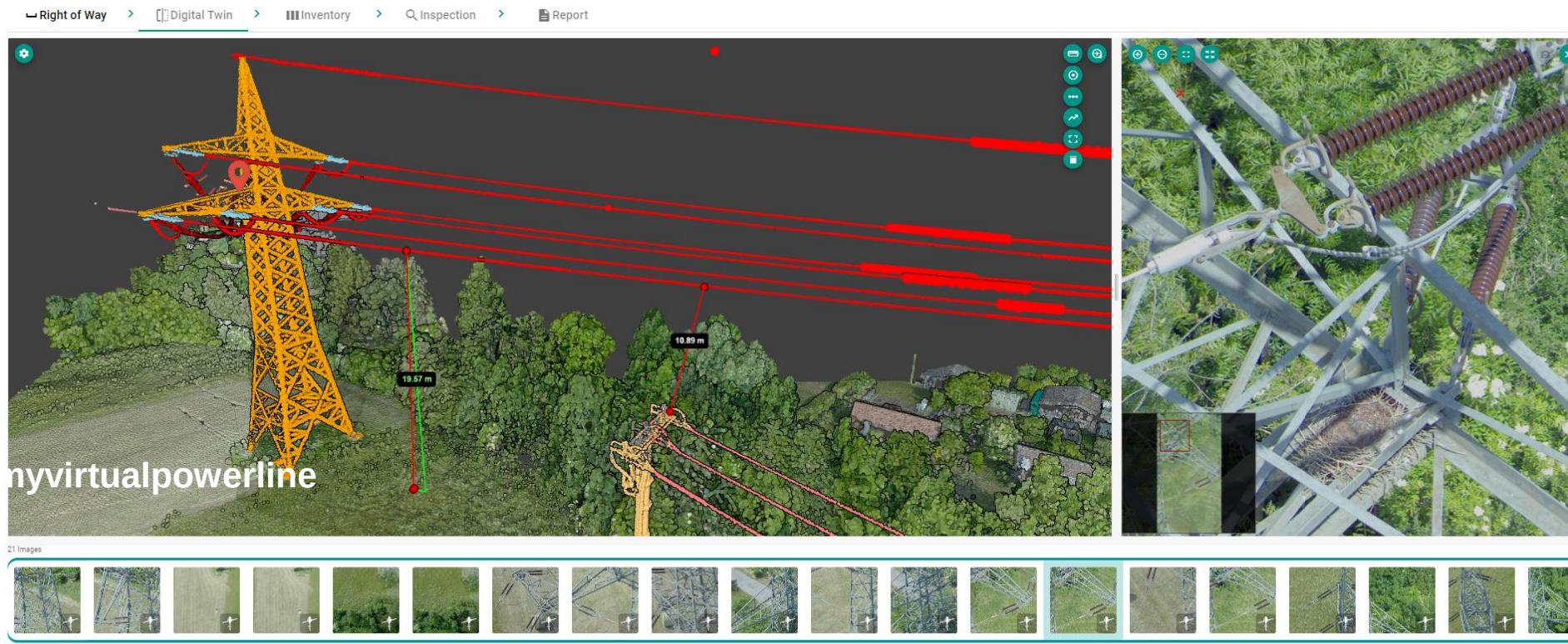
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SIEAERO : the new standard for digitizing powerlines



SIEAERO enables TSO and DSO to digitalize their overhead lines and radically transform traditional field operations into data-driven processes for grid maintenance and grid planning.



Key use cases & benefits

- Digital copy on the line for automated component inventORIZATION and line inspections
- Check powerline integrity and secure its surroundings
- Ecological vegetation and Right of Way management
- Use for BIM modelling of the line and analyze in the 3D pointcloud construction scenarios

SIEAERO is a game-changer service to enable the data-driven strategy and digital transformation of Utility companies

SIEAERO end-to-end Service

Overheadlines digitization for lines inspection & corridor monitoring



Top notch technologies combined by energy experts to enable your digital transformation

Today

Current traditional inspections are

Inaccurate



Slow



Mainly manual work



Dangerous



SIEAERO

Next generation service with the following features

More precise

Faster

Automatic detection and evaluation

Integrated

Safer

More cost efficient

Multi-Sensor System

Integrated system with highest resolution (incl. patents)



RGB



UV



Lidar



IR

More precise/more comprehensive

Customer System Integration

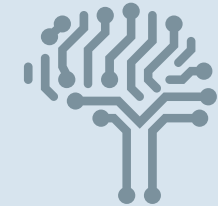
Highest data security



Integrated

Artificial Intelligence

Expert algorithms thanks to energy domain know-how



Faster, automated, more cost effective

Helicopter
(Short Term)



Long Range Drones
(Mid Term)
Most advanced UAV, partner-ships



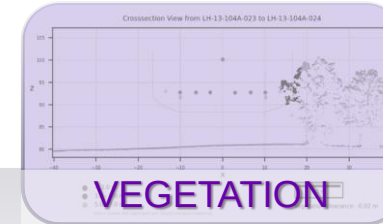
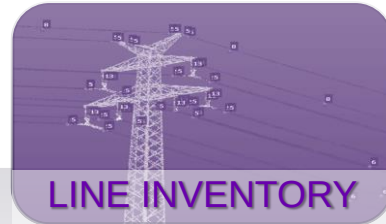
Safer

SIEAERO Services

Overheadlines digitization for lines inspection & corridor monitoring



USE
CASES



SIEAERO Full Service



Unified Analytics Platform

SIEAERO Modular Service

Analytics-as-a-Service (AaaS)

End-to-end service to address
all use cases at once



Modular services to target
specific use cases



Analytics platform
„Bring your own data“





Published by

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