MOVE THE WORLD FORWARD MITSUBISHI HEAVY INDUSTRIES GROUP

Energy Transition
- New frontier of MHI group

Diversified approach for carbon net zero society

October 2023

Mitsubishi Heavy Industries EMEA, Ltd.

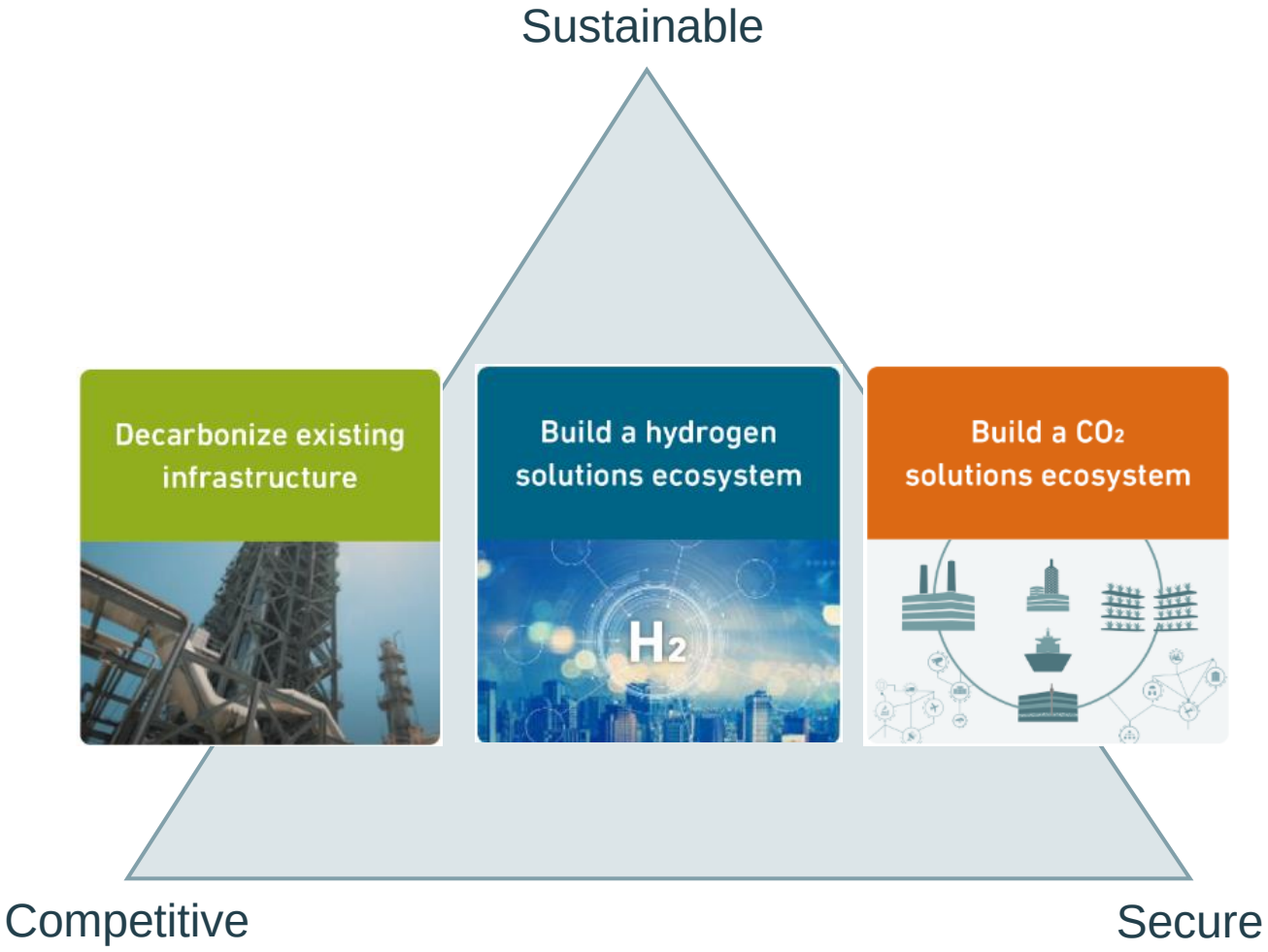
MITSUBISHI HEAVY INDUSTRIES

MHI’s strategy to support a carbon-neutral world

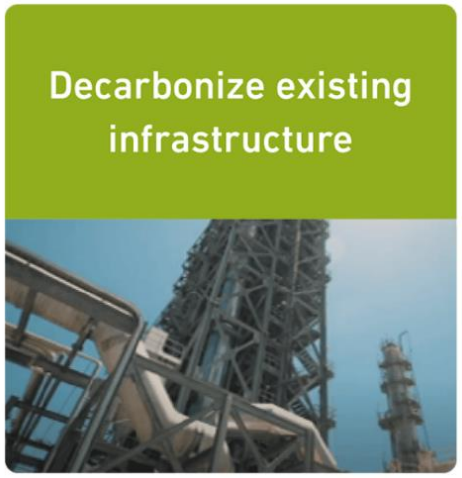
Our strategy is based on…

- development of new decarbonisation solutions alongside improvement of existing ones
- balancing **sustainability, affordability** and **energy security**

to deliver integrated solutions that optimize and future-proof existing infrastructure, hydrogen and CO_2 ecosystems.



Delivering on the energy transition in developing countries



- Optimizing assets through energy savings and energy efficiency, including centralized and distributed power & heat solutions
- Promotion of new carbon-neutral technologies, cooperating with international funding

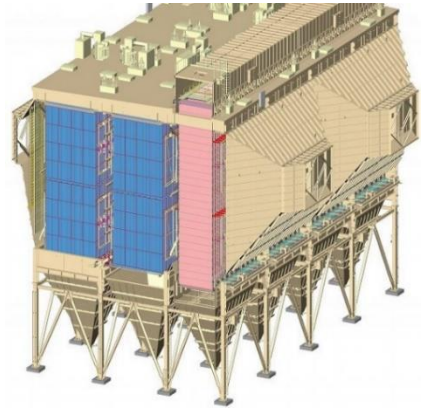
- Supporting the deployment of basic technologies, ready for hydrogen implementation
- Searching the roles inside global value chain for hydrogen and ammonia

- Searching the opportunities for CO_2 capture in hard-to-abate industries, including its use and storage.
- Development of pilot demonstration plants of smaller scale

Towards clean and sustainable thermal power

- Introducing more efficient gas-fired cogeneration leveraging the existing Gas turbines fleet; potentially ready for hydrogen / ammonia; and able to decrease APG flaring
- Promote cleaner coal-fired generation, which is hard-to-abate, with Air Quality Control System

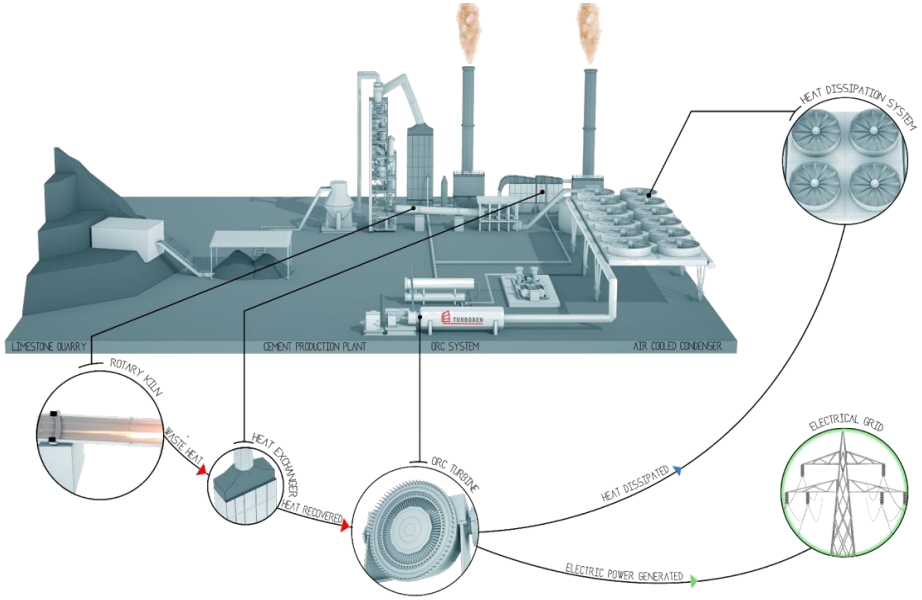
APG-fired power plant based on 3 x H-25 in Kazakhstan



Rotating type ESP, able to handle Ekibastuz coal

Optimizing energy-intensive assets through energy savings

Energy efficiency solutions to increase the sustainability of hard-to-abate production processes



In the cement production process, **Turboden ORC systems** can produce electric power by recovering waste heat from two hot gas streams:

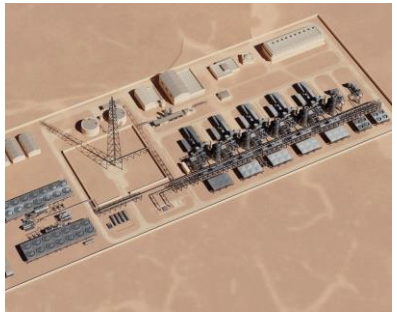
- **Kiln pre-heater (PH) gas**
- **Clinker cooler (CC) gas**

In O&G area, ORC technology can help to decarbonize gas transport at compressor plants, with **no impact on main process, to produce fuel-free electricity**

Other applications include biomass, concentrated solar power, geothermal, steel, glass, waste incineration etc.

Customer: CRH (former Holcim Group)
Location: Slovakia
Orc electric power: 5 MW
Status: in operation since 2014
Clinker production capacity: ~3,600 t/day

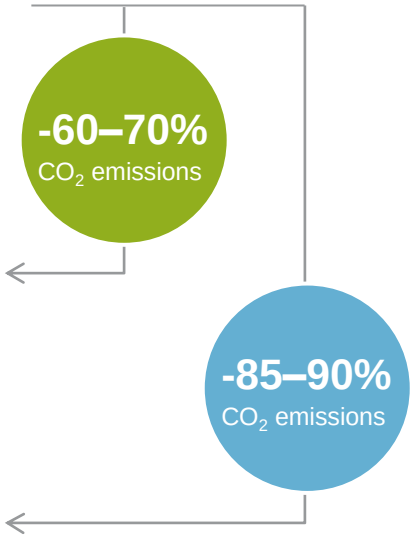
Customer: CTP Team / Sönmez Çimento
Location: Turkey
Orc electric power: 7 MW
Status: in operation since 2020
Clinker production capacity: ~6,000 ton/day



Customer: GASCO
Location: Egypt
Orc electric power: 24 MW
Status: under construction
Concept: first cascade compressor plant, where waste heat from 5 GT feed 2 x 10 electric compressors

Hydrogen-ready ecosystem: Decarbonizing iron and steel

		Emission factor **80 g CO_2** / kWh (2050)	Emission factor **226 g CO_2** / kWh (EU 27 –2019)
COKE/COAL BASED	**BF and BOF route** (84% hot metal and 16% scrap in BOF)	**1,943** kg CO_2 / t liquid steel	**1,968** kg CO_2 / t liquid steel
NATURAL GAS BASED	**DR and EAF route** (80% hot DRI and 20% scrap in EAF)	**577** kg CO_2 / t liquid steel	**659** kg CO_2 / t liquid steel
HYDROGEN BASED	**DR and EAF route** (80% hot DRI and 20% scrap in EAF)	**187** kg CO_2 / t liquid steel	**260** kg CO_2 / t liquid steel



Note: Based on a calculation model for an average modern blast furnace with 2.5 MTPY capacity and PCI injection; Location – EU-27. Sinter plant and coking plant assumed within boundaries of integrated steel works boundary. Pellets are imported. Scope 1, 2 and 3 are considered for CO2 emission calculation. Emissions for each plant to be calculated individually based on actual situation.

Flexibly capturing CO_2 from various emission sources

- MHI Group provides core technologies essential for CCUS, including CO_2 capture, Our solutions accommodate small- to large-scale capacities and different CO_2 capture challenges.
- Challenges are based on impurities, exhaust gas temperature, load variation, installation constraints, structure and proximity to our existing technology.
- We are further expanding the number of applications for CO_2 capture based on our core technology.
- Smaller capture devices will be modularized and digitized.

EAR
Chemical
Blue ammonia

Coal/gas power generation	**World's largest CO_2 capture plant (as of 2021) 1.4 mtpa** **Petra Nova**	
Biomass	**World's first negative emissions project (planned) >8 mtpa (> 5x Petra Nova)** UK's first carbon capture project at scale **Drax**	
LNG liquefaction	**Full-scale development of 27 mtpa** (5.4 mtpa x 5 trains) = The **greenest LNG project** in the world. **NextDecade**	
Cement	**Demonstration test starting in June 2022** **Tokuyama Corp.**	
Steel	**Technology verification on multiple emission sources in ironmaking process in Belgium and North America** **ArcelorMittal**	
Shipping	**World's first verification of onboard CO_2 capture during an actual voyage** **"K" Line**	
Waste incineration facility gas engines small boilers/furnaces	**CO_2 capture by small-scale facility through modularization**	

Hydrogen production, storage, use: Takasago Hydrogen Park

Takasago Hydrogen Park

World's first integrated hydrogen technology validation center covering all steps from hydrogen production using various methods (green and turquoise) to power generation.

Validation of 100% hydrogen firing in large-frame gas turbines to start in 2025.

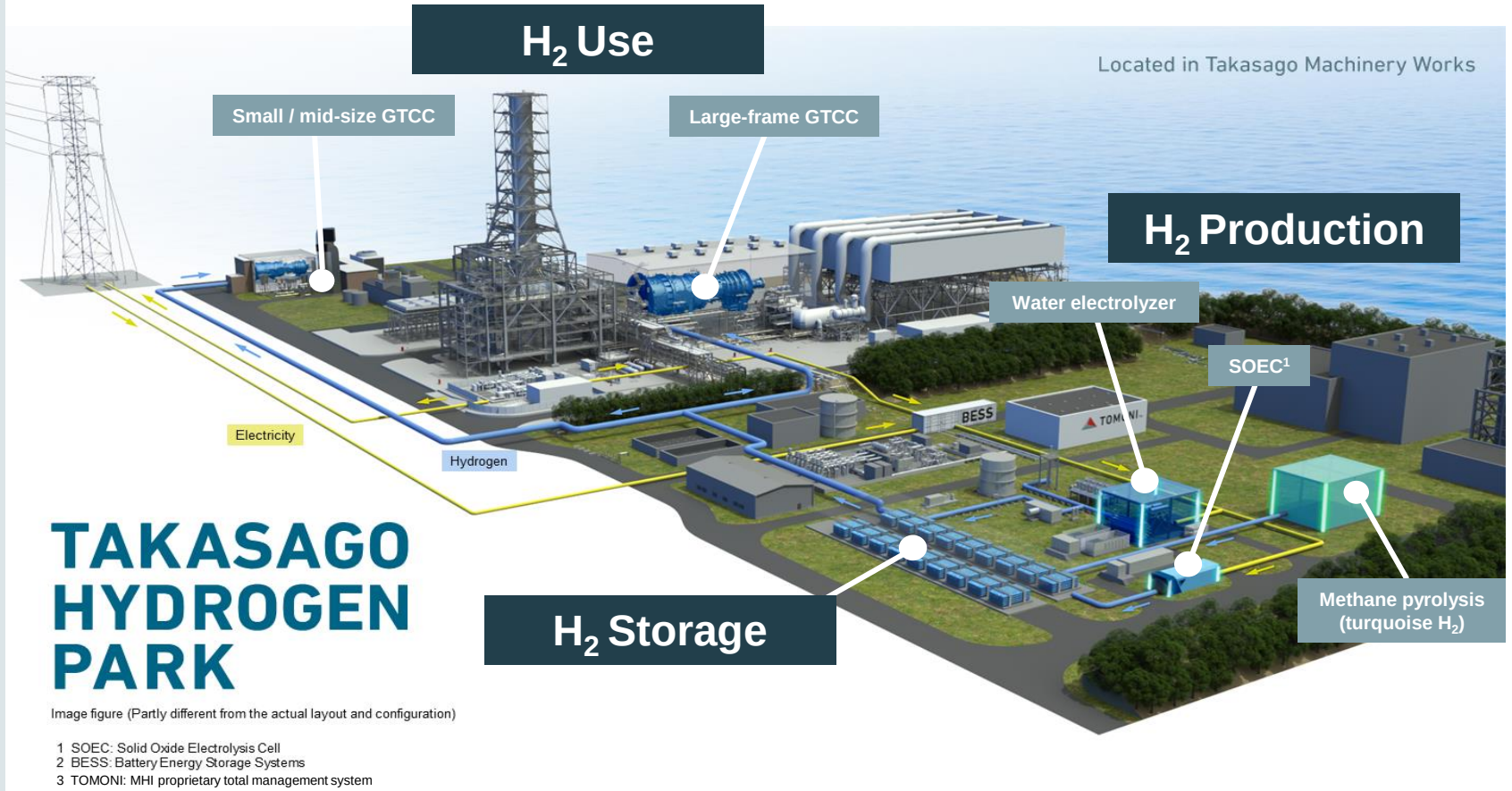


Image figure (Partly different from the actual layout and configuration)

1 SOEC: Solid Oxide Electrolysis Cell
2 BESS: Battery Energy Storage Systems
3 TOMONI: MHI proprietary total management system

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