



Hydrogen Energy Ministerial Meeting

H₂EM 2018

HYDROGEN FUTURE STREAM

Hydrogen Energy Ministerial Meeting 2018

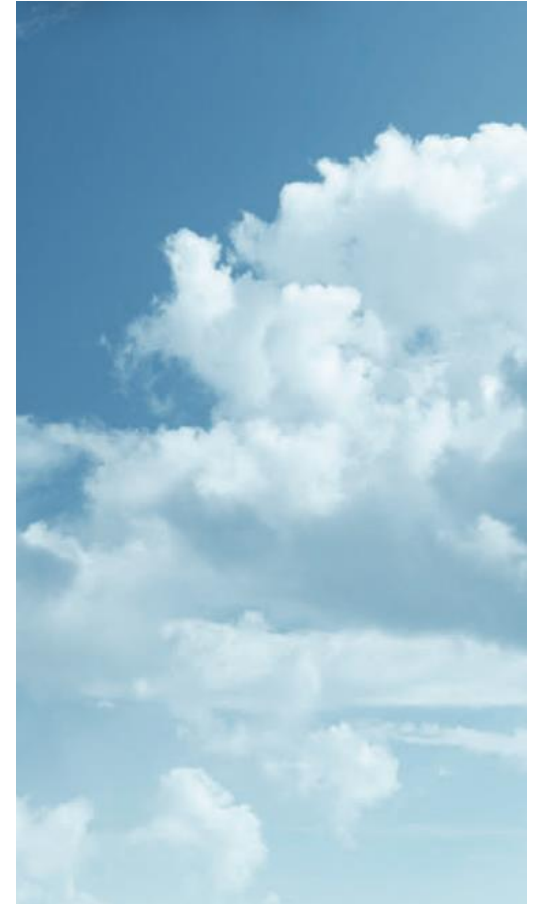
Akimasa Muyama
Senior Executive Vice President and CTO

1. **M**HI FUTURE STREAM
2. **H**ydrogen Scenario
3. **P**roducing a Global Hydrogen Supply Chain
4. **S**olutions in Action

1. MHI FUTURE STREAM

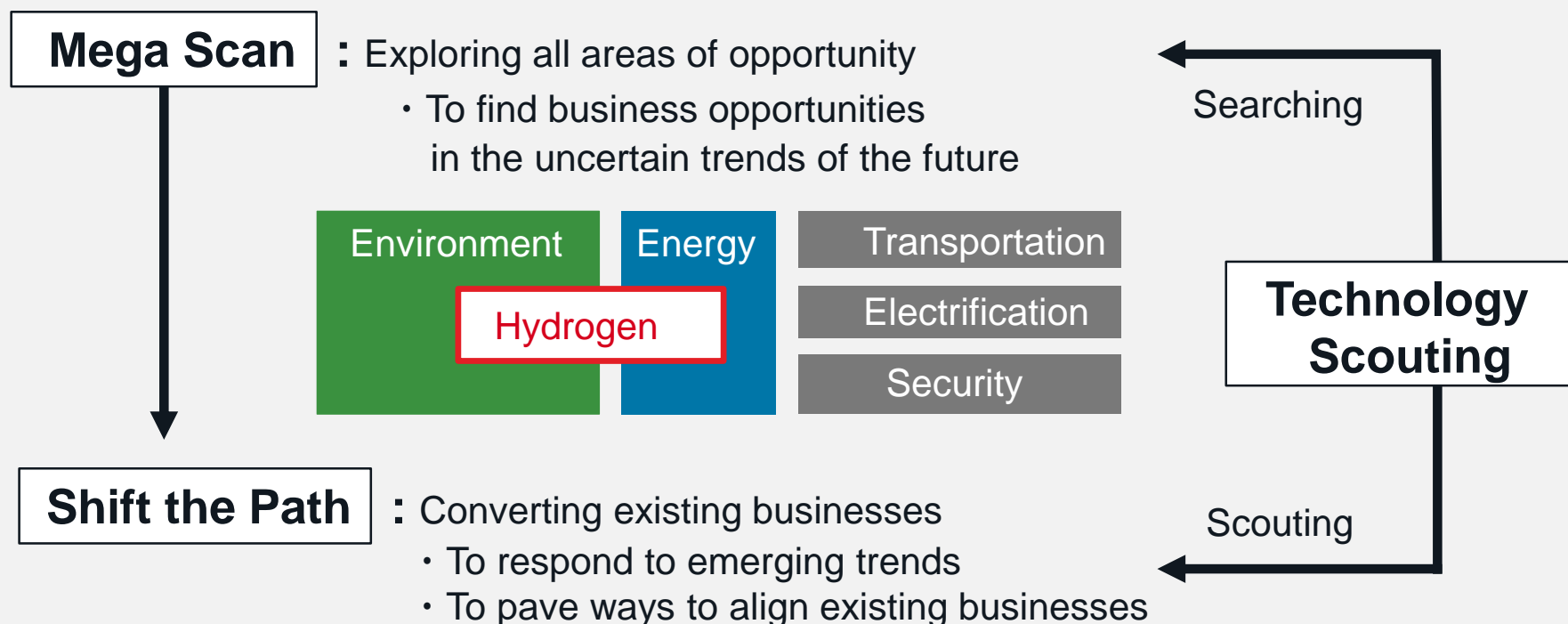
Mitsubishi Heavy Industries Group Objectives

1. Resolve complex and difficult social issues of today and the near future
2. Take on challenges of the distant future
3. Continue making positive changes to serve the needs of mankind and contribute to society



1. MHI FUTURE STREAM

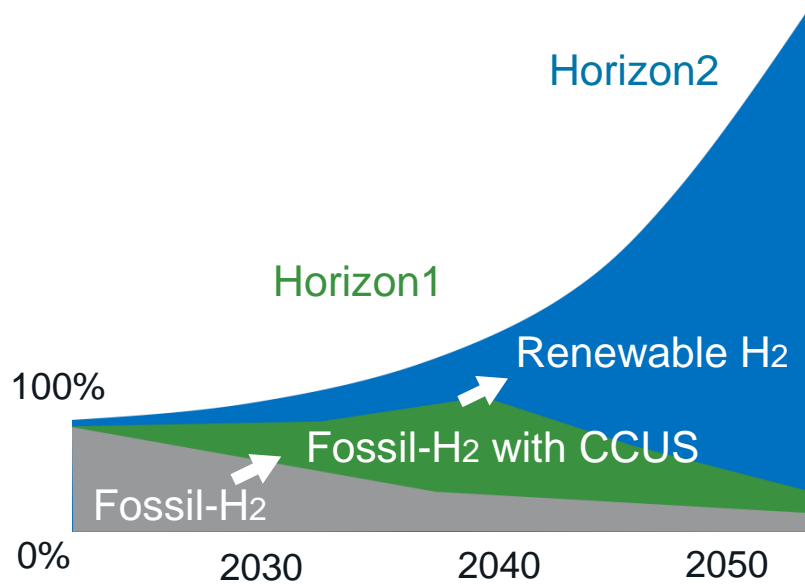
- The framework of MHI FUTURE STREAM consists of 3 activities, Megascan, Shift the Path and Technology Scouting.
- Each activity is integral in achieving industry leadership and optimum contribution to society



“Hydrogen-based energy society” is the key to MHI FUTURE STREAM

2. Hydrogen Scenario

How do we acquire Hydrogen?



Horizon 1 : Medium term

Fossil-H₂ with CCUS to be the initiator and accelerator of hydrogen society

Horizon 2 : Long term

Renewable-H₂ to be dominant through successive/disruptive innovation & significant cost reduction

How Japan reduces CO₂ from thermal power production to zero

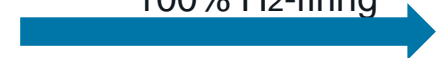
Natural gas power

H₂ co-firing



Shift to

100% H₂-firing



Coal power

Ammonia co-firing

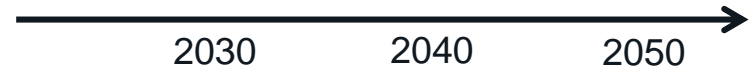


Shift to CCUS



Horizon1

Horizon2



Horizon 1 : Medium term

Co-firing

by CO₂-free hydrogen and ammonia

Horizon 2 : Long term

CO₂ net zero emission

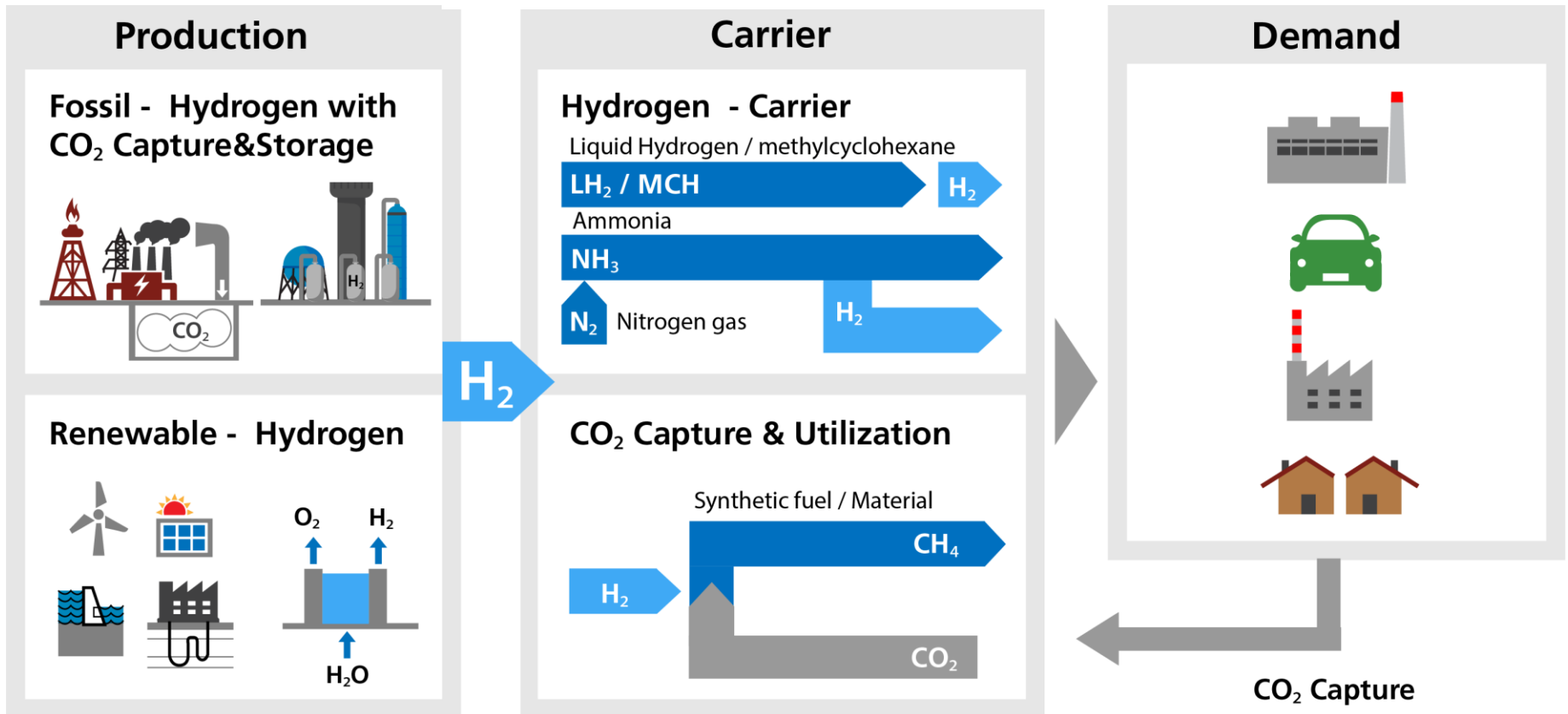
by 100% H₂-firing with RE and CCUS

3. Producing a Global Hydrogen Supply Chain

Challenges

- New levels of cooperation across supply chain
- Incentivizing hydrogen-based energy
- Global consensus for CCS and bilateral/multilateral G2G agreement

Global Hydrogen Supply Chain



3. Producing a Global Hydrogen Supply Chain

Our strengths

- Vast range of products and technologies to support comprehensive global H₂ supply chain
- Power generation equipment adaptable for all kinds of H₂-carriers
- Mass consumption of power generation

H₂ consumption of 1 unit GTCC※ ≒ 2,000,000 FCV ※400MW, 100%H₂-firing

MHI Group's related products & technologies



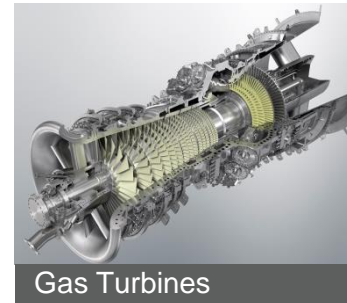
Steam power



Geothermal



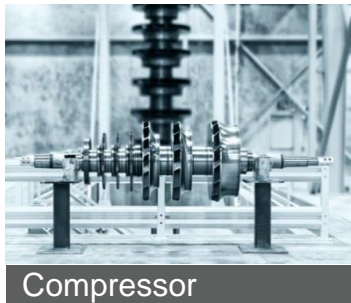
Offshore wind turbines



Gas Turbines



Carbon Capture facility



Compressor



LNG carrier



Fuel cell



Ammonia & Methane plant



Gasification plant

4. Solutions in Action - 2018

Proactive Industry trendsetter

Global initiatives

- Joined Hydrogen Council as support member
- Joined EU-Group action's ALIGN-CCUS project

Defining energy carrier

- Green ammonia consortium : NH_3
- AHEAD : MCH
- CCR study group : CH_4

Commercialized projects actively contributing to the society

- Solid Oxide Fuel Cell(SOFC)
- 100% hydrogen firing



Kyushu University

- Currently operating in 6 sites
- 1 site is under construction



Nuon's Magnum plant

- Convert one of the three existing GTCC units to 100% Hydrogen fuel by early 2024
- CO₂ reduction : 1.3Mtons/year

R&D Collaboration to activate Hydrogen Supply Chain

- Hydrogen-fueled gas turbine with NEDO
- Ammonia fueled GTCC with SIP



- ALIGN-CCUS project in EU to reuse captured CO₂ as synthetic fuel

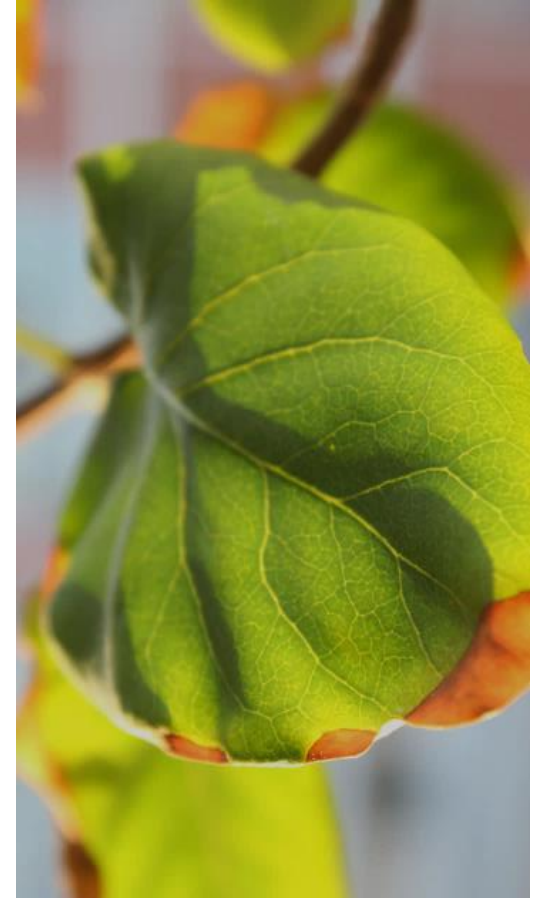
- Apply mixed fuel in existing steam plant



4. Solution Action Items

MHPS will not only focus on providing H₂ power generation but will also work on developing and implementing a supply chain.

1. Promote the supply chain business concept based on MHI FUTURE STREAM
2. Participate in the upstream of the chain
3. Realize the supply chain by collaborating with MHI group and other companies



Power for a Brighter Future

Part of this presentation is based on the results obtained from projects entrusted by METI, CAO and NEDO.