International Transport Forum

EXPERT WORKSHOP

Mapping standards for low- and zero-emission electric heavy duty vehicles

17-18 February 2020 – Paris, France

Efforts toward the Realization of Hydrogen-utilized Society in Japan

February 17, 2020

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1. About JXTG Nippon Oil & Energy Corporation

2. Hydrogen Business in Japan

3. Efforts for CO_2-free Hydrogen Society

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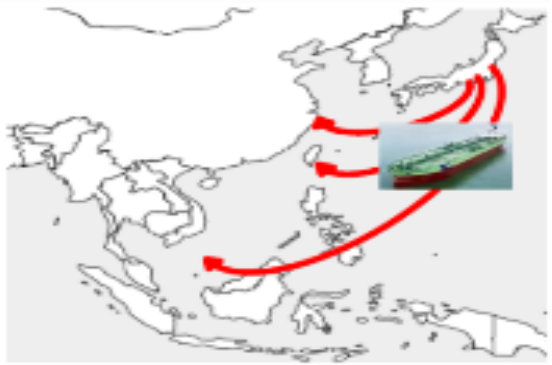
Introduction of JXTG

➢ JXTG Nippon Oil & Energy is one of the core company in JXTG Holdings.

JXTG Holdings

JXTG Nippon Oil & Energy



Domestic fuel oil sales share

50%

* FY2018 results

Paraxylene external sales capacity

3.62 million tons/year

*FY2018 results

Propylene supply capacity

1.70 million tons/year

*FY2018 results

JX Nippon Oil & Gas Exploration

Crude oil and natural gas equity-entitled production volume

110 thousand barrels/day

*Crude oil equivalent (FY2018 results)

JX Nippon Mining & Metals

Equity-entitled copper mine production

200 thousand tons/year

*Amount of copper contained in copper concentrate (FY2018 results)

Refined copper production capacity

920 thousand tons/year

*Equity basis as of March 2019 ※1

Our Energy Businesses

- JXTG is **"Comprehensive Energy Company"** that handles not only petroleum but also various energy such as coal, gas and electricity.
- In addition, we are now working on **hydrogen business as next energy**.

Upstream → **Downstream**

JX Nippon Oil & Gas Exploration

Crude oil and natural gas development

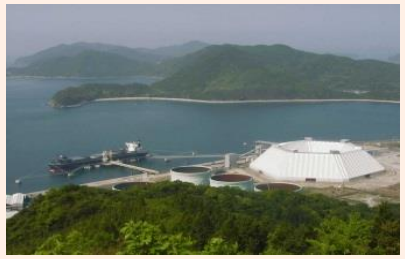
JXTG Nippon Oil & Energy

Oil refining and production

Sales

Petrochemical products (Paraxylene)

Coal



Natural Gas

Electricity

Hydrogen

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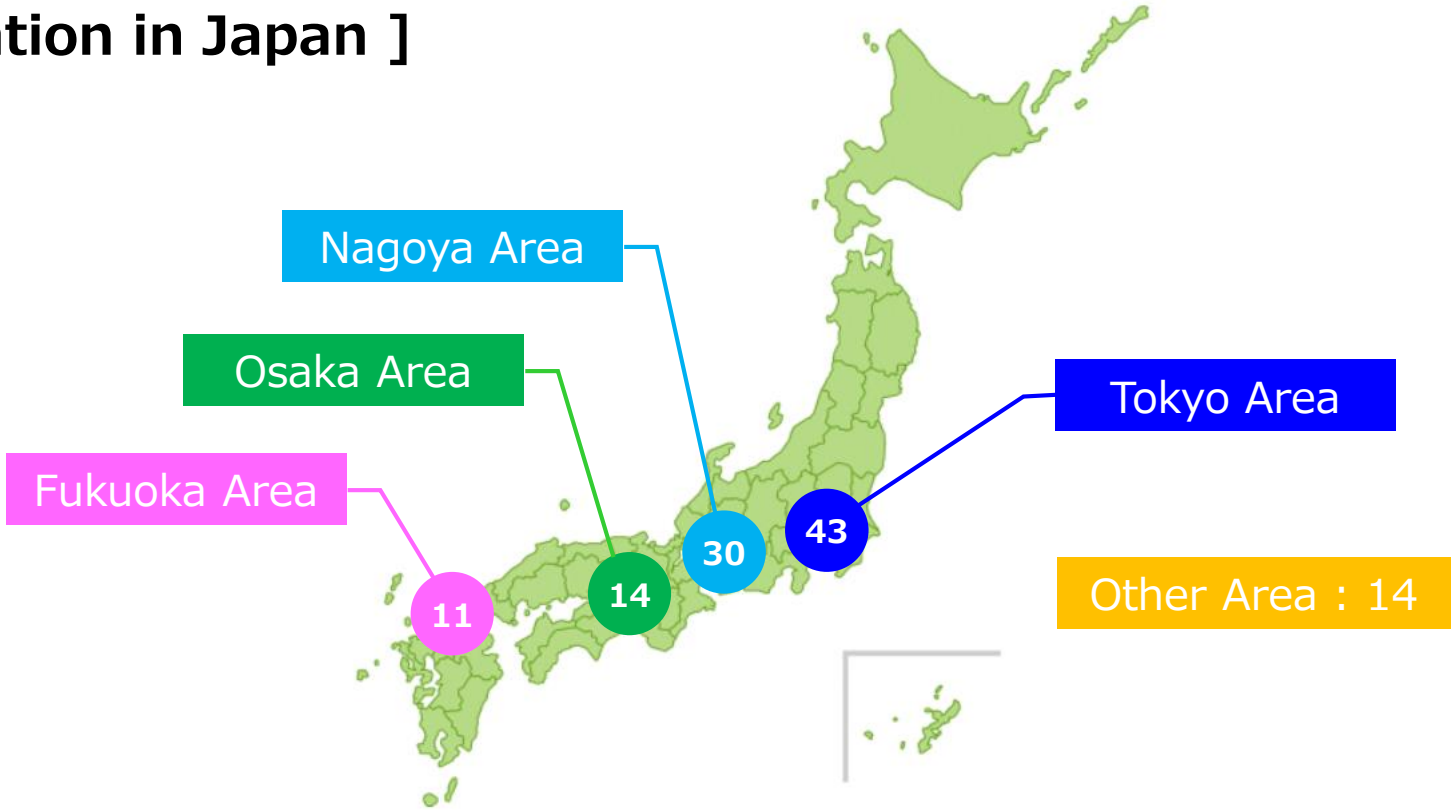
HRS Locations in Japan

- At present, hydrogen fuel is supplied to FCV mainly at HRS. And refueling to FC bus has been started in Tokyo area.
- In Japan, there are **112 HRS in operation**. [As of end of December, 2019]
  Among them, JXTG operates 41 hydrogen stations.
- Almost of HRS are located in Tokyo, Nagoya, Osaka, and Fukuoka metropolitan areas, and we are planning to gradually expand the supply area.

[HRS Location in Japan]



Lineup of HRS

- There are 3 type of HRS mainly, integrated type, standalone type and mobile type.
- JXTG is promoting the **integrated type,** because it could improve customer's convenience and satisfaction.

■ Integrated Installed in gas station

Dr. Drive self-service Ebina Chuo Service Station in Kanagawa

Dr. Drive self-service Shiomikouen Service Station in Tokyo

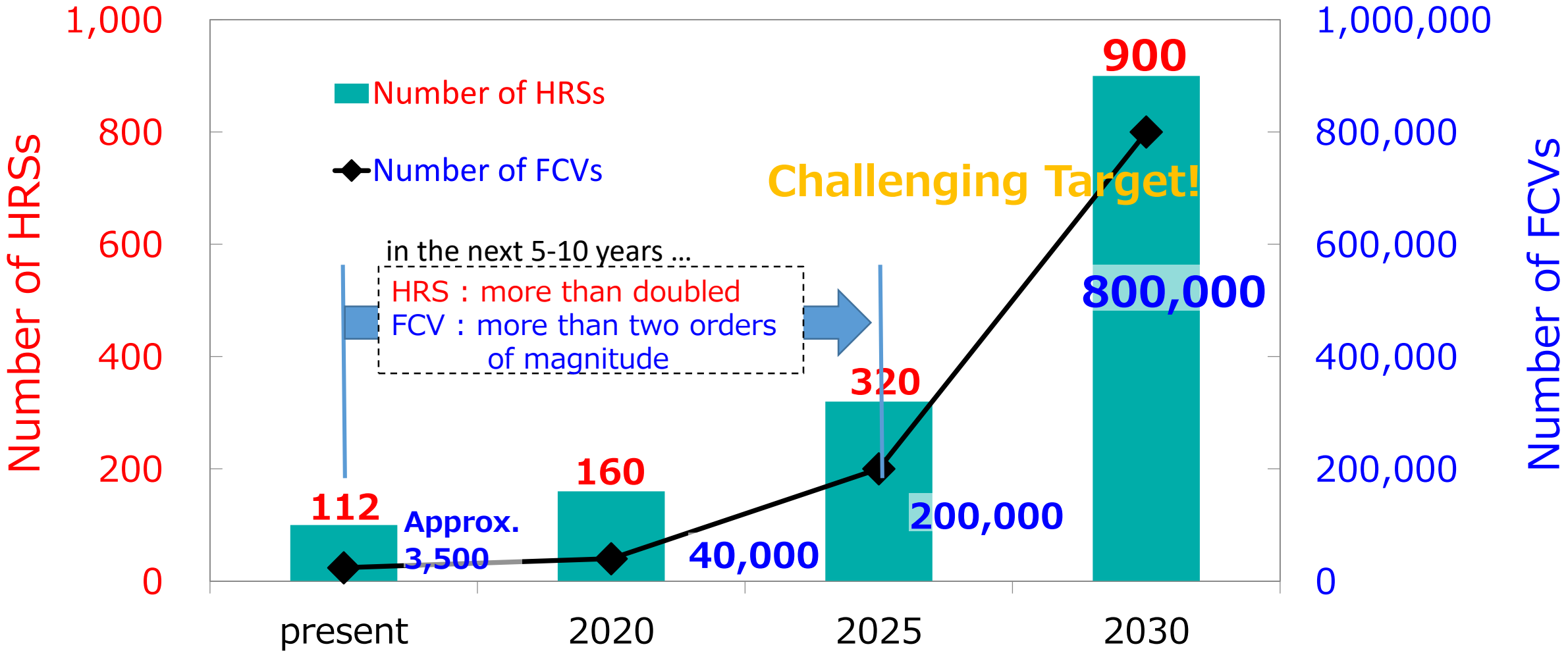
■ Standalone (Tokyo Meguro Hydrogen Refueling Station)

■ Mobile (Yokohama Osanbashi Hydrogen Refueling Station)

“Strategic Road Map for Hydrogen and Fuel Cells” by METI

METI : **M**inistry of **E**conomy, **T**rade and **I**ndustry

- The targets are **900 HRSs and 800,000 FCVs** in 2030.
- At present there are still **112 HRSs and 3,500 FCVs**, but in the next 5 years the number of HRS will be more than doubled and FCV more than two orders of magnitude.



Issues for HRS and FCV

➢ Government and private sectors are working together to solve the issues to promote FCV and HRS.

HRS's issues

- **Cost reduction(CAPEX/OPEX)**
- Area expansion

= How to **improve customer convenience** is the most important

FCV's issues

- **Cost reduction**
- Expanding vehicle model and manufacturers

= How to **improve the attractiveness as product** is the most important.

Common issues

- Promoting public understanding of the safety and significance
- **Regulatory review**

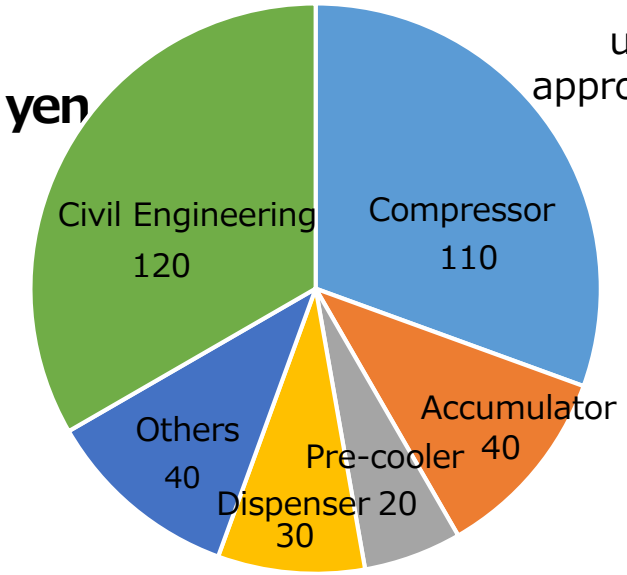
HRS Related Costs

- CAPEX/OPEX of HRS are 4 to 5 times the cost of conventional gas stations, so hydrogen business is not to be profitable at present.
- To make the HRS business profitable, it is necessary to **reduce CAPEX/OPEX to about half of the present**.

CAPEX breakdown

Total: 360 M yen /site

unit: Myen
approx.10kUSD

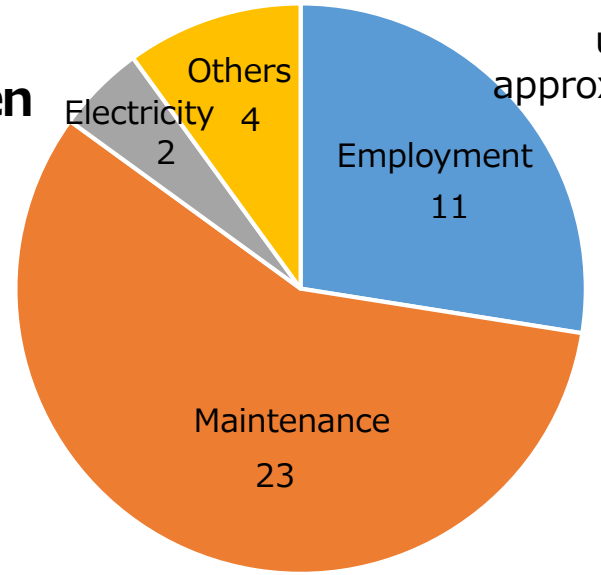


※Average of 2015 subsidy (Off site type:300Nm3 / h)
※Excluded non-subsidized equipment costs (barriers, canopy etc.)

OPEX breakdown

Total: 40 M yen /site/y

unit: Myen
approx.10k USD



※ Average of 2015 subsidy (Off site type:300Nm3 / h)
※ Excluded expenses not covered by subsidy (land fee etc.)

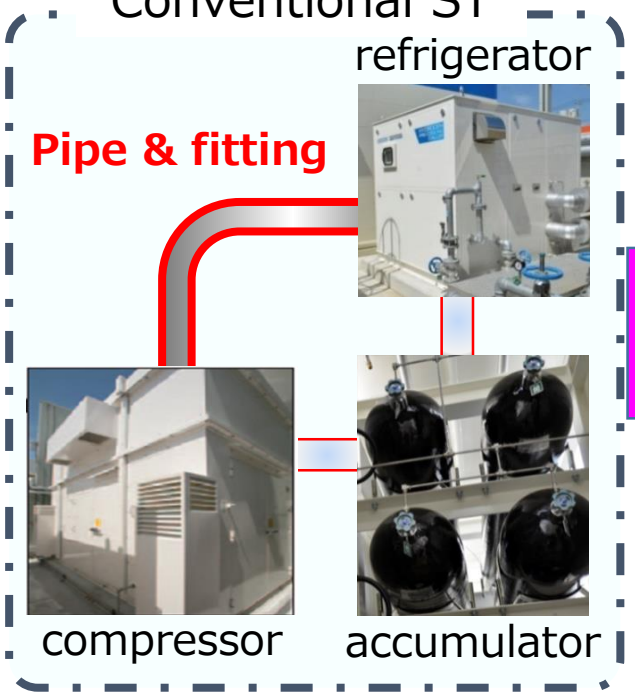
Source: METI "The 8th Hydrogen and Fuel Cell Strategy Council" Material (March 2017)

Efforts to CAPEX Reduction

- The next generation package-type station realizes integration of all components through “**downsizing**" and "**standardization**“ of equipment and piping.
- Many manufacturers and operators are jointly discussing standards and promoting common module design. <NEDO Project>
- In addition, **innovative refueling protocol** and **dual refueling system**, supplying to two nozzles with one compressor, are also core technologies. <NEDO Project>

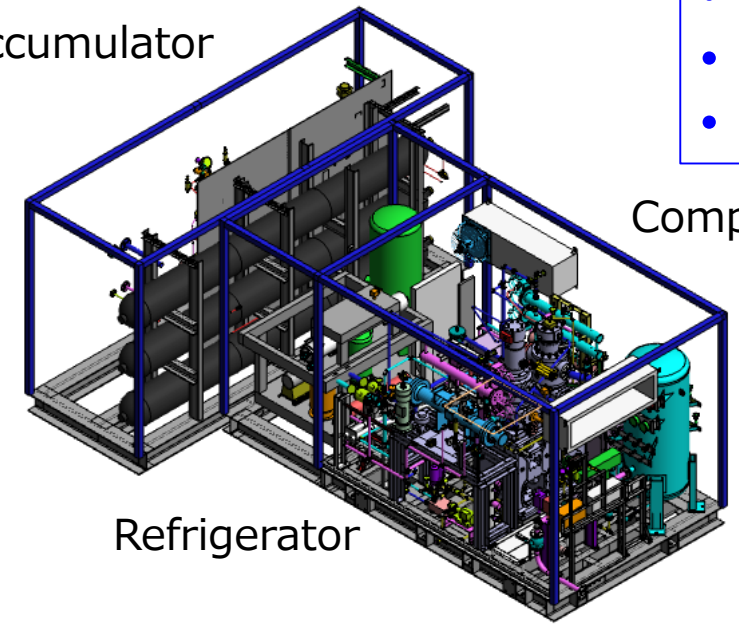
NEDO : **N**ew **E**nergy and Industrial Technology **D**evelopment **O**rganization

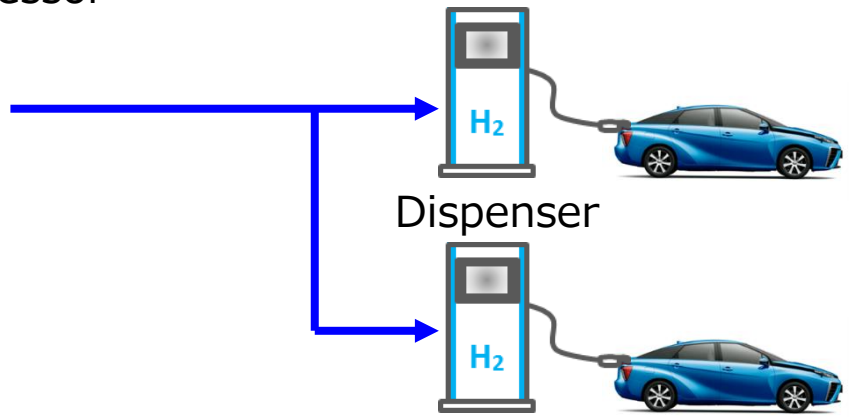
Conventional ST



Package-type System

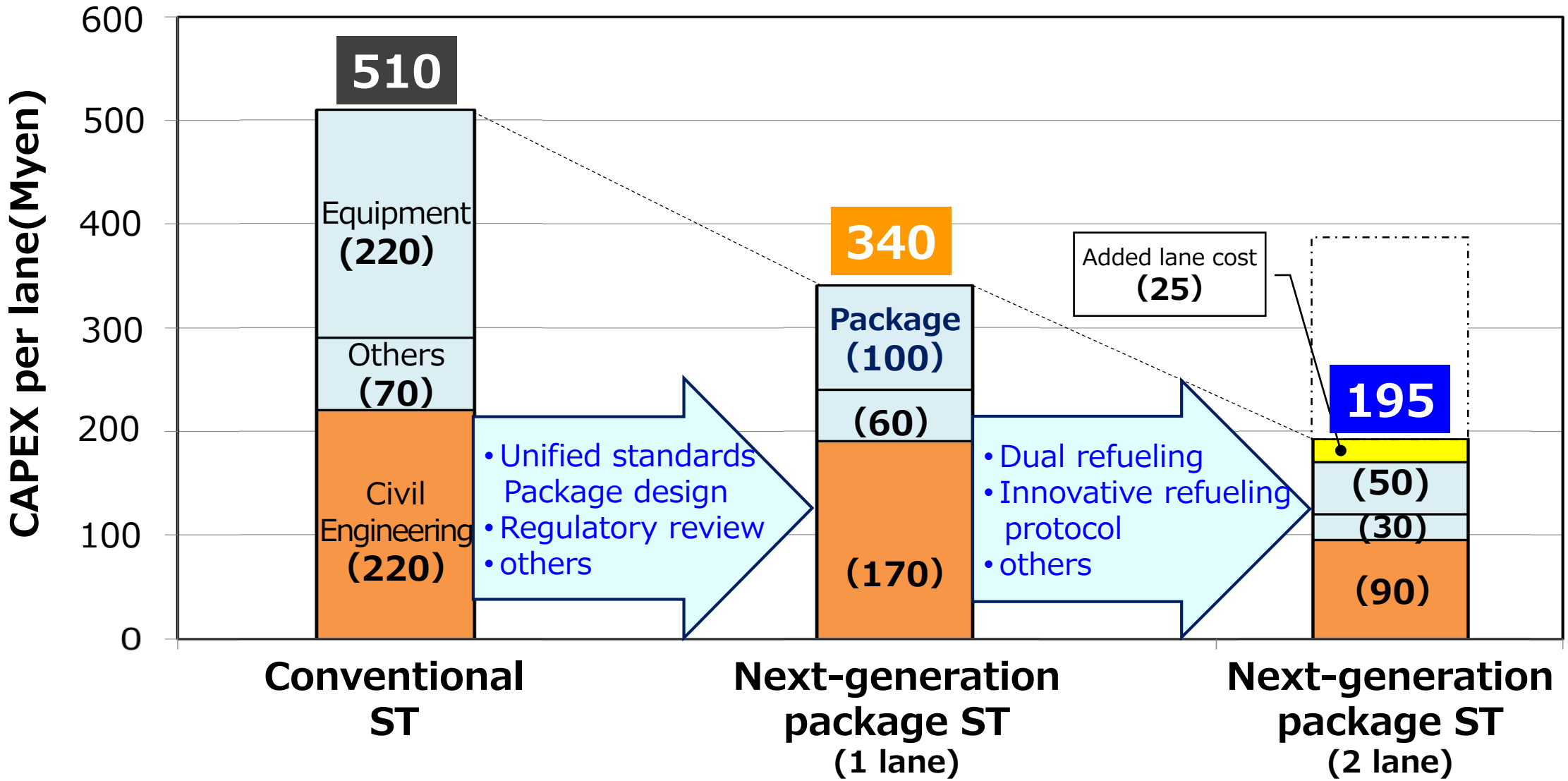
- Down sizing
- Standardization of design
- Dual refueling system
- Innovative refueling protocol





Prospects for CAPEX Reduction

- As shown in this graph, we prospect that **CAPEX of less than half can be realized** with these efforts.



Regulatory Review : Regulatory System in Japan

➢ **The High-Pressure Gas Safety Act** was originally designed for large-scale plants and has room for optimization for HRS.

[Law]

High Pressure Gas Safety Act

[Ministerial Ordinance]

Security Regulation for General High Pressure Gas

⇒ Maximum operating pressure is 82MPa

Illustrative criteria

⇒ **Barrier for high pressure equipment**

⇒ **Applicable materials for high pressure equipment**

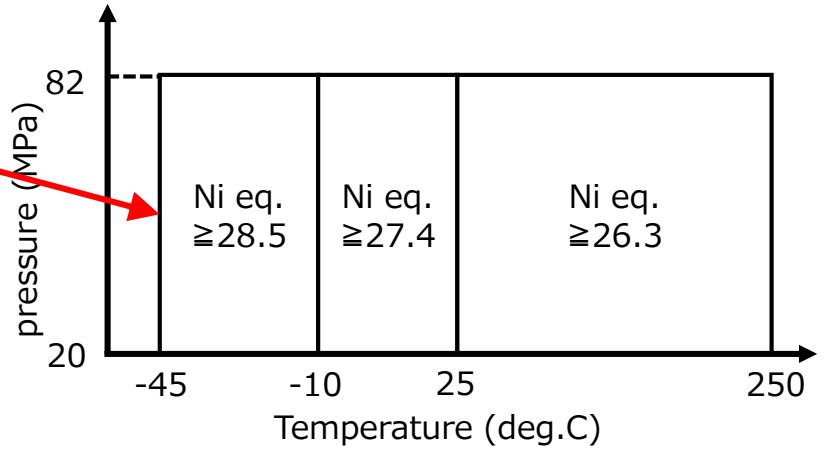
Security Regulation for Specific equipment

Illustrative criteria

⇒ Maximum Allowable Stress Values (Design factor is 4, 3.5)

Regulation on Safety of Containers

The barrier for High pressure equip.



Req. of Ni equivalent in materials

Regulatory Review : Optimization of regulations

➢ **Regulatory review** has been conducted under public-private cooperation to achieve an **appropriate safety level for HRS**.

Regulation of Location

- Setting standard to city and urbanization control area
- Expansion of H2 storage limit

Regulation of Distances

- Installation standard to gas station
- Measures to shorten the separation distance with surrounding facilities / equipment / public road
- Optimization of barrier structure criteria

Others

- Upper limit optimization of refueling pressure (35 →70MPa)
- Permission of self-refueling (with staff)
- Easing standards on operation

(Unmanned operation, Extension of security inspection period)

Regulation of Materials

- Use of Carbon composite accumulator (Type Ⅱ／Ⅲ)
- Application of overseas standard materials
- Optimization of pressure design safety factor
- Use of general stainless steel

Regulation of Transportation

- Establishment of transport container standards
  Upper limit optimization of pressure (35 → 45MPa)
  Maximum temperature optimization (40 to 65 ° C)
  Optimization of loading and fixed standards

Started Supplying Hydrogen to FC Bus

- In October 2019, we have started **a hydrogen supply for FC buses** to reduce carbon emissions in public transportation systems in Yokohama City .
- At the Yokohama South HRS, **the hydrogen refueling protocol** that can be used for FC bus was applied.

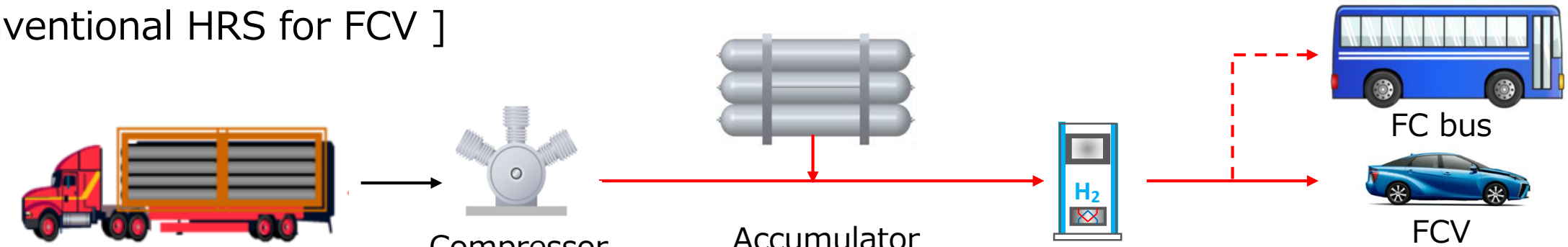
State of the FC bus accepted

Departing Ceremony

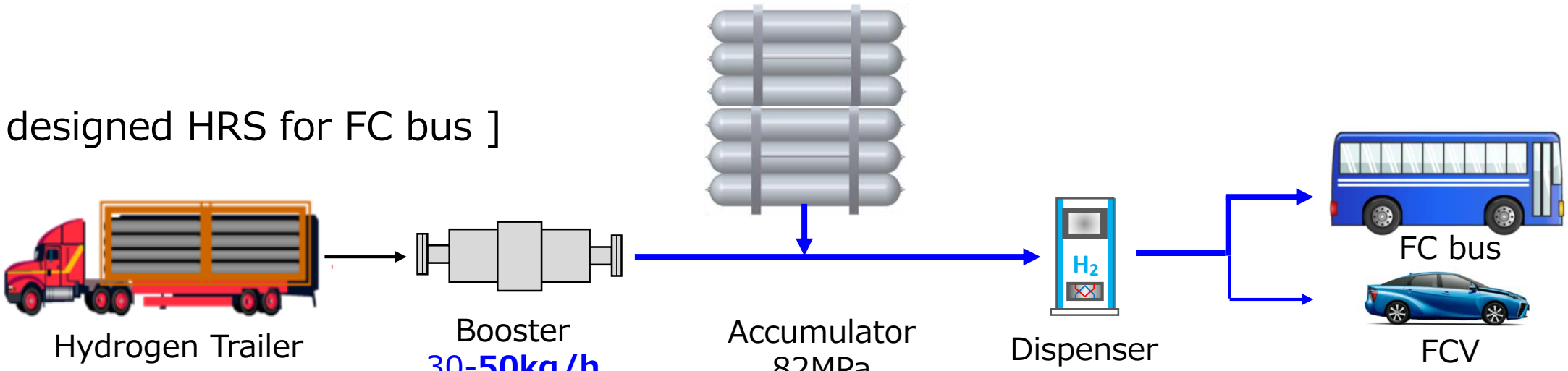
Started Supplying Hydrogen to FC Bus

➢ We are trying to apply **new design HRS to improve the hydrogen refueling to FC bus**.

[Conventional HRS for FCV]



[New designed HRS for FC bus]



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Summary of the "Basic Strategy of Hydrogen " (by METI in December, 2017)

- The final goal is to use so-called "**CO_2 free hydrogen**", made from **renewable energy** or **unused resources with CCS**.
- To achieve this, it is necessary to establish not only domestic but also **large-scale international hydrogen supply chain**.

	Present	2030	Future target
Supply	**Fossil fuel-based hydrogen** (by-product hydrogen, natural gas reformation)	✓ Building international hydrogen supply chains ✓ Developing domestic Power-to-Gas for renewable hydrogen supply	**CO_2-free hydrogen** (Unused resources with CCS*, utilizing renewable energy)

※CCS (Carbon dioxide Capture and Storage)

Scale-up
Substantial cost cuts

Use

Power Generation: **R&D stage** → **Commercial stage** → **Replacing gas power generation**

"Roadmap" targets

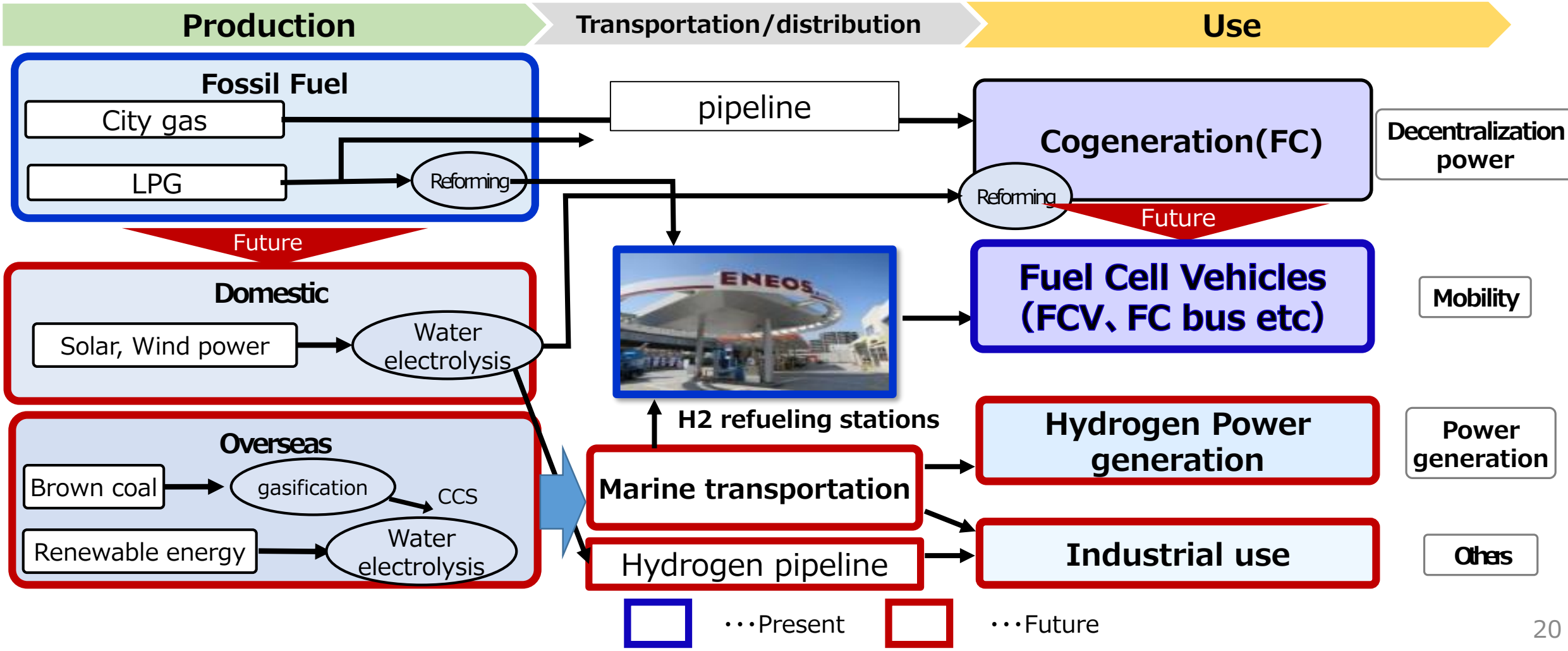
Mobility

	(Present)	(2025)		(2030)	
HRSs (locations)	112	→ 320	FCV/HRSs becoming Self-sustaining *latter half of the 2020s	900	→ Replacing gas stations
FCVs (units)	3.5k	→ 200k		800k	→ Replacing conventional gasoline mobility

Source: Prepared based on the "Basic Hydrogen Strategy."

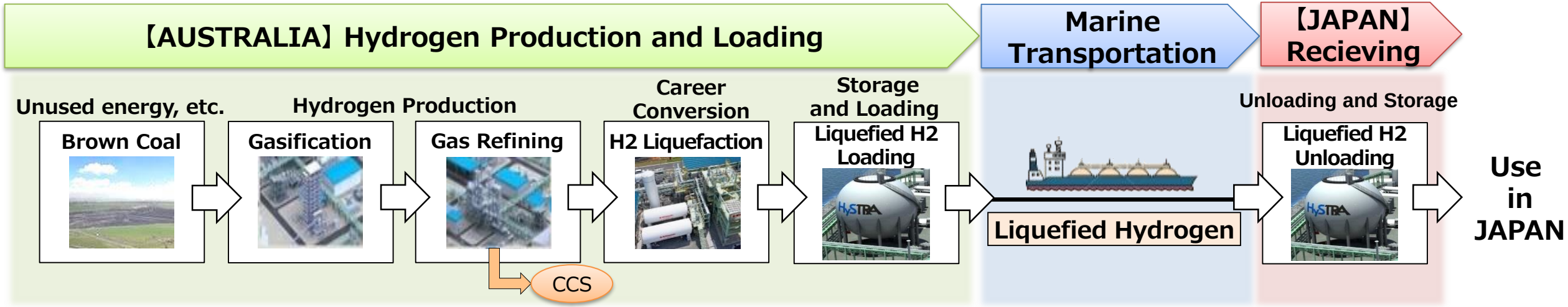
Activities towards CO_2-free Hydrogen Society

- In order to realize a CO_2-free hydrogen society, it is essential to establish a **supply chain** that connects **large-scale demand** and **CO_2-free hydrogen sources**.
- For commercialization of supply chain, we **collaborate with some leading companies**.



HySTRA (CO2-free **Hy**drogen Energy **S**upply-chain **T**echnology **R**esearch **A**ssociation)

- We participated in **HySTRA** in August 2019.
- HySTRA is the association working towards creating a **CO_2 free hydrogen supply chain** comprised of **liquefied hydrogen production effectively** utilizing brown coal, transportation, storage and utilization of hydrogen, and establishing and demonstrating the technologies to commercialize the supply chain around 2030.



Members (6 companies)

Kawasaki Powering your potential　Iwatani　J-POWER　Shell　Marubeni　JXTG

CO_2-free H_2 Business Model in the Future

- **Refineries use the largest amount of hydrogen** throughout industry.
- Refinery has also **port** and **pier** where large tankers can land. So we could use the refinery as a **receiving base** when importing a large amount of CO_2-free hydrogen from overseas.
- As a large-scale customer, we will be able to **procure a large amount of CO_2 -free hydrogen**, and **supply it to chemical plants, power plants and mobility use around refineries effectively**.

Hydrogen Production

Carrier Conversion

Refinery **1M tons**

①Desulfurization and purification of oil
②Power generation

By the CO2-free hydrogen business in this way, we would contribute to create sustainable society. This is our vision.

Liquefied Hydrogen

Methylcyclohexane

Ammonia

<Demand Potential>

Chemical Complex

60,000 tons @ 2012

Hydrogen Power Plant

300,000 tons @2030

Mobility

80,000 tons @ 2030

※Source: Journal of the Japan Society of Mechanical Engineers Vol. 82, No. 836, 2016

Thank for your kind attention

Enegori-kun (The mascot of JXTG)