Update of
CO_2 free hydrogen chain project

The 3rd Australia-Japan Coal Technology Workshop in Melbourne Australia

10th March, 2011

Kawasaki Heavy Industries, Ltd.

Why CO2 free Hydrogen?

Background

Italy L'Aquila G8 Summit (2009 July)

Commitment about Greenhouse Gas Emissions

- **80% reduction in the developed countries**
- **50% reduction in all the others countries**

relative to 1990 levels by 2050

Need for CO2 free energy in the world

- **Nuclear energy**
- **Renewable energy**
- **CO2 free hydrogen energy from fossil fuels with combination of CCS**

CO2 free hydrogen chain

.Australia.

.Japan.

Brown coal

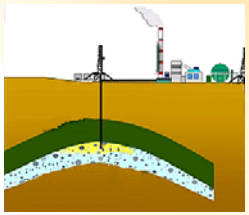
Gasifier

Hydrogen refinement

H_2

CO_2

Capture & storage



Loading base

Maritime transport

Unloading base

Liquefied Hydrogen

H_2

Renewable energy Electrolysis

Land transport

Hydrogen for de-Sulfur at oil refinery

Hydrogen Reduction Steel making

Gas Engine & Turbine

Fuel Cell

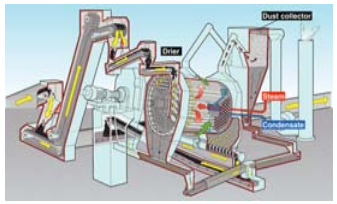
CCPP

Hydrogen car

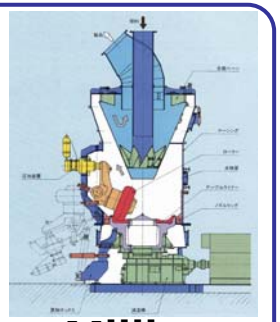
Production | Transport & Storage | Utility

Hydrogen production using Brown Coal

Coal Pre-treatment



.Drying



.Milling

.Gasifier

O_2

Ash

Synthetic-Gas

CO, H_2

.Shift Reactor

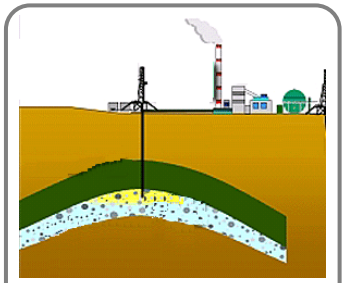
H_2O

CO_2, H_2

.CO2 Capture

CO_2

H_2



.Storage

Advantages of CO2 free hydrogen derived from brown coal

1. **CO2 free**
   CO2 free energy like renewable energy

2. **Enabling massive and stable utilization**
   Enabling massive and stable utilization whenever and wherever customer like (Renewable energy is relatively small scale and not stable supply)

3. **Low cost**
   Low cost if produced from brown coal (to be able to supply H2 at lower price within Australia)

Current, near future and future hydrogen demand

1. **Current**

   Industrial use such as semi conductor, chemical, glass and space industry

2. **Near future**

   De-sulfur at oil refinery, hydrogen steel making

3. **Future**

   Hydrogen car (Fuel Cell), fuel for industrial use and power generation

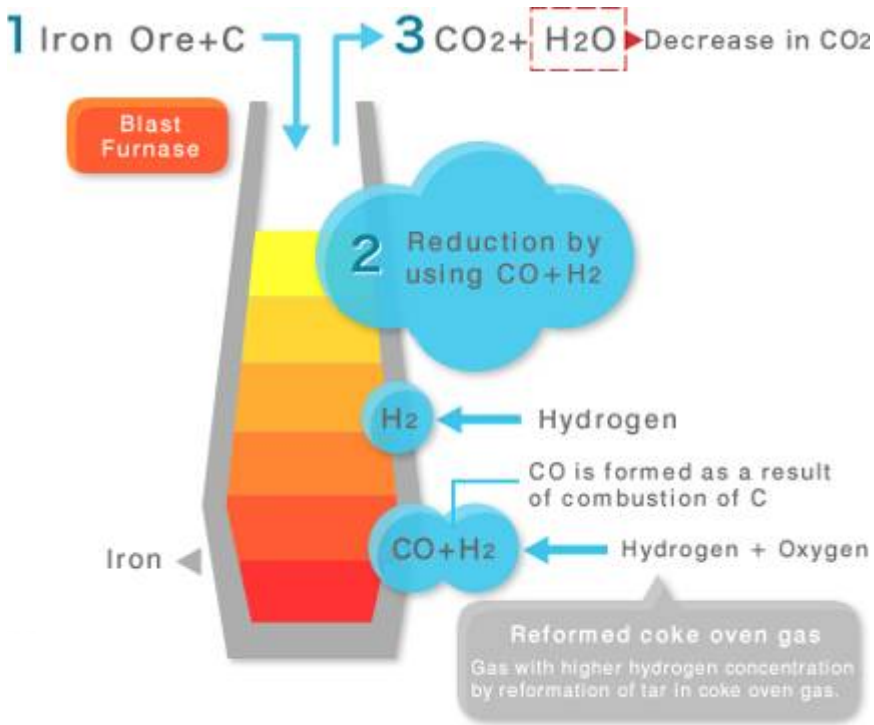
Current hydrogen demand and comprehensive agreement with IWATANI

- ✓ 350 – 360 million Nm3/year for industrial use.
- ✓ *IWATANI Corporation* has 5.1 ton/day x 3 units (approximately 60 million Nm3/year) liquid hydrogen production plant in Japan and is a top runner of hydrogen supplier in Japan.

Recently *IWATANI and Kawasaki* agreed to promote and try to realize CO2 free hydrogen chain jointly.

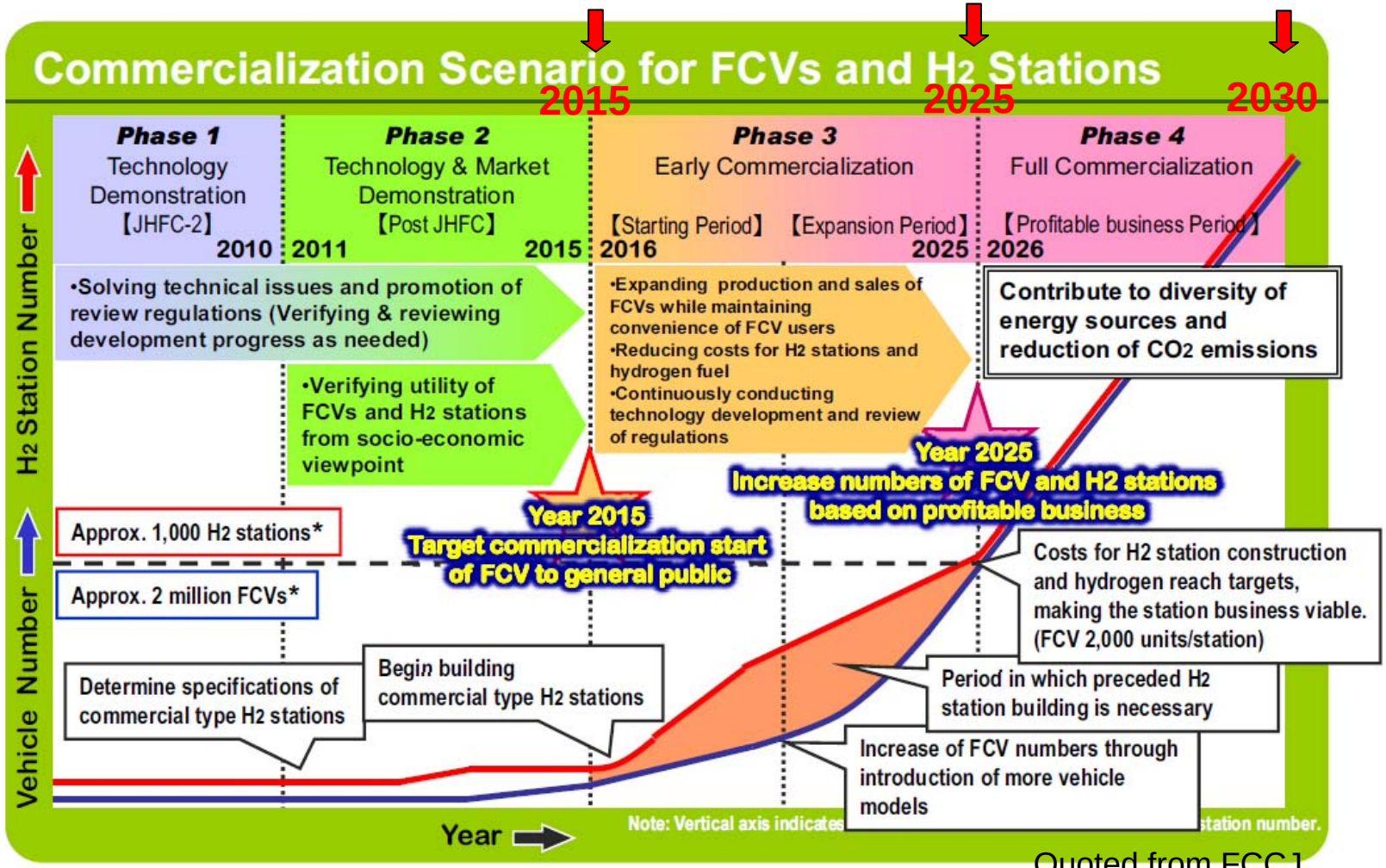
Near future hydrogen demand for Steelmaking Process in Japan

- The steel industry in Japan agreed with Japanese government to reduce CO2 emission by utilizing hydrogen in the next generation steelmaking process.
- For this process, massive quantity of CO2 free hydrogen is required.
- The steel industry is investigating the possibility of importing CO2 free hydrogen.
- KHI is asked to investigate the possibility of transportation of liquid hydrogen
  - Establishing the technology by 2030
  - Industrializing and transferring the developed technologies by 2050



Future hydrogen demand for Fuel Cell Vehicle in Japan

	2015	2025	2030
Hydrogen demand (billion m3 / year)	0.24	2.4	5.6
(ton/year)	21,600	216,000	504,000
Nos. of Hydrogen Filling Station	100	1000	> 2000

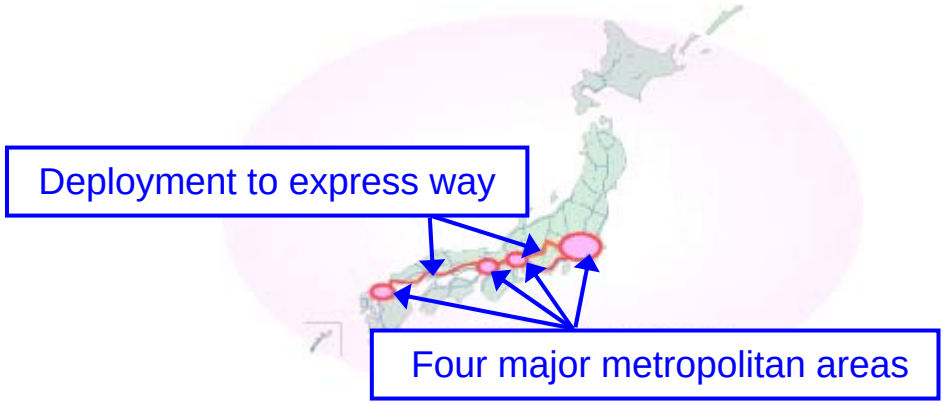


Quoted from FCCJ

Japanese Domestic Launch of FCVs -Development of Hydrogen Supply Infrastructure Key-

On January 13, 2011, 3 FCV manufacturers and 10 energy suppliers jointly announced the following details;

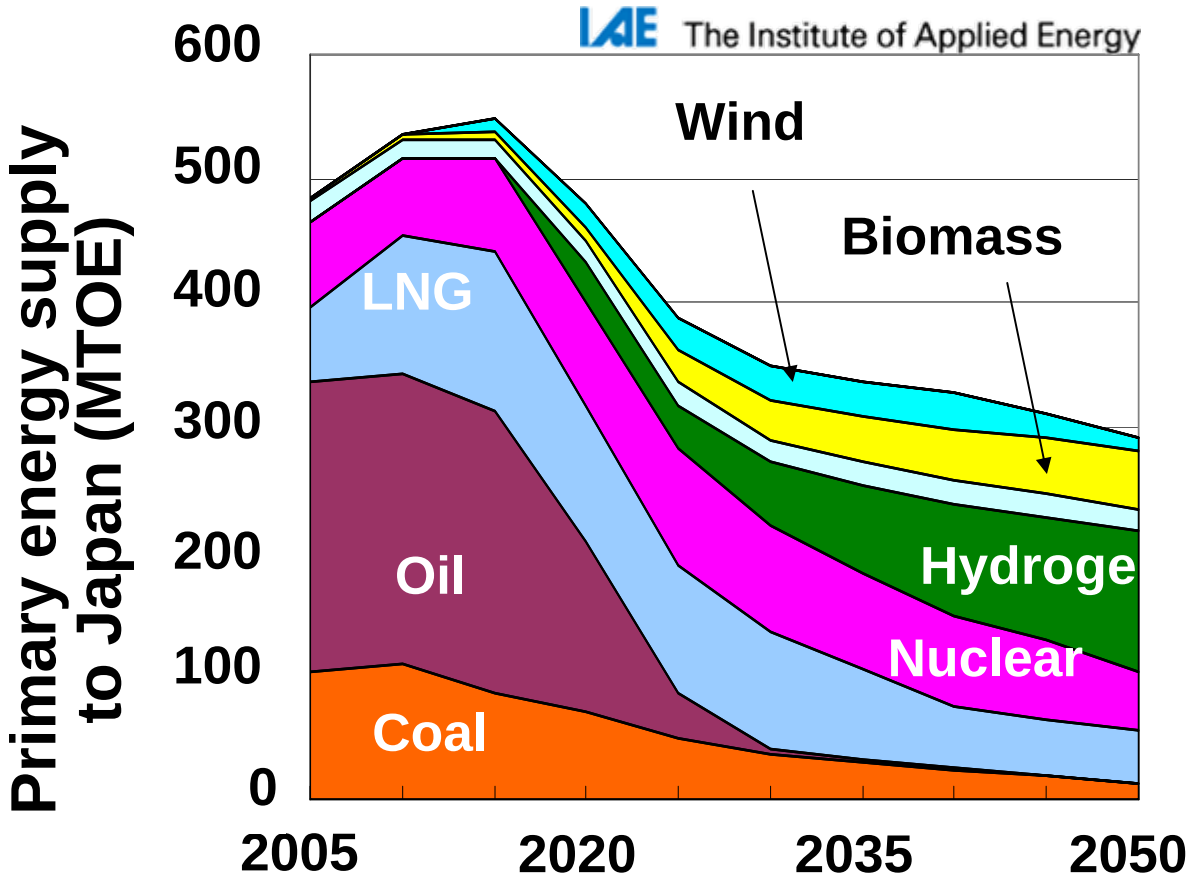
1. 3 Japanese automakers launch FCVs in the Japanese market -mainly in the country's four major metropolitan areas- in 2015
2. 10 Hydrogen fuel suppliers to construct app.100 hydrogen fueling stations by 2015
3. With an aim to significantly reduce the amount of CO2, automakers and hydrogen fuel suppliers to work together to expand the introduction of FCVs and develop the hydrogen supply network throughout Japan with the government in forming various strategies to support their joint efforts and to gain greater consumer acceptance



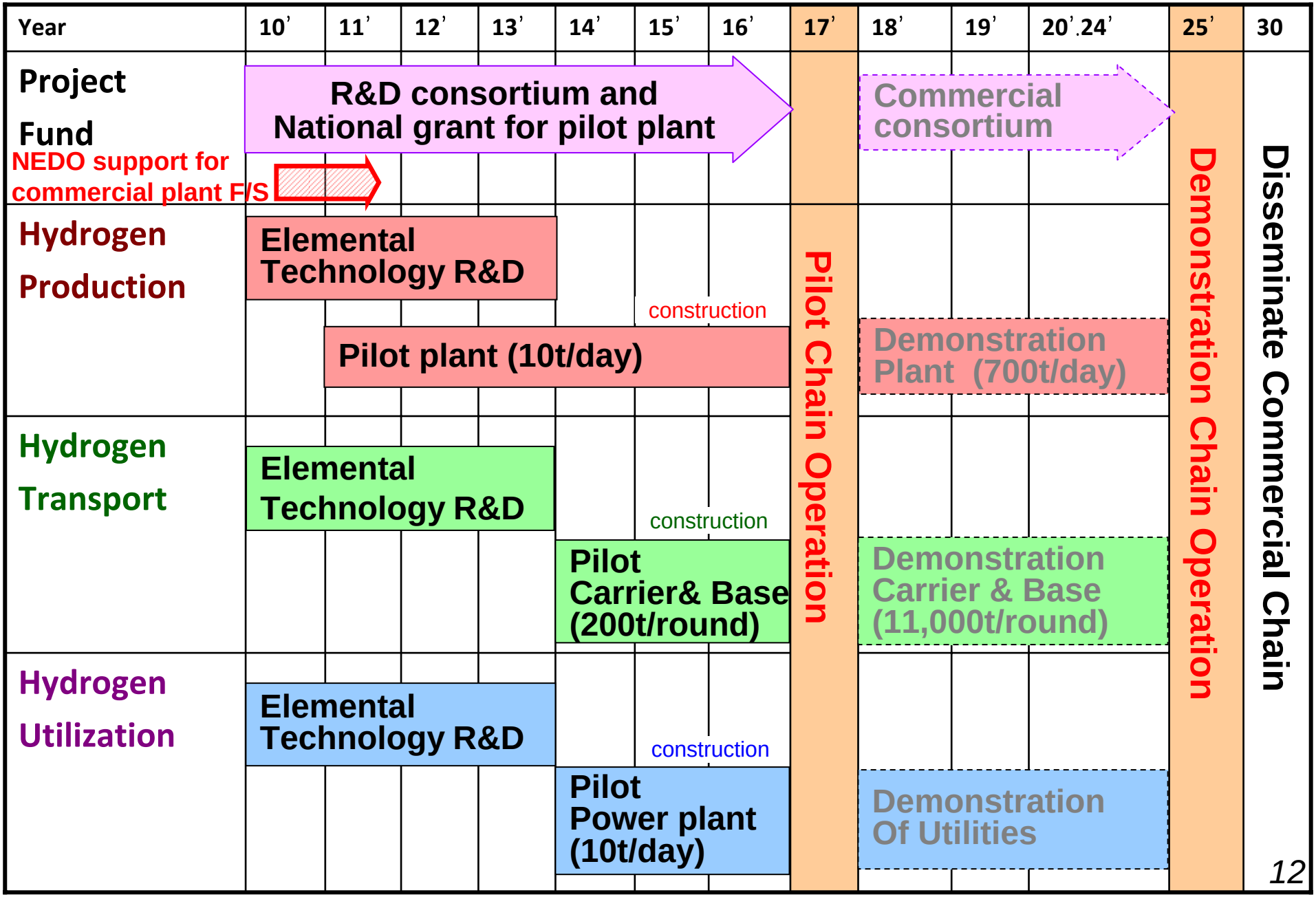
TOYOTA hopes to make FCV technology available and affordable (1/20 cost reduction) for customers by 2015.

Future demand of CO2 free hydrogen

We are simulating for 80% CO2 reduction in Japan by 2050 with hydrogen cost of 30-50 AU./Nm^3.CIF)



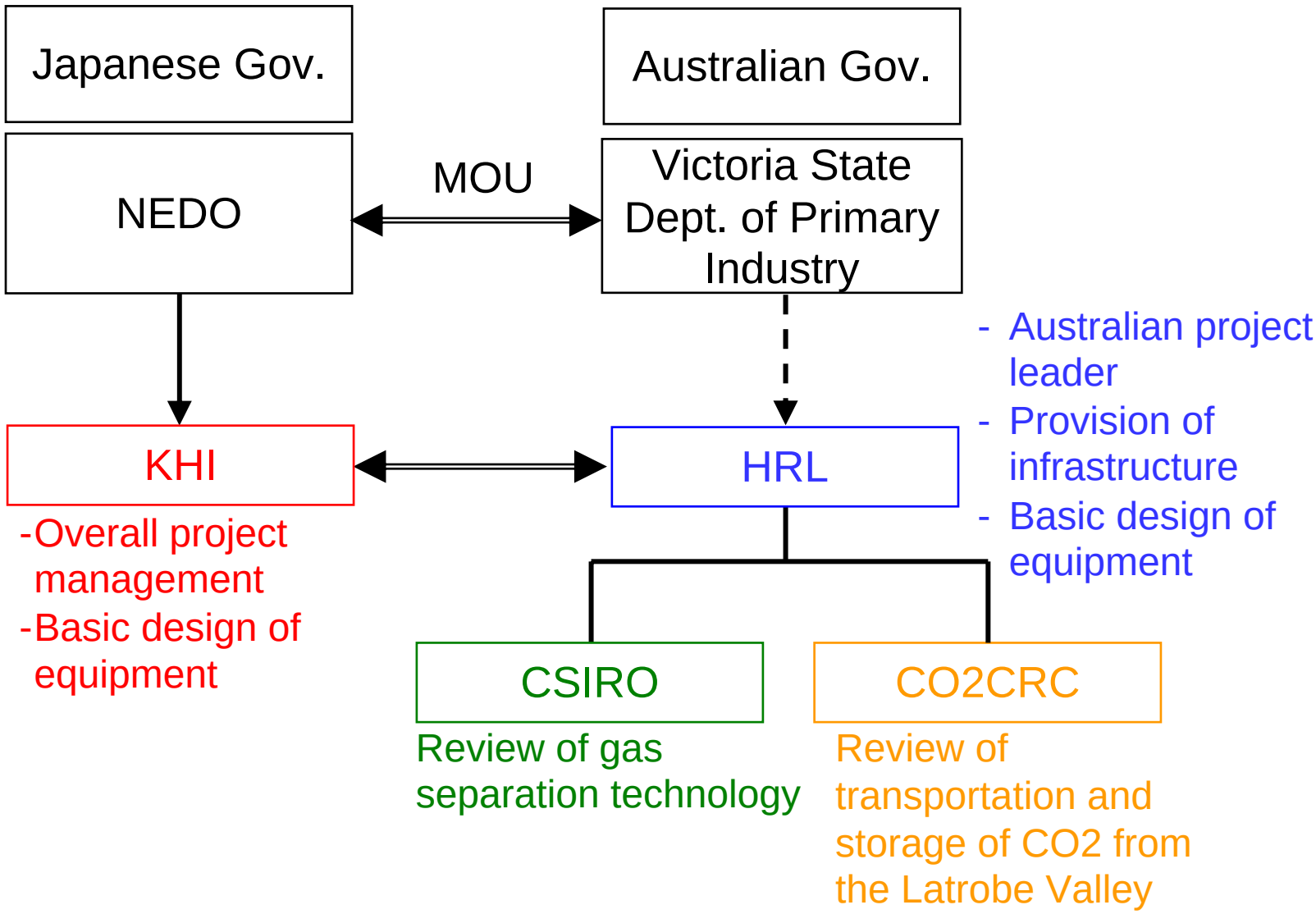
The latest tentative schedule



Objectives of Commercial Scale Feasibility Study (F/S)

- ✓ To confirm technical feasibility of the proposed CO2 free hydrogen chain to be realized in Australia
- ✓ To optimize overall hydrogen supply chain
- ✓ To calculate the refined hydrogen production cost
- ✓ To confirm economic feasibility of CO2 free hydrogen chain

Execution scheme of F/S



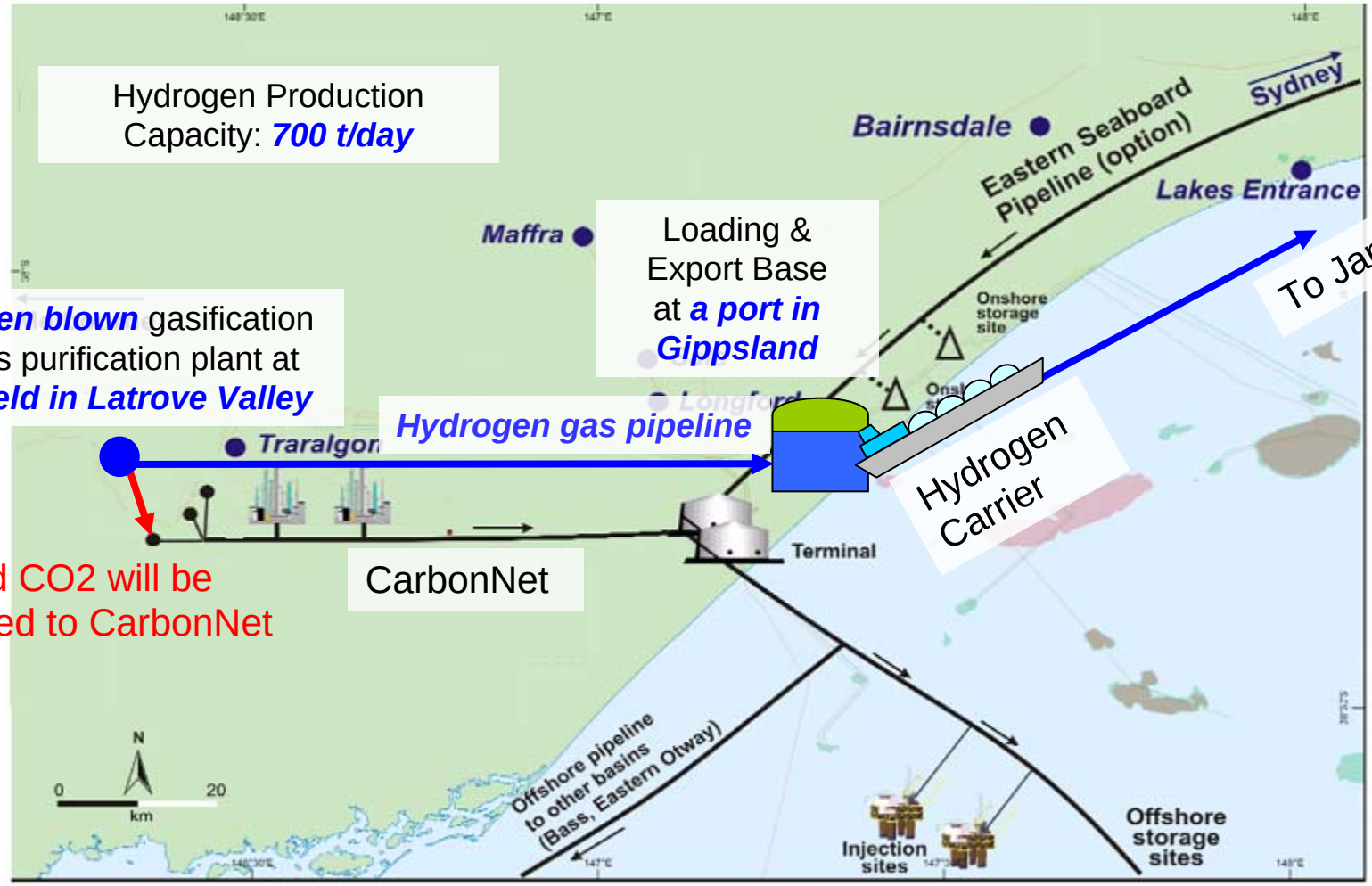
Completed tasks of F/S

1. Determination of hydrogen plant capacity: App. ***700 t/day-H2(based on loading to carrier)***
2. Addressing possible process schemes
3. Investigation, characterization and cost estimation of each scheme
4. Sites selection for brown coal gasification-purification plant and export port: ***Driffield and a port in Gippsland***
5. Selection of the most feasible process scheme: ***Oxygen Blown Gasification – H2 gas pipeline transportation***
6. Basic engineering for the selected scheme proceeding
7. Review of the gas separation technology by CSIRO
8. Review of transportation and storage of CO2 from the Latrobe Valley by CO2CRC

Remaining tasks of F/S

1. Basic engineering for the selected scheme is proceeding
2. Summarization of plant data
3. Evaluation of technical feasibility
4. Evaluation and summarization of plant cost data
5. Evaluation of economic feasibility

Overview of CO2 free hydrogen chain in Australia



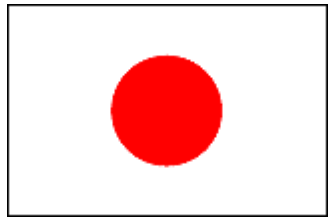
Quoted from DPI

Conclusion

With this project there are many merits for both Australia and Japan

Australia

- Generation of employment for hydrogen production and export industry
- Effective and valuable utilization of brown coal
- Export of clean energy (hydrogen)
- CO2 reduction by using produced hydrogen for automobile in Australia



JAPAN

- Security of massive and stable CO2 free energy (Energy security)
- Achievement of vast reduction of CO2 in Japan (Environment-friendly)
- Security of low cost CO2 free energy (Economic energy)

We would like to realize this project!!

Thank you for your attention!