Welcome to our Webinar on

Clean Coal Technologies (CCT) in Japan

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To begin with …

- The Paris Agreement calls for a rapid decarbonisation of power generation worldwide.
- Coal is the most carbon-intensive power generation source.
- around 20% of Japan's greenhouse gas emissions come from coal-fired power generation.

➡ So here is an important lever to achieve Japan's climate goals!

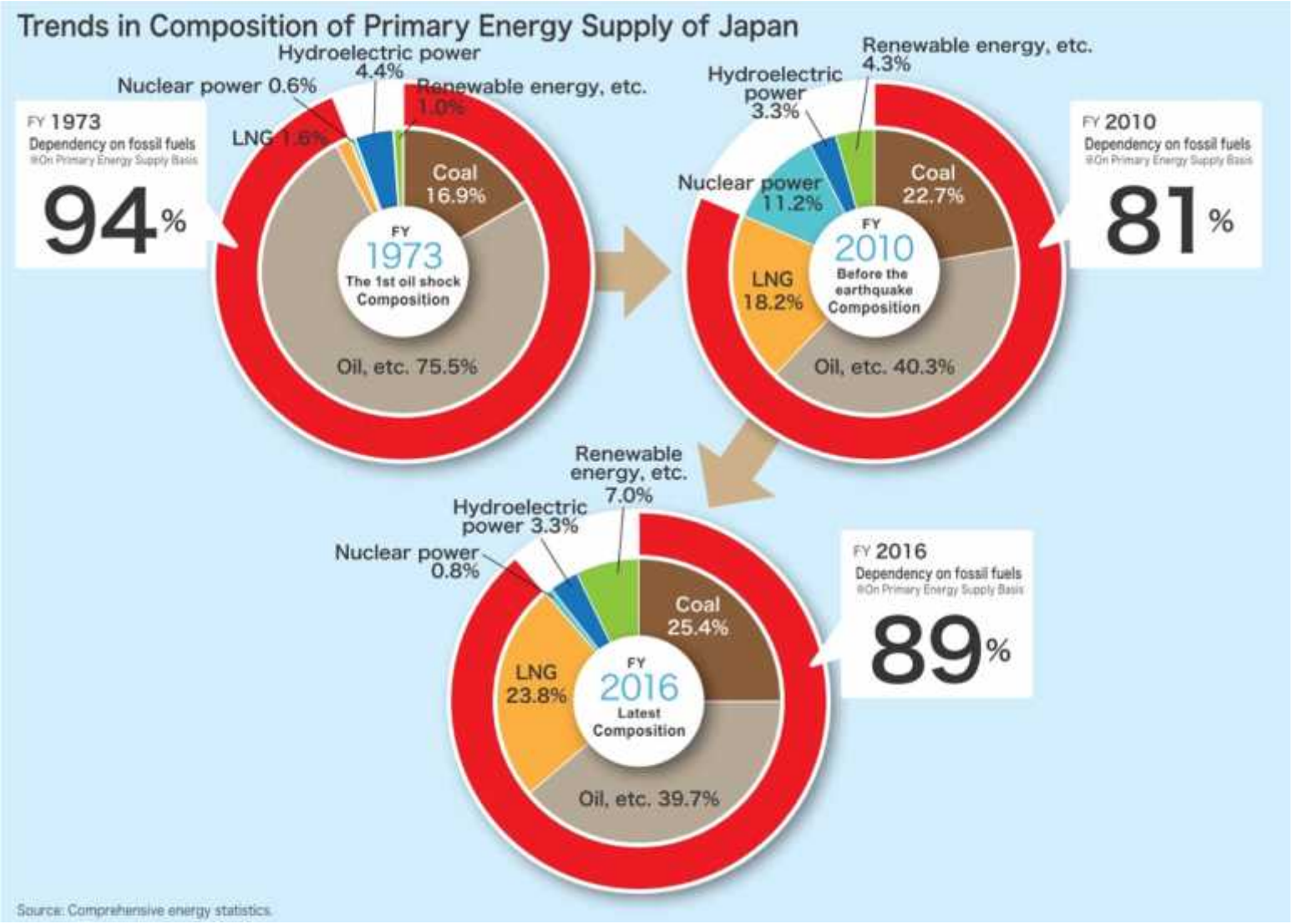
Agenda

1. Current Situation of Energy Supply in Japan and Political Agenda
2. Clean Coal Power Generation: Technology Overview and Roadmap
3. Carbon Capture & Storage (CCS): Technology Overview and Roadmap
4. CCS Project Examples
5. Summary/Conclusion

Part 1: Current Situation and Political Agenda

Current Situation

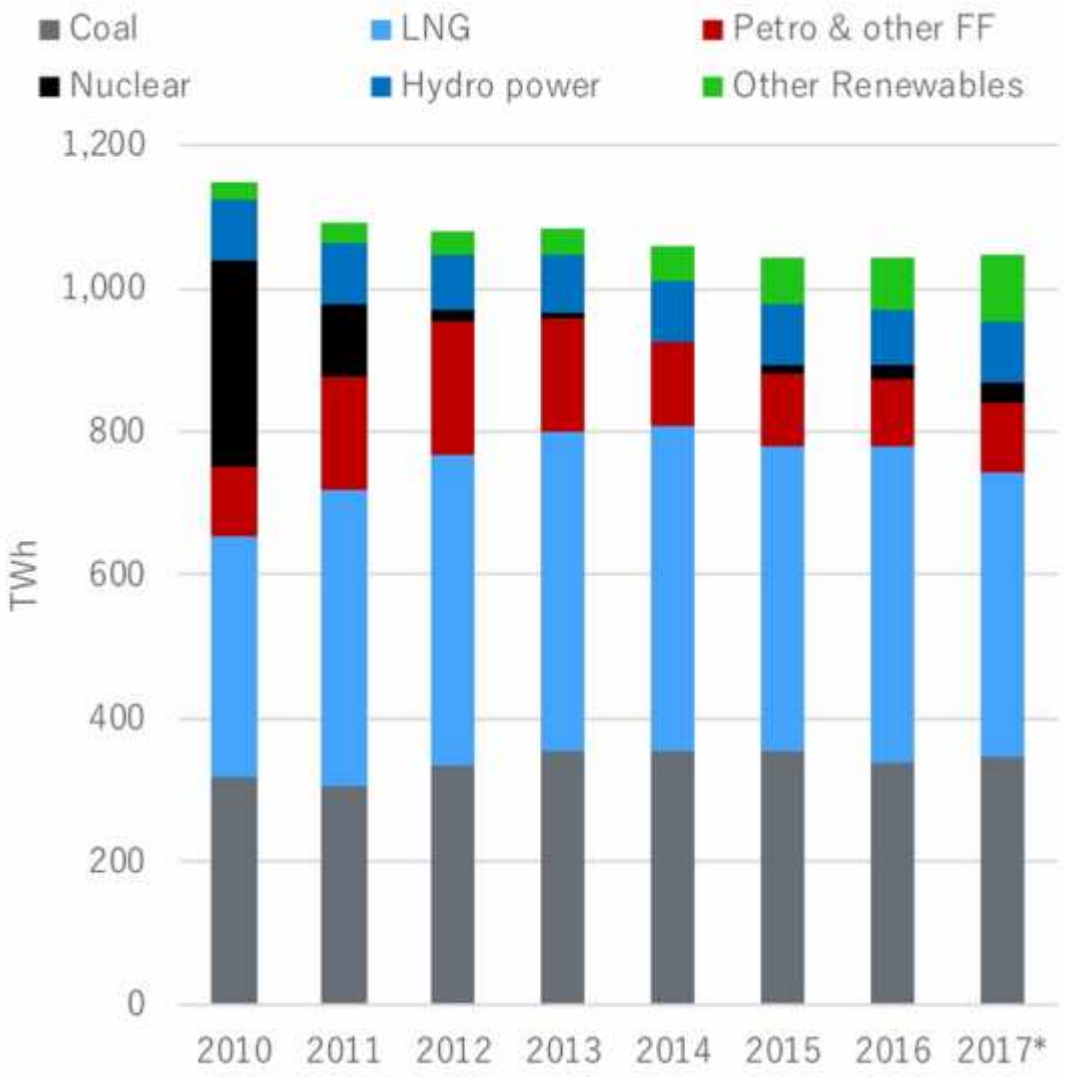
Primary Energy Supply

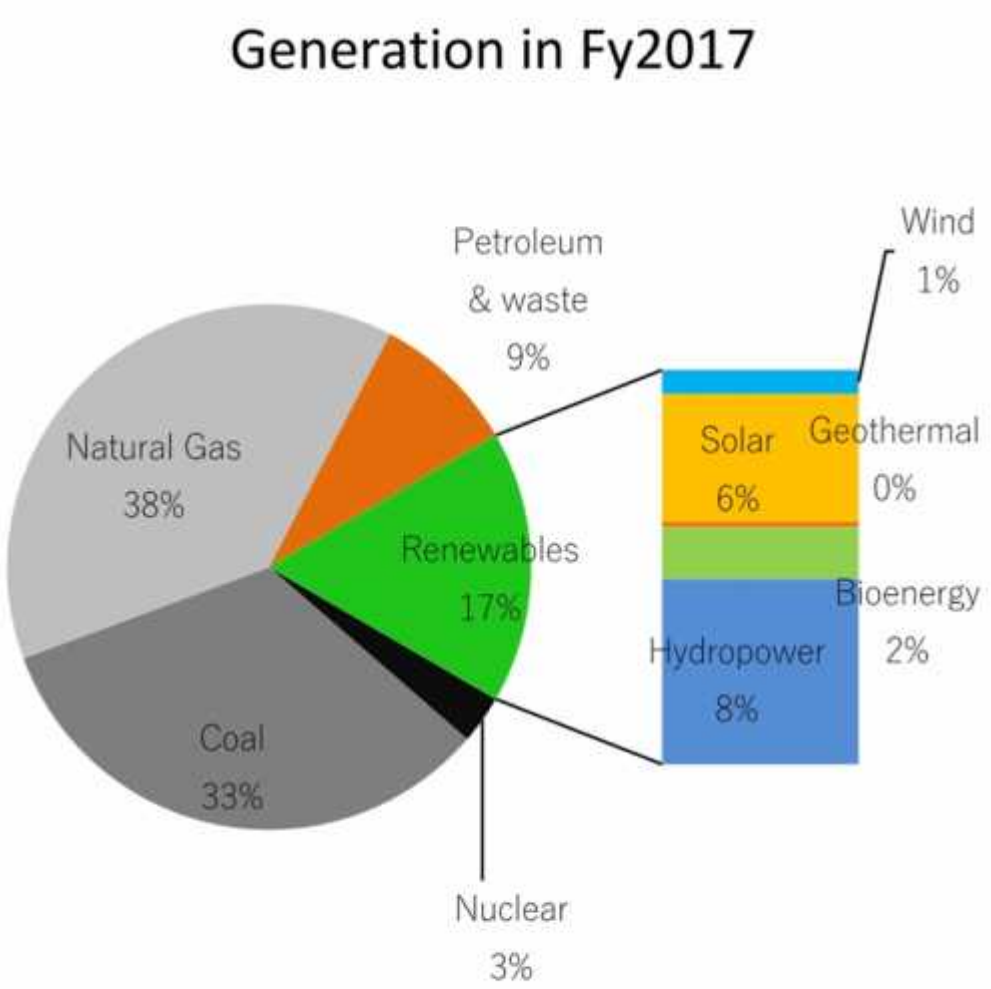


Source: METI 2018

Current Situation

Electricity Generation Mix (2010-2017, in TWh)

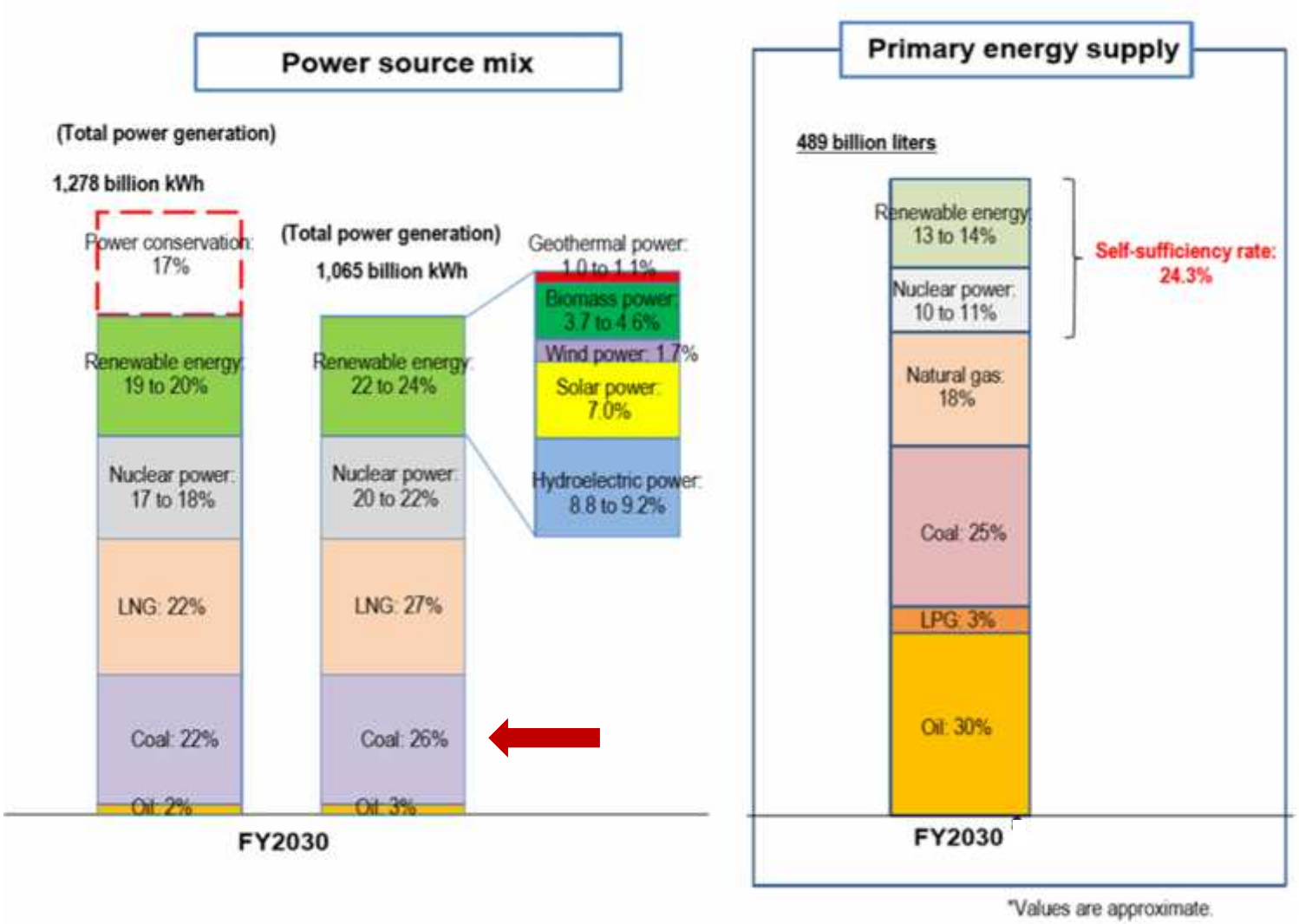




Renewable Energy Institute, 2018

Political Agenda

METI's long-term Energy Supply and Demand Outlook



- Expansion of CCT,
- Carbon Capture,
- Utilization and Storage (CCUS)

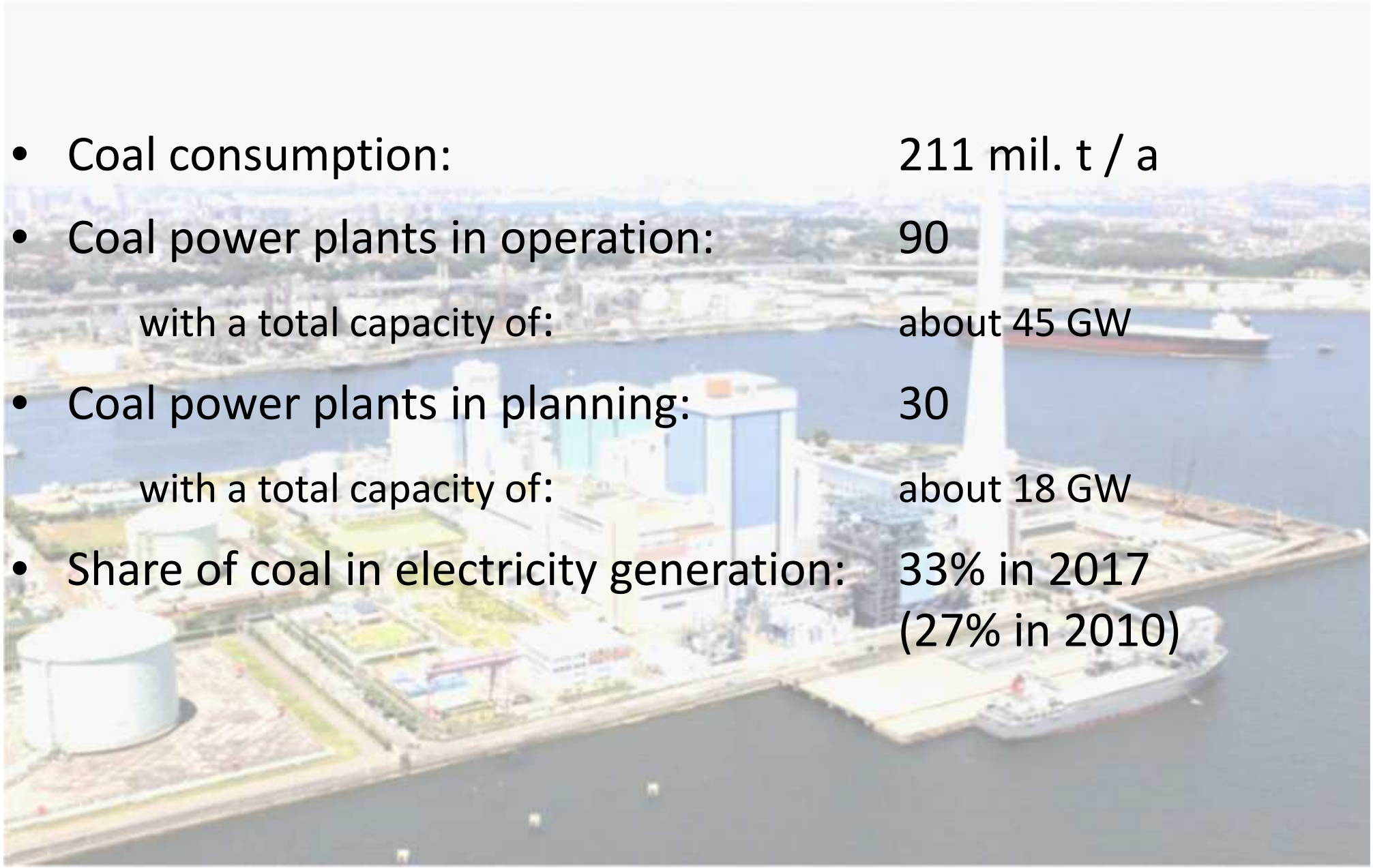
is intended to decarbonise fossil fuel

Target 2030:
0,37 kg CO_2/kWh
Target 2050:
Zero emission

Promotion:
low-carbon infrastructure

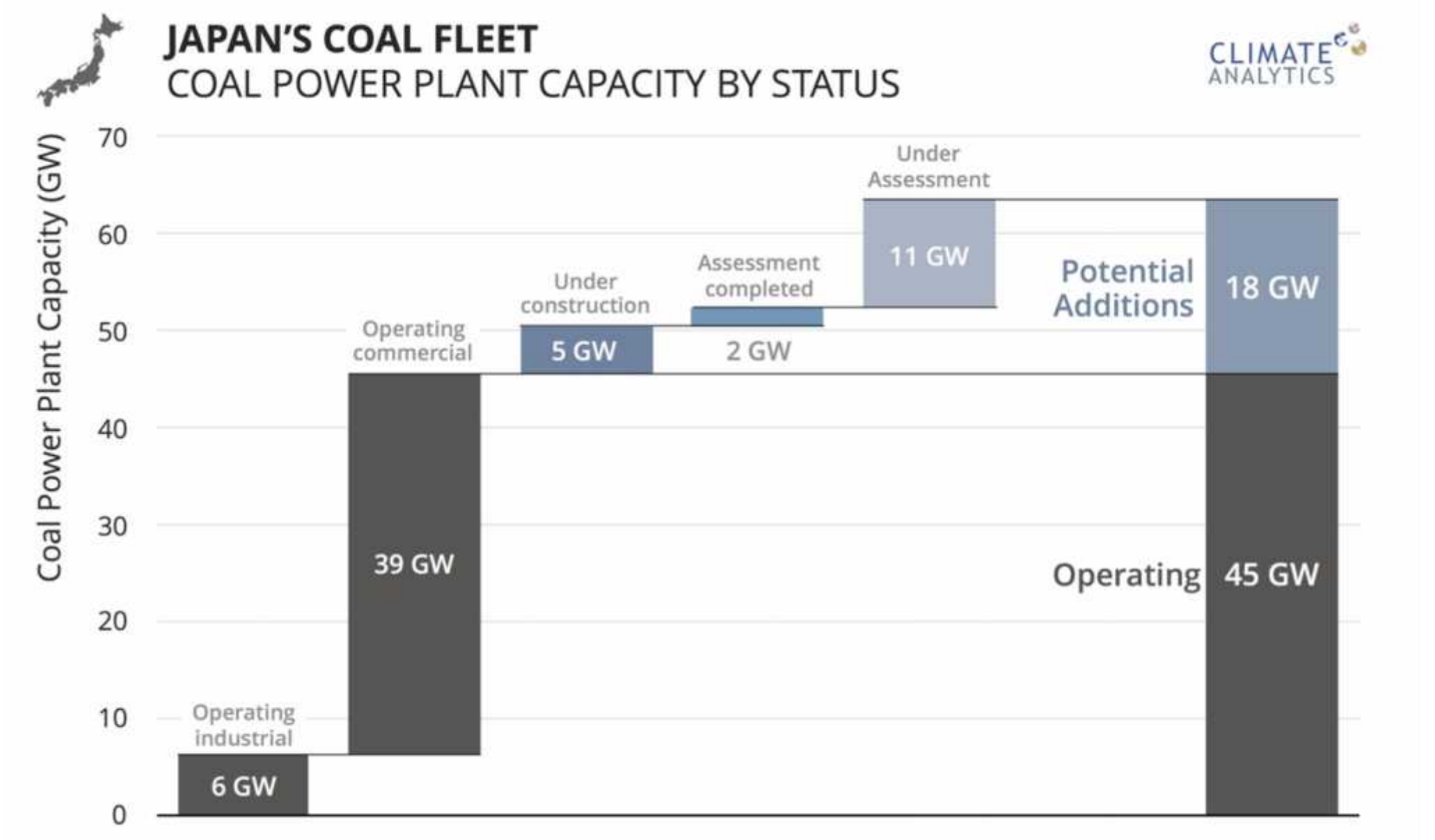
Source: METI (2015)

Current Situation: plant fleet



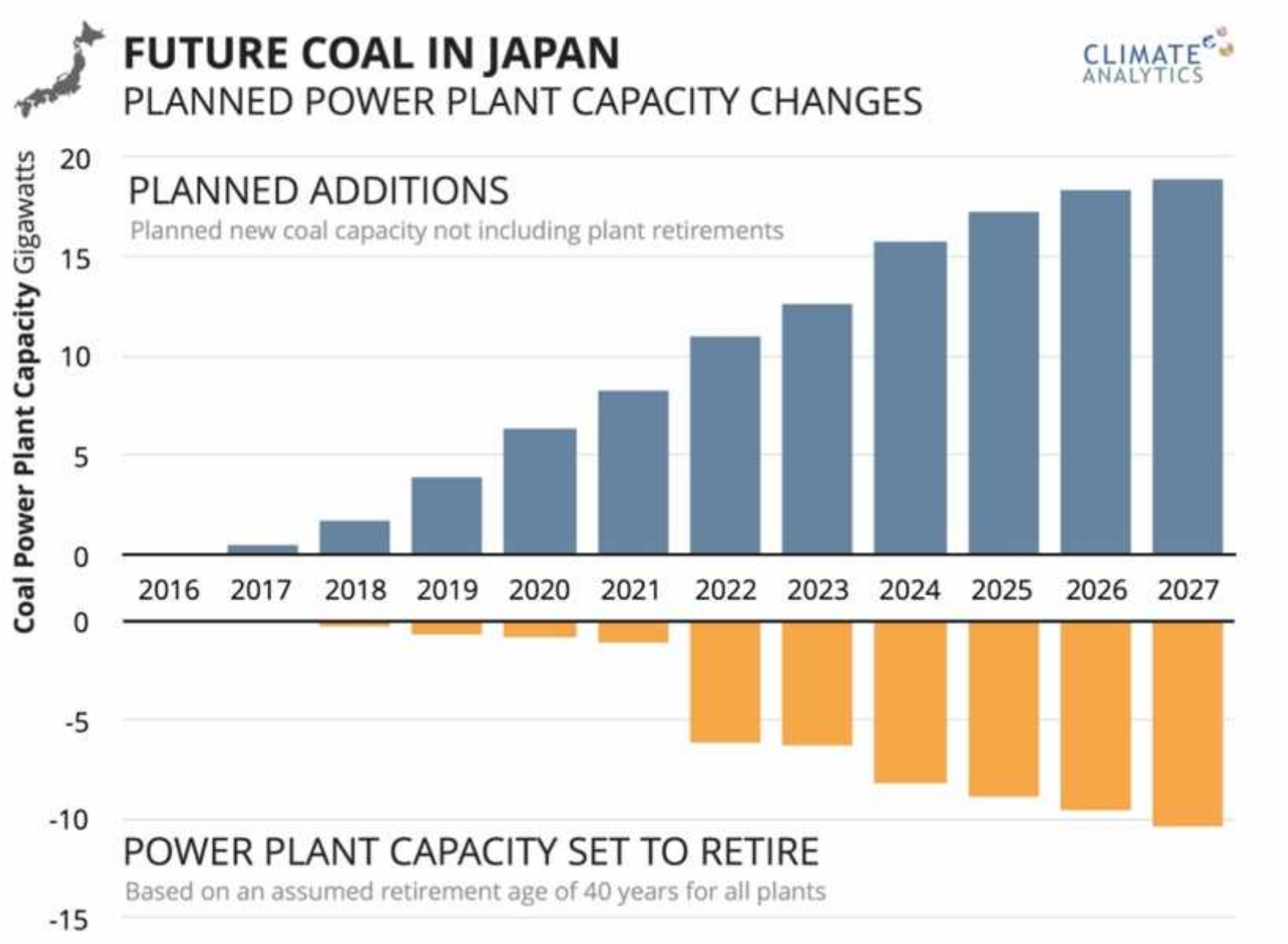
- Coal consumption: 211 mil. t / a
- Coal power plants in operation: 90
  - with a total capacity of: about 45 GW
- Coal power plants in planning: 30
  - with a total capacity of: about 18 GW
- Share of coal in electricity generation: 33% in 2017 (27% in 2010)

Coal-fired Power Plants in Japan



Renewable Energy Institute, 2018

Planned Coal-fired Power Plants in Japan



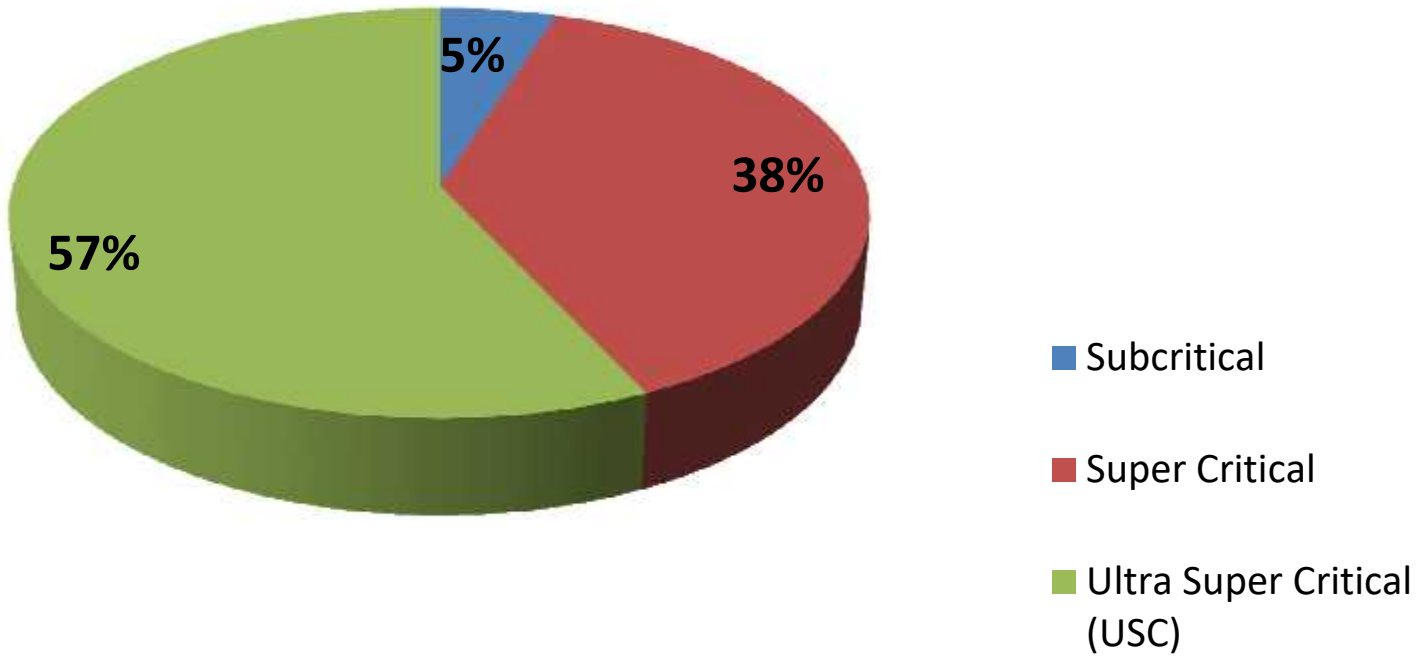
Source: Climate Analytics - REI coal plants database (version Feb 2018)

Part 2: Clean Coal Power Generation

Current Situation: technology implemented

Technology implemented: High Efficiency Low Emission (HELE)

Plants > 300 MW (34.6 GW):

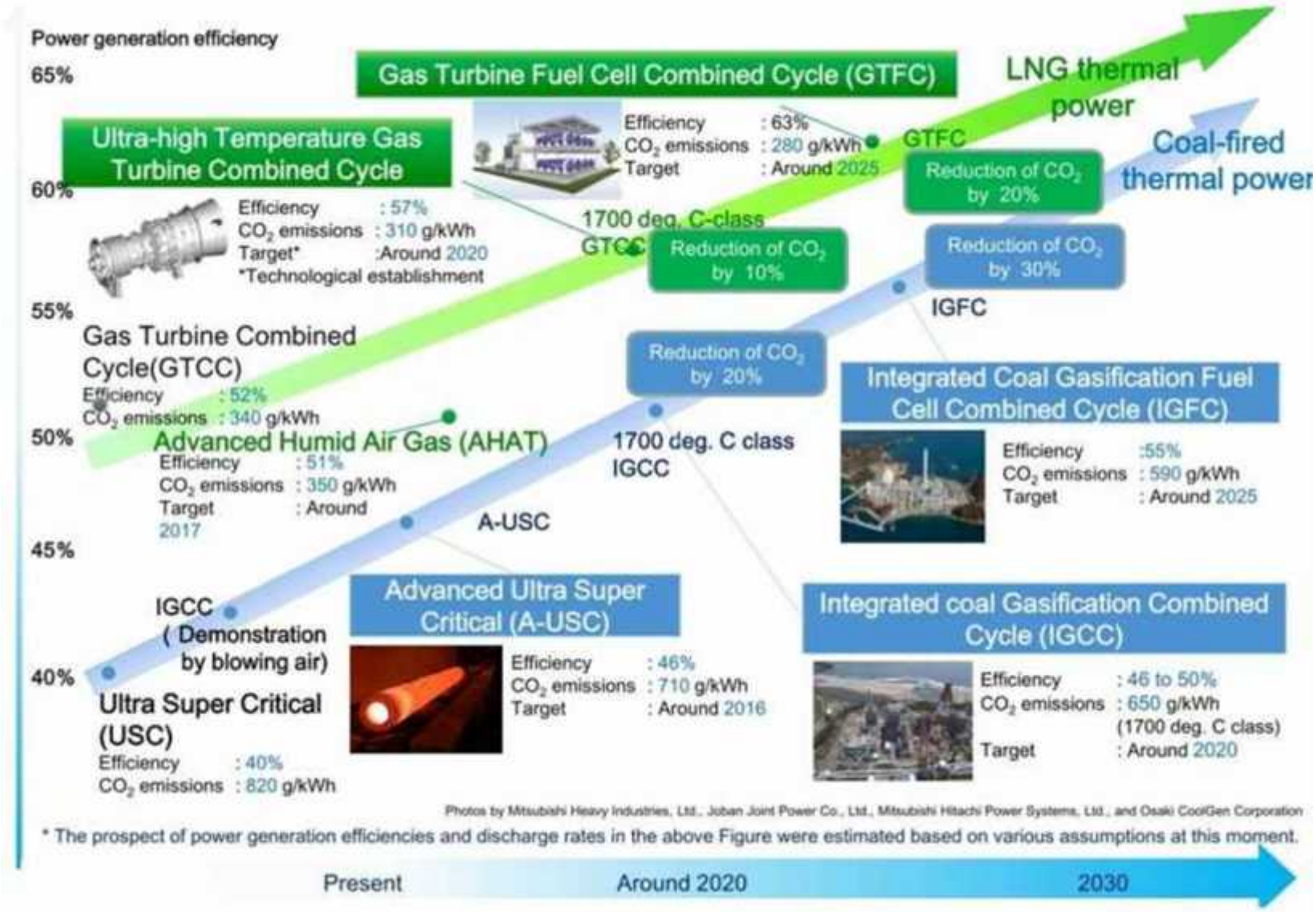


Power Generation Technologies

Power-generating technology	Outline and characteristics of technology	Technological establishment (Year)	Transmission end efficiency (% HHV)	CO_2 discharge rate (g-CO_2/kWh)
① USC 	- high temperature and pressure steam generated by a boiler. - Long experience & reliability	1995 -	40	820
② A-USC 	- higher temperature and pressure steam turbine than USC. - Advanced type of USC with heat resistant materials.	2016	46	710
③ AHAT 	- A single gas turbine power generation using humid air. - suitable for medium and small turbines	2017	51	350
④ GTCC (1700 dig. C class) 	- combined cycle power generation technology using a gas turbine and a steam turbine.	2020	57	310
⑤ IGCC (1700 deg. C class) 	- A combined cycle power generation technology through coal gasification and combination of a gas turbine with a steam turbine.	2020	46 - 50	650
⑥ GTFC 	- A triple combined power generation technology combining GTCC with fuel cells.	2025	63	280
⑦ IGFC 	- This is a triple combined power generation technology combining IGCC with fuel cells.	2025	55	590
⑧ Innovative IGCC (Steam entrained bed gasification)	- adds steam to gasification furnace on the IGCC system. - reduces oxygen ratio and increases cold gas efficiency.	2030 -	57	570
⑨ Closed IGCC (CO_2-capturing next-generation IGCC)	- circulates CO_2 contained in exhaust gas as an oxidant throughout a gasification furnace or gas turbine.	2030 or later	42 After CO_2 capture	-

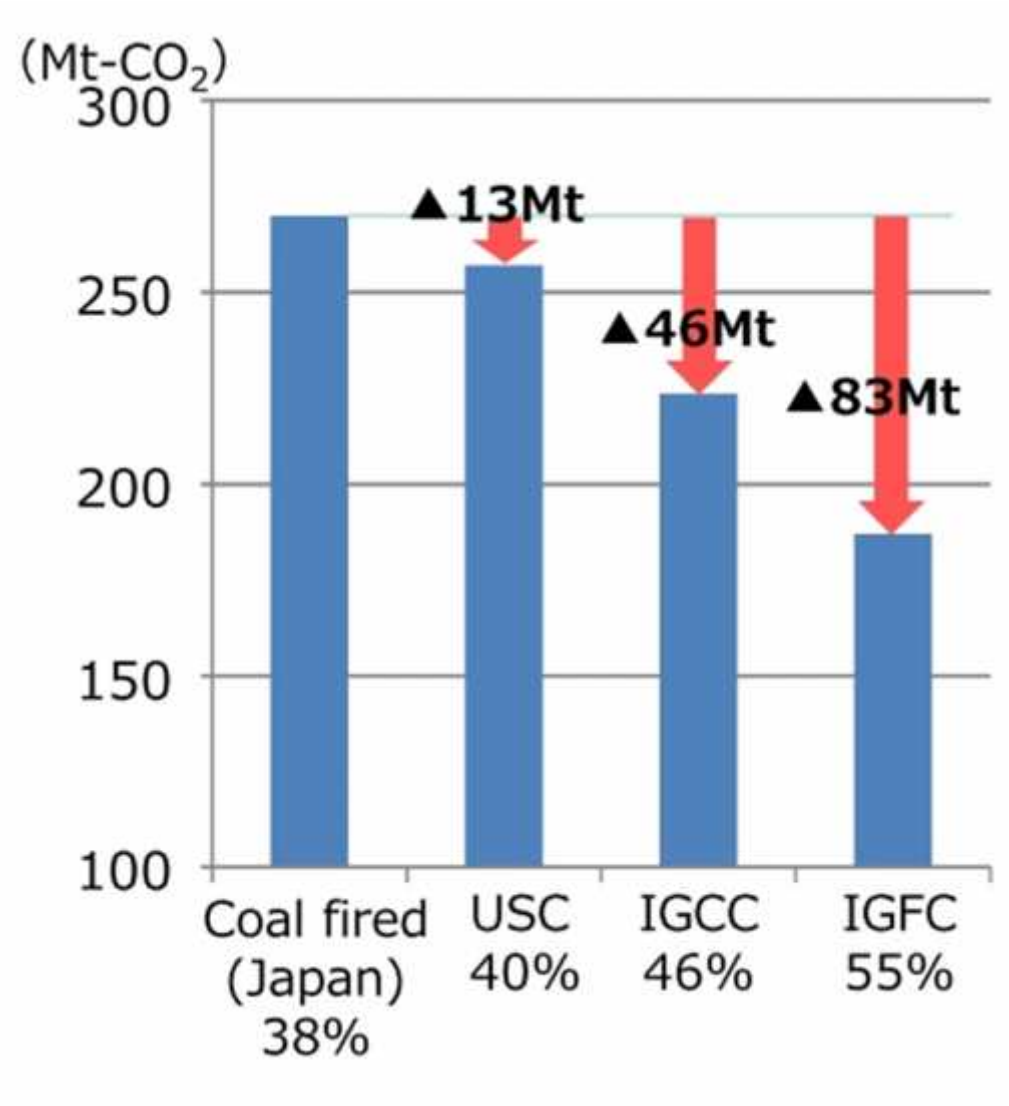
Source: NEDO 2018

High efficient power generation Technologies Roadmap of NEDO



Source: NEDO 2018

Technology Roadmap



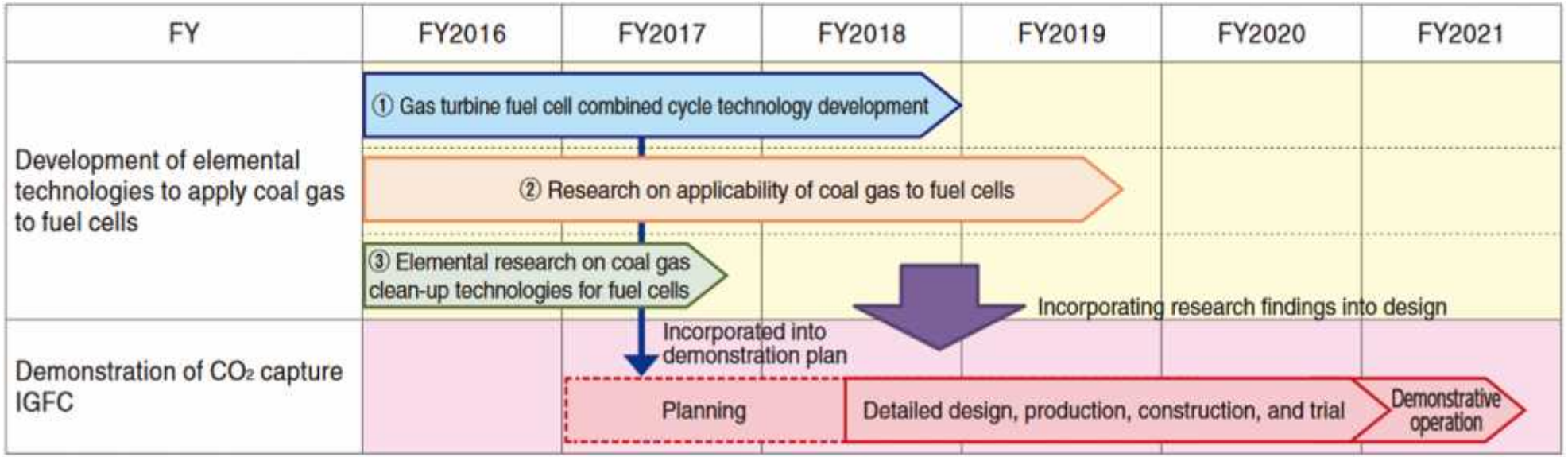
CO_2 reduction potential for coal-fired power plants in the efficiency improvement

Source: NEDO 2018

Technology Roadmap

Clean energy generation technologies

Research Plan of the IGFC Technology



Source: METI 2018

Funding of CCT in 2018

NEDO's budget for the development of CCT totaled over EUR 188 million in 2018.

Clean Coal Technologies	Budget [in million €]	
Project name	FJ2017	FJ2018
Development of next-generation thermal power generation technologies	88.48	90.00
Development of Clean Coal Technologies	3.52	0.40
CO_2 Ultimate Reduction System for Cool Earth 50 (COURSE50) Project	11.92	6.64
Project for the international promotion and dissemination of advanced thermal power generation technologies	13.52	14.40
International Demonstration Project on Japan's Energy Efficiency Technologies	0.40	2.40
Research, development and demonstration of CCS-Technology	-	74.40
Total	**117.84**	**188.24**

1 JPY = 0,008 EUR (11.04.2019)

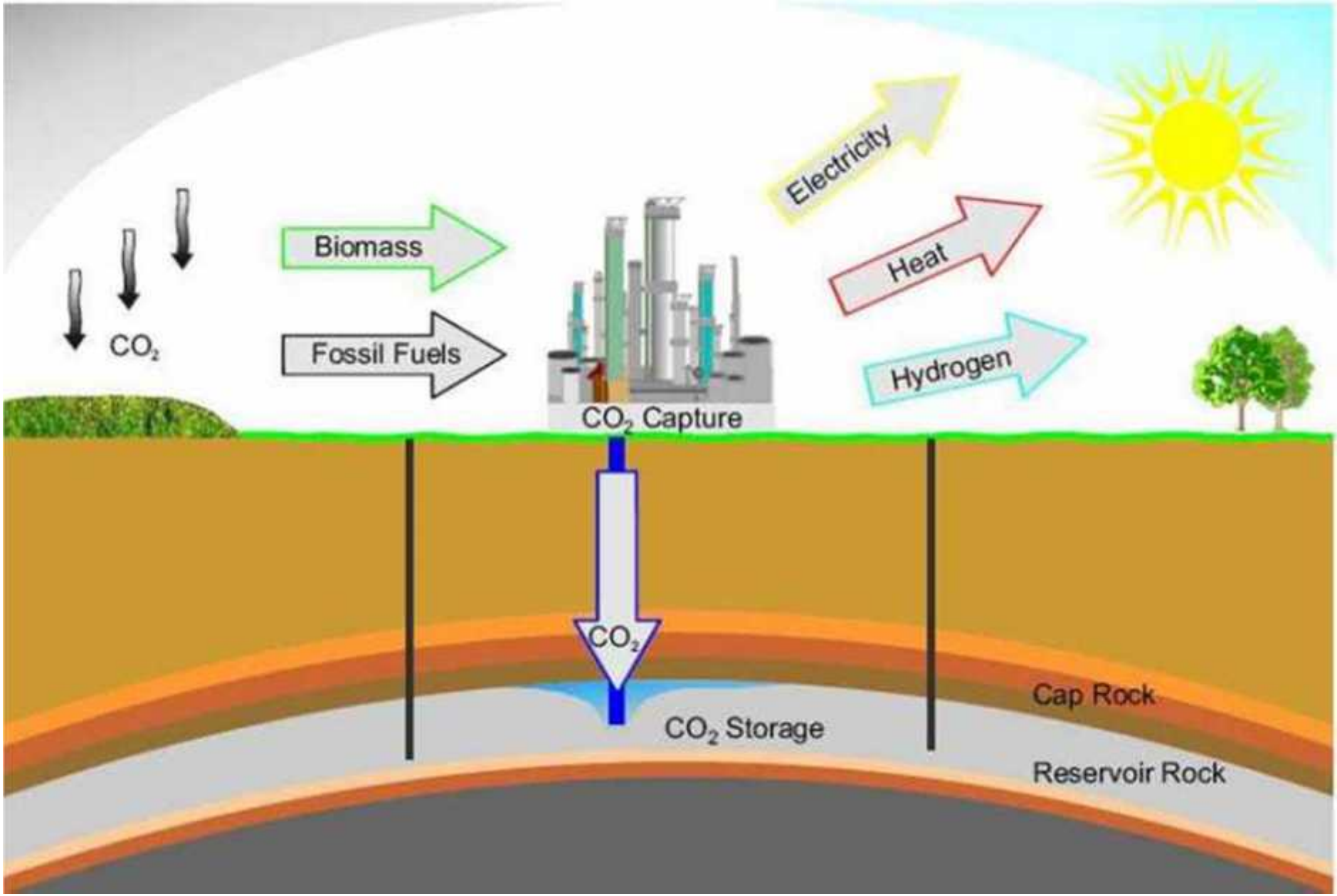
Funding of CCS by MoEJ

The Japanese Ministry of the Environment (MoEJ) invested nearly EUR 29 million in the development of CCS technologies in 2018.

MoEJ Basic Environment Plan, April 2018:

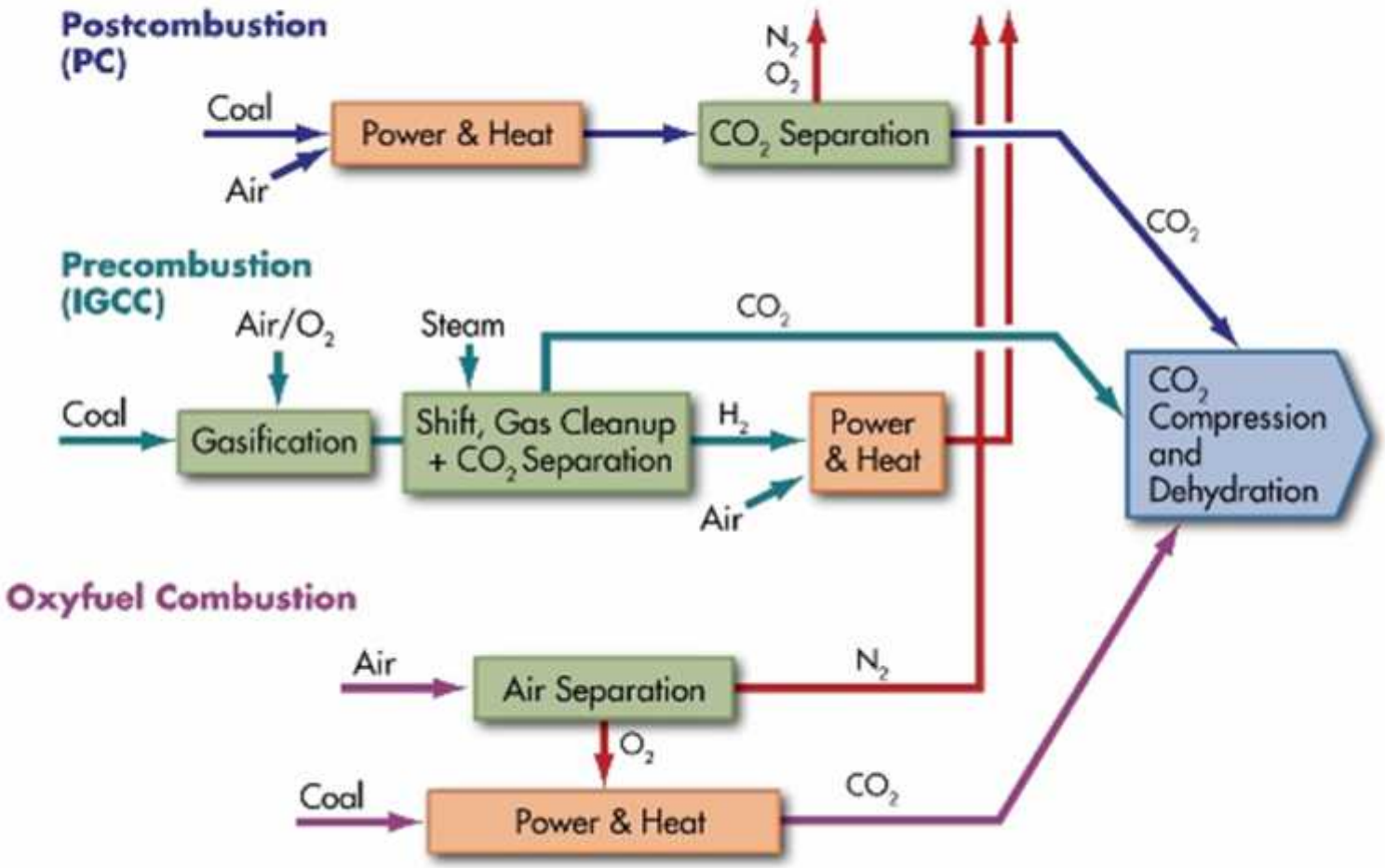
- MoEJ is aware that the plan to build more coal plants could pose a threat to the climate.
- MoEJ aims to promote R&D of innovative technologies that contribute to drastically reducing global greenhouse gases, such as CCUS.
- MoEJ wants to take all measures to reach the emission quota of 0.37 kg CO2 / kWh, which is in line with the reduction target and the energy mix of METI planned for 2030.

Part 3: Carbon Capture and Storage (CCS)



CCS Technology Options

CO_2 Capture in Coal Power Systems



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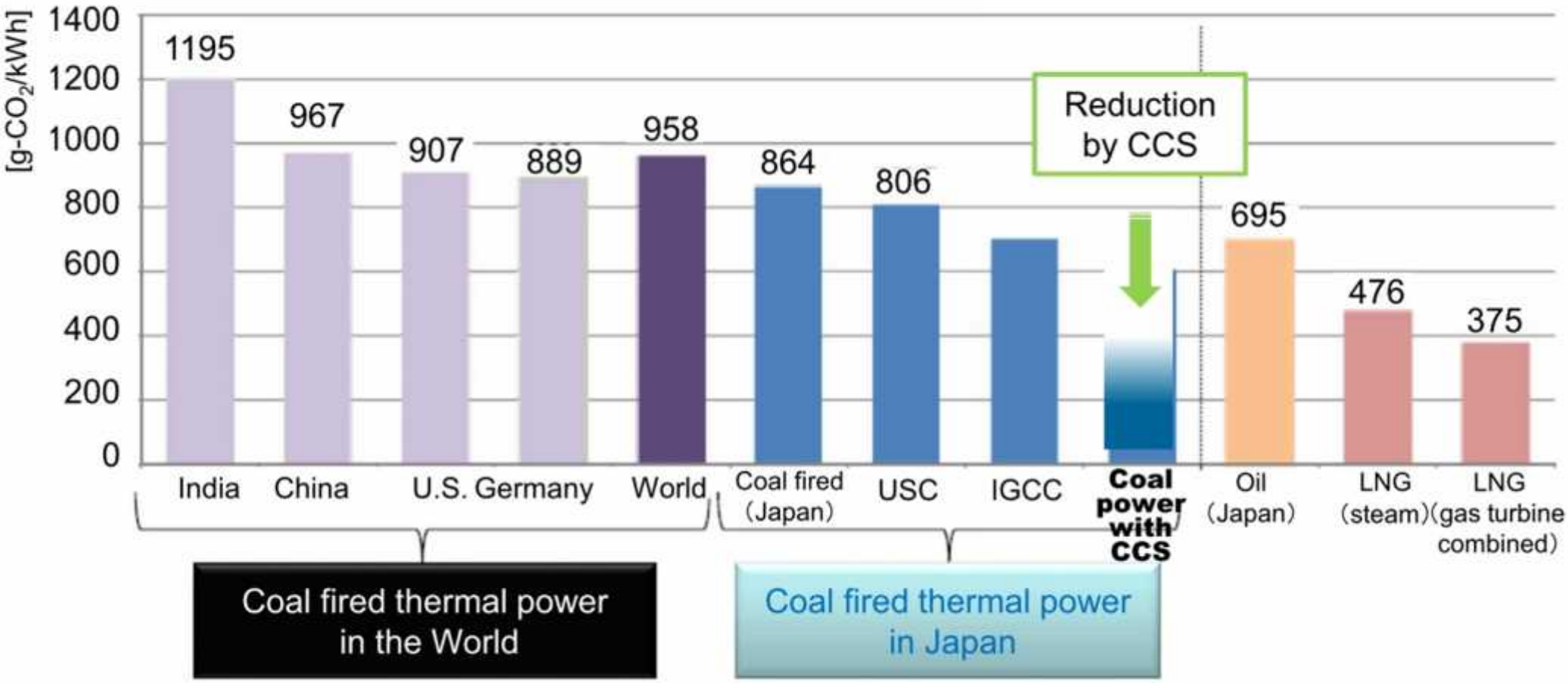
Technology Roadmap

CO_2 Capture and Storage (CCS)

Emissions



Source: NEDO 2018

CCS Technology Roadmap

Source: NEDO 2018

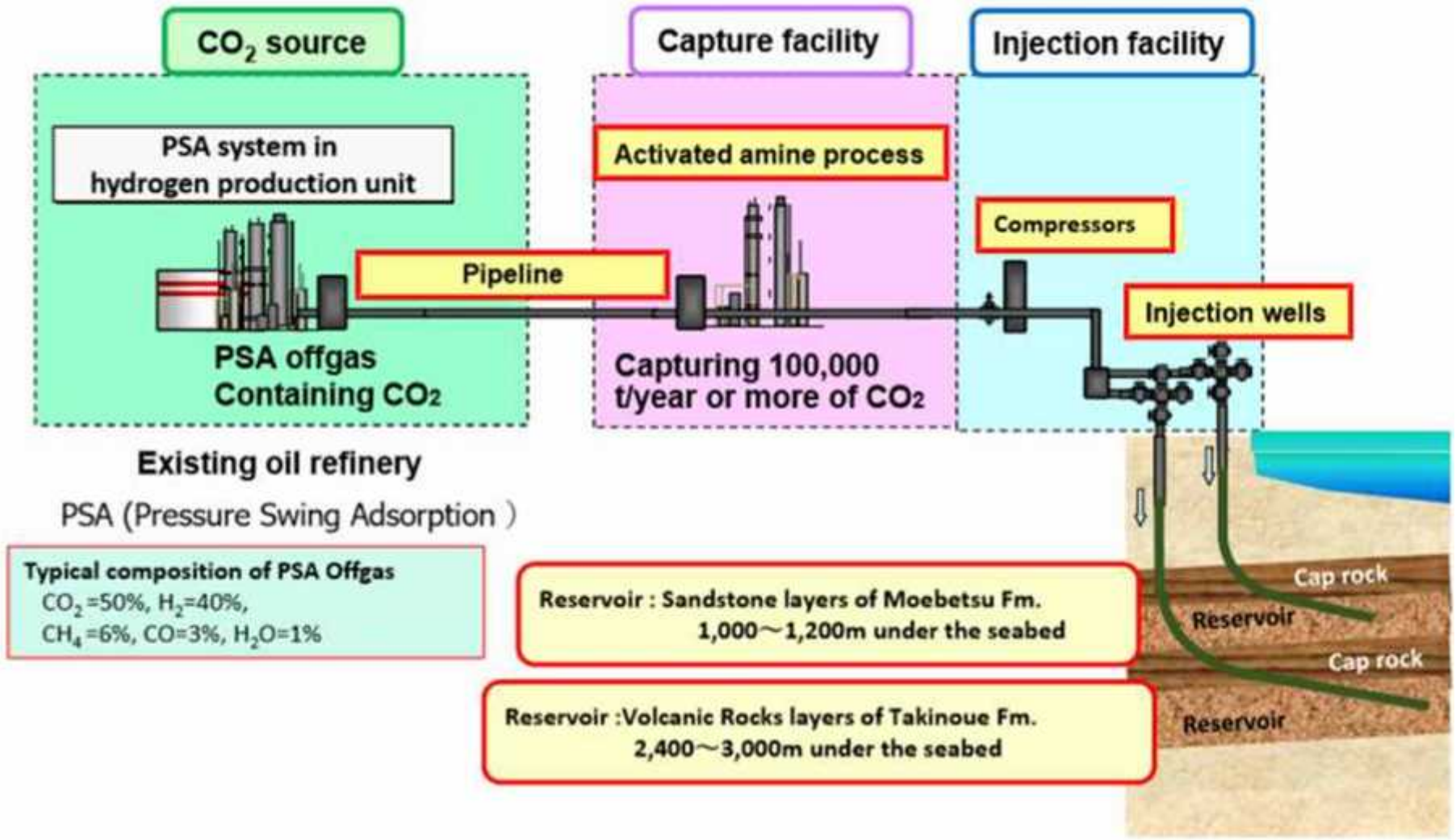
Part 4: CCS Project Examples

National CCT Demonstration projects

Overview

Source:
Scottish Carbon Capture & Storage (2019)

Tomakomai CCS Demonstration project



Source: JCCS (2017)

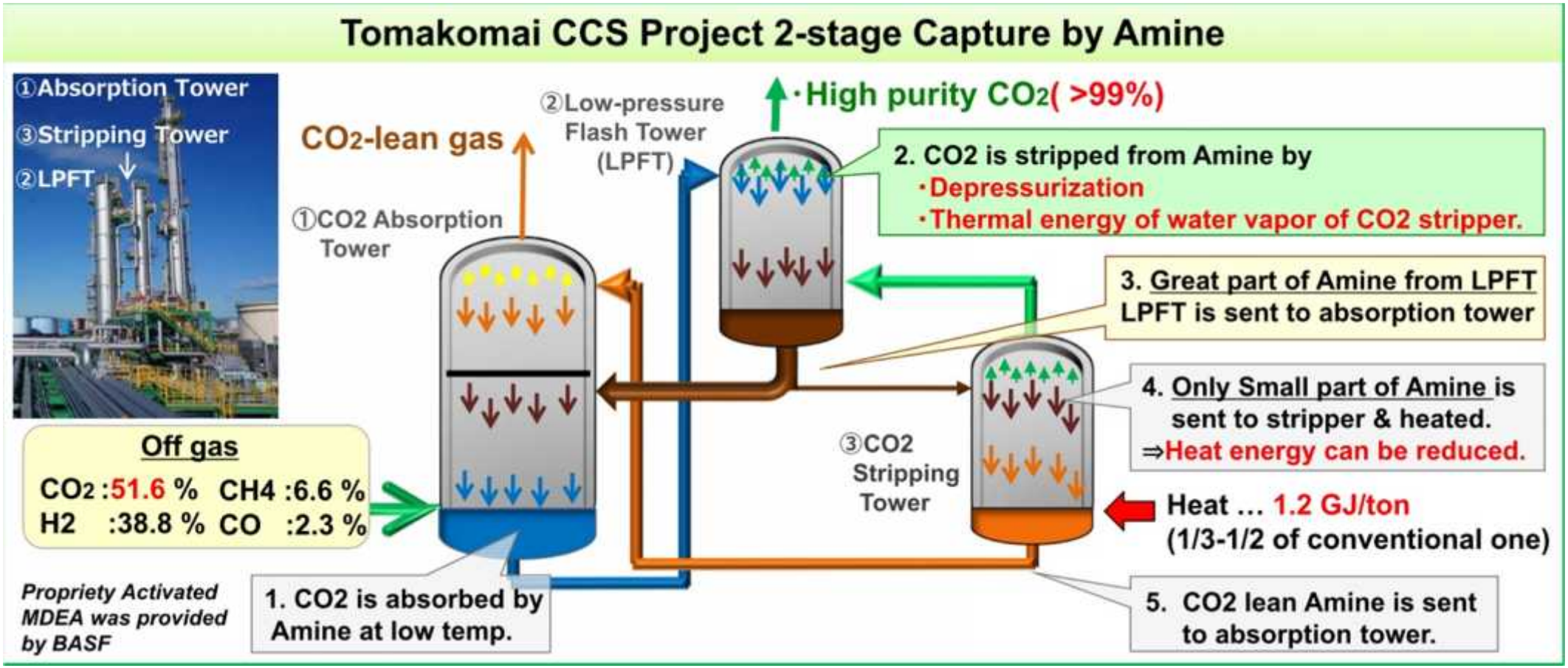
Tomakomai CCS Demonstration project

main features of the project:

1) Extensive monitoring system in seismically active country
2) Deviated CO_2 injection wells drilled from onshore to offshore
3) Marine environmental survey
4) Low energy CO_2 capture process

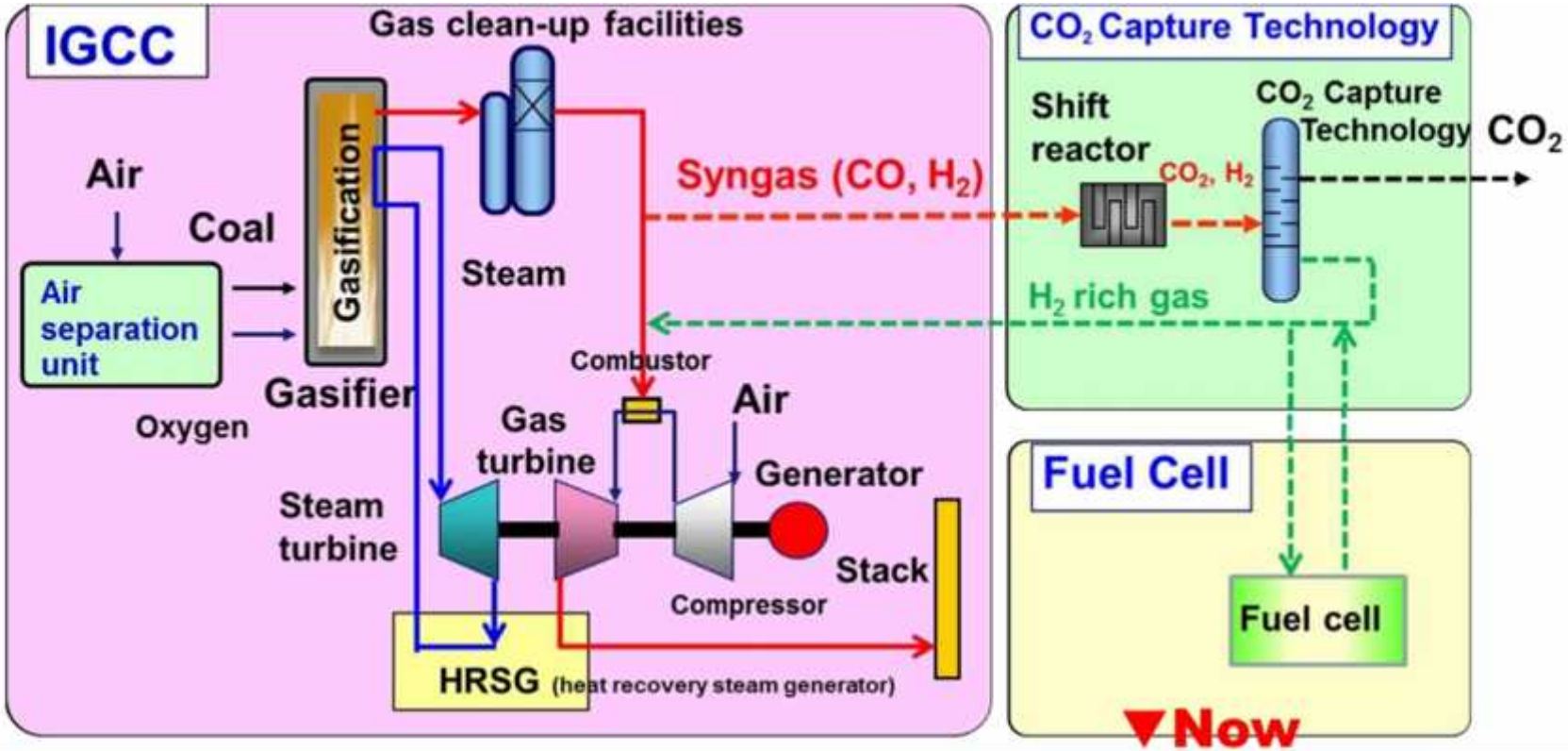
Source: JCCS (2017)

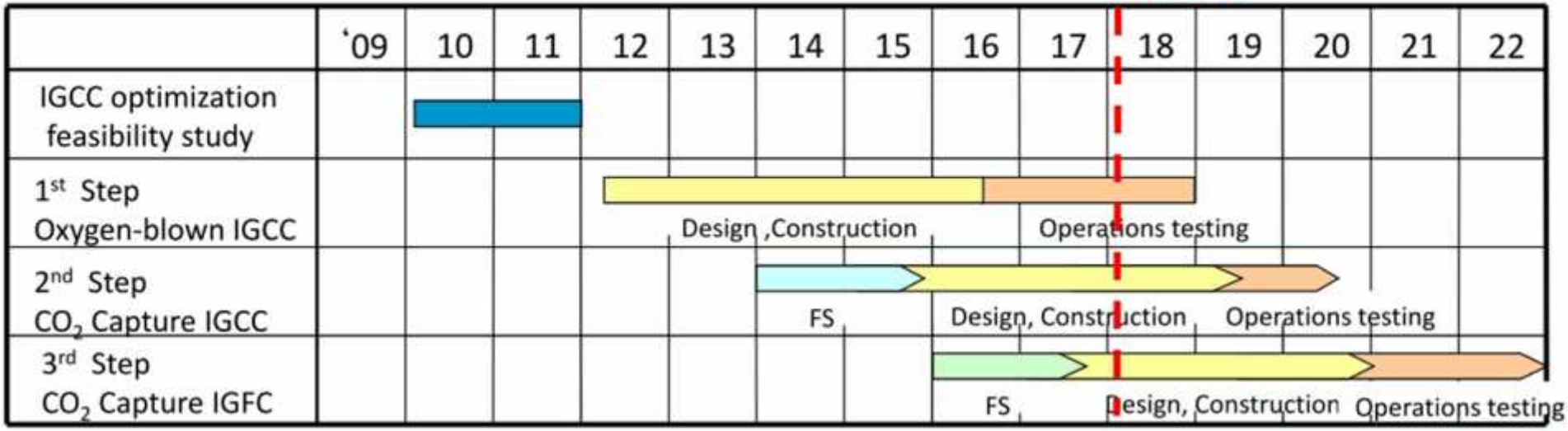
Tomakomai CCS Demonstration project



Source: METI (2016)

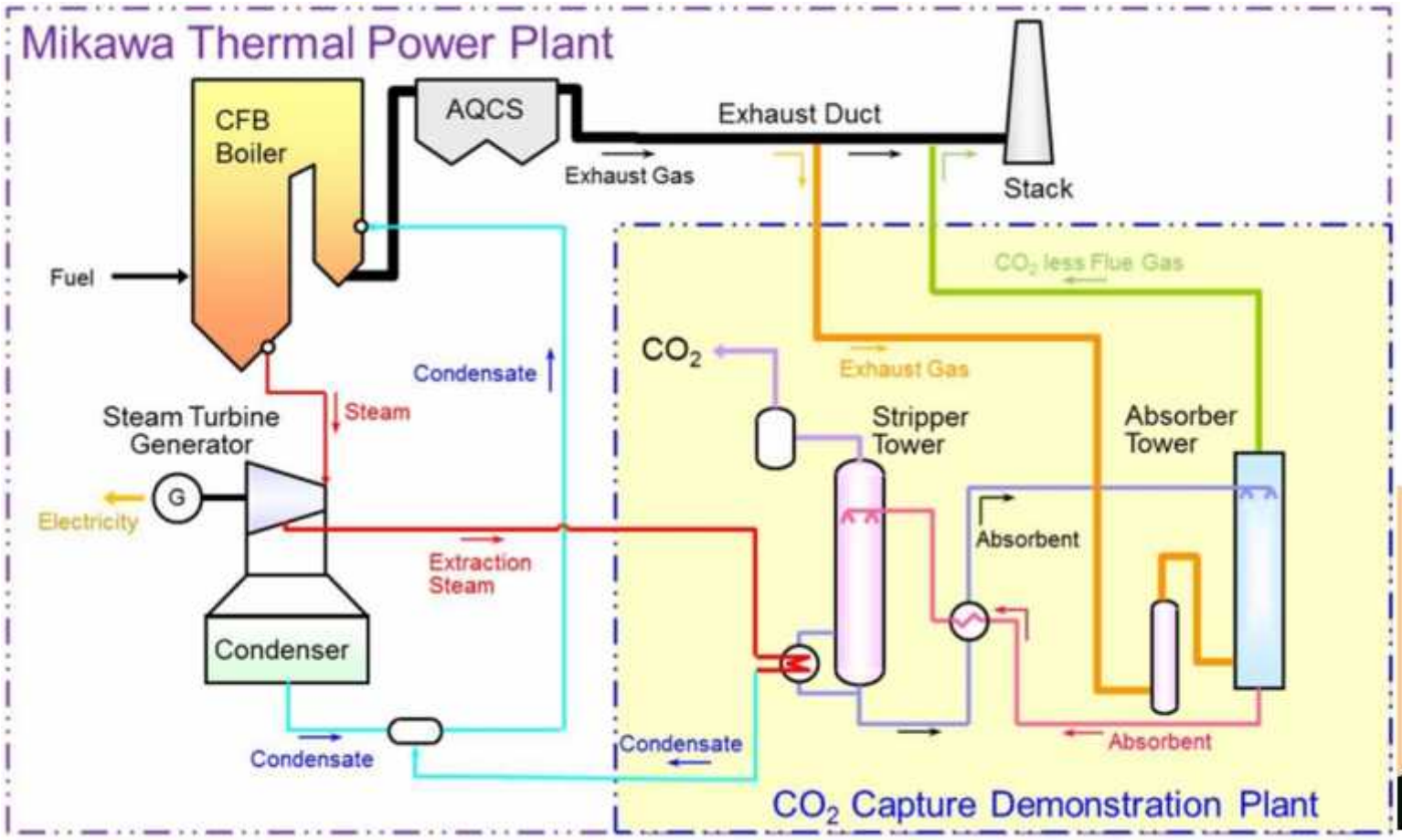
Osaki CoolGen (OCG) Demonstration project





Source: Osaki CoolGen Corp. (2018)

Mikawa CCS Demonstration project

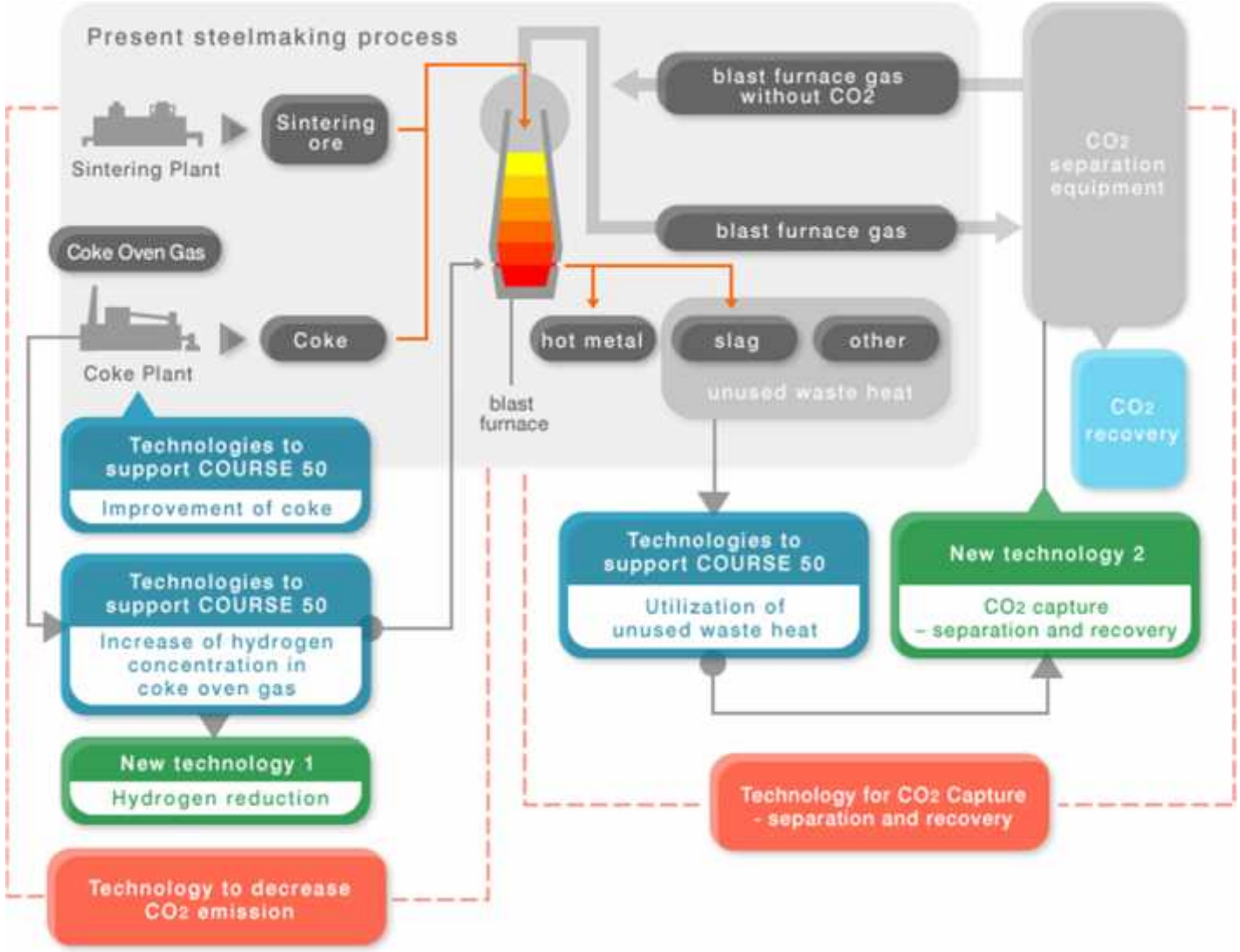


- To capture more than 500 tons of CO_2 per day. (500 tons of CO_2 per day is about 50% of the daily emissions from the 49 MW Mikawa Power Plant). Demonstration phase: 2019 & 2020
- To evaluate performance of technology under various operating conditions, cost and environmental aspects of the amine-based post-combustion chemical absorption technology.

Source: Japan CCS Forum 2018, Toshiba Energy Systems & Solutions Corporation

National Research Program “COURSE 50”

CO_2 Ultimate Reduction in Steelmaking process by Innovative technology for cool Earth 50



Source: The Japan Iron and Steel Federation

2 CO_2 capture methods are tested:

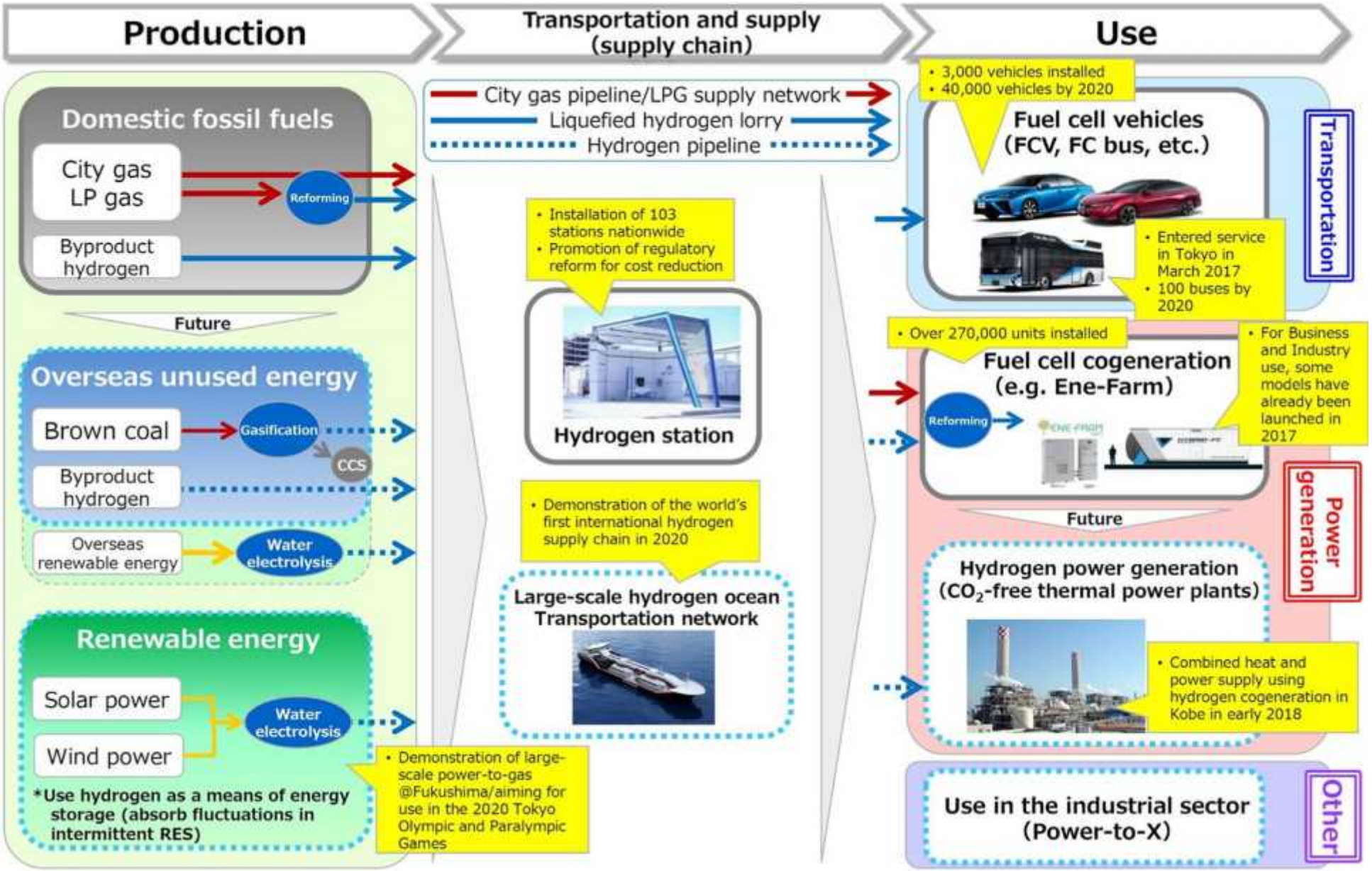
1. Chemical absorption in which a new liquid absorbent was subjected to a performance test

2. Physical adsorption in which the development of a pressure swing adsorption (PSA) technology was tested

International Projects

- Since 2015, the Japan International Cooperation Agency (JICA) supports the financing of USC and super-critical coal-fired power plants at national and international level.
- e.g. India: the Indian state-owned energy utility NTPC received EUR 200 million in loans from JICA and the Japan Bank for International Cooperation in 2015.
- e.g. Canada: a Japanese consortium are jointly assessing the feasibility of the application of Japanese CCUS technologies in Saskatchewan, Canada.

Japanese Activities to Realize a "Hydrogen Society"



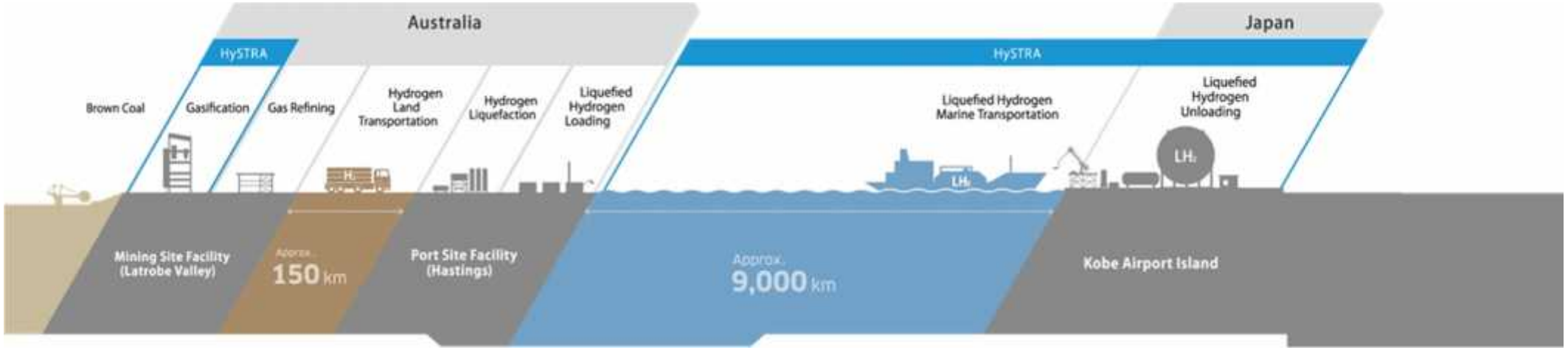
Source: METI 2019

Ongoing H_2 Supply Chain Projects

Source: METI 2019

International cooperation project HySTRA

HySTRA (Hydrogen Energy Supply Chain Technology Research Association) is a pilot project to establish an H_2 supply chain from abroad in conjunction with CCS.



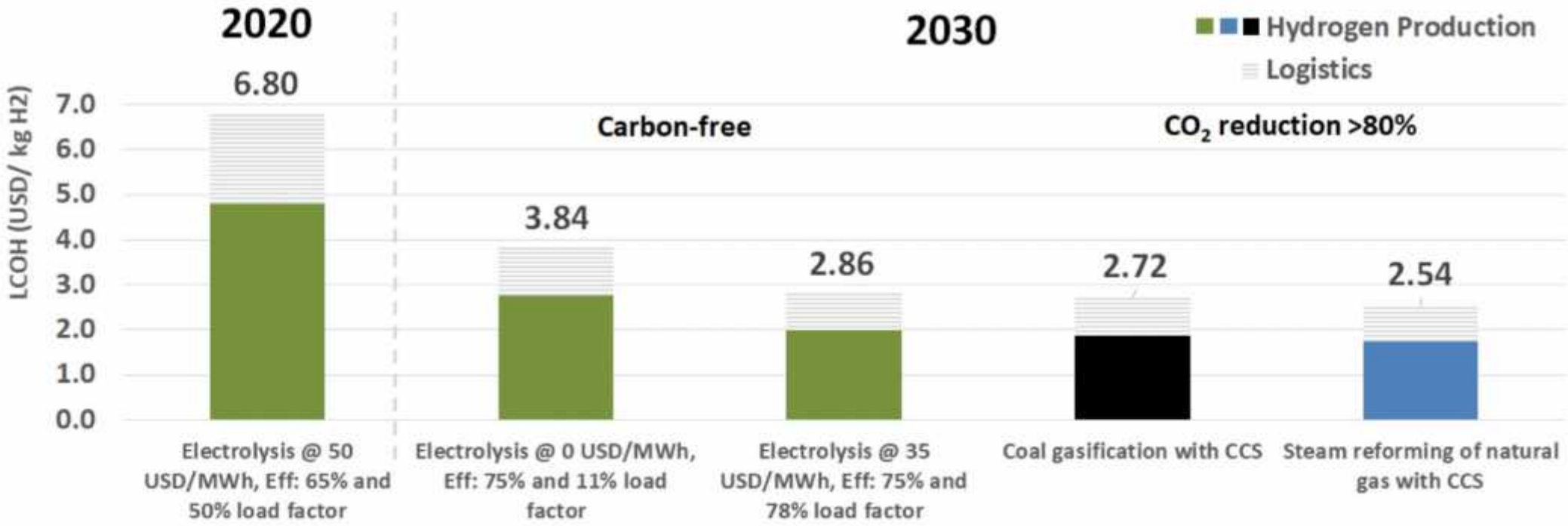
The result of the pilot phase should be a commercially viable power plant in the Latrobe Valley, in which a CCS plant is integrated. This plant injects CO_2 into various local storage caverns.

Source: HySTRA

Hydrogen: Total supply costs (production, storage and shipping)

Australia -> Japan - (USD/ Kg H2) – present costs

- Wind + PV 2030: Free-Electricity and 1000 h/year;
  35 USD/MWH and 6840 h/year
- Natural Gas price: 5 USD/million BTU
- Coal price: 2 USD/GJ and 10.3 MJ/kg



Source: IRENA, 2019

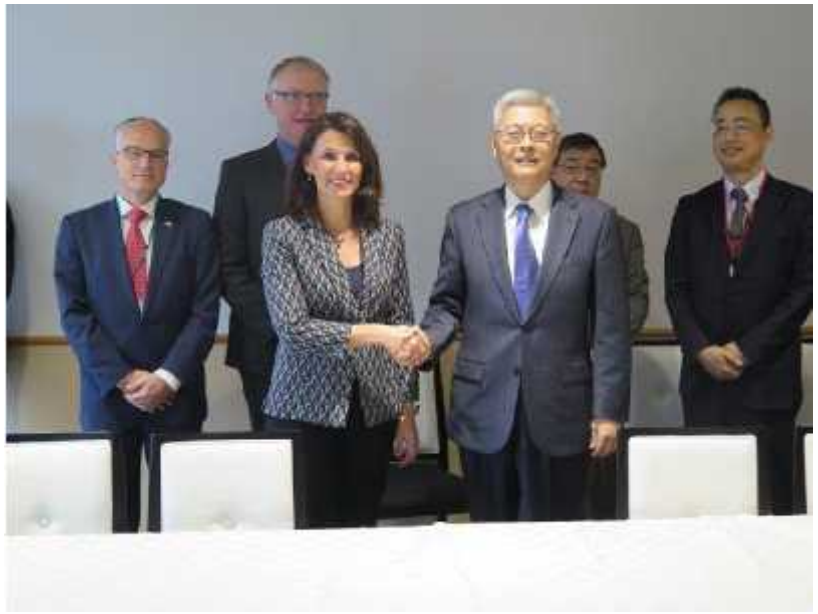
5. Summary/Conclusion

- The aim: zero domestic CO_2 emissions in 2050
- The plan: promote “clean” coal-fired power plants and CCS technology domestically and abroad
- The problem:
  - even clean coal is not really emission-free
  - it is highly uncertain whether and when CCS technology will be economically viable on a large scale
- The reality: Coal-fired power is being phased out around the world

Save the Date: EEDF 2019

10th German-Japanese Environment & Energy Dialogue Forum

29/30 October 2019, Tokyo



Thank you for joining!

We are looking forward

to your questions and comments

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