R & D of CCT(LRC)
-Status and Prospects of Utilization-

WHY DOES JAPAN DEVELOP TECHNOLOGIES FOR LOW RANK COAL UTILIZATION?

Two Objectives in Coal Policy of Japanese Government:

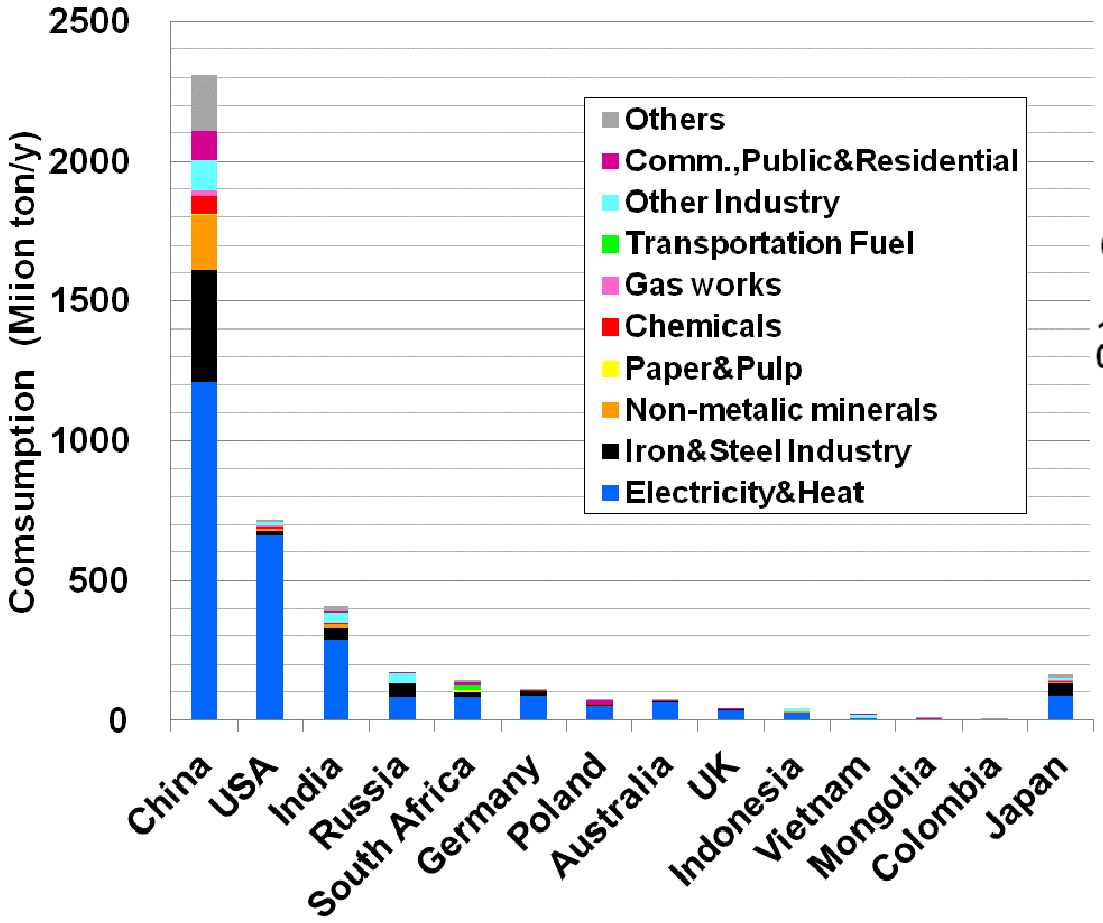
1. **Selling Japanese technologies for low rank coal utilization. As results, expanding usable coal resources**

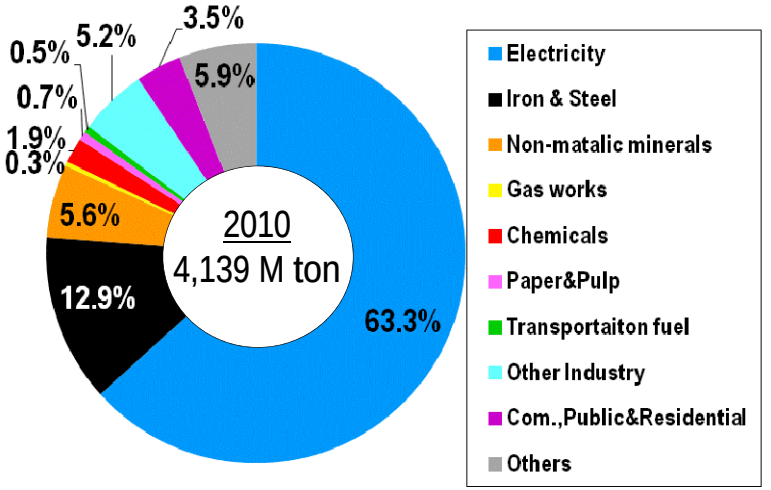
2. **Not only selling Japanese technologies but also investing the project using the technologies for low rank coal utilization, and exporting products made by the project to Japan.**

Concept of Good Theme and Good Business

Coal Utilization Area in the World

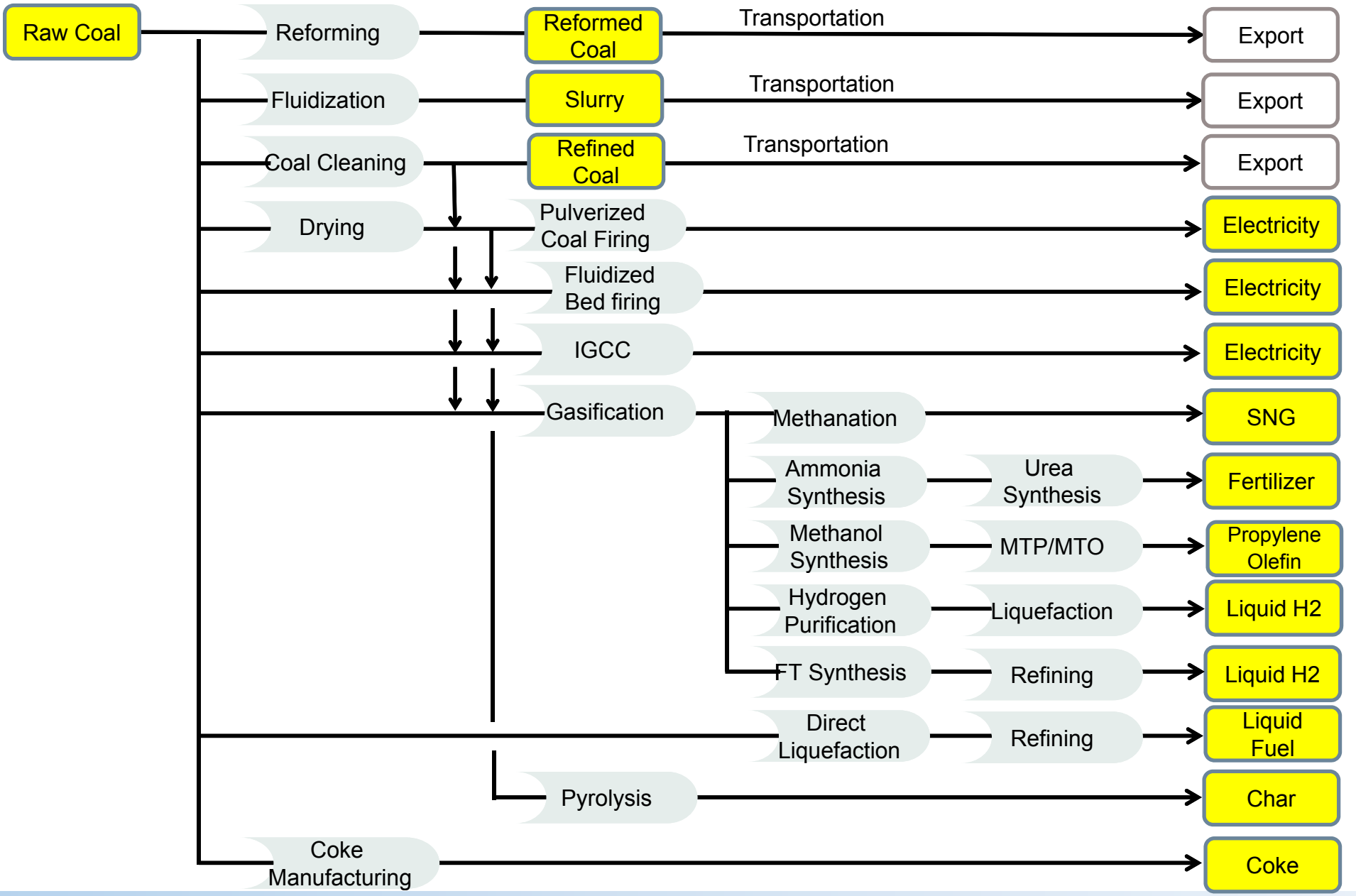
Source : IEA Statistics, Coal Information-2012





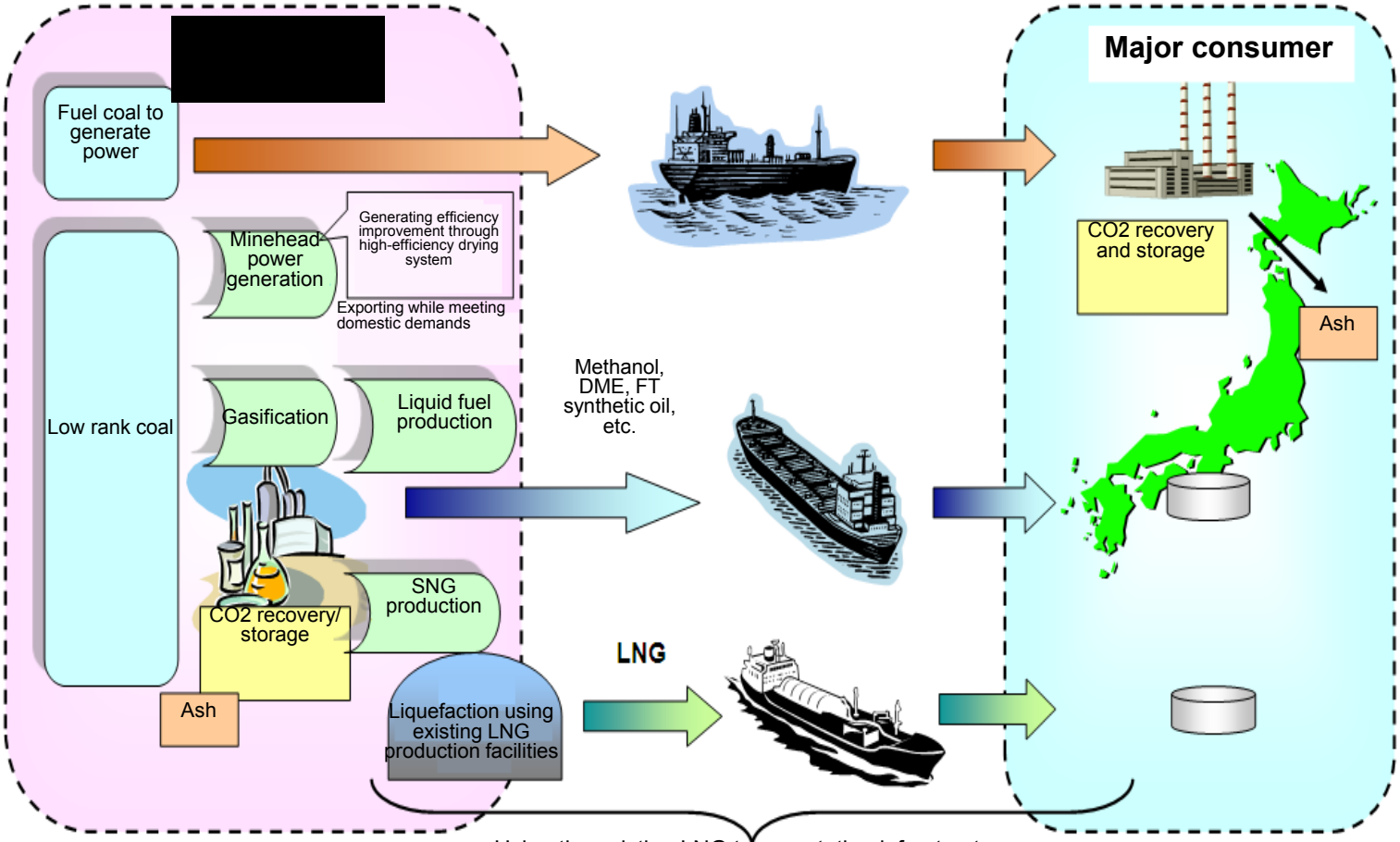
- Coal Consumption is mainly Power Generation and Iron field
- Most Important to develop the Electric Power Technology (Combustion etc.)
- 5 countries in EU : Ratio of Power Generation by Lignite is 30%

Value-chain of LRC



Effective utilization of low rank coal

1. Development of gasification technologies for low rank coal
   Methane/DME, etc. from gasification of low rank coal can contribute to supplying clean energy
2. Development of upgrading technologies for low rank coal
   Development of new dehydrating/drying technologies



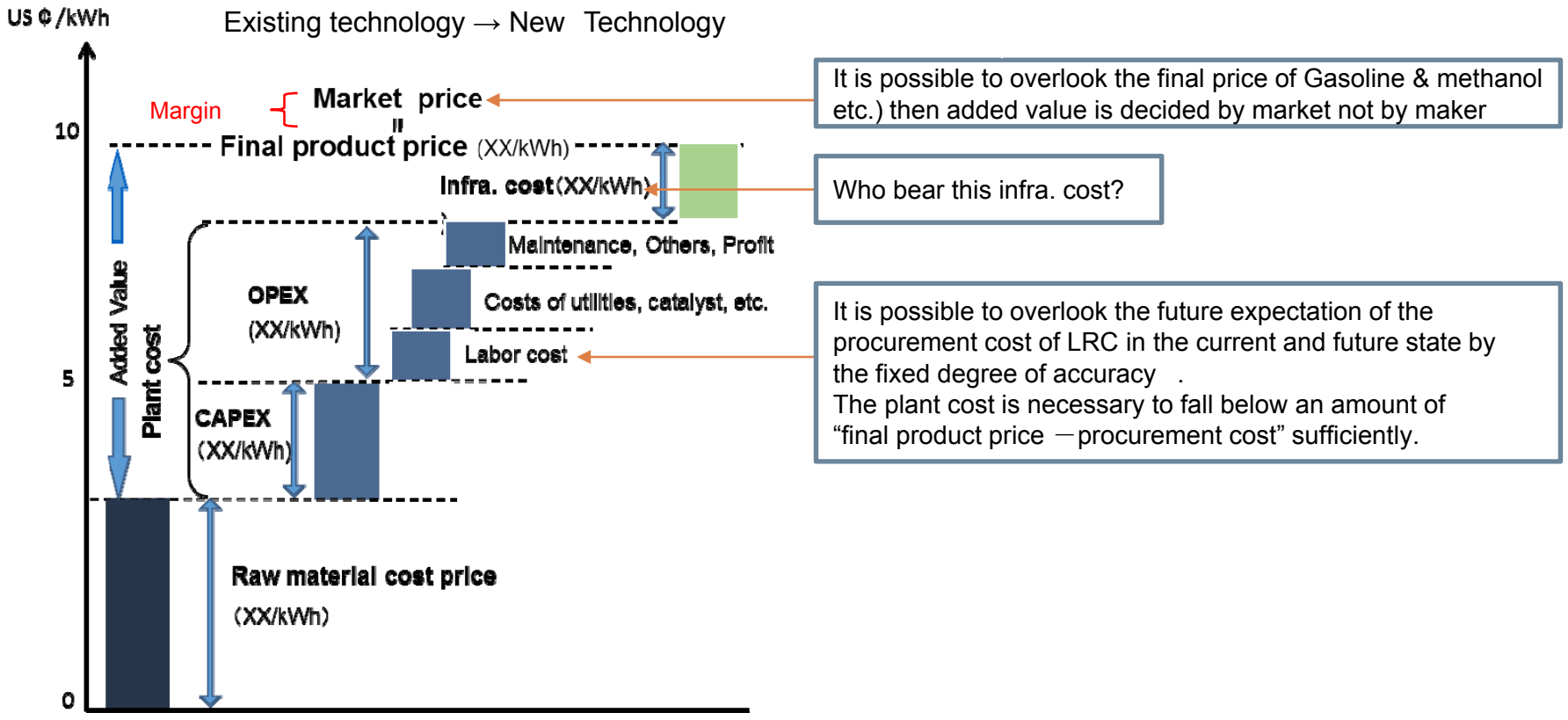
Needs of Utilizing Technology for LRC in Producing Countries

storong | normal | Weak/Potential

Technical \ Coal Producing country		Australia	China	Indnesia	Vietnam	Mongolia	India	Rossia	Germany	Poland	U.S.A.	Columbia	South Africa	Mozambiq
Pre-processing	Coal Cleaning		Air Pro-tection		Anthracite Export	Coking Coal Export	Demand Inclease							Coking Coal Export
	Drying	Use/High Moisture Coal	Gas Treat-ment	Use/High Moisture Coal					Use/High Moisture Coal	Use/High Moisture Coal				
	Reforming	Use/High Moisture Coal	Reformed Lignite	Alternativ e Black Coal									LRC Export	
	Liquidazatio n (CWM)		Alternativ Heavy Fuel	Outlier Fuel										
Combu stion	Pulverized Coal Firing	Brown Coal Power Station	USC DeNOx	Big Demand of Elect.		New Power Generation	New Power Generation	New Power Station	High Efficiency	High Efficiency	High Efficiency	High Efficien cy	High Efficiency	
	Fluidized Bed firing		Diversificati on of Raw Material	Small Despersal Elect. Supply		Use of Cleaning Residue	Use of Creaning Residue		Use of Lignite	Useof LRC	LRC Co-firing			
	IGCC		Elect.Deman d Increase	Green Electiric Power			Green Electiric Power		Green Electiric Power	Green Electiric Power	Green Electiric Power			
Gasification (Chemical Usage)			SNG/Chemic als,Coprodu ct	Fertilizer (SNG)	Fertilizer		Fertilizer		Chemicals	Fertilizer (SNG)	SNG/Chemi cal Coproducti on		FT Symthesis Fuel & Chemicals	
Liquefa -ction	Indirect Liqe.		SNG/Chemic als,Coprodu ct	Lack of Oil									FT Symthesis Fuel & Chemicals	
	Direct Liqui		Lack of Oil	Lack of Oil										
Coking			Semi-coke	Molding SCC		Semi-Coke	Semi-coke	Semi-Coke		Semi-coke				

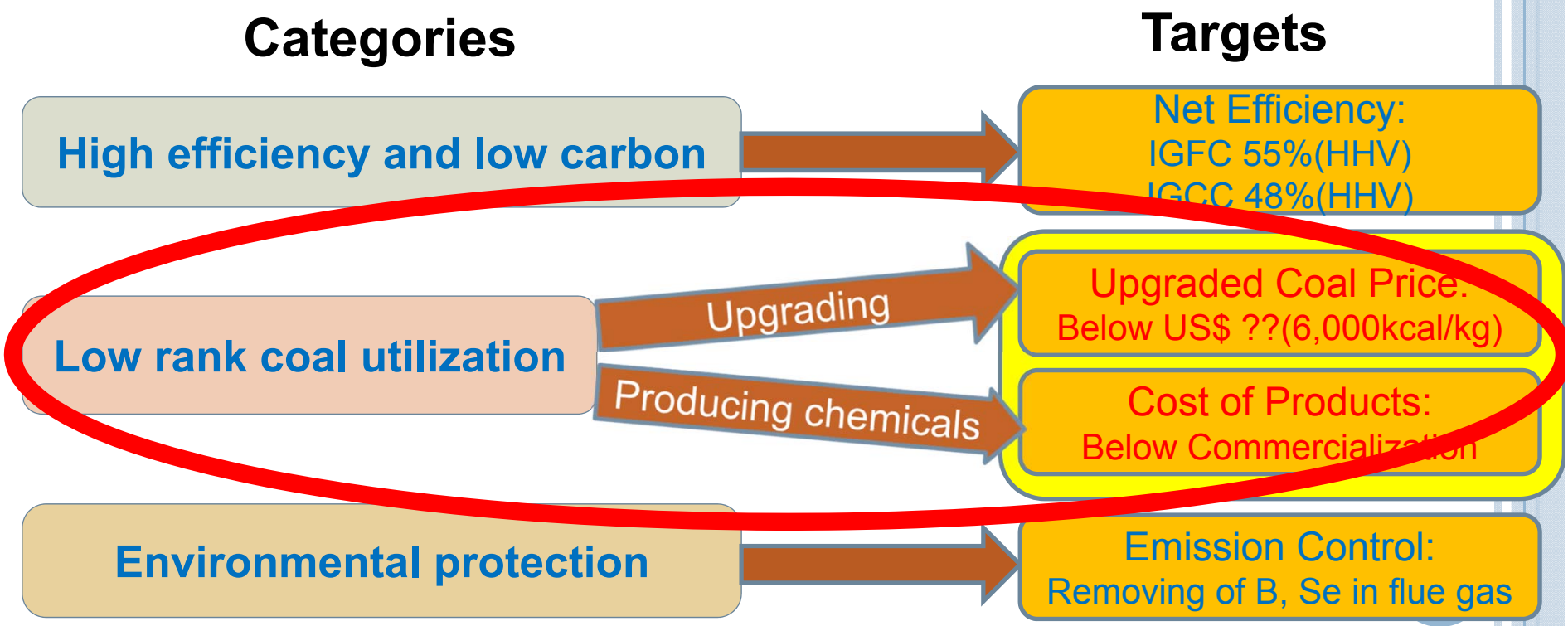
Setting up of the Cost Target

- It's indispensable to establish a target severely from an early stage of Demo. Plant stage about the cost performance of the technology.
- Technology quantifies the created additive value and establishes the cost target sincerely.
- A finite difference of the final product price and the raw coal price of LRC is defined as the added value by technology bears.
- It's important for adding up of the plant cost, the working expenses and the transport costs to fall below an additional value sufficiently.



Source: : NEDO Report 2012 Study of LRC Promotion business by MRI、JCOAL

TARGETS OF CCT ROADMAP



R&D of Low Rank Coal Utilization Technologies in Japan

Targets

- Upgraded Coal Price: Below US$??(6,000kcal/kg)
- Cost of Products: Below Commercialized product

Country	Products	Technology	Company
Indonesia	Urea	Gasification	IHI
	JCF(CWS)	High Temp. water treatment	JGC
	SNG	Gasification	MHI
	PCI	Pyrolysis	MHI
China	SNG	Gasification	NSENGI
Australia	Hydrogen	Gasification	KHI
Australia	Reformed Coal	Pyrolysis	KEPCO

TIGAR® (FLUIDIZED BED GASIFICATION) BY IHI CORPORATION

Low Energy substance(Lignite and Biomass etc.), was difficult to use economically and technically, which is put to effective use in a chemical material and fuel by Gasification.

TIGAR 50t/d Prototype plant at Kujang in Indonesia

Background:

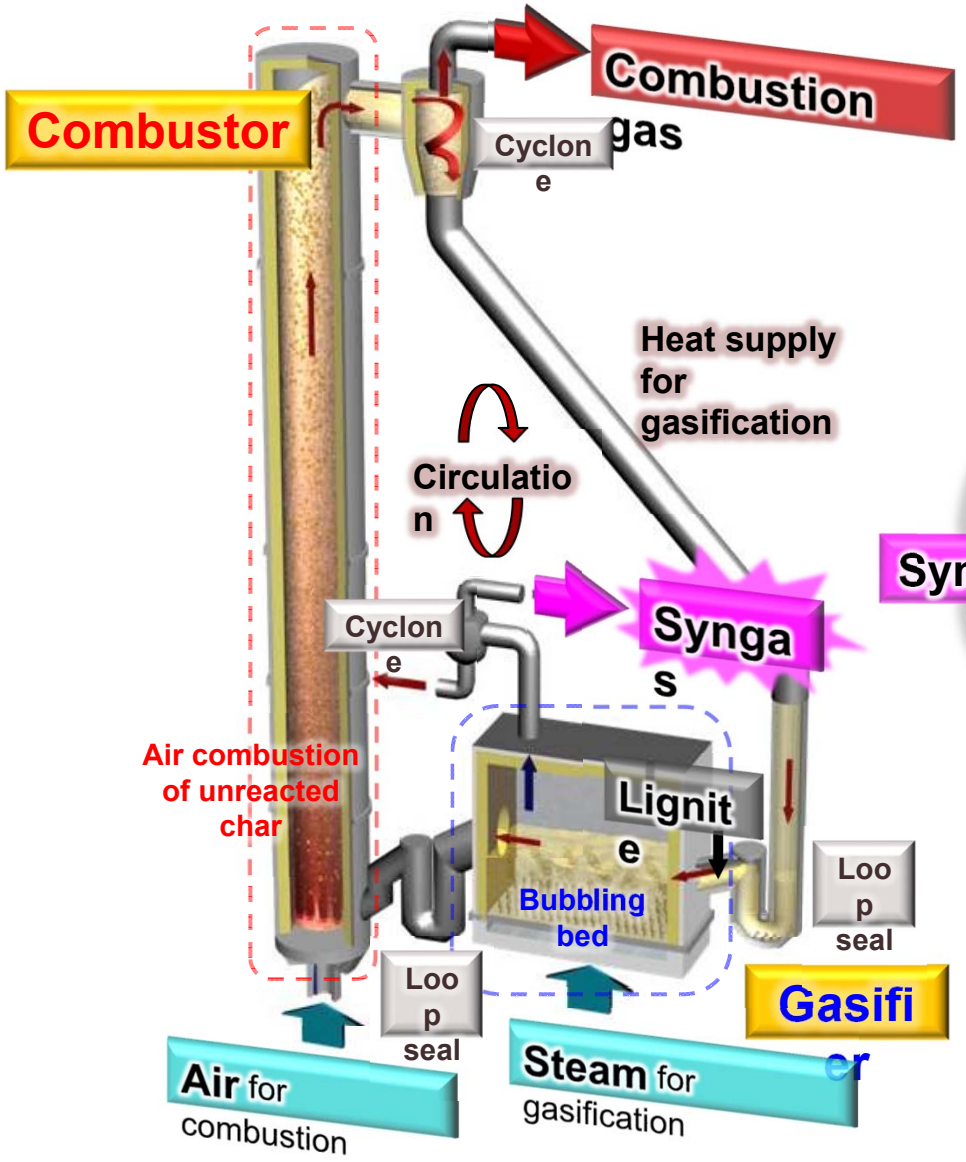
Production of Natural Gas (NG) in Indonesia, which is a major feedstock of fertilizer, is declining. LRC is abundant but not used effectively. Gasification of LRC as a back up of NG is expected.

Objectives:

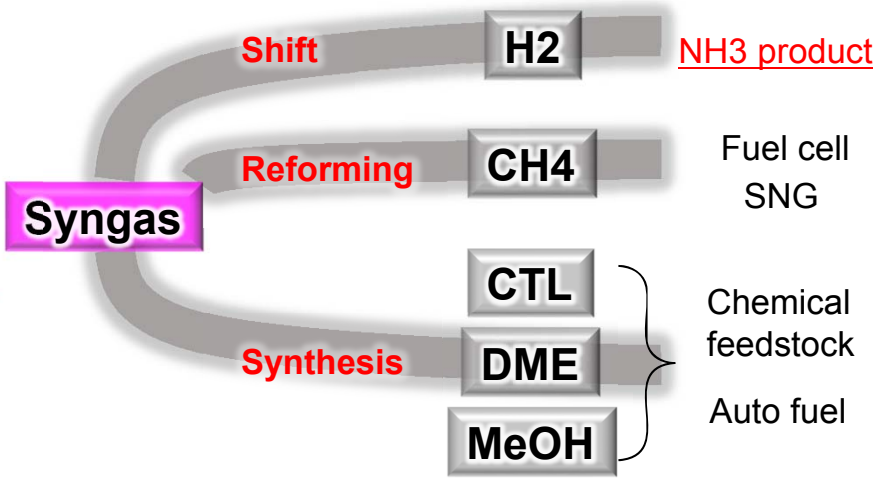
To make implementation plan for conversion of fertilizer feedstock from NG into LRC

■ Components of TIGAR® are combined mature CFB and BFB technology.

*1 CFB : Circulating Fluidized Bed, *2 BFB : Bubbling Fluidized Bed



Multi product application



TIGAR® can produce several kinds of chemical feedstocks and fuel from lignite and biomass.

JCOAL Japan Coal Energy Center

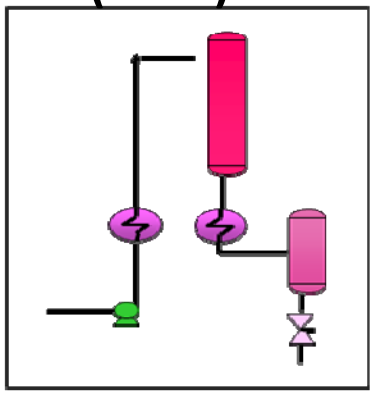
JCF Demonstration Plant

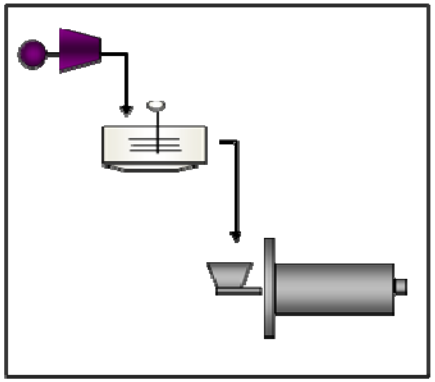
- ✓ JCF demonstration plant is located in Karawang.
- ✓ Production capacity of the demonstration plant is 10,000t/y.
- ✓ JCF demonstration plant was supported by Japanese government (JOGMEC and NEDO).

Coal Water Slurry by JGC Corporation

JCOAL Japan Coal Energy Center

Lignite | **Upgrading (HWT)** | **Slurrification** | **Upgraded Coal Slurry**



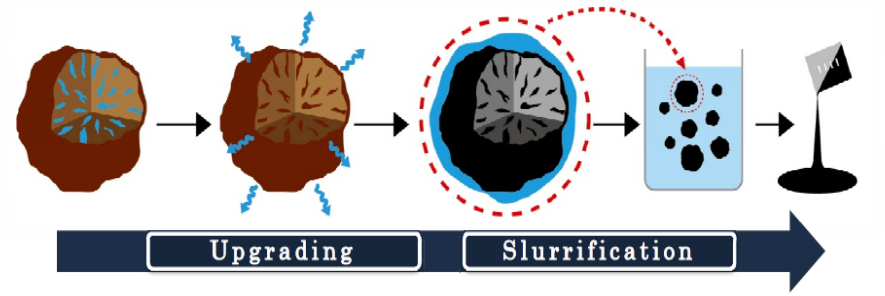


Liquid Fuel from Low Rank Coal

LRC → **JCF®**

- Abundant Resources, but
- Bulky
- Low Calorific Value
- Spontaneous Ignition

- Liquid-type Fuel
- High Calorific Value
- Substitute for Oil/Gas



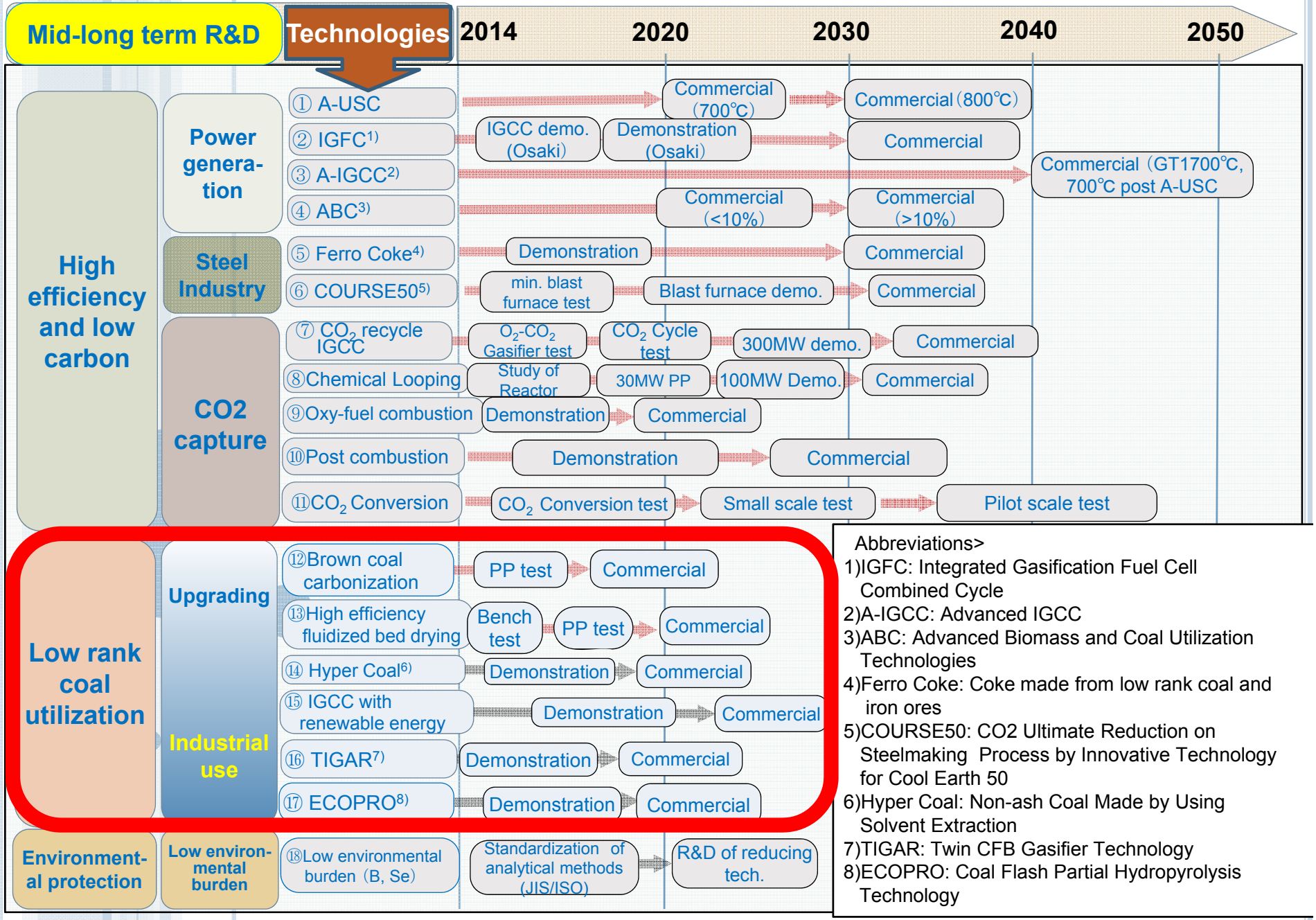
JCF® Properties

- Liquid type fuel similar to heavy fuel oil
- Closed storage / transportation
- Free from dust problems / spontaneous ignition

JCF® Properties

Calorific Value	4,000 – 4,500 kcal/kg
Coal Concentration	60 – 65 %
Density	1.2
Viscosity (25℃)	1,000cp
Mean Particle Size	20μm

Japanese Roadmap of Clean Coal Technologies(1))



Abbreviations>

1)IGFC: Integrated Gasification Fuel Cell Combined Cycle

2)A-IGCC: Advanced IGCC

3)ABC: Advanced Biomass and Coal Utilization Technologies

4)Ferro Coke: Coke made from low rank coal and iron ores

5)COURSE50: CO2 Ultimate Reduction on Steelmaking Process by Innovative Technology for Cool Earth 50

6)Hyper Coal: Non-ash Coal Made by Using Solvent Extraction

7)TIGAR: Twin CFB Gasifier Technology

8)ECOPRO: Coal Flash Partial Hydropyrolysis Technology

Japanese Roadmap of Clean Coal Technologies(2)

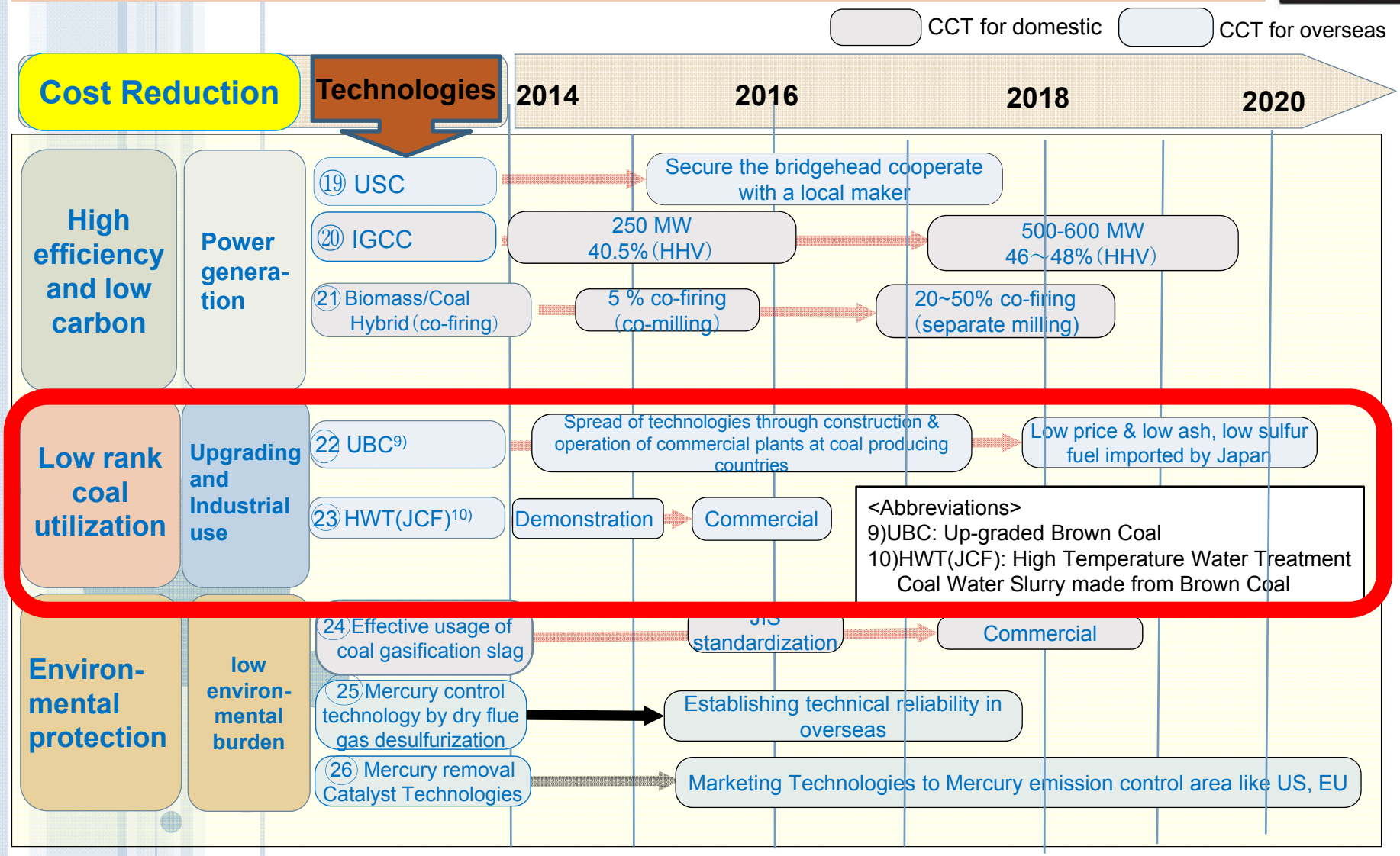


Fig. 2/3 Japan's CCT Road Map

Japanese Roadmap of Clean Coal Technologies(3)

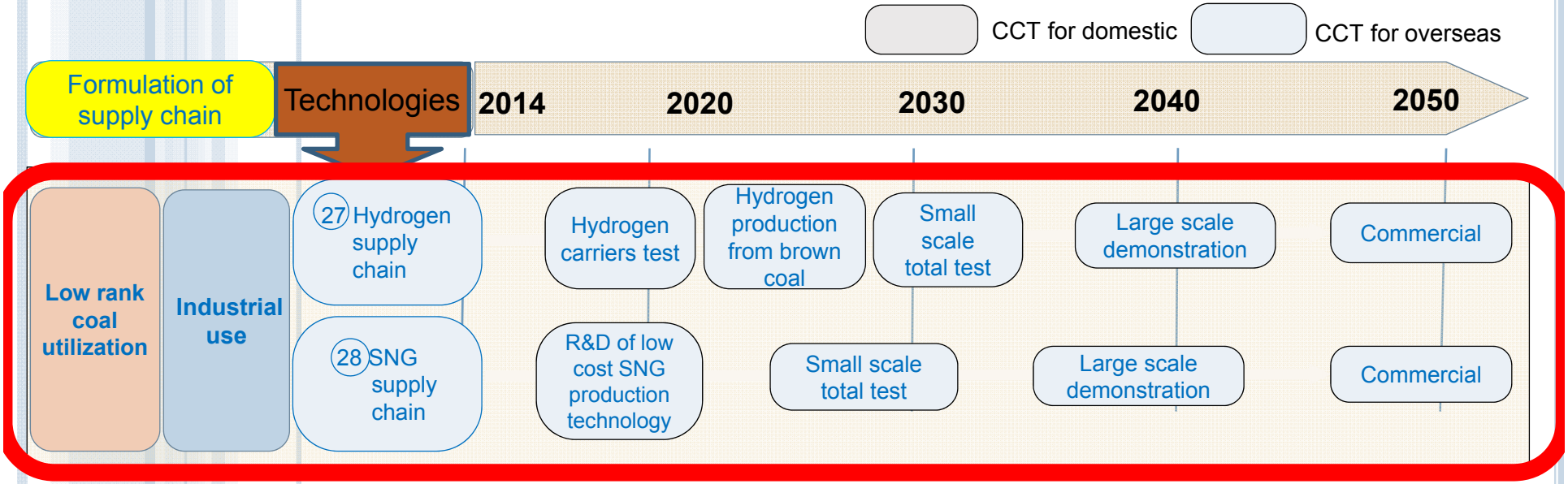


Fig. 3/3 Japan's CCT Road Map

CONCLUSIONS

1. The objectives for developing technologies for low rank coal utilization in Japan are:
   - to sell Japanese technologies
   - to supply fuels and chemicals produced from low lank coal with cheaper than commercial prices
2. TIGAR and JCF projects are carrying out in Indonesia by the Demonstration Plant and some projects are planning to start in near future.
3. JCOAL is studying the Road Map for Future Projects. and is promoting the R & D of CCT with member companies

Thank you for your attention!