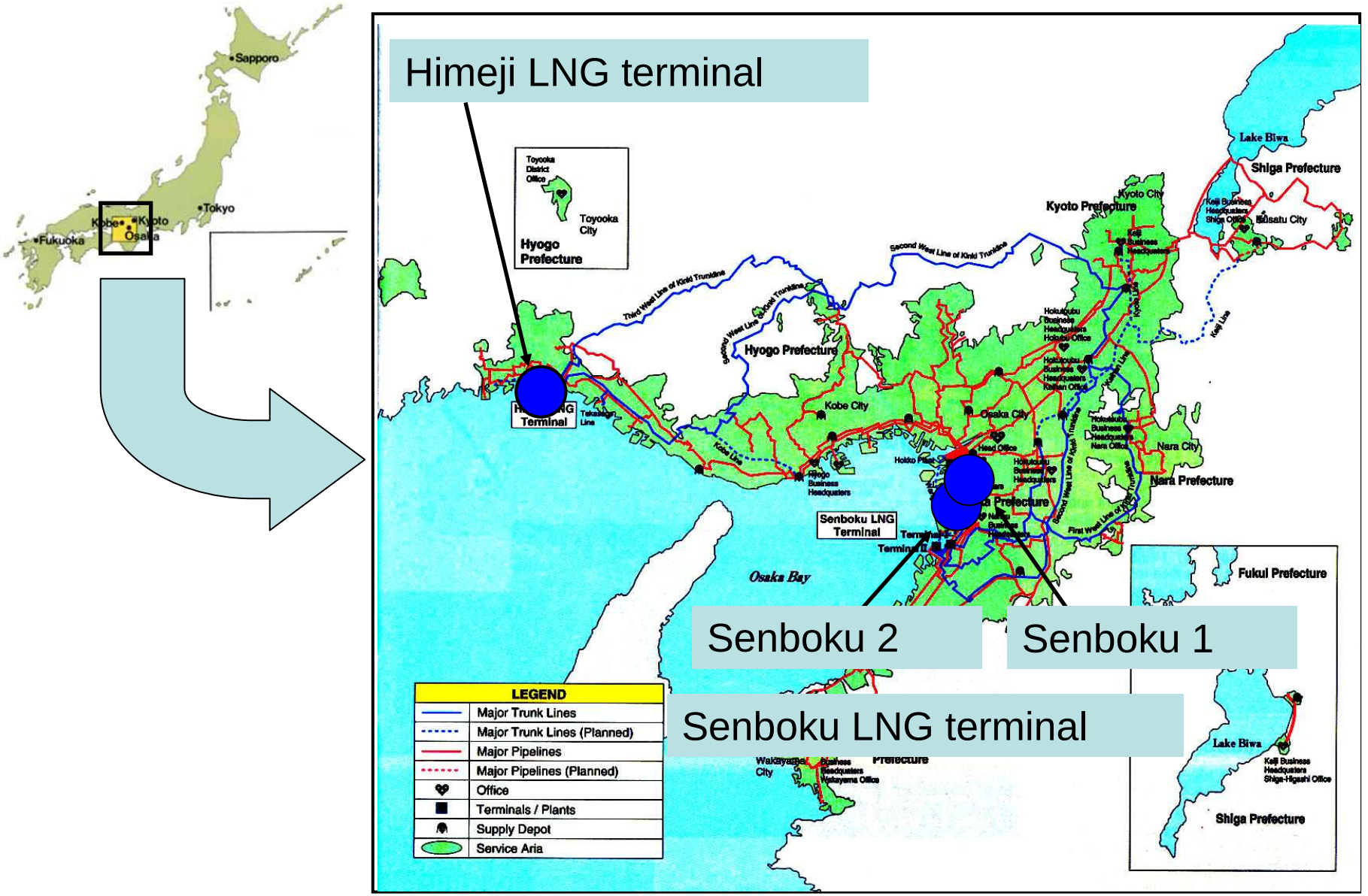
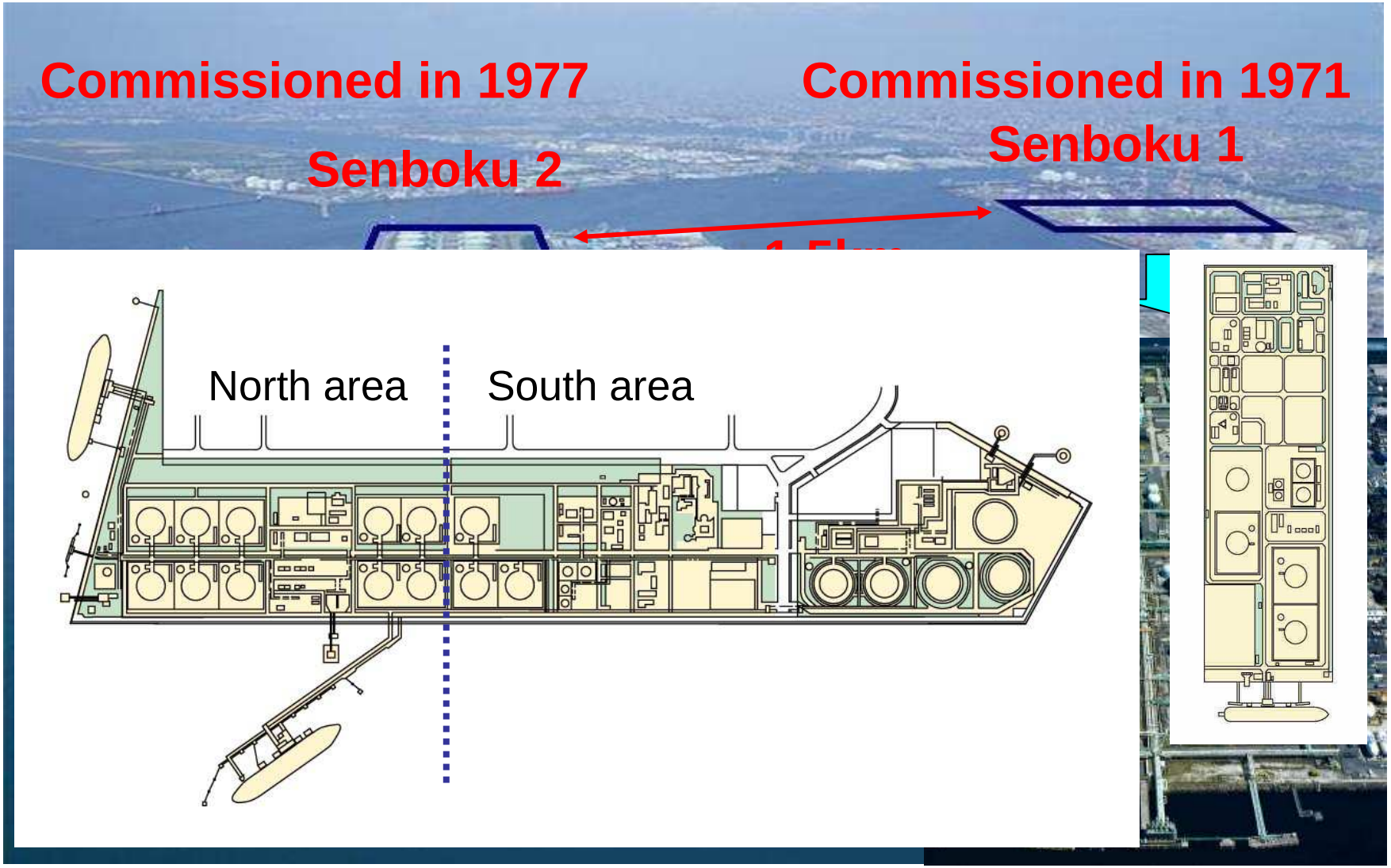
Evolution of an LNG Terminal: Senboku Terminal of Osaka Gas

Toshiro Otsuka
Senboku LNG Terminal
Osaka Gas Co., Ltd.

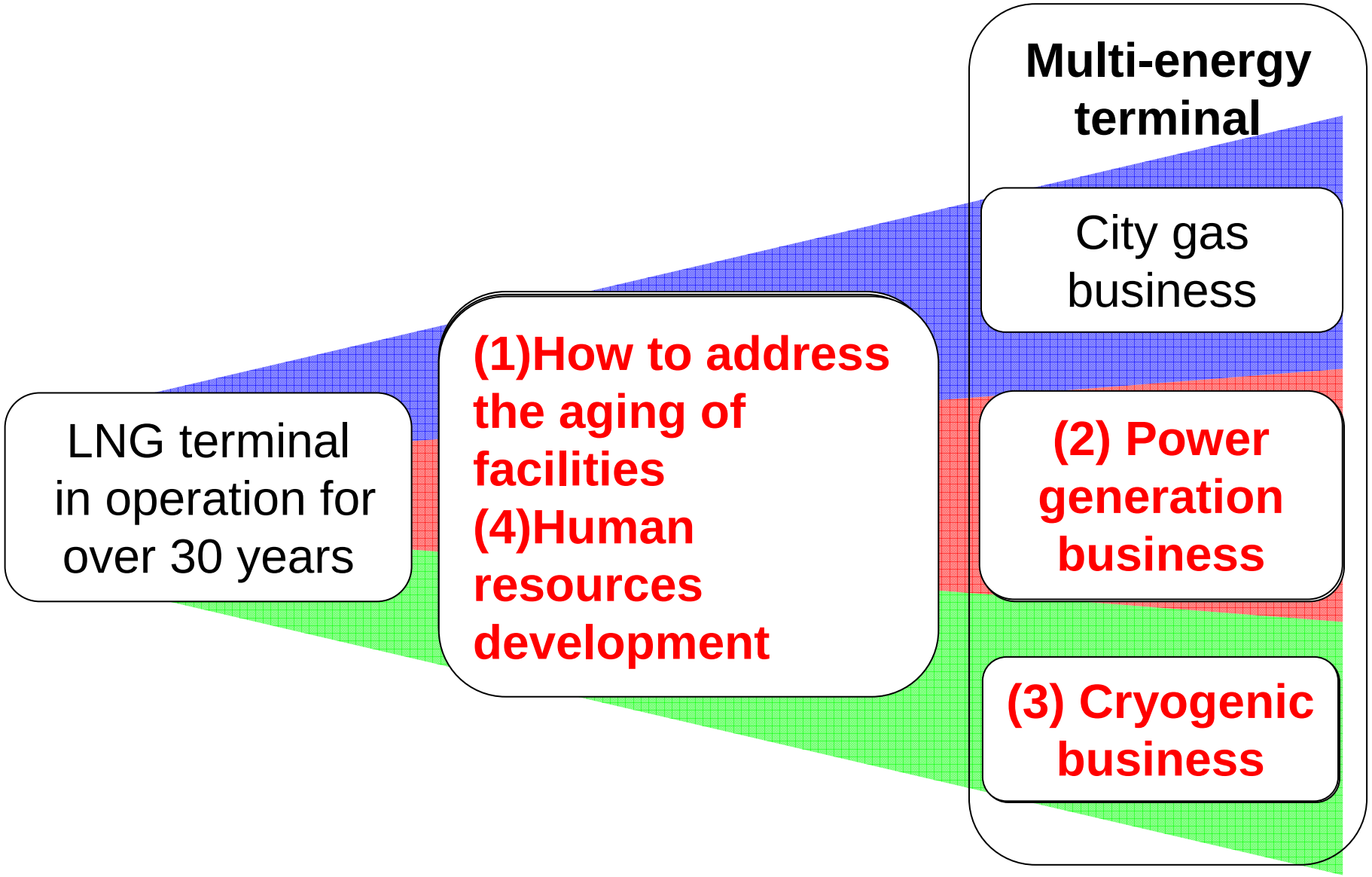
Osaka Gas service territory



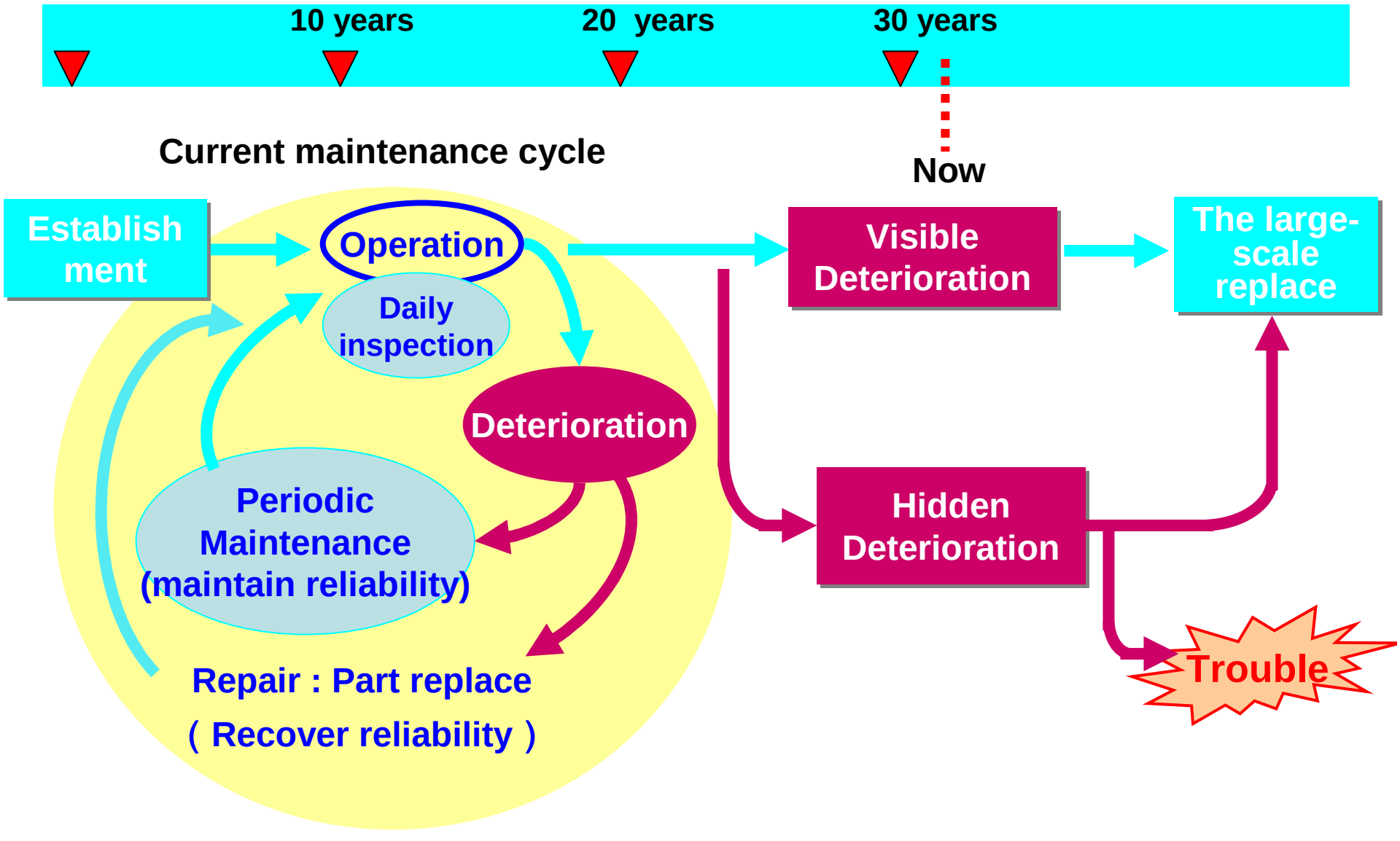
Senboku LNG Terminal



Evolution into multi-energy terminal



There is the fear of hidden deterioration advancing (machine facilities and concrete structures)

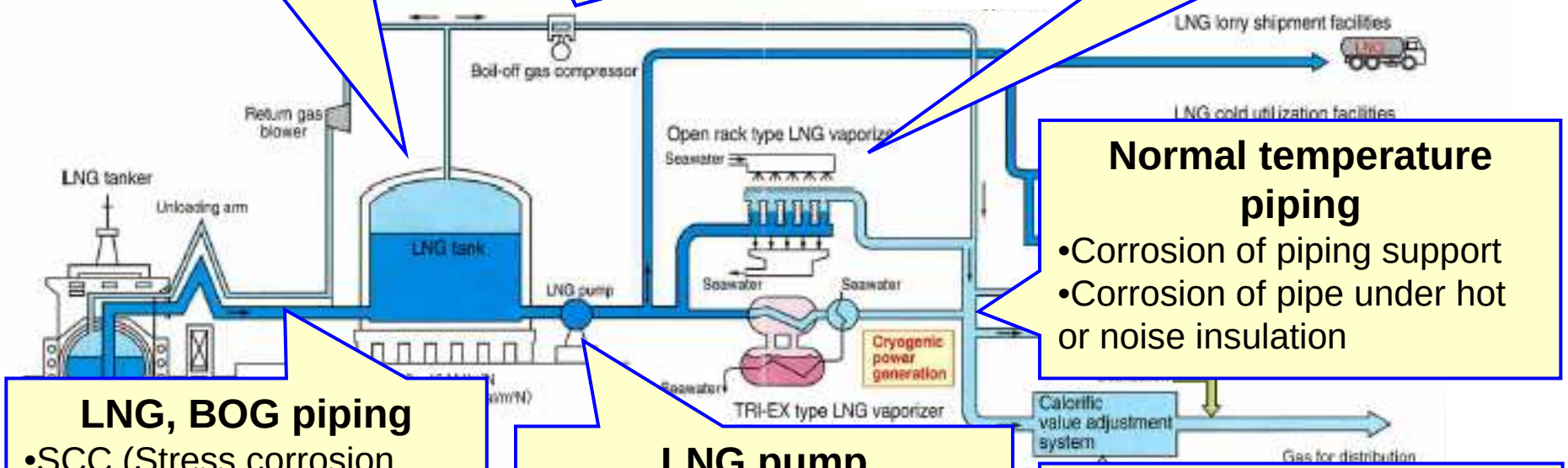


We are digging up and assessing items of uncontrolled, invisible deterioration

LNG Tank
- Fatigue degree of inner tank
- Corrosion of drain nozzle

Boil-off gas compressor
- Heat fatigue of impeller
- Fatigue of crank
- **Insulation-deterioration of electric motor**

Open rack type vaporizer
- Heat fatigue of inside surface of tube
- Corrosion and SCC of header of sea water line



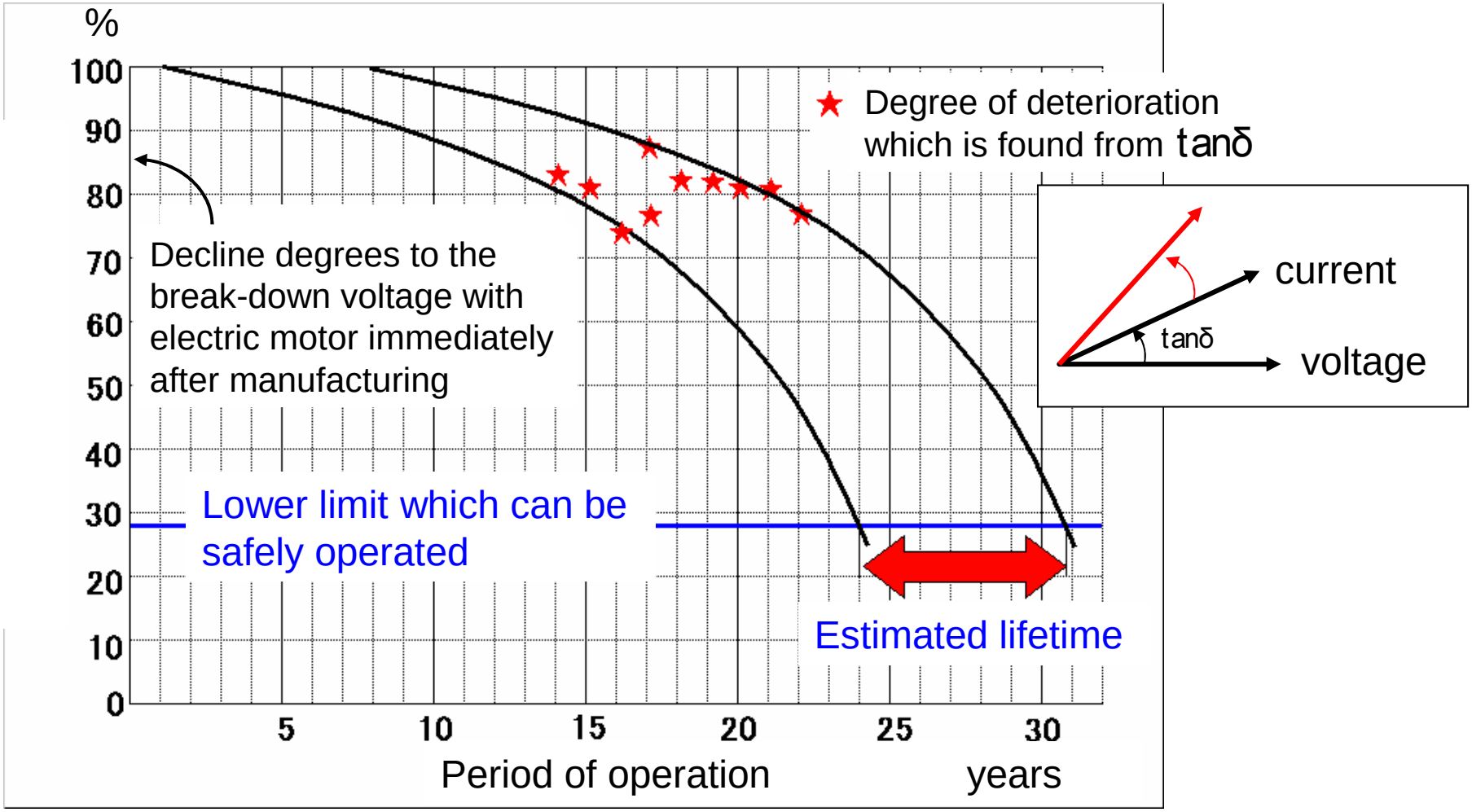
Normal temperature piping
- Corrosion of piping support
- Corrosion of pipe under hot or noise insulation

LNG, BOG piping
- SCC (Stress corrosion crack) of pipe under cold insulation
- Degradation of urethane support

LNG pump
- Fatigue degree of shaft and keyway
- Strain of shaft and casing

Concrete structure
- Chloride attack and neutralization
- Alkali-aggregate reaction

Evaluation of the insulation-deterioration with electric motor



Maintenance of the electricity and instrumentation facilities

The electric and the instrumentation facilities need to be updated in the period between 15 and 20 years for the following reasons.

1) Application limits of the parts
2) Parts supply termination
3) Expiration of the maintenance contract

Renewal timings of operation control systems

Site	Installation	The 1st update	The 2nd update
Senboku 1	1971	1987	2002
North area of Senboku 2	1976	1994	2006
South area of Senboku 2	1988	2007	

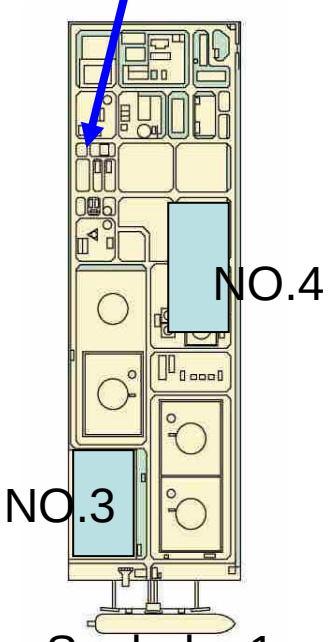
Power generating plants of Osaka Gas

Site	Power generation method	Output	Start of operation
Senboku 1	gas turbine combined cycle	18MW (9 MW x 2units)	July 2002
Himeji Terminal	gas turbine combined cycle	50 MW	June 2004
Senboku 1 & 2	gas turbine combined cycle	1,100 MW (270 MW x 4 units)	November 2009

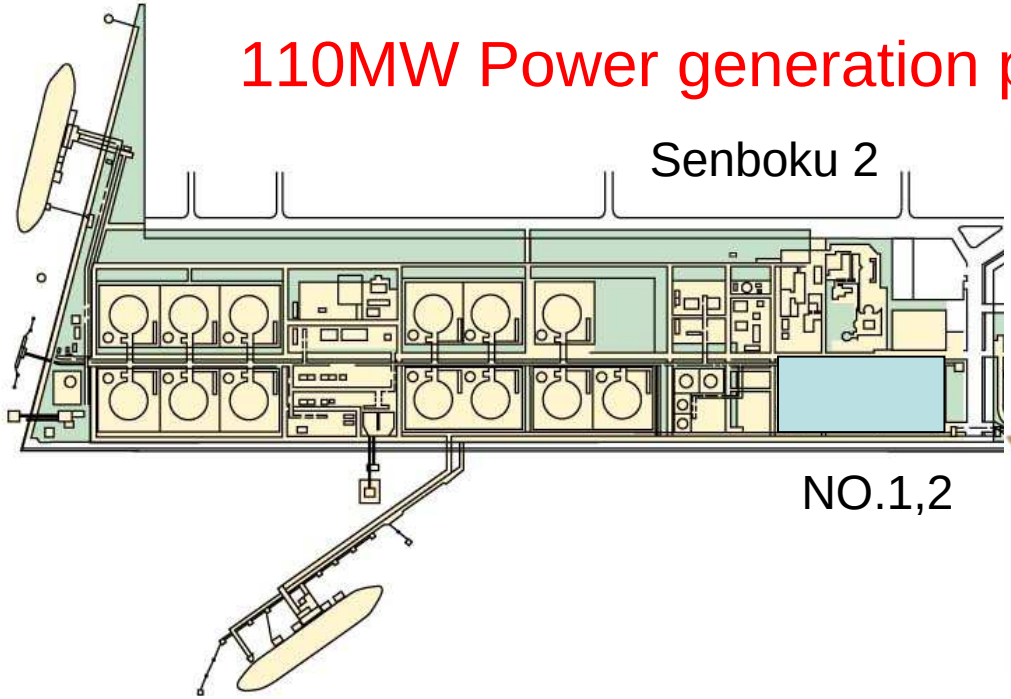
Power generating plants of Osaka Gas

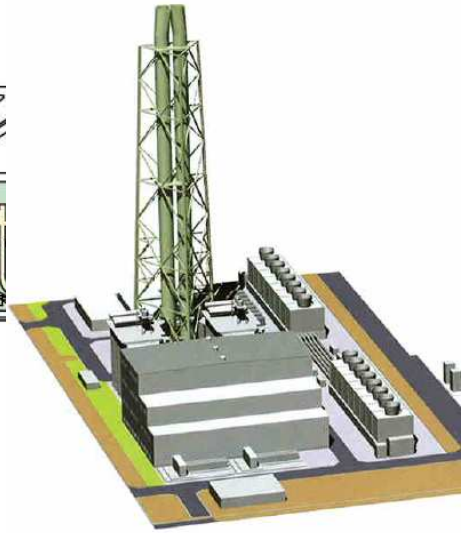
Power generation plant at Senboku 1

Type of power generation	Single-shaft gas turbine combained cycle (combined heat and power)
Power output	18,000kW (15℃)
Gross thermal efficiency	44% (LHV)
Main equipment	・Gas turbine (6,600kW X 2 lines) ・Steam turbine (2,400kW X 2 lines) ・Heat recovery steam generator (12t/h X 2 lines)
NOx	below 30ppm (O_2 0% conversion) Type of gas turbine combustion : low NOx combustor Type of NOx removal : urea



110MW Power generation plant



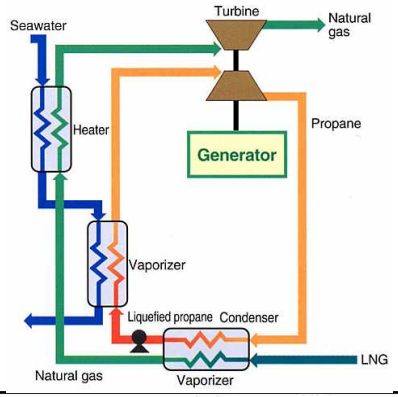


History of LNG Cold Use at Senboku LNG Terminal

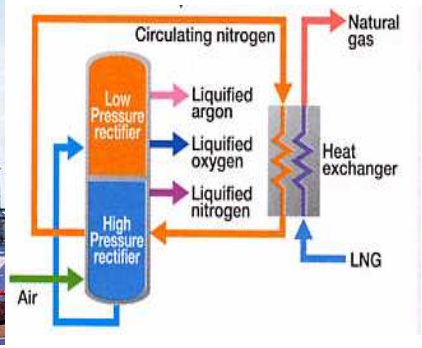
‘70s	‘77	: Air Separation (Cold Air Products #1)
	‘79	: Cryogenic Power Generation (Propane Rankine Cycle)
‘80s	’80	: Carbon Dioxide Liquefaction
	‘82	: Cryogenic Power Generation (Propane Rankine+Direct Expansion)
	‘83	: Air Separation (Cold Air Products #2)
	‘87	: Cold Source for the Chemical Industry
‘90s	‘93	: Air Separation (Cryo Air)
	‘97	: Boil Off Gas Liquefaction
‘00s	‘04	: **Cascade LNG Cold Energy in an Industrial Complex**

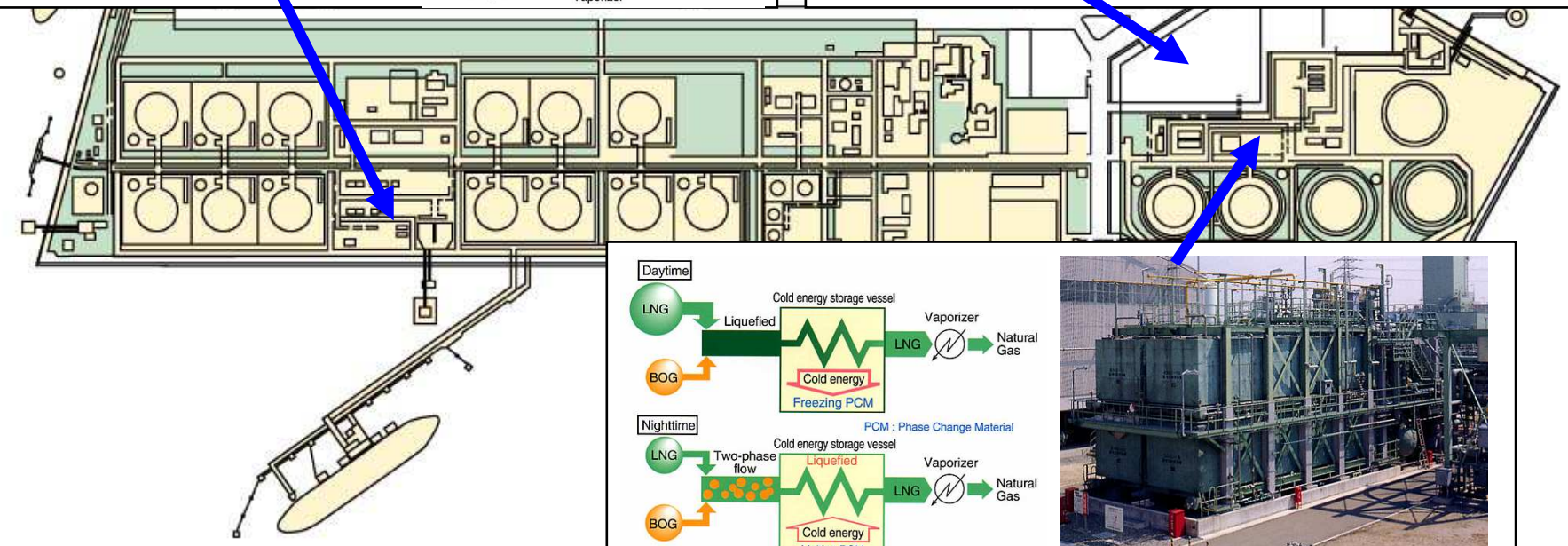
Major cryogenic applications in the past

Cryogenic power generator



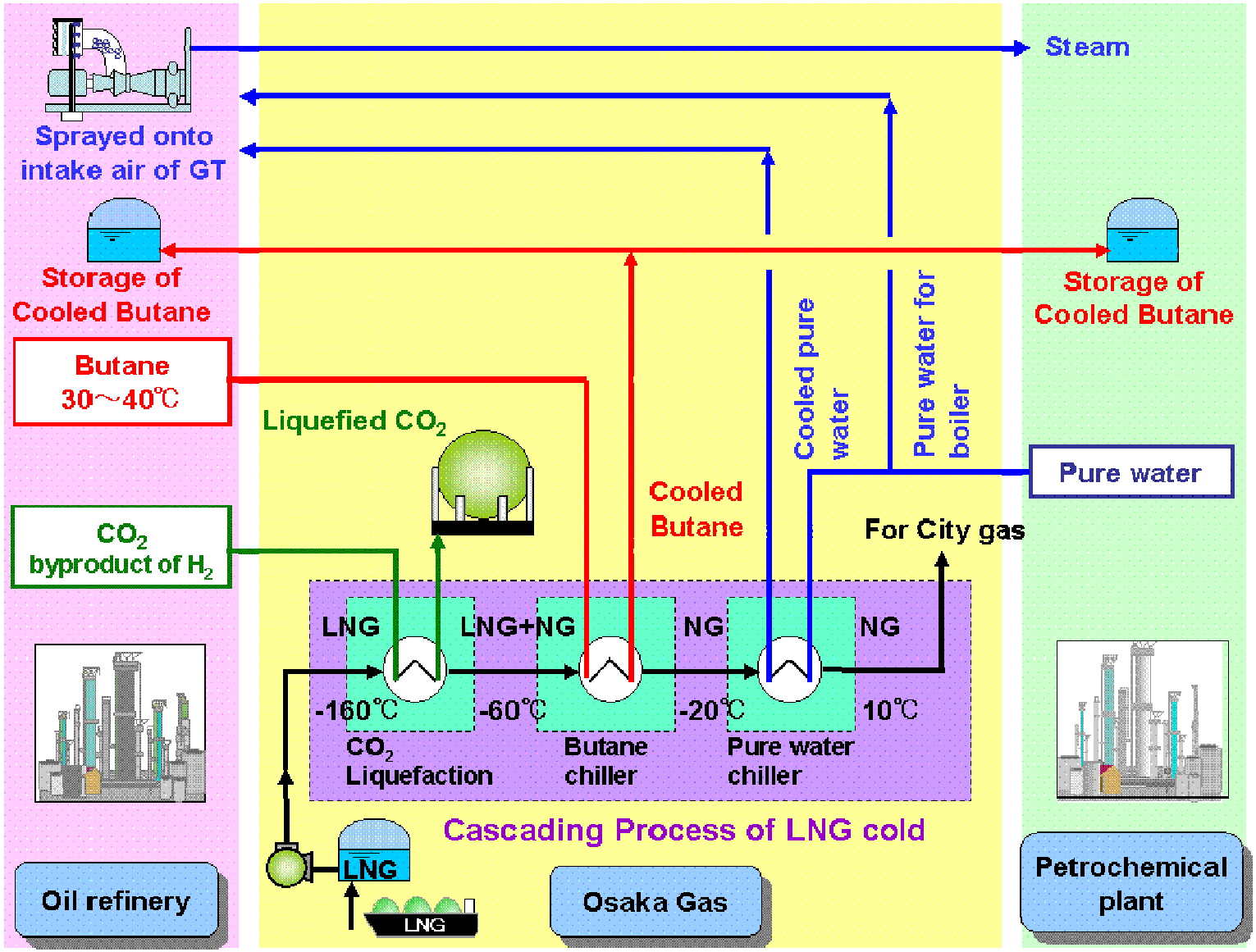
Air separation





Boil-off gas liquefaction system

LNG cryogenic energy cascade process



Policy on human resources development

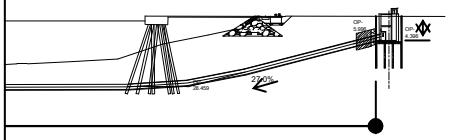
We have developed the simulator equipment which can reproduce the dynamics of the operational process with high precision.

By using the simulator, we can train operators under contingency situation that are difficult to experience in normal operations

Conclusion

City gas business

Senboku 1



LNG underwater pipeline

Power generation business

Cryogenic business