November 5, 2003

17. A Field Study of Thermal Power Plants

火力発電所視察
（資料）

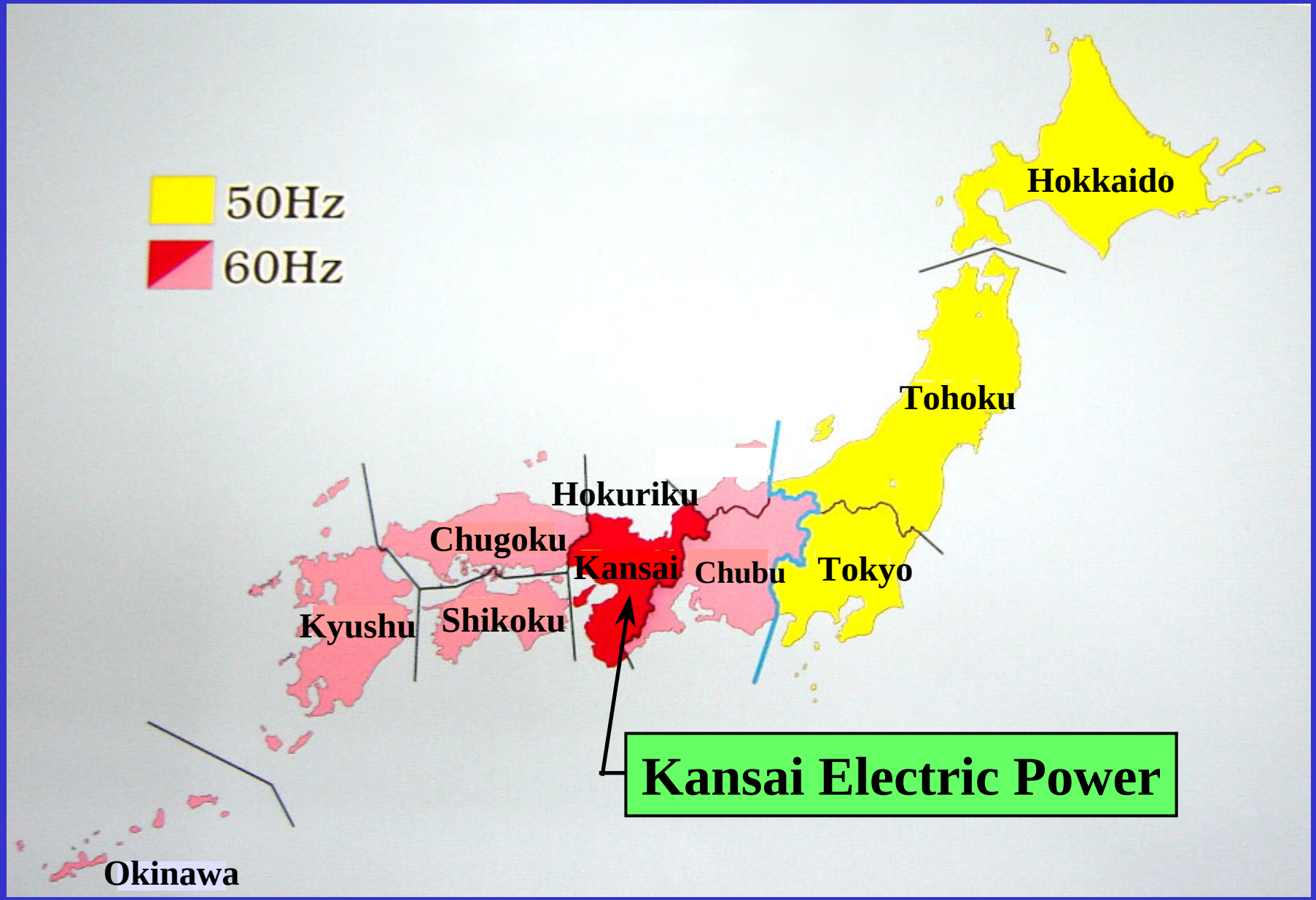
NANKOU Thermal Power Plant
THE KANSAI ELECTRIC POWER CO., INC.

関西電力株式会社
南港発電所
計画課

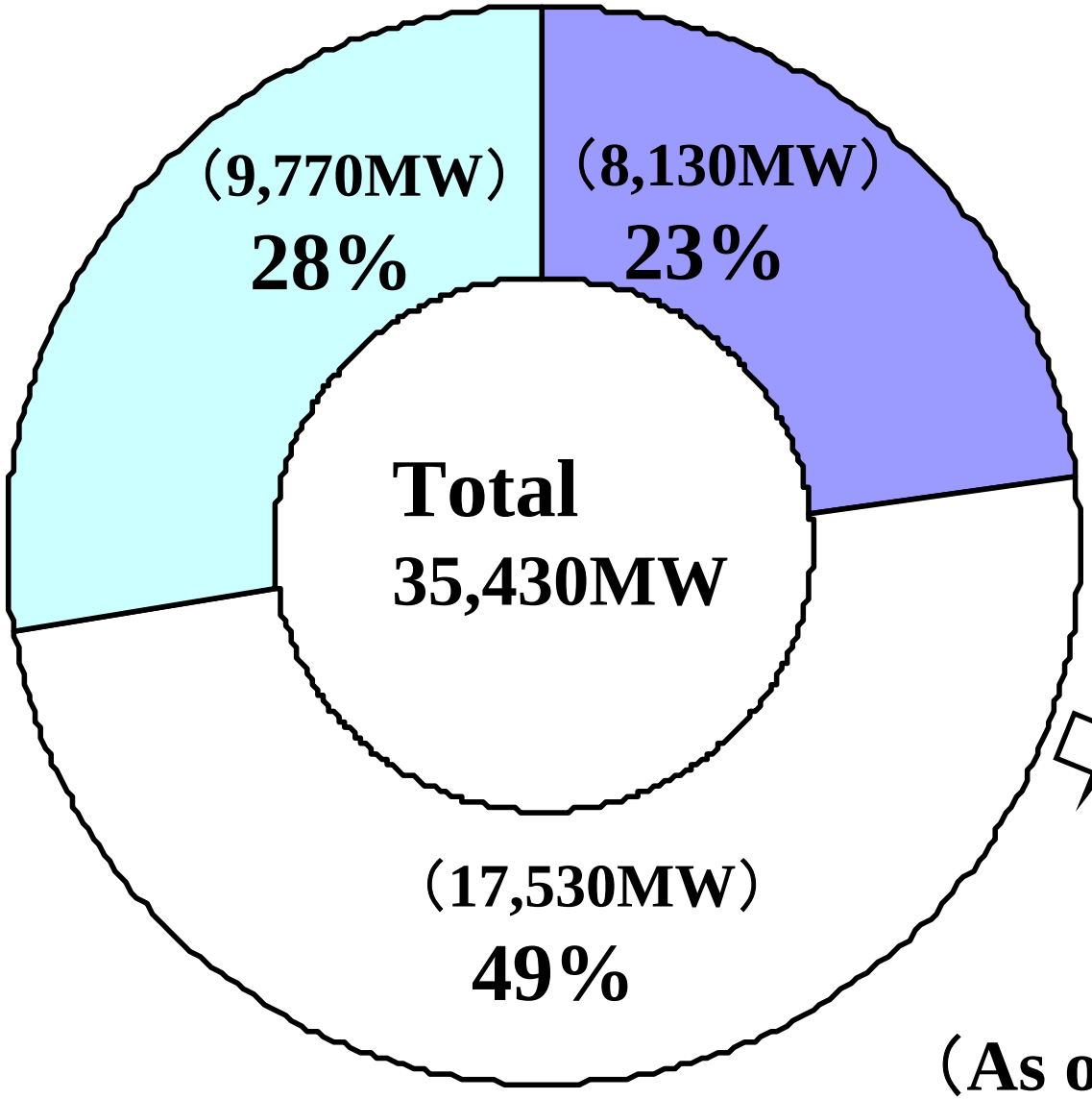
NANKO POWER PLANT

The Kansai Electric Power Co.,Inc.

Area Map


50Hz
60Hz
Hokkaido
Tohoku
Tokyo
Chubu
Hokuriku
Chugoku
Kansai
Shikoku
Kyushu
Okinawa
Kansai Electric Power

Plant Capacity（KEPCO）

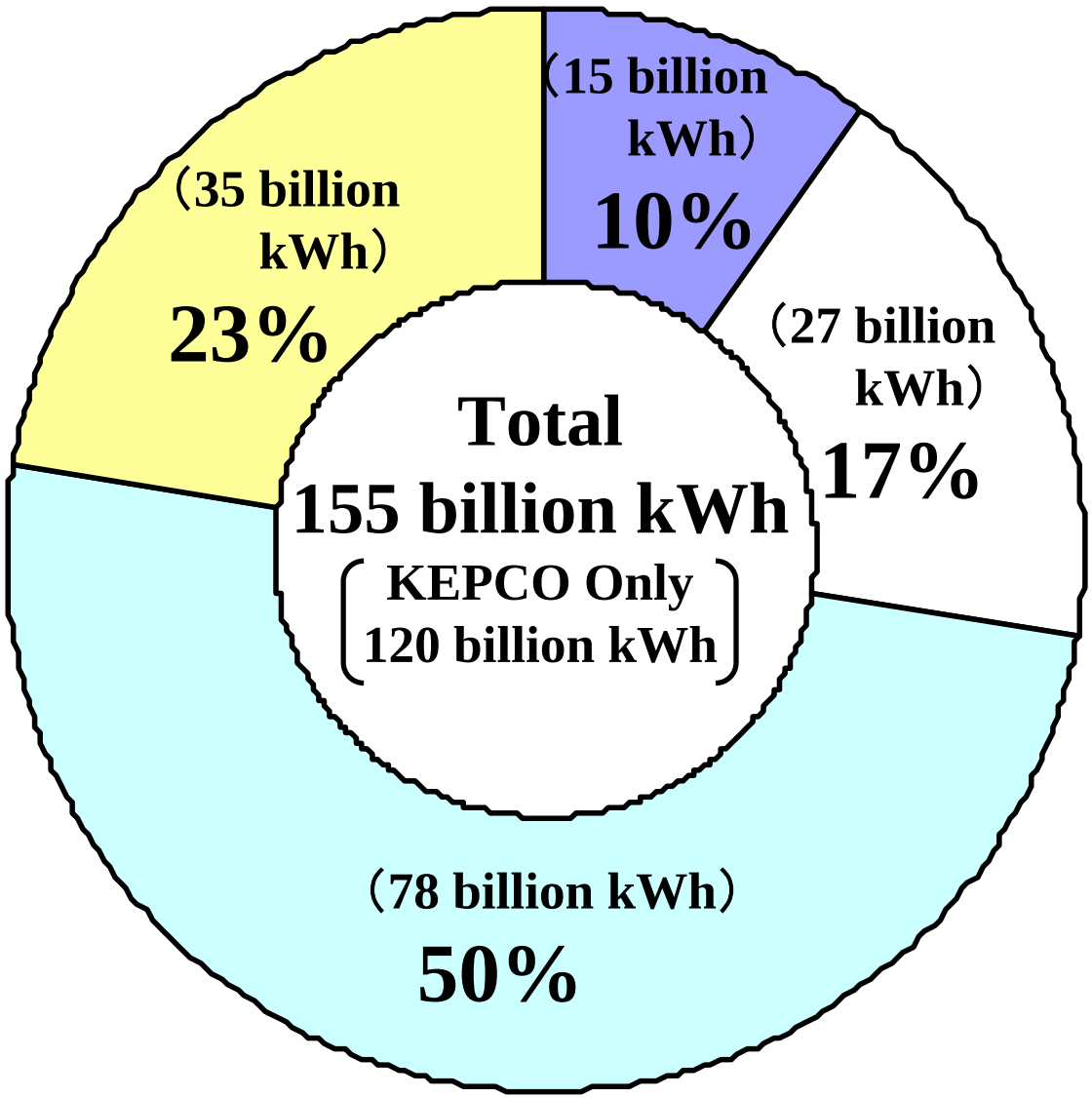


Hydro
Fossil fuel
Nuclear

NANKO
（1,800MW）
5%

（As of End of FY 2002）

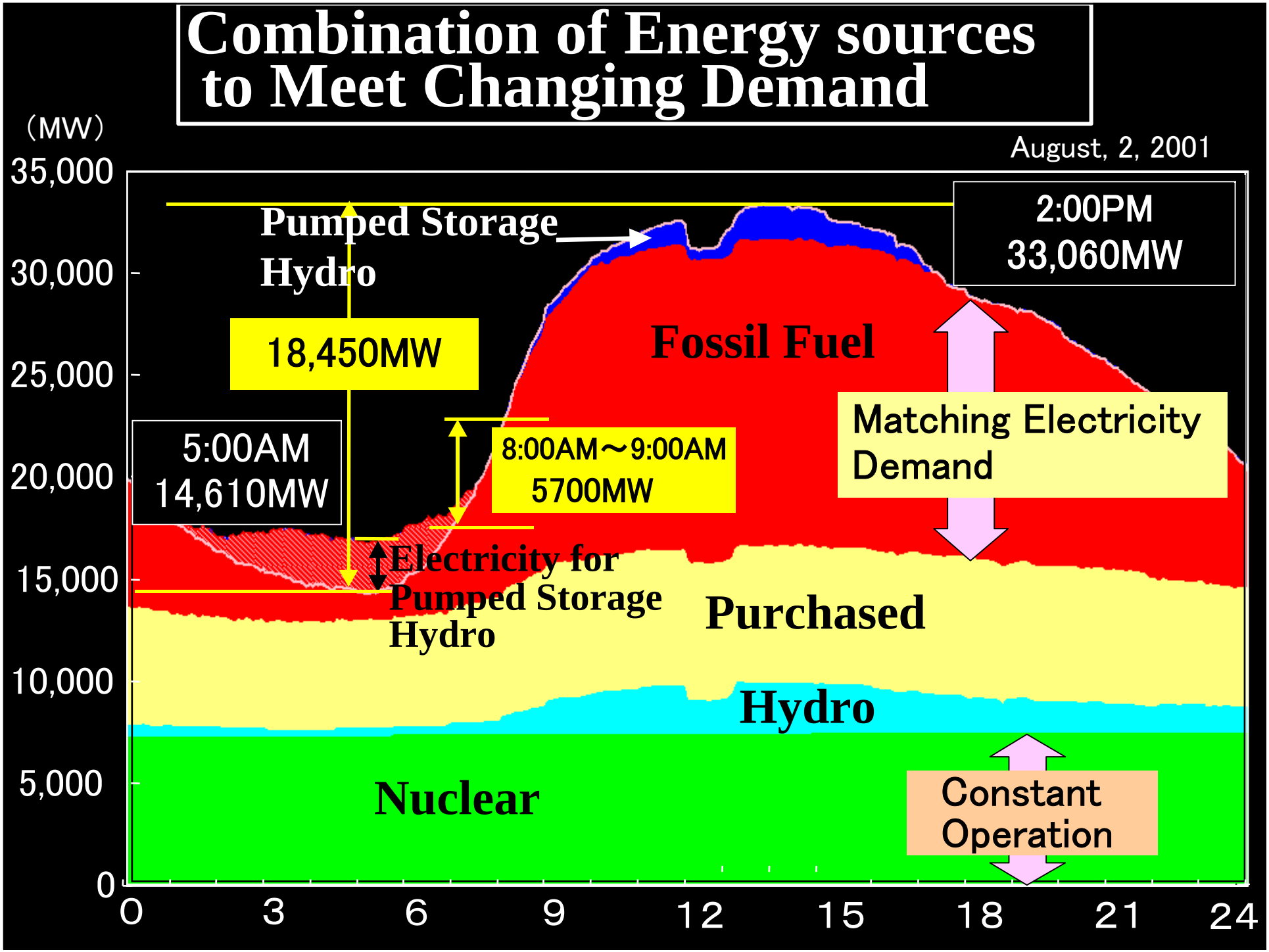
Power Output（KEPCO）



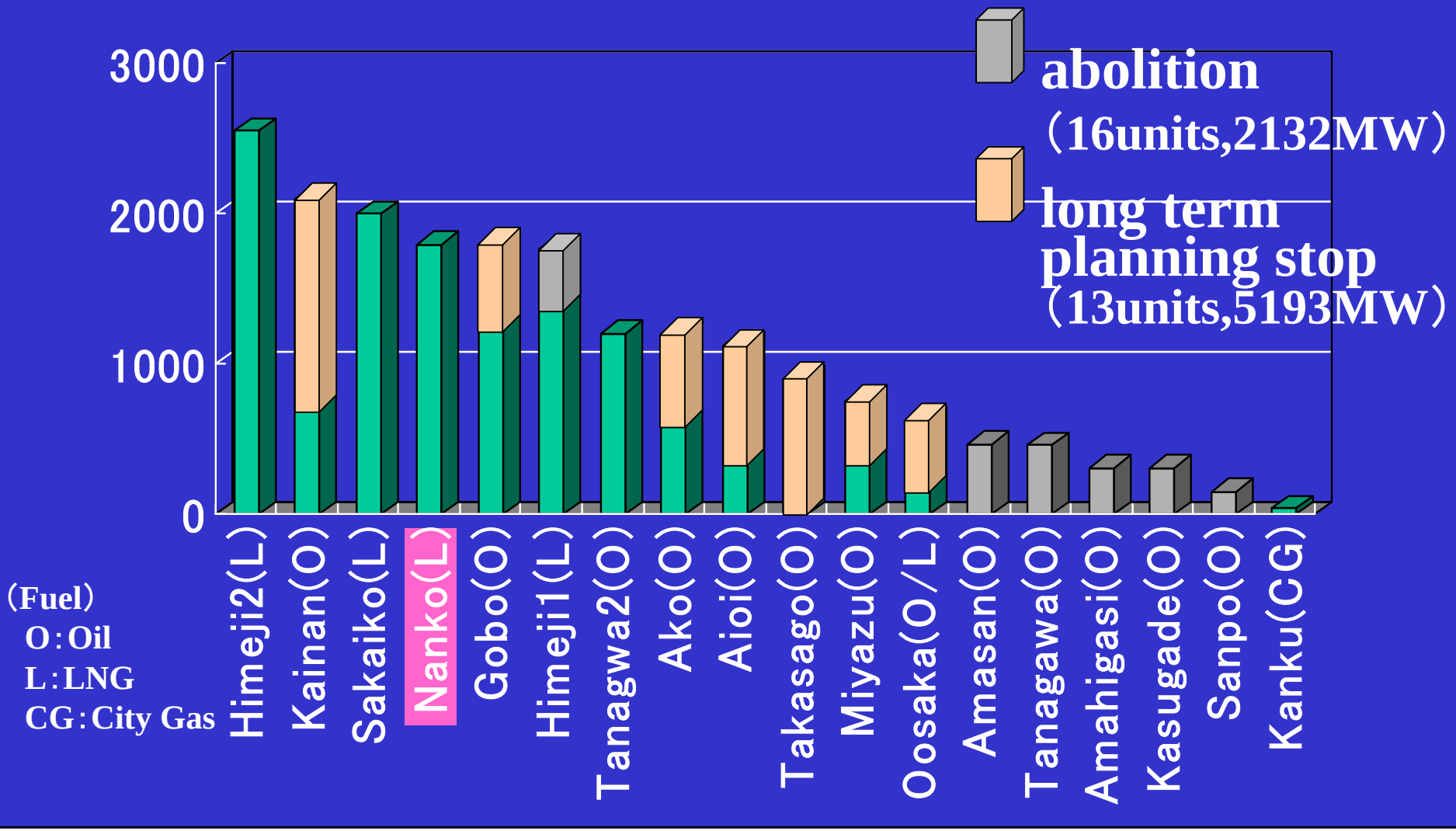
- Hydro
- Fossil fuel
- Nuclear
- Purchased etc.

NANKO
（5.7 billion kWh）
5%

（FY 2002）

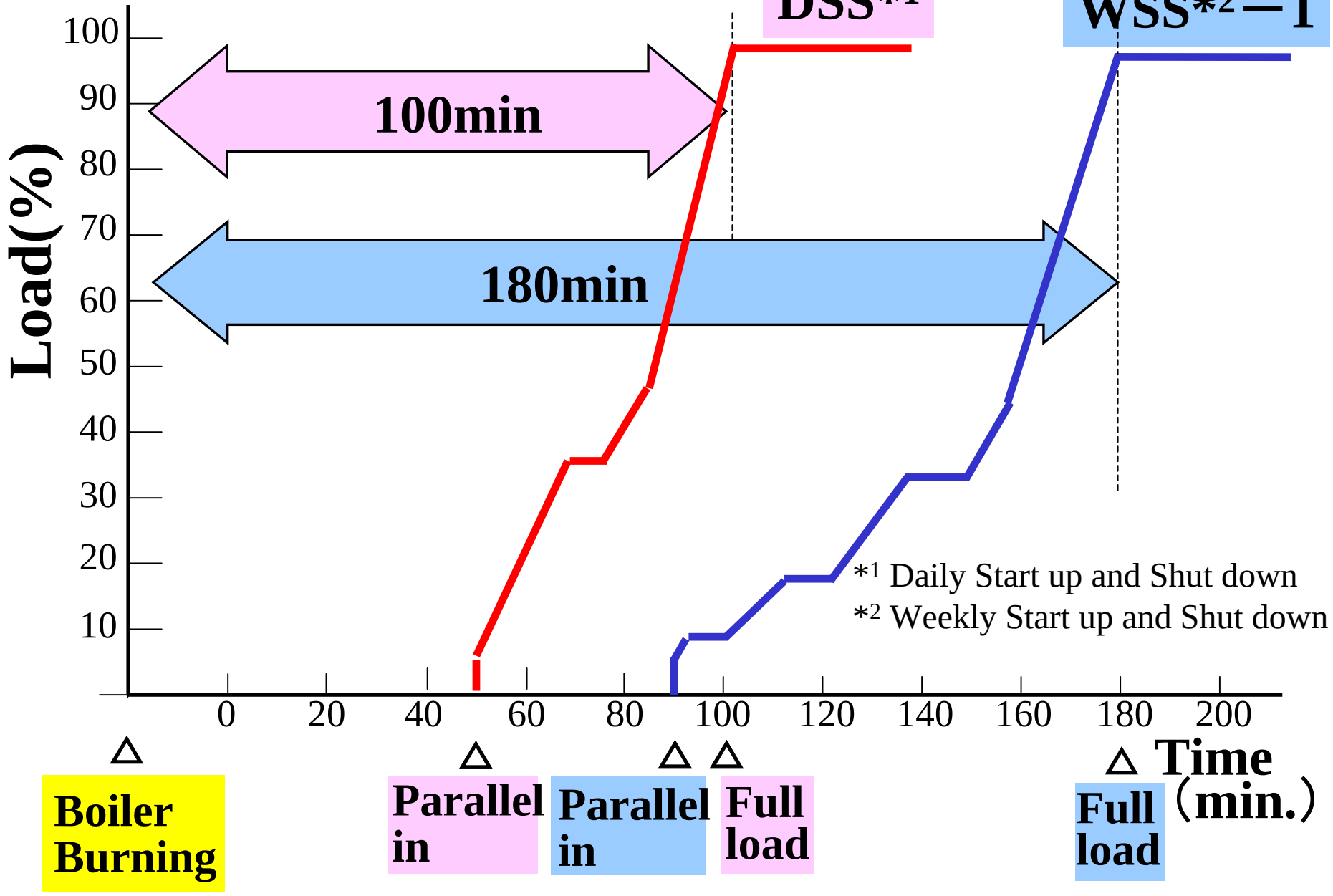

Combination of Energy sources to Meet Changing Demand
(MW)
August, 2, 2001
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
3
6
9
12
15
18
21
24
Pumped Storage Hydro
18,450MW
2:00PM
33,060MW
Fossil Fuel
5:00AM
14,610MW
8:00AM～9:00AM
5700MW
Matching Electricity Demand
Electricity for Pumped Storage Hydro
Purchased
Hydro
Nuclear
Constant Operation

Fossil-fired Power Station Rated Capacity（43units,17531MW）



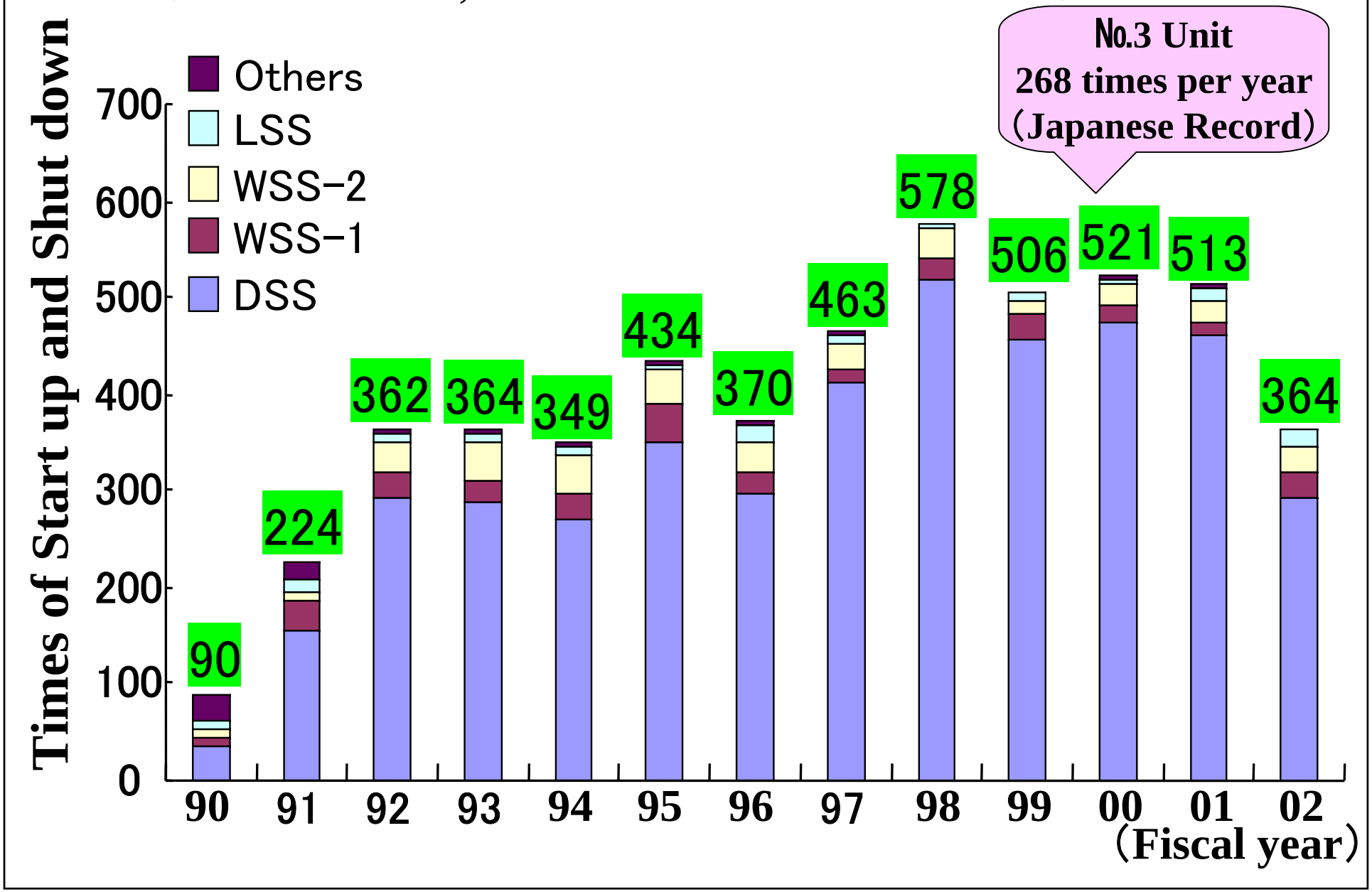
Location of Nanko Power Plant

Unit Start up Curve

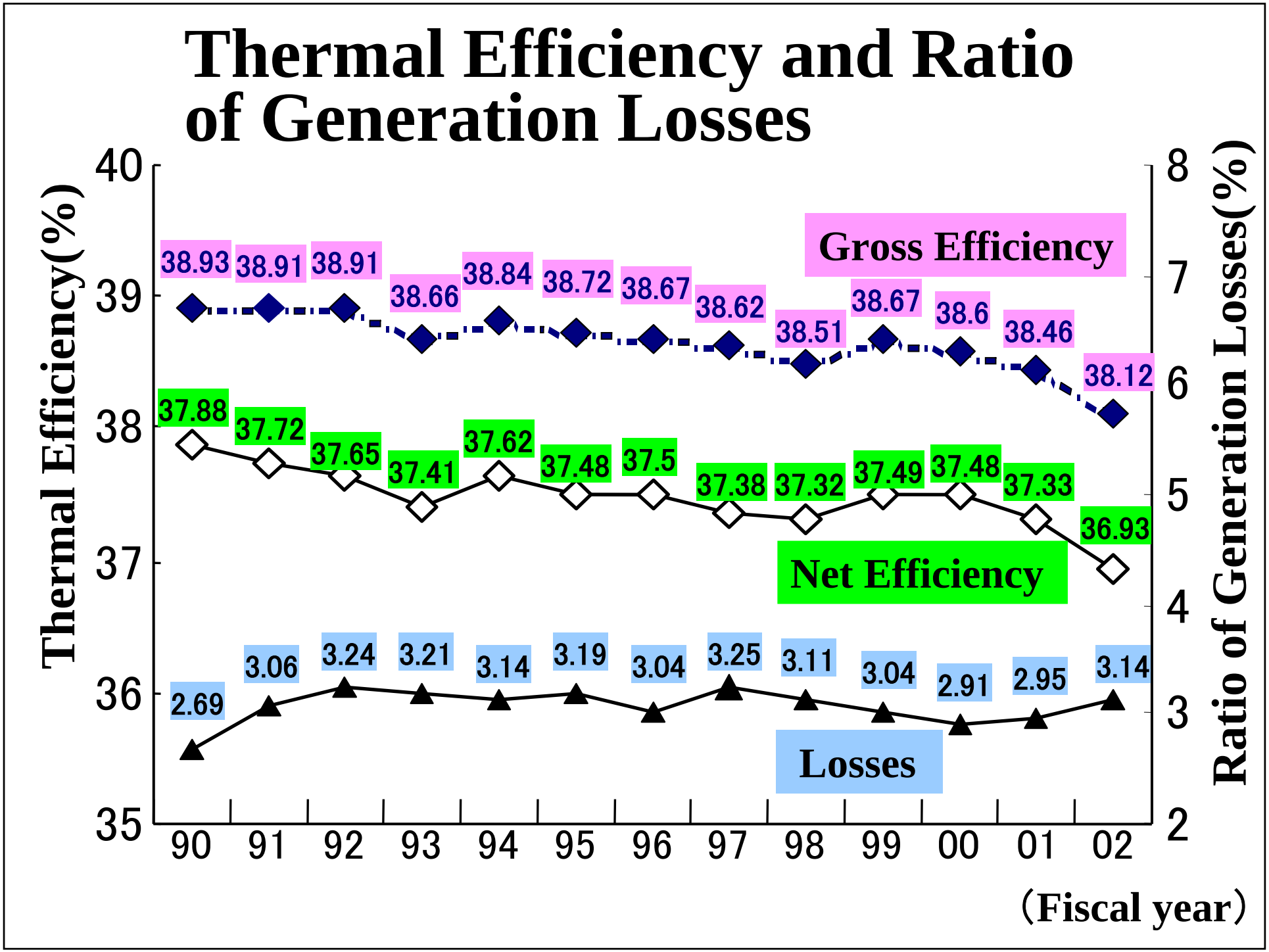


Times of Start up and Shut down

（Total of 3 units, Accumulated times：5142 times）



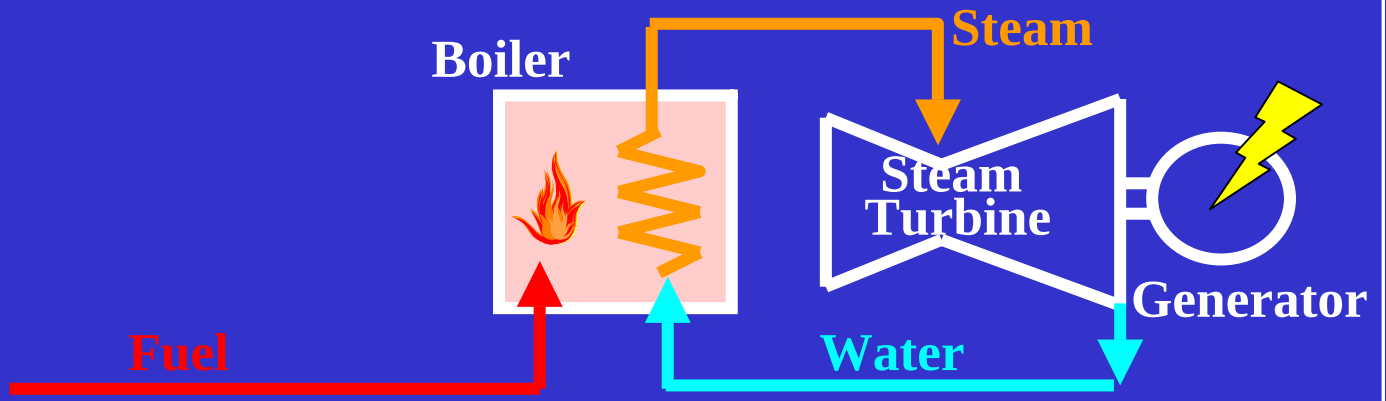
Thermal Efficiency and Ratio of Generation Losses



Mechanism of Combined Cycle System

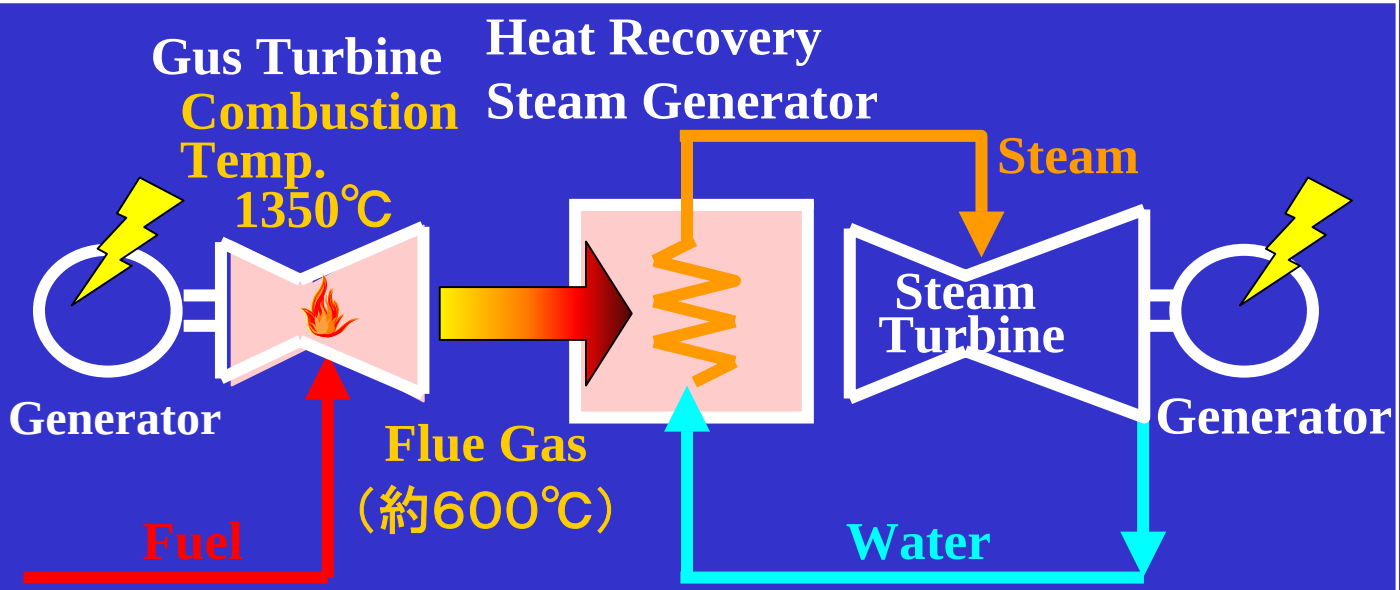
Conventional Type
(Nanko №1 unit)

Thermal Efficiency
44% LHV
(40% HHV)

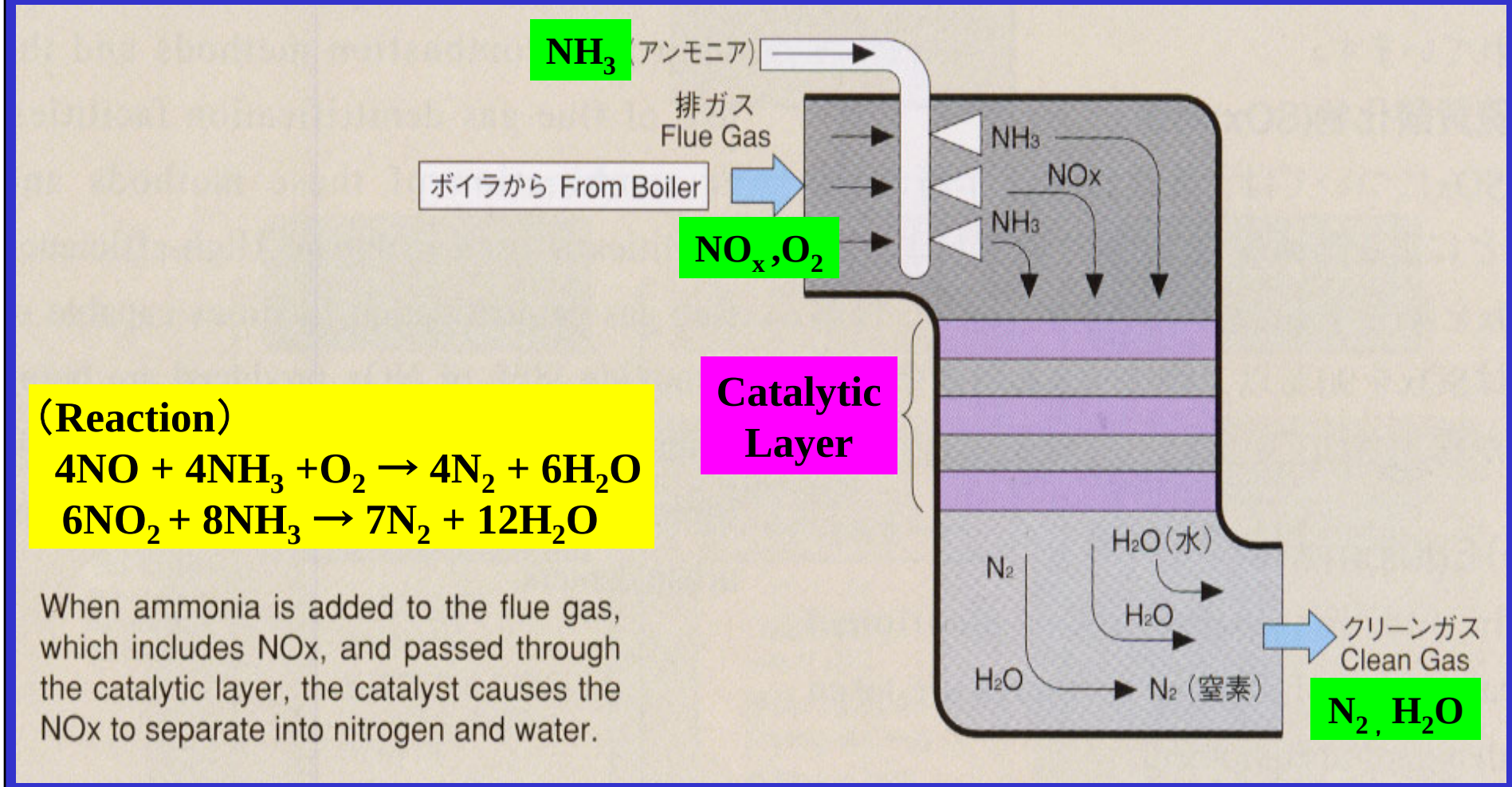


Combined Cycle Plant
(Himeji1 №5 unit)

Thermal Efficiency
54% LHV
(49% HHV)



Flue Gas Denitrification Facility



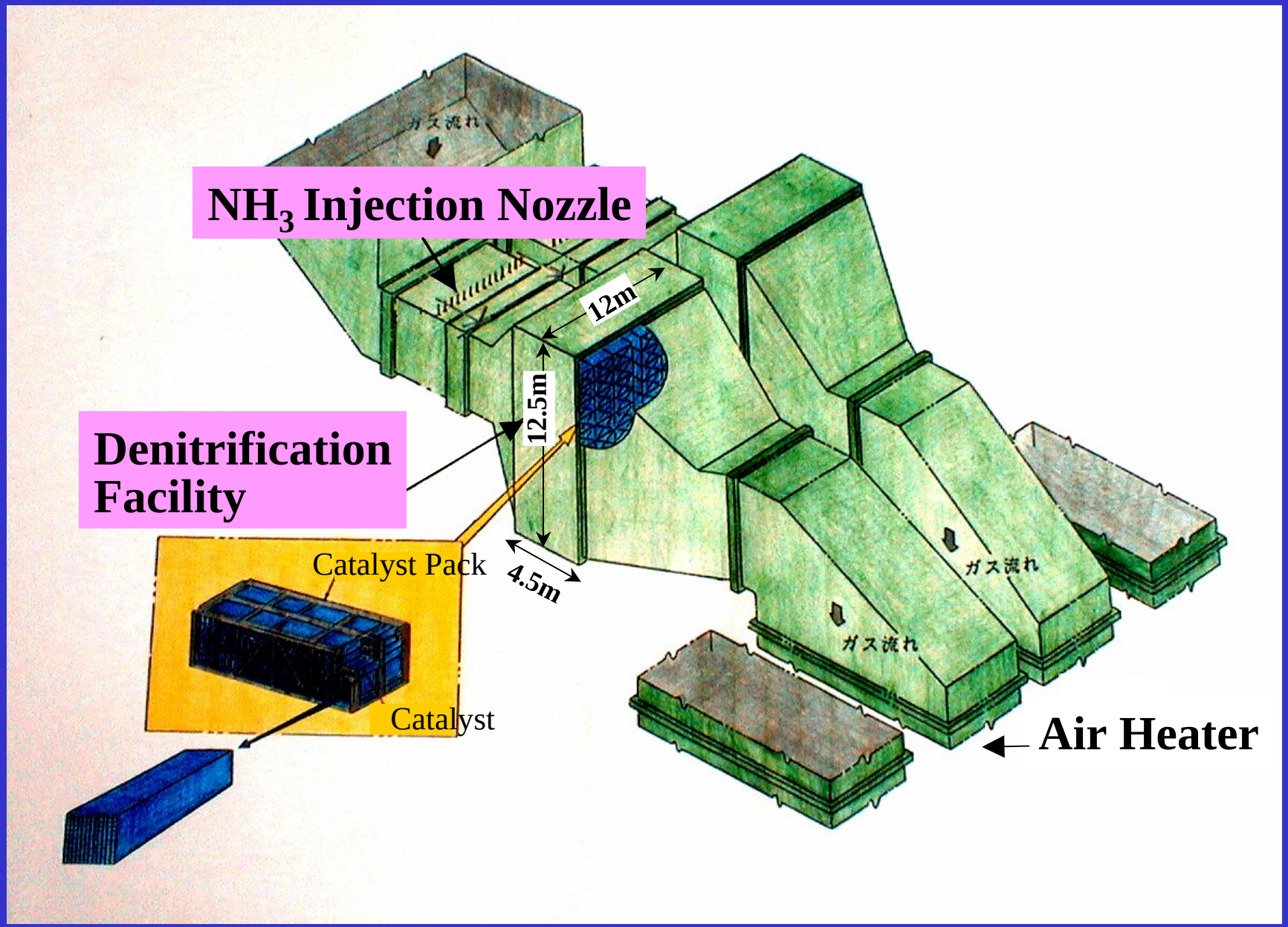
(Reaction)

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$

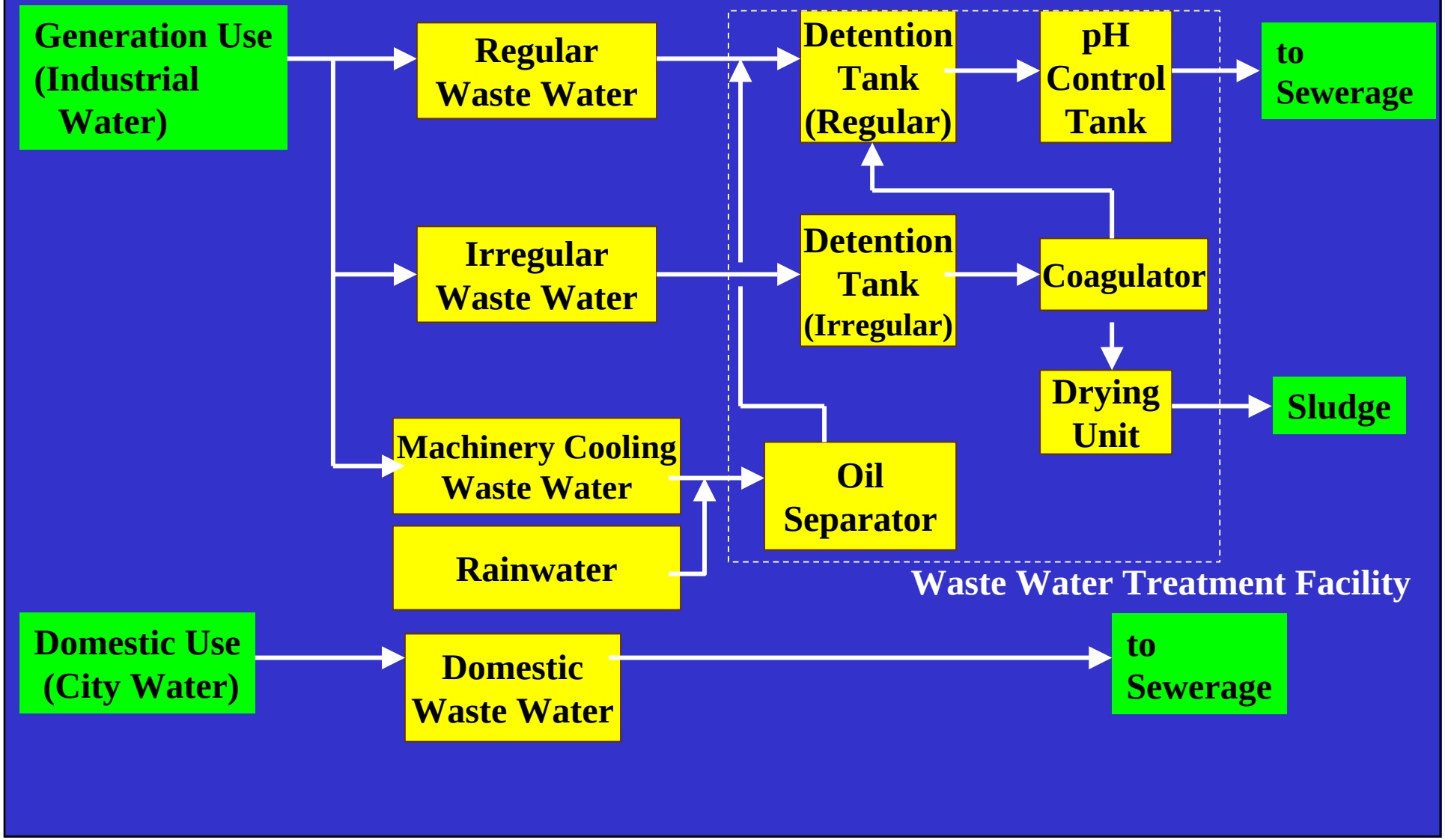
$$6NO_2 + 8NH_3 \rightarrow 7N_2 + 12H_2O$$

When ammonia is added to the flue gas, which includes NOx, and passed through the catalytic layer, the catalyst causes the NOx to separate into nitrogen and water.

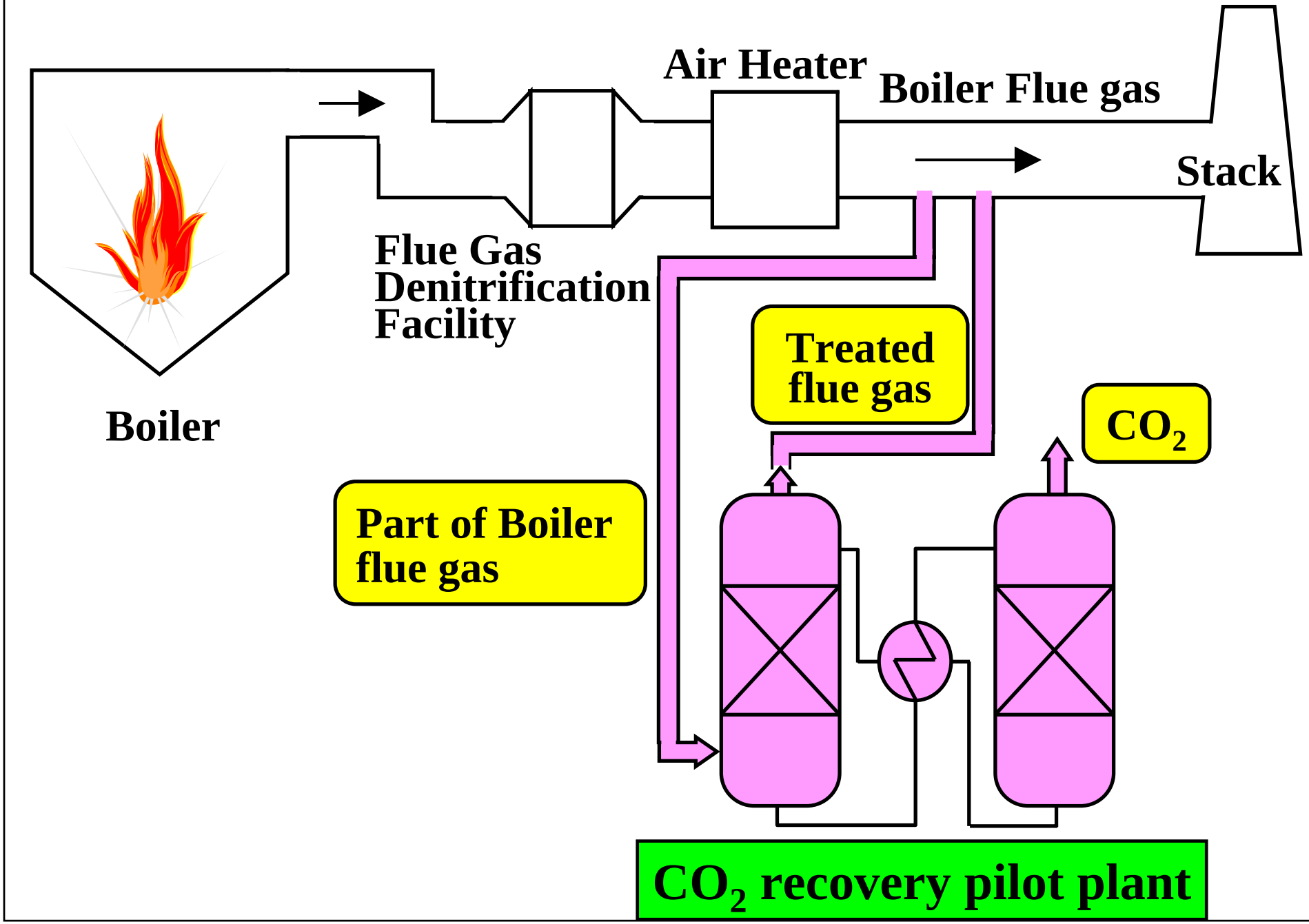
Flue Gas Denitrification Facility



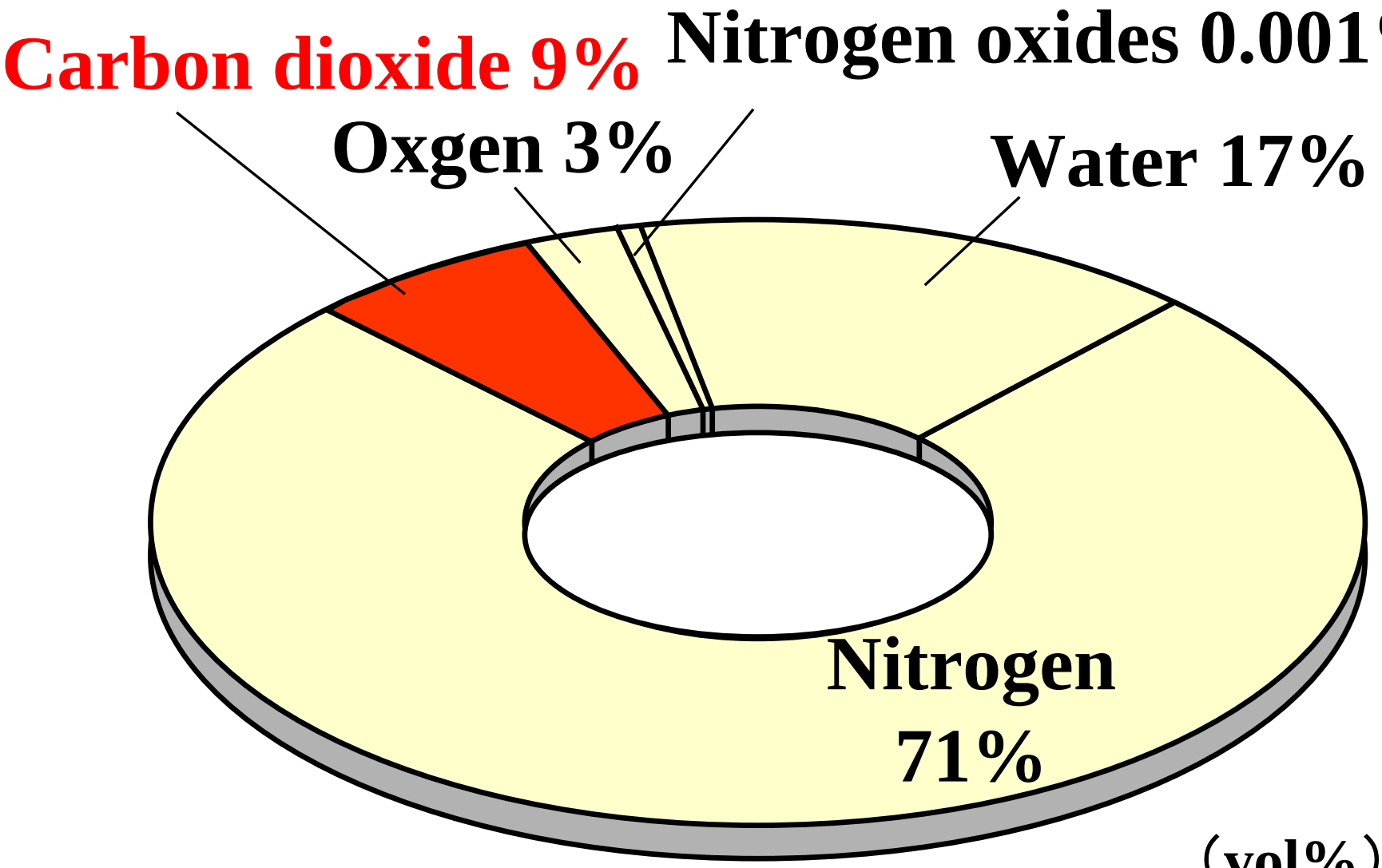
Nanko Power Station
Waste Water Treatment System



R&D of CO_2 Recovery from Flue Gas



An Example of the Composition of Flue Gas（LNG fired Power Plant）

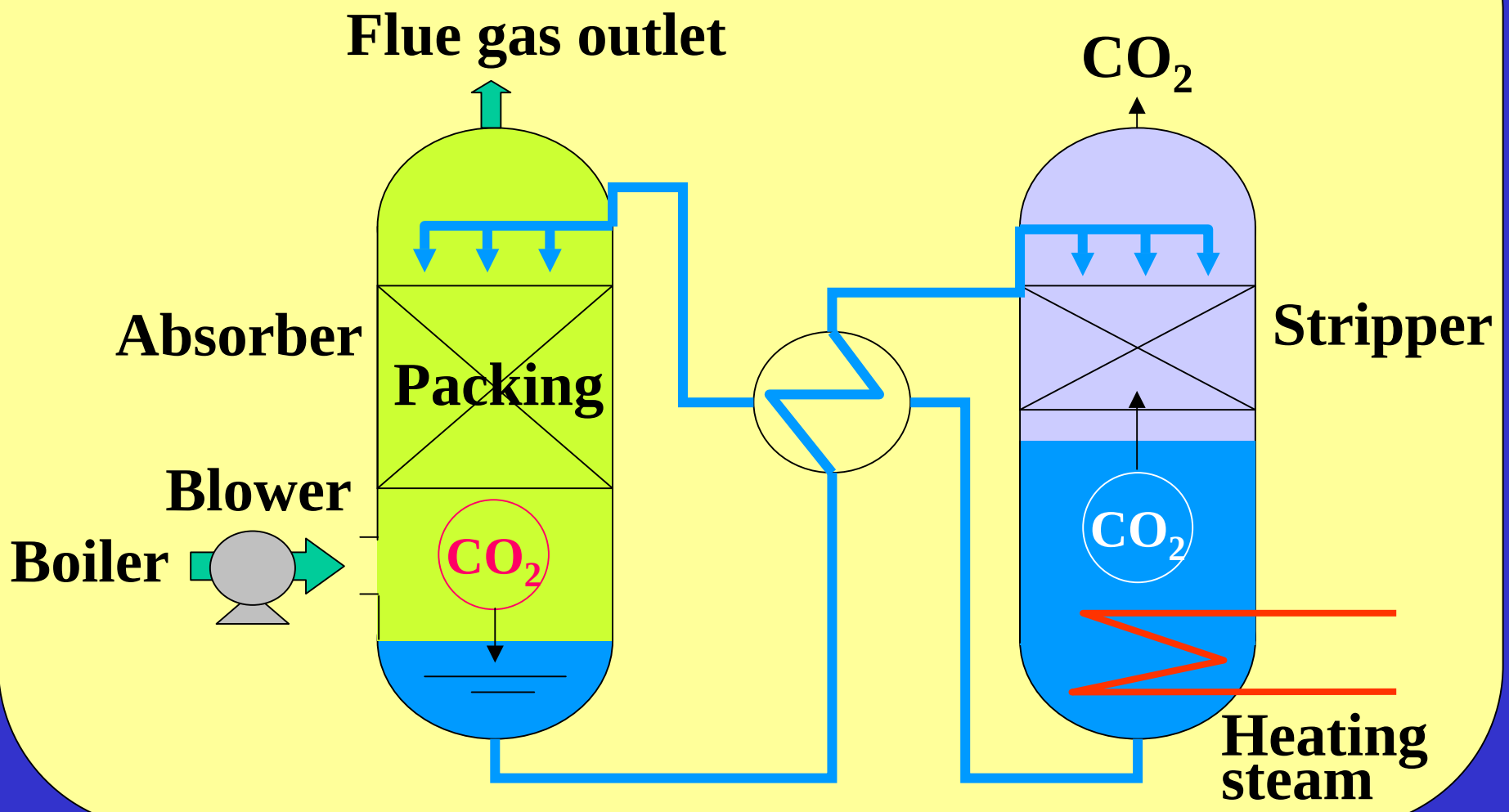


Flue Gas Carbon Dioxide Recovery Pilot Plant

- R&D start : April 1991
- Gas to be treated : Flue gas from NG boiler
- Quantity of gas to be treated : 600m^{3}N/h（about 200kW）
- Solvent : Alkanol amine
- CO2 recovery rate : 90%
- Purity of recovered CO2 : 99.9%
- Quantity of recovered CO2 : 2t/day

CO_2 Recovery System Process Flow

$$2R - NH_2 + CO_2 \longleftrightarrow R - NH_3R - NHCOO$$
$$R - NH_2 + H_2O + CO_2 \longleftrightarrow R - NH_3HCO_3$$



Dimethyl Ether Synthesis from Carbon Dioxide

DME synthesis reaction from CO_2 by catalytic hydrogenation

$$CO_2 + 3H_2 \xrightarrow{\text{(Catalyst)}} CH_3OH + H_2O + 11.7\text{Kcal/mol}$$

(methanol)

$$2CH_3OH \xrightarrow{\text{(Catalyst)}} CH_3OCH_3 + H_2O + 5.6\text{Kcal/mol}$$

(DME)

- Catalyst : DME synthesis hybrid catalyst
- Quantity of catalyust Filled up : 100mL
- Quantity of supplied gases : CO_2 9NL/h, H_2 27NL/h
- Methanol/DME production : 0.5L/day
- Reaction temperature : 250～300℃
- Reaction pressure : 4～10MPa