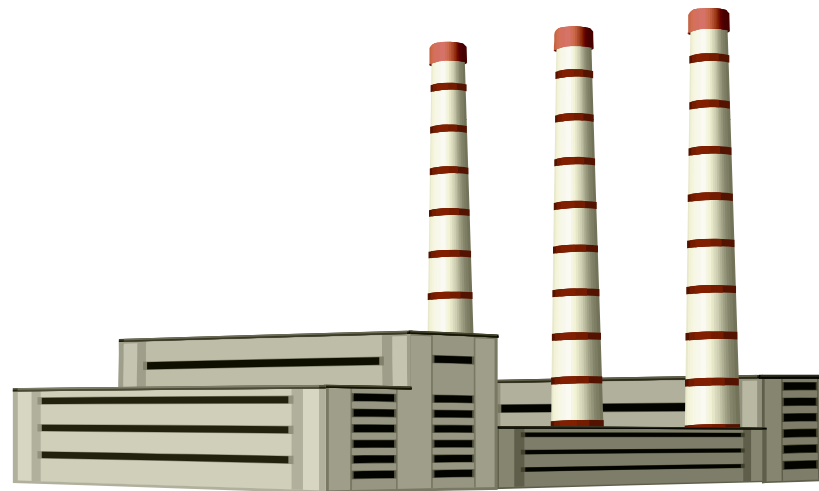


**Feedback Seminar on  
Energy-Efficiency Potential in South Africa**

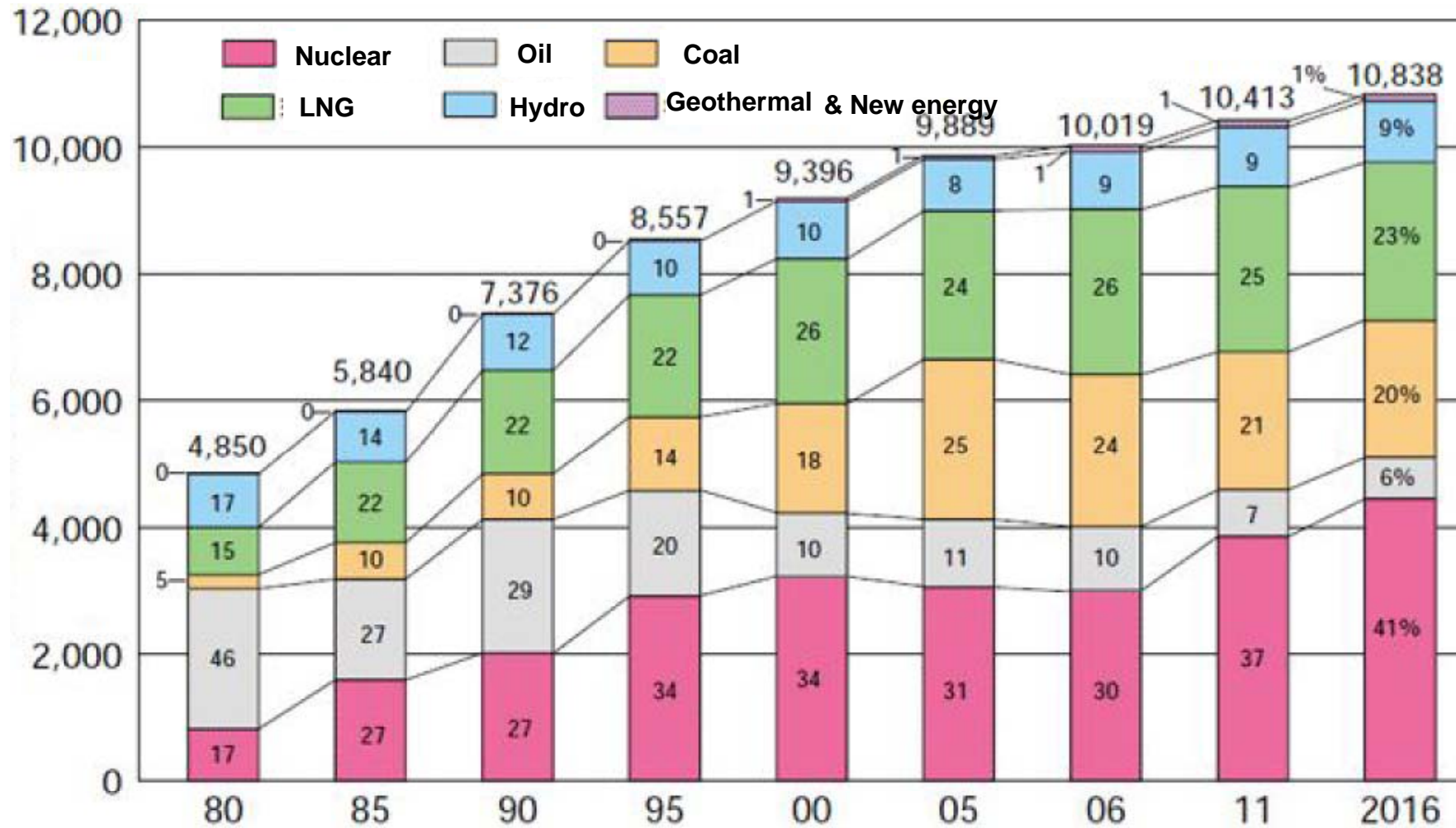
# Efficient Operation and Maintenance of Existing Coal Power Plants



**January 2009  
JICA Study Team  
Kiyoshi Kataoka**

# Power Generation Trend by Source

(100GWh)

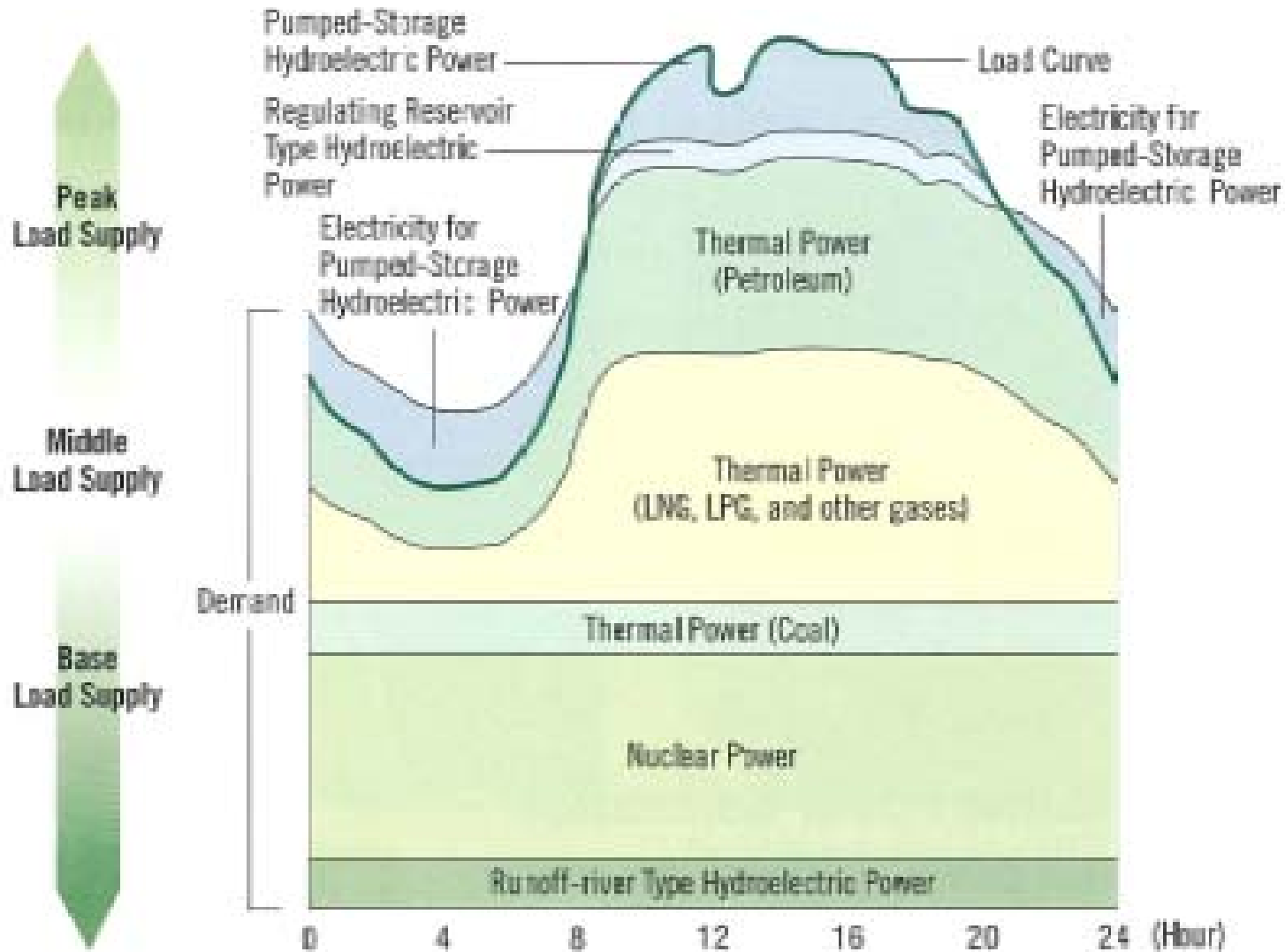


Annual Power Generation (FY)

Source: Federation of Electric Power Companies of Japan



# Generation Curve of A Day



# Operation of Thermal Power Plants by Fuel Types

- Coal-fired power plants are of base-load operation.  
Coal-fired power plants can continue safe operation at approximately 50% without auxiliary fuels.
- LNG power plants represent middle-load operation.  
In case of TEPCO, most power plants operating in densely-populated areas such as Tokyo are LNG-fired.
- Heavy oil/crude oil power plants are used to adjust the load or cope with the peak.  
Many plants repeatedly start and stop operation every day.

# Characteristics of Thermal Power Plants in Japan

- All fuels used at thermal power plants are imported.  
(crude oil, heavy oil, coal, LNG, etc.)
- Thermal power plants are built along coastlines.  
(seawater is used as the cooling water for condensers in most cases)
- The capacity per generator of thermal power plants has increased to 125, 175, 350, 600, and 1000 MW. The steam conditions have also been upgraded in parallel with the increase of the capacity.
- 600 and 1000 MW class boilers are categorized as supercritical pressure boilers or ultra supercritical pressure boilers.

# Operation/Maintenance of a Thermal Power Plant – 1/2

(securing quality and safety of facilities under laws and regulations)

- Maintenance of the reliability and safety of thermal power generation facilities is controlled under the Electricity Enterprise Law established by the Government (it is obliged to report occurrence of facility and personal accidents).
- Power producers must strive to maintain/improve thermal power plants operated under harsh service conditions with high temperature and high pressure (welding repair and non-destructive inspections must be performed by engineers who have passed national examination).
- Only facilities that have received and passed on-the-spot inspections by specialized inspectors of the government when they are opened for periodical inspection/maintenance are allowed to operate.
- In case of a facility accident or personal accident, the plant may be suspended from operation depending on the content of the accident (the power producer must identify the cause of the accident and take a countermeasure, and receive an on-the-spot inspection by a specialized inspector of the government. The plant cannot resume operation unless it passes the inspection).

## Operation/Maintenance of a Thermal Power Plant – 2/2 (securing the environment under laws and regulations)

- The Basic Environment Law defines the environmental standards and standard values for air-quality issues, water-quality issues, noise, vibrations, etc. (in many cases, standards by local governments are added to regulation values of the national government, and on-the-spot inspections by a dedicated inspector may be involved).
- Major environmental preservation measures
- Air quality control → SOX, NOX, dust, coal dust fly
- Water quality control → drainage, warm drainage, oil leakage
- Noise and vibrations → noise, vibrations
- Wastes → coal ash, desulfurized gypsum
- Environmental harmonization with surroundings → greening, scenic preservation

# Standard Inspection and Maintenance Intervals under the Electric Enterprise Law

	Minor Inspection	Major Inspection
BOILER	Every 2 years	Every 4 years
STEAM TURBINE	Every 4 years	Every 8 years
GAS TURBINE	Every 2 years	

Plants that are not inspected and maintained within the period defined under the law cannot be operated.

State of inspection and maintenance of gas turbines is controlled in EOH.

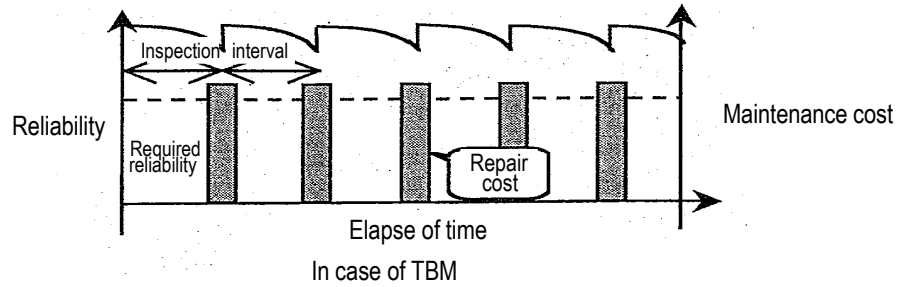
Gas turbine combustors: minor inspection after 8,000 hr (EOH)

Gas turbine main units: major inspection after 25,000 hr (EOH)

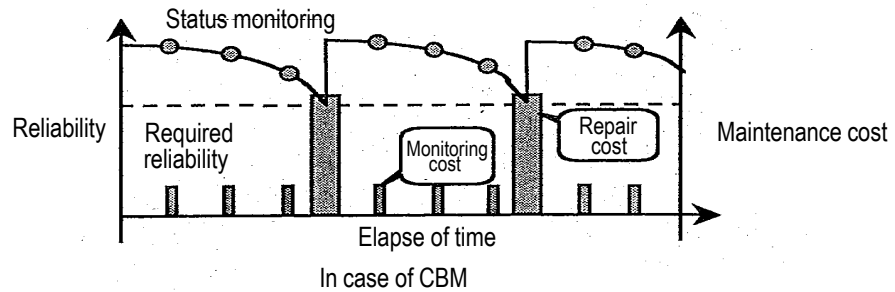
[EOH = Equivalent Operation Hour]

# Maintenance Mechanism

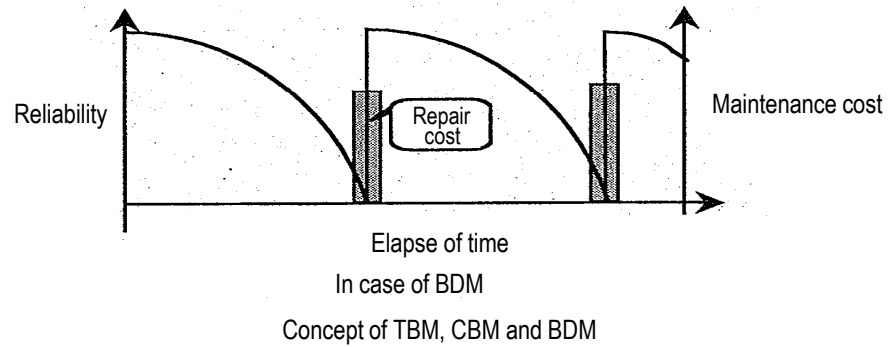
TBM: Time Based Maintenance



CBM: Condition Based Maintenance



BDM: Break Down Maintenance



# Examples of Specific Contents of TBM and CBM

- Contents of TBM (time based maintenance) (examples of major inspection)
  - Building a temporary scaffolding at the top inside the furnace
  - Visual inspection of the furnace interior, and measurement of thickness/outer diameter of representative regions (comparison with the previous data, inspection of corroded/thinned, discolored or bulged regions in particular)
  - Removal of sample tubes (scale thickness measurement, metallographic inspection)
  - Repair of burner tiles and repair of burnt region of the air nozzle
  - Replacement of deteriorated and damaged parts
- Contents of CBM (condition based maintenance) (examples of major inspection)
  - Diagnosis of points where abnormally high temperature is indicated with SH and RH tube metal
  - Follow-up inspection of regions where abnormal metal texture was detected in the previous inspection data
  - Inspection of the bearings of large auxiliary units that have been operated at allowable limit of vibrations
  - Lateral spread check of trouble that has occurred in similar units

# Operation of Thermal Power Generation Facilities

- Formation of teams on watch for coal-fired power generation facilities (e.g., latest facility with 600 - 1000 MW, 1 control room for 1 unit)  
8-hour shift with 5 teams, 1 team consisting of 4 to 5 people (1 team consisting of 6 to 7 people in case of 1 control room for 2 units)
- Operation of auxiliary facilities is commissioned to an external organization
  - Coal facilities (coal unloader, coal storage, coal feeder)
  - Ash handling system (clinker-based wet type, ash-based dry type)
  - Electrostatic precipitator, desulfurization equipment (wet type)
  - \*Effective utilization of ash and gypsum

# Maintenance Structure for Thermal Power Generation Facilities

- Daily maintenance (performed by plant employees in principle)
  - Minor repair/instrument calibration that can be performed during operation
- Scheduled outage maintenance (performed by an affiliated specialty company)
  - Stop the facility for 1 to 2 weeks due to supply-demand adjustment, and perform minor repairs and condenser tube cleaning.
- Periodical inspection/maintenance (performed by affiliated company, while quality, safety and process control is performed by the plant)
  - Voluntarily maintain weak facilities/regions based on legal inspection
- Preventive maintenance (to be studied based on the inspection/maintenance database)
  - Replacement and major repair of age-deteriorated regions
  - Example: replacement of boiler tubes, replacement of facilities with degraded performance

# New Employee Training Program (in Case of Staff on Watch)

- Basic training (on routine work, for 2 months)  
Education on the mechanism of power plant and on safety, and how to read related drawings
- Training on work on watch (introductory training for 1 month in routine work)  
Safety education mainly on-site work, knowledge on patrols, etc.
- Training on work on watch (for 6 months)  
Basics of equipment operation, maintenance and disaster control, OJT
- Simulator-based training and repetitive training on OJT (all group members to be on watch will participate, and recognize their respective roles allocated)  
Facility operation and response to generated alarms

# Efforts to Improve Independent Technological Capability

- Mechanism of education and training
  - Establishment of various technical documents, manuals, etc.
  - Education and training using the company's training facility
  - Training for external specialized lecturers
- Mechanism of skill certification
  - Certify employee who have specialized knowledge and contribute to the company as special staff (treatment according to the techniques/skills)
  - Identification of personal technique/skills using a skill map