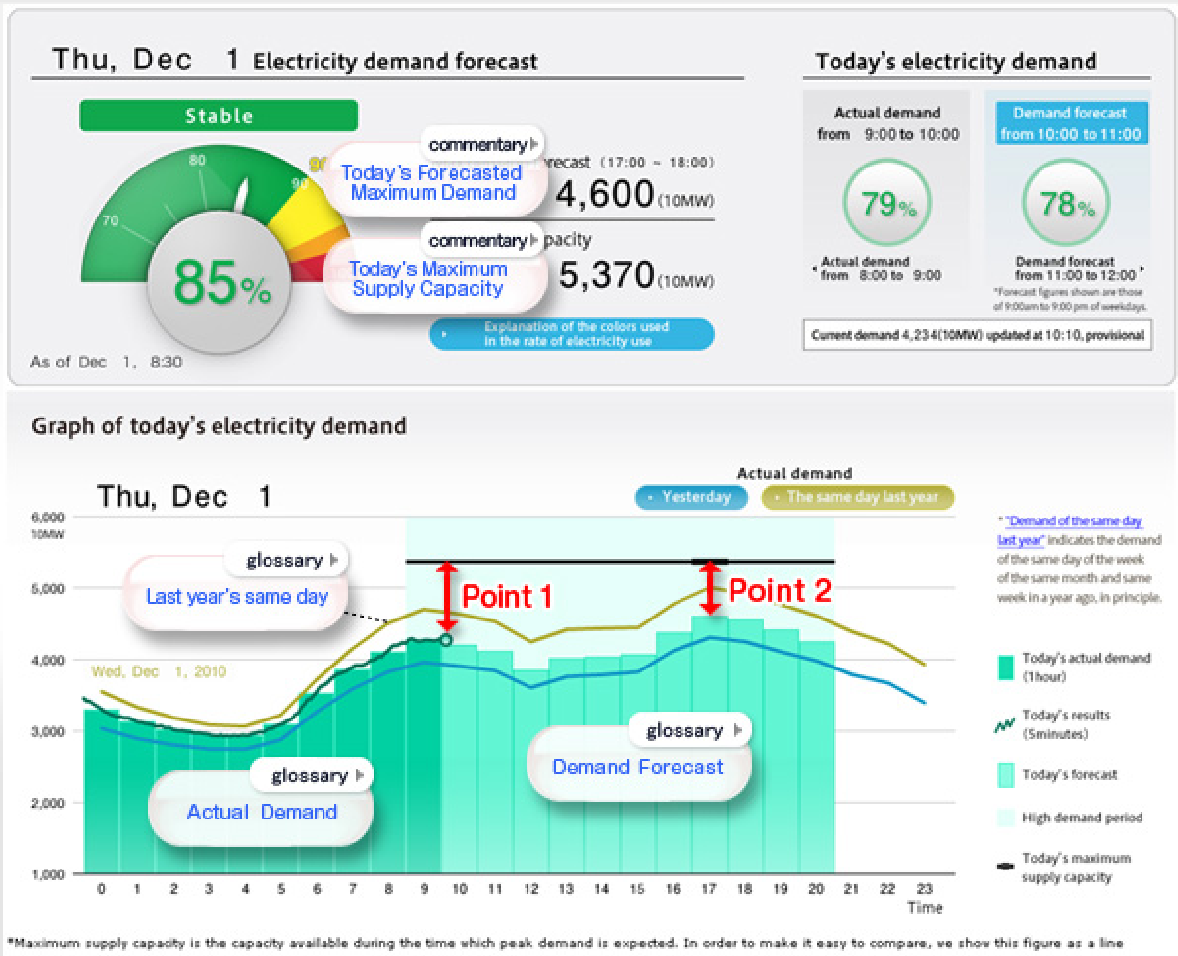
TEPCO ELECTRICITY FORECAST

Why does the supply capacity change every day?

Commentary on Electricity Forecast

The objective of "Electricity Forecast" is to provide easy-to-understand information on the status of electricity demand and our actual supply capacity. With charts and data, the forecast of supply-demand balance of electricity for the next day, the real-time information such as actual demand at five-minute intervals and the forecast of hourly demand for the day are provided.

Electricity Forecast



*This view is a sample image of electricity consumption.

Point 1

Supply-demand balance of electricity is indicated based on the comparison between actual demand updated every five minutes and the maximum supply capacity.

Point 2

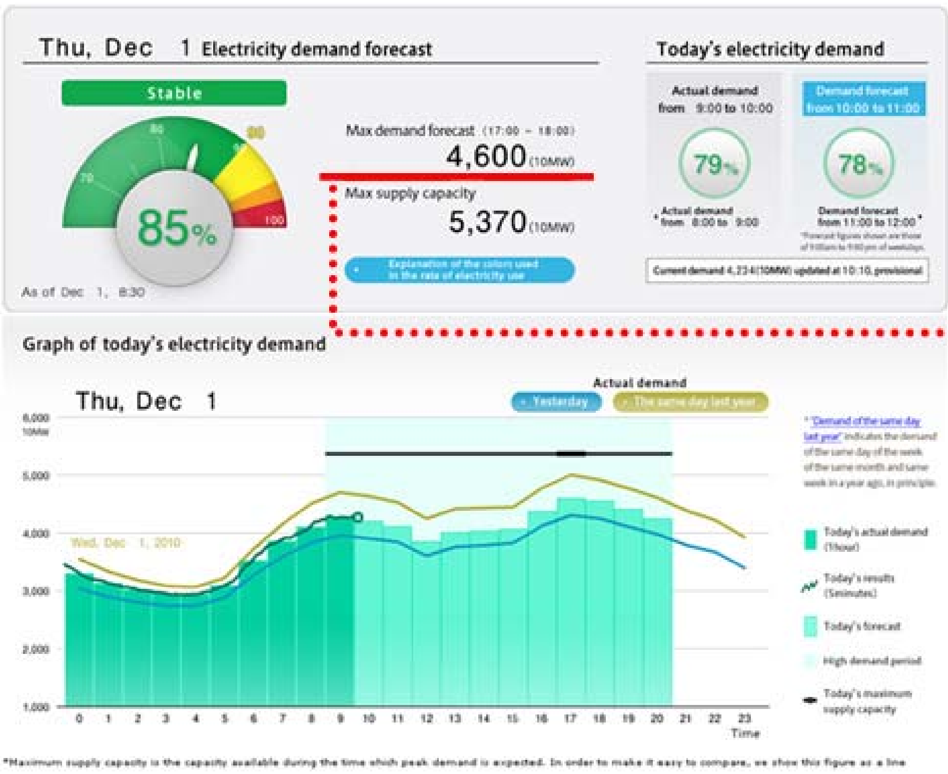
Demand forecast＊ is provided at around 8am, indicating hourly forecast of maximum demand from 9am to 9pm on weekdays.

＊The demand forecast Is updated every hour on the hour from 10am to 8 pm

By the comparison with the maximum supply capacity you can check the demand forecast and the possibility of tightening of supply-demand balance in advance.

What is Forecasted Maximum Demand?

Forecast of demand at peak time, forecasted by utilizing several information such as weather forecast



*This view is a sample image of electricity consumption.

Forecasted Maximum Demand

Weather forecast (fine, cloudy, rain etc.)

Temperature forecast (Highest/Lowest)

Actual electricity demand in the past

Characteristics of the days
*** Difference between weekdays and holidays etc.**

Maximum electricity demand in a day , forecasted by considering the impact from electricity saving and business condition

* Forecast for the next day is provided every day at around 6:00 pm.

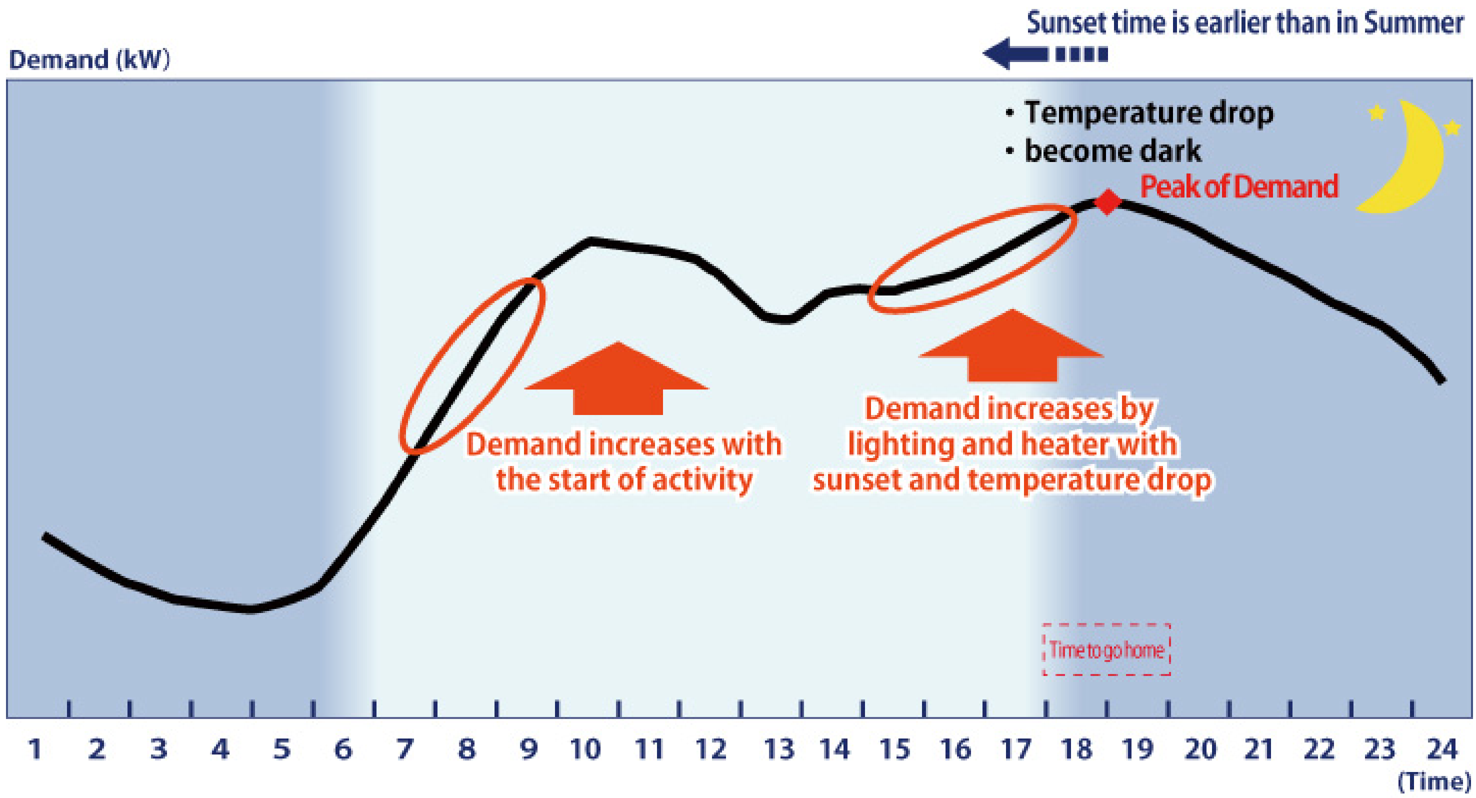
* Data is updated at 8:30 am on weekdays, posted at around 9:00 am.

Characteristics of Power Usage in Winter

Different Timing of Peak Demand between Summer and Winter

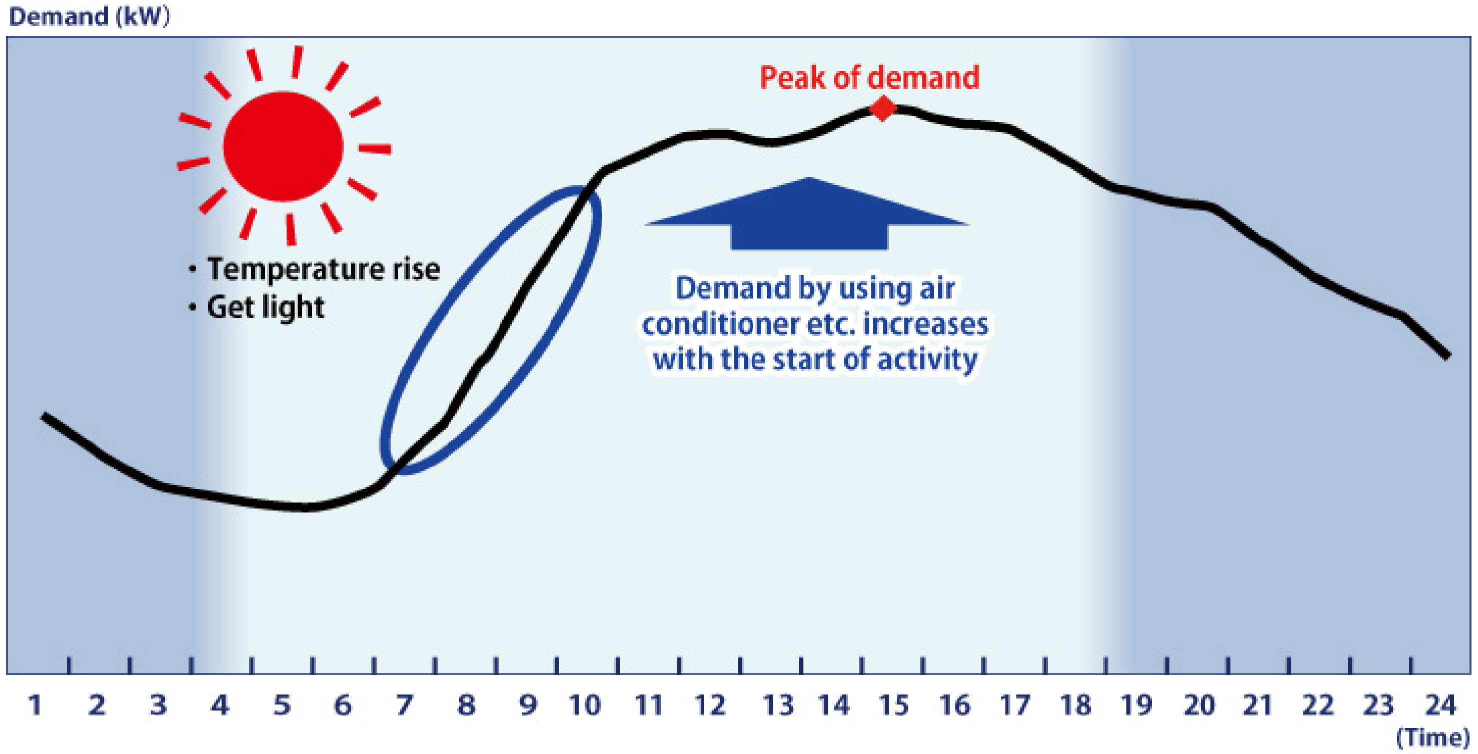
General Demand Curve in Winter

Normally, peak demand in winter is recorded from 5pm to 7pm due to economic activity and home use overlapping.



*Sunshine hours are imaged by the reference of the sun rise and sunset time in Tokyo on Jul.23 which is the day with maximum demand in summer in 2011
[Reference] National Astronomical Observatory of Japan website

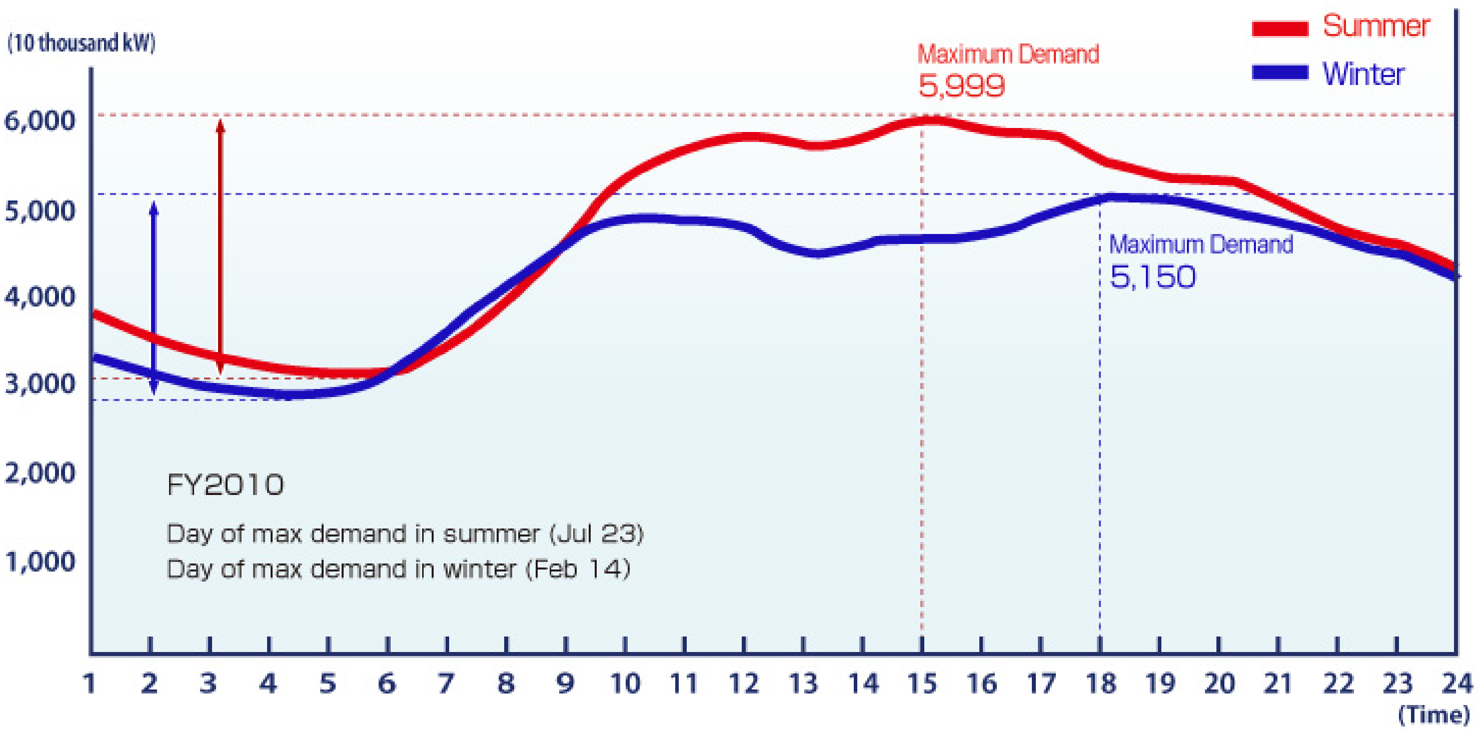
General Demand Curve in Summer



*Sunshine hours are imaged by the reference of the sun rise and sunset time in Tokyo on Jul.23 which is the day with maximum demand in summer in 2011
[Reference] National Astronomical Observatory of Japan website

Comparison between summer time demand carve and winter time demand

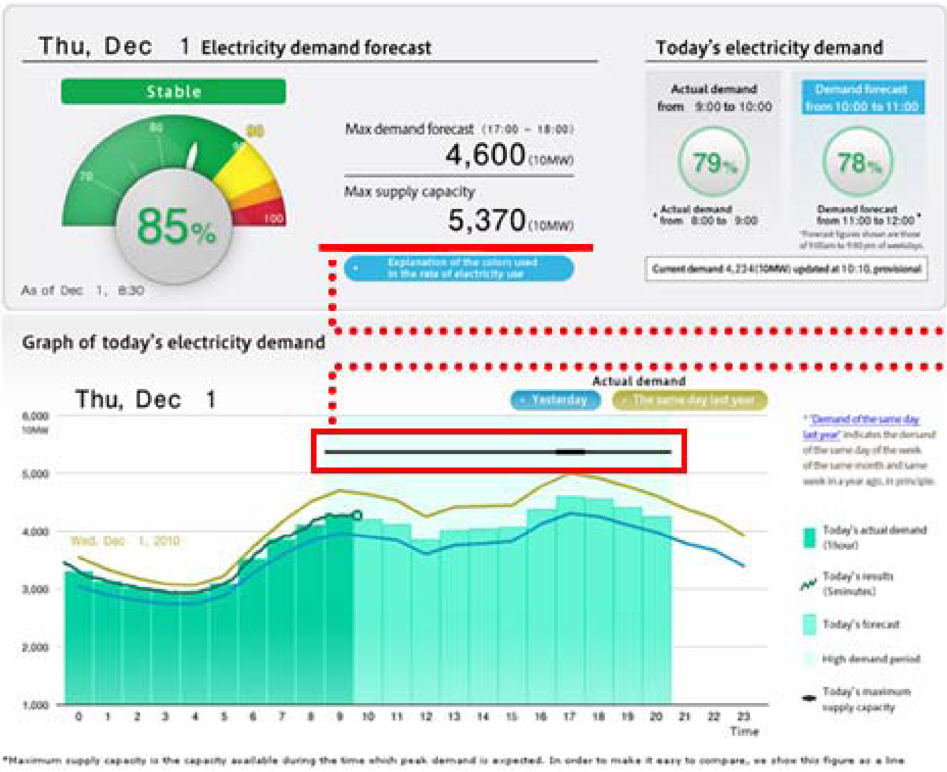
In winter, demand difference between day and night is small and shape of demand curve is relatively flat compared to demand in summer.



What is Maximum Supply Capacity?

Maximum generation capacity available at peak time. Please be noted that this does not necessarily mach generation capacity

Supply capacity and generation capacity



*This view is a sample image of electricity consumption.

Maximum Supply Capacity

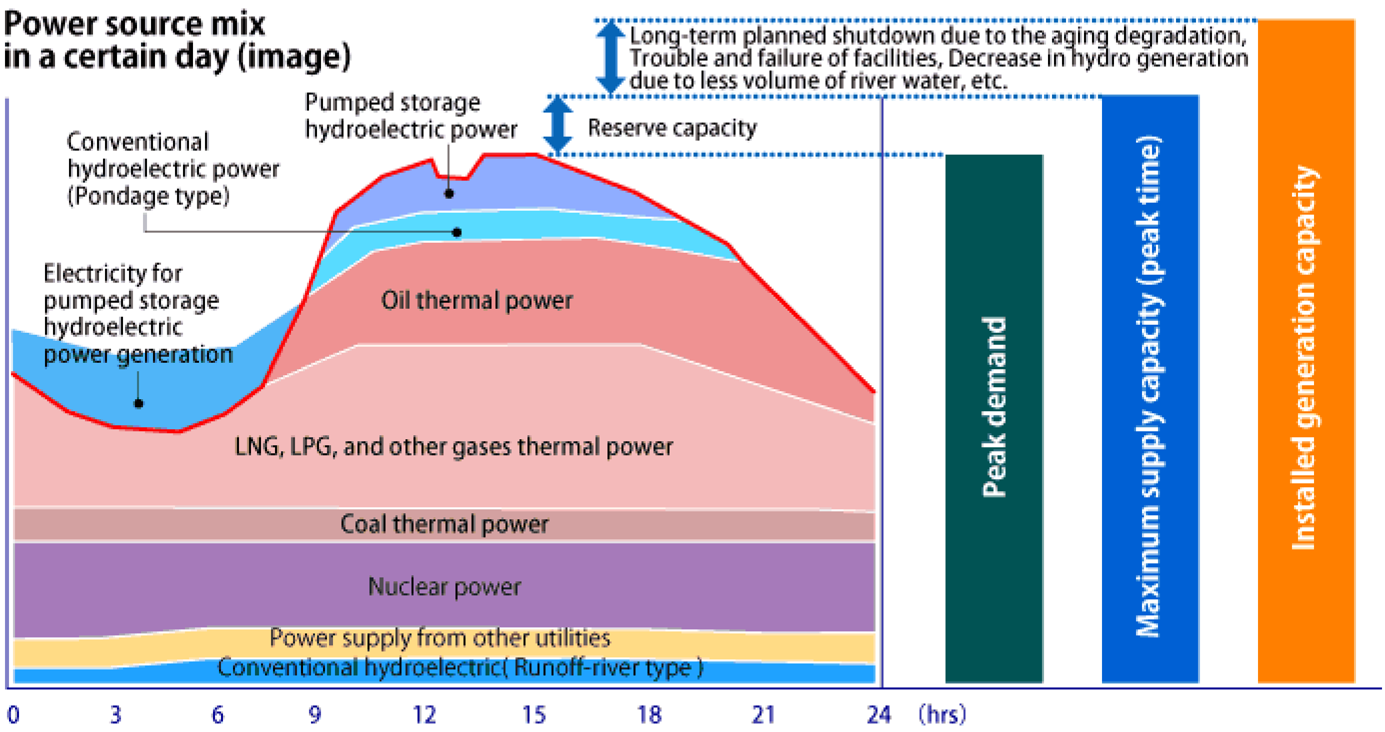
Maximum Supply Capacity is the maximum generation output available at the day,
which can be obtained by deducting the capacity of outage plants for maintenance and the decreased capacity caused by decreased flow rate of rivers from the total generation capacity.

As flow rate of rivers and available generators vary every day, Maximum Supply Capacity accordingly change every day.

* Forecast for the next day is provided every day at around 6:00 pm.

* Data is updated at 8:30 am on weekdays, posted at around 9:00 am.

● Relations between demand and daily maximum supply capacity of electricity

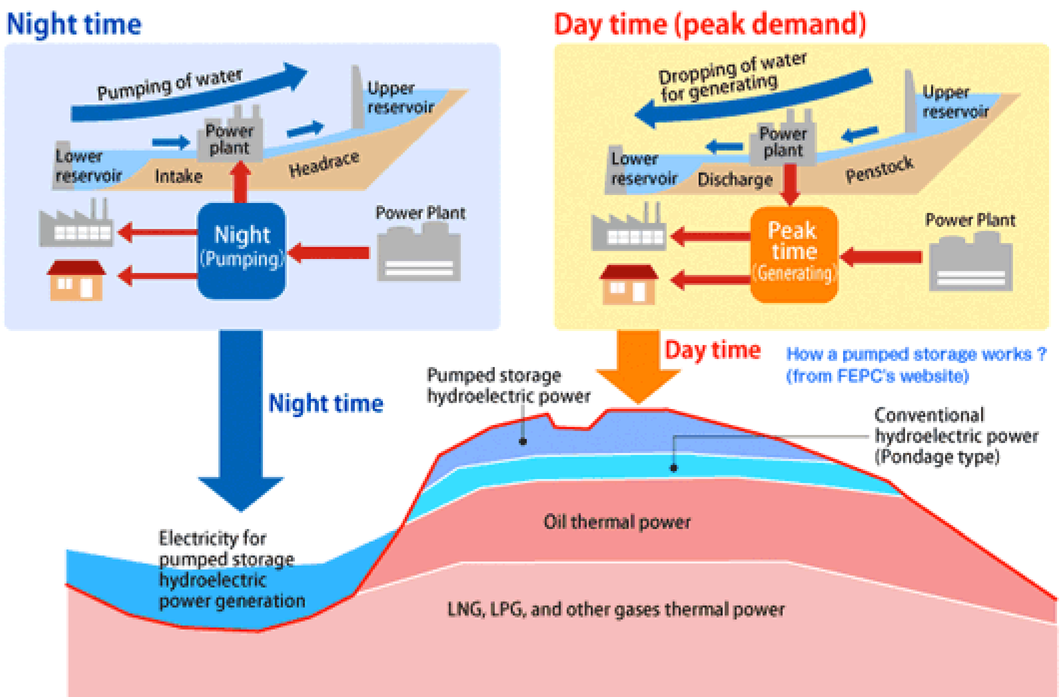


[Topic] Pumped storage that is active at peak time

POINT

①Electricity generated (= power supply volume) is determined by the volume of water in the upper reservoir.

②To steadily operate a pumped storage, we need to pump up at night the same volume of water as had been dropped down in the day time.

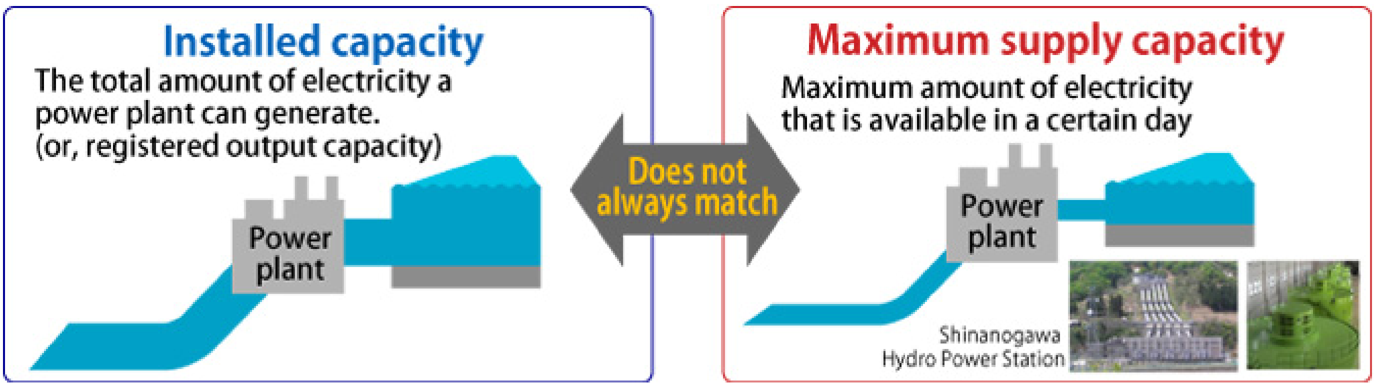


Why does the supply capacity change?

"Installed capacity" does not necessarily match "maximum supply capacity". There is a reason.

case of hydro power generations

Hydro power plant A



Installed capacity is the amount of electricity generated that each power plant is able to output when they can get full amount of permitted river flow*, though the volume fluctuates every day.

***Permitted in-take volume of river flow : Each hydro generating facility has been permitted by the Government for how much water volume they can take from the river. The volume of river flow should be more than permitted.

The amount of electricity generated decreases, depending on the season and weather.
It also decreases when the river flow is smaller or when fallen leaves or dusts pour into river water after a hurricane. For some reason the generating facilities sometimes become unable to take in river water.

Installed capacity：100 > Supply capacity：60～80

Why does the supply capacity change?

"Installed capacity" does not necessarily match "maximum supply capacity". There is a reason.

case of thermal generations

Thermal Power Plant A

Installed capacity

The total amount of electricity a power plant can generate.
(or, registered output capacity)

(Futtsu Thermal Power Station)

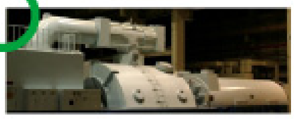
Installed capacity 1,000MW
250MW each × 4 units *

※ different from the real capacity

Does not always match

Maximum supply capacity

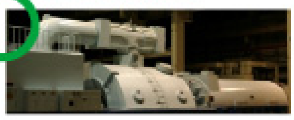
Maximum amount of electricity that is available in a certain day



Unit 1
250MW

Unit 2
250MW
→100MW
Limitation

Sometimes a generator sustains some failure, but it can generate electricity while at the same time we fix it without having to fully shutdown. We continues operating the generator by lowering down its output.



Unit 3
250MW

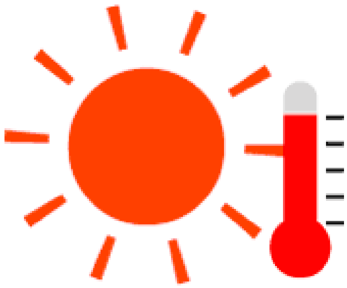
600 MW

Unit 4
250MW→0MW
Maintenance Shutdown

When a plant suffers a trouble or when it enters a regular inspection/overhauling

Installed capacity: 1,000MW > Supply capacity: 600MW

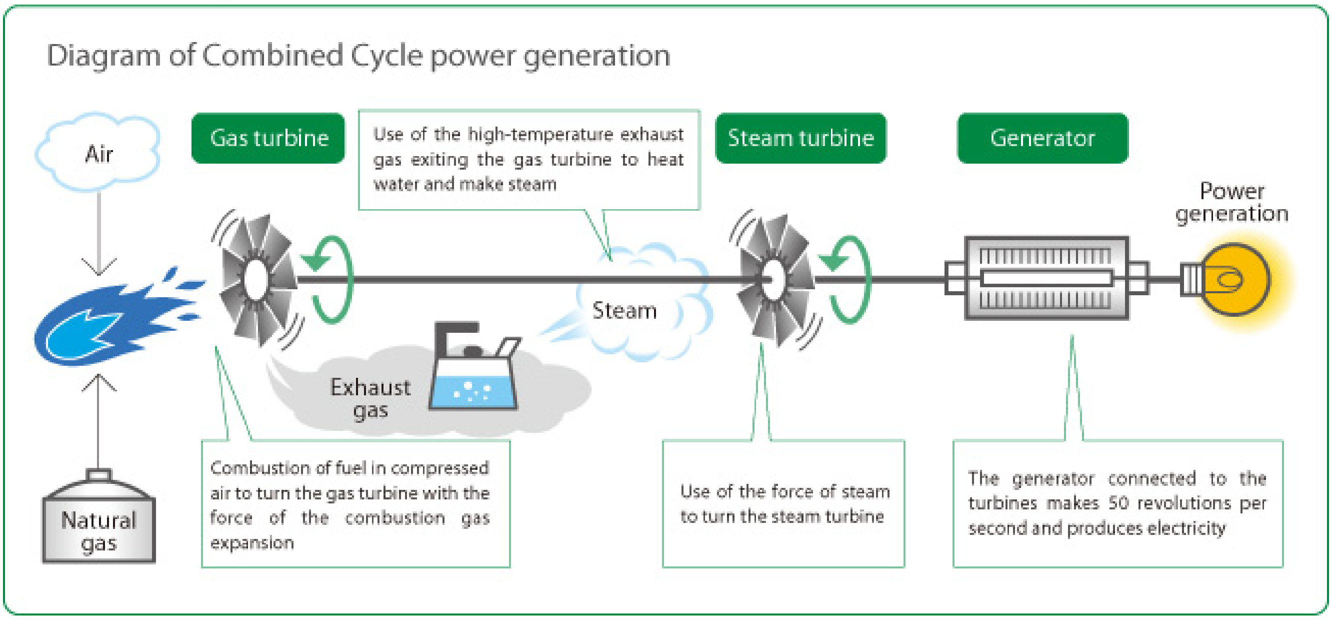
[Topic] Combined Cycle Generation when outside temperature rises



The volume of intake air changes in case of gas turbine generation facilities, depending on the outside temperatures.
The air coming from the outside goes from a compressor to a combustor.
Especially in summer, the higher the outside temperatures, the less the amount of electricity generated by a combined cycle.

Supply capacity 10 to 20% lower

Combined Cycle is a combination of a fuel-fired turbine and a steam power turbine.



Why does the supply capacity change?

"Installed capacity" does not necessarily match "maximum supply capacity". There is a reason.

Case of purchase from other companies

〇TEPCO used to purchase electricity continuously from Independent Power Producer (IPP).
<approx. 40% of privately-owned electrical power facility in kanto region (16,600MW) >.
TEPCO also purchase surplus electricity from privately-owned electrical power facility to secure supply capacity.

Power purchase from IPP

IPP

Power purchase from IPP vary depends on contract (weekday, holiday, daytime, night time, etc)

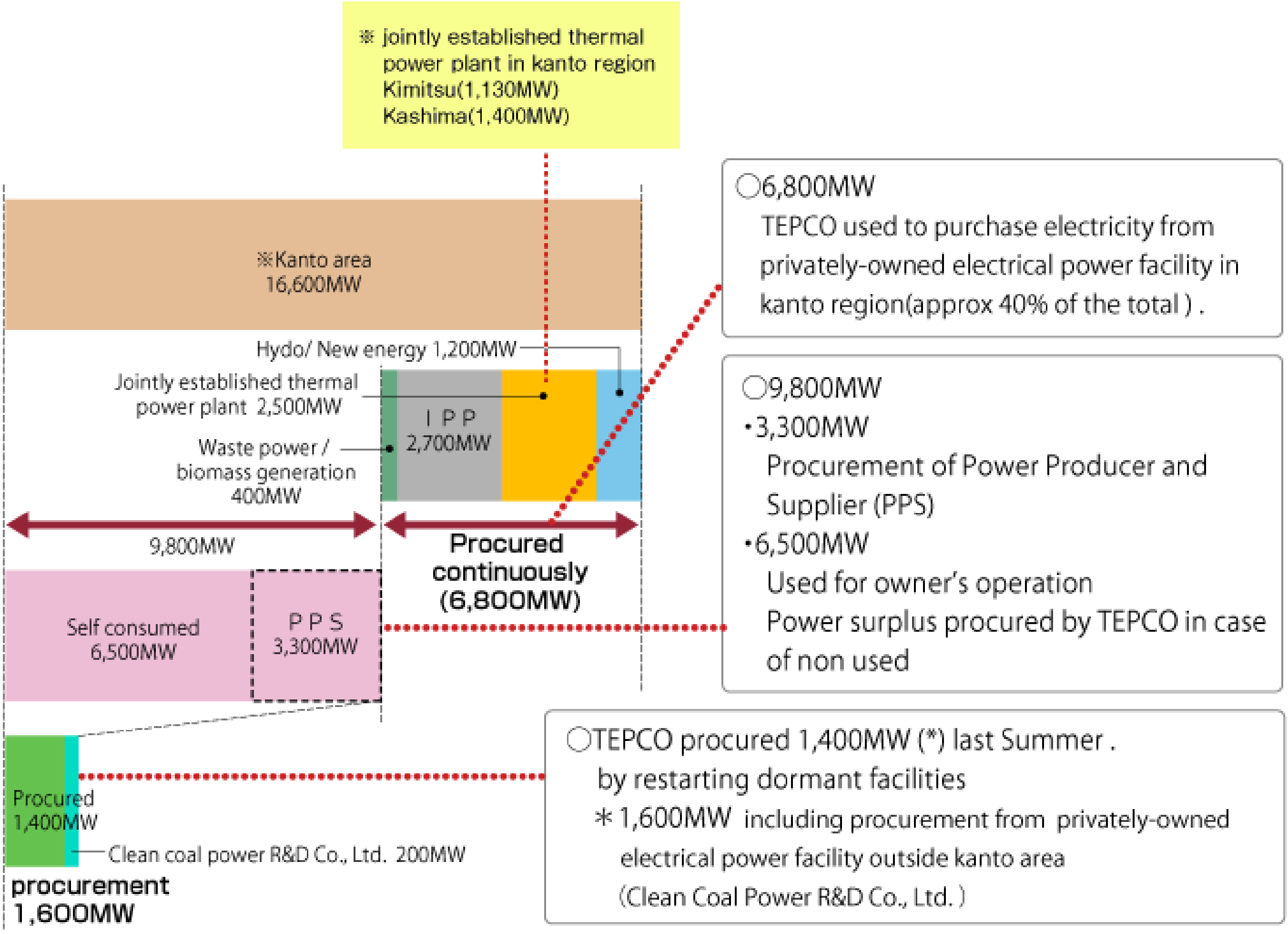
Power purchase from privately-owned electrical power facility

privately-owned electrical power facility

Power purchase from privately-owned electrical power facility vary depends on operating conditions

[Topic] Power purchase from privately-owned electrical power facility ~Is there surplus power?

Details of privately-owned electrical power facility



(*source)
Agency for Natural Resource and Energy[electricity statistics(2011Mar)]
*excluding privately-owned electrical power facility below 10,000MW

IPP(Independent Power Producer)
Supply electricity to electric power companies

PPS(Power Producer and Supplier)
Supply electricity using transmission line of electric power companies to customers who can decide power source

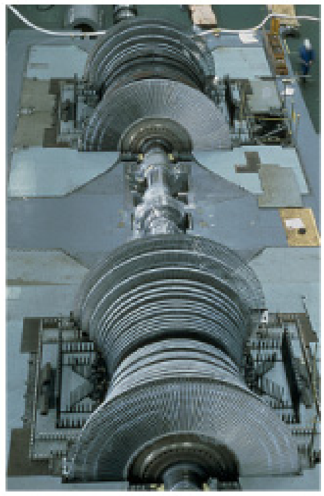
Why does the supply capacity change?

"Installed capacity" does not necessarily match "maximum supply capacity". There is a reason.

About the maintenance

◯Maintenance is conducted mainly in spring and autumn when the electricity demand is low in order to secure stable electricity.

◯When the unexpected event occurs, we will conduct urgent repair to resume smoothly.



Steam turbine
Taking off the cover for maintenance

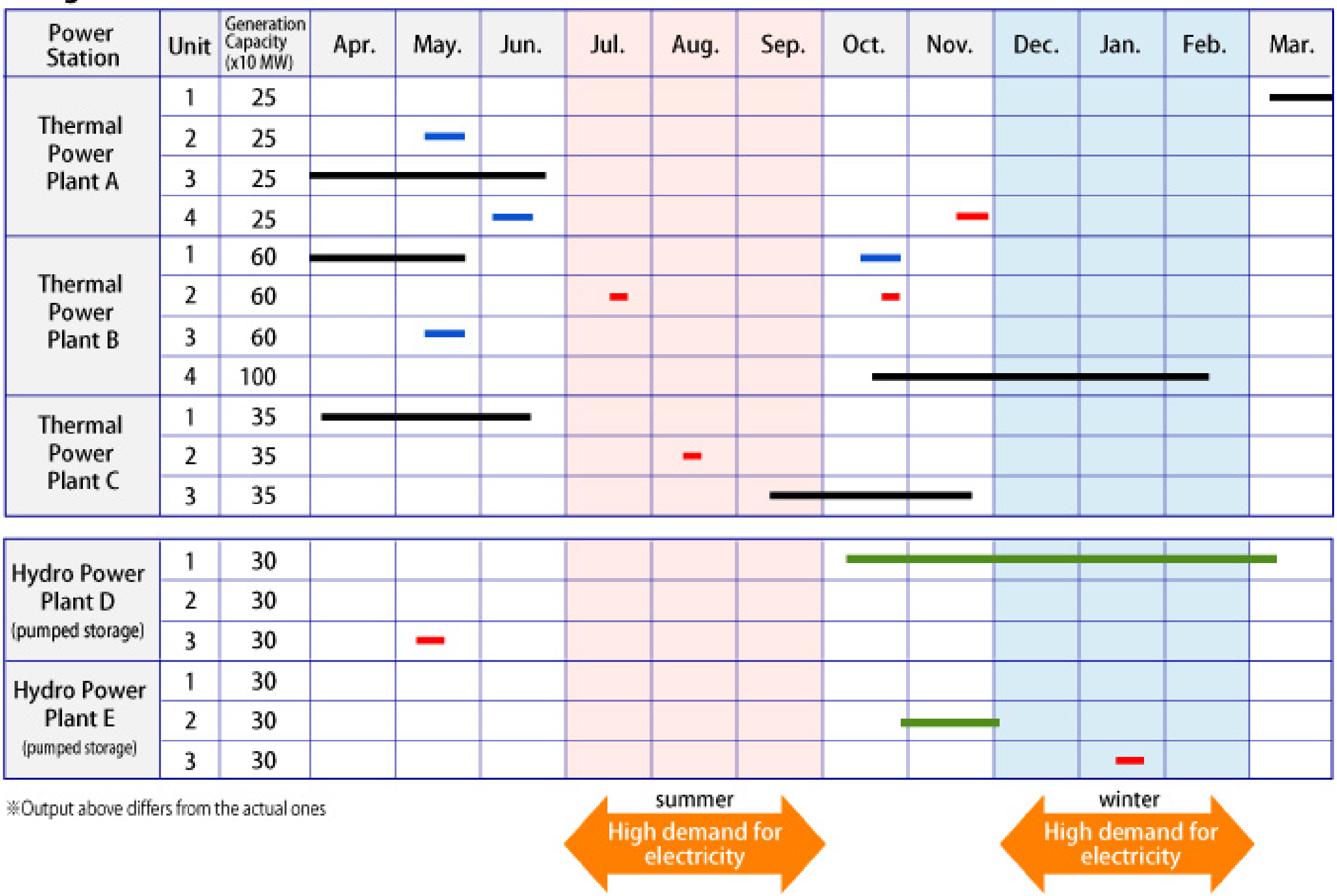
◯**Ordinary inspection** <Blue>:
Maintenance conducted in needed-basis according to the result of daily diagnosis in order to secure soundness of generation facilities.

◯**Regular inspection** <Black>:
Maintenance conducted as per regulation etc. by stopping generation facilities for a maximum of a few months.

◯**Urgent repair** <Red>:
(Malfunction, etc.) Maintenance conducted by urgently suspending generation facilities in case of malfunction.

◯**Inspection・Repair** <Green>:
Inspection is conducted and if needed, repair as well in order to secure soundness of generation facilities.

Image for annual maintenance schedule



※Output above differs from the actual ones

Taking out gas turbine for maintenance

Visual inspection on gas turbine combustor

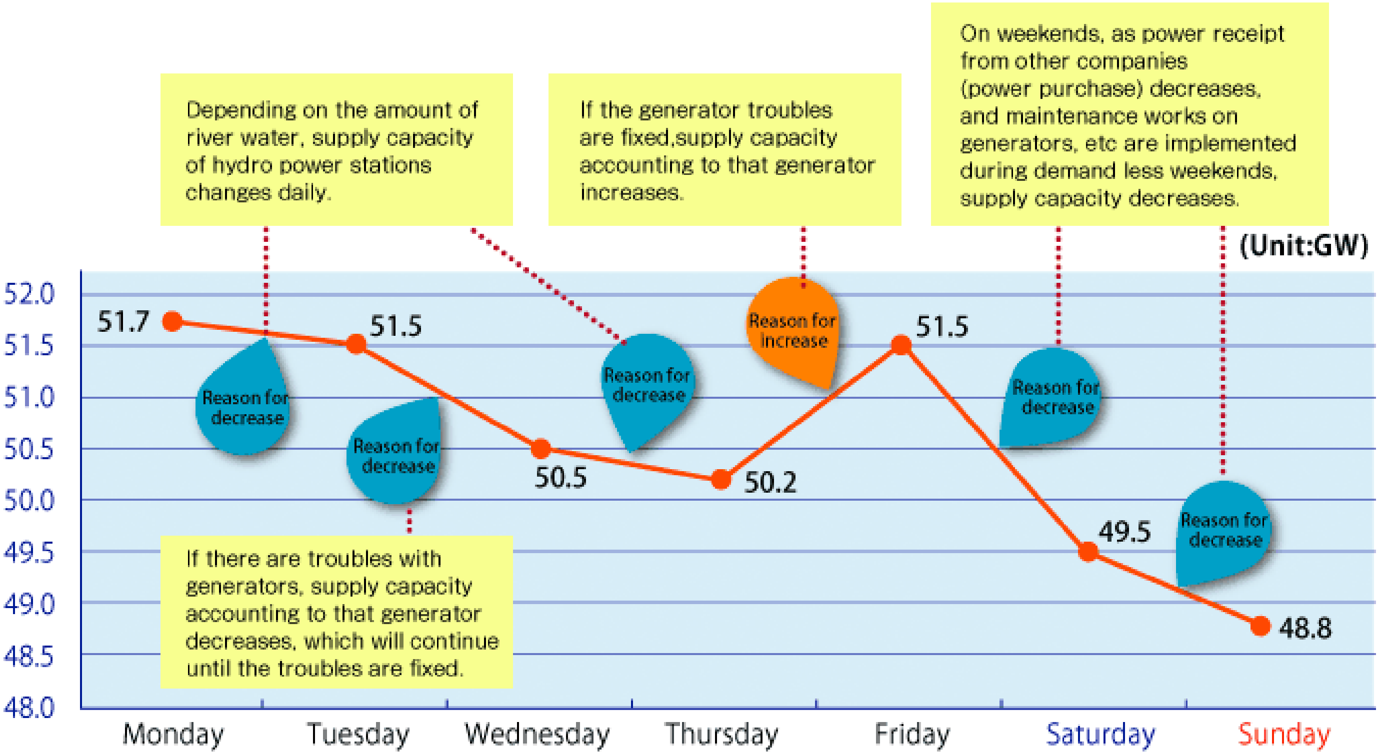
Welding pipes

Diagnosing turbine blades by dismantling them

Fluctuation Status of supply capacity

Like forecasted maximum demand, supply capacity also changes daily. There are various reasons to this change.

Model of fluctuation status of a week



(Unit:GW)

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Supply capacity during peak hours	51.7	51.5	50.5	50.2	51.5	49.5	48.8

- Tuesday: Capacity decrease of hydro power ▲0.2
- Wednesday: Troubles at generators ▲1
- Thursday: Capacity decrease of hydro power ▲0.3
- Friday: Restoration of generators +1, Hydro power capacity increase +0.3
- Saturday: Purchase from other companies ▲1, Generator maintenance ▲1
- Sunday: Purchase from other companies ▲0.7

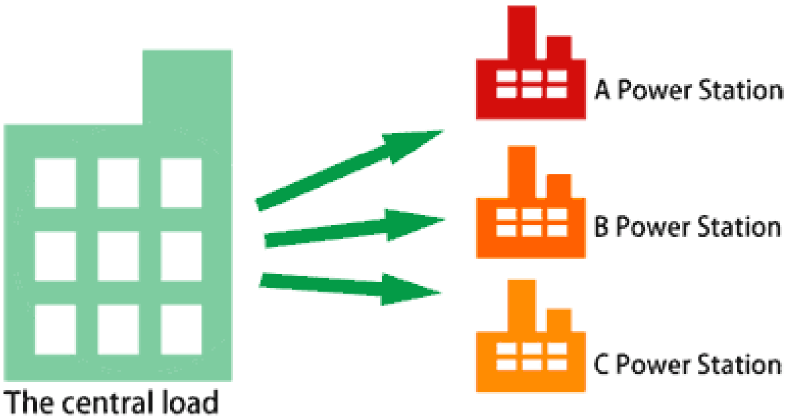
Where does excess electricity go?

There will be no excess electricity. It is because there is a control tower that adjusts electricity generation in response to the status of actual electricity consumption.

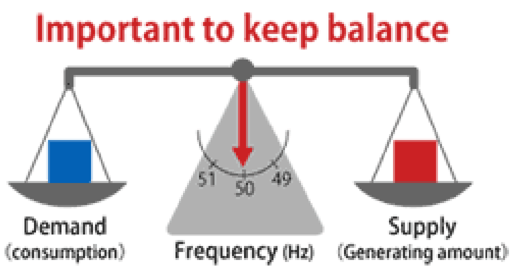
Balance does matter

Electricity generation is adjusted to avoid possible electricity shortages but with minimum excess.

Because of the inability to store electricity, in response to the demand (consumption) changing from moment to moment along with ongoing social activities, the central load dispatching office is balancing between demand (consumption) and supply (generating amount) by instructing each power plant to start, stop or give output adjustments to their generators.



(Photo: Shinagawa Thermal Power Station)



The center balances between demand (consumption) and supply (generating amount) to make them equal.

(Photo: Kawasaki Thermal Power Station)

Where does excess electricity go?

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Roles of the control tower

●Adjustments utilizing the characteristics of different power plant systems

There are several power generation systems: hydroelectric power, thermal power, and nuclear power, etc. Electricity generation plans are worked out by taking into account the characteristics of each electricity generation system, such as thermal power generation capable of responding flexibly to fluctuating demand (consumption), and pumped storage hydroelectric power generation capable of responding quickly to demand during peak time. The output from each power station is adjusted based on this plan.

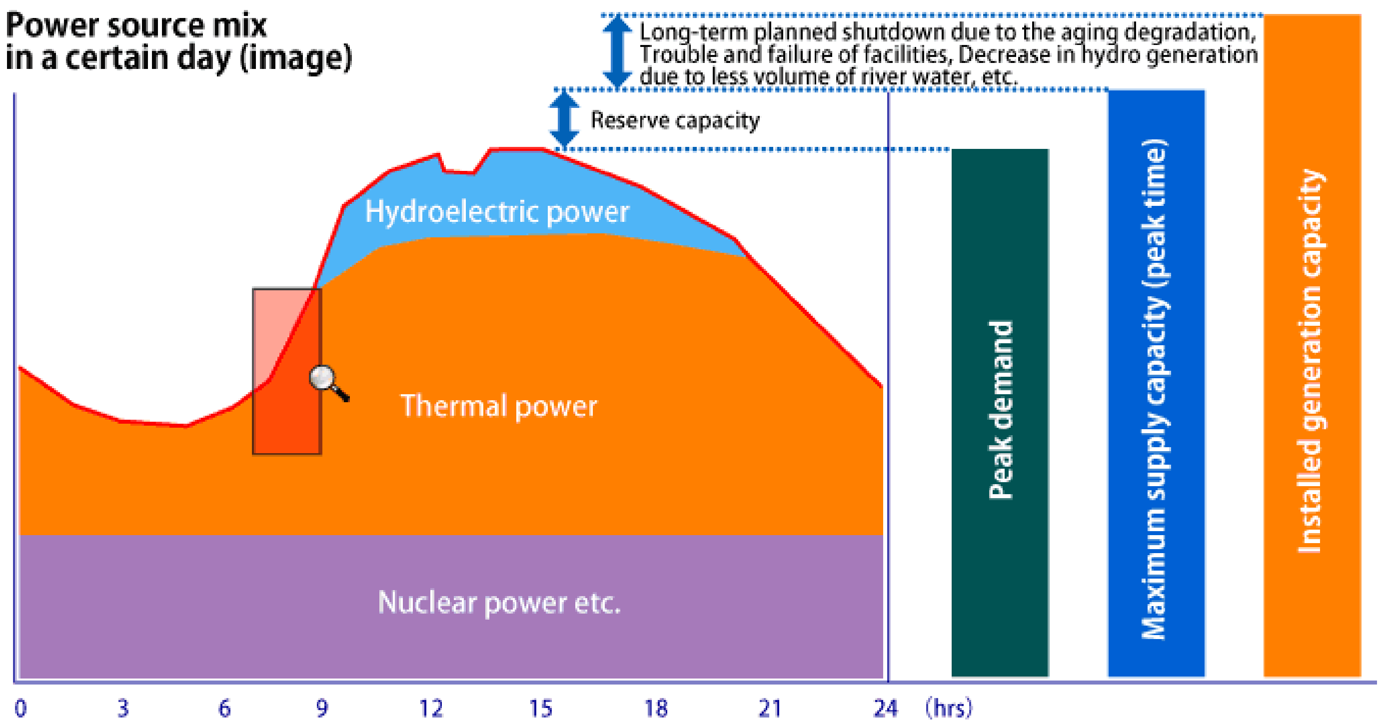
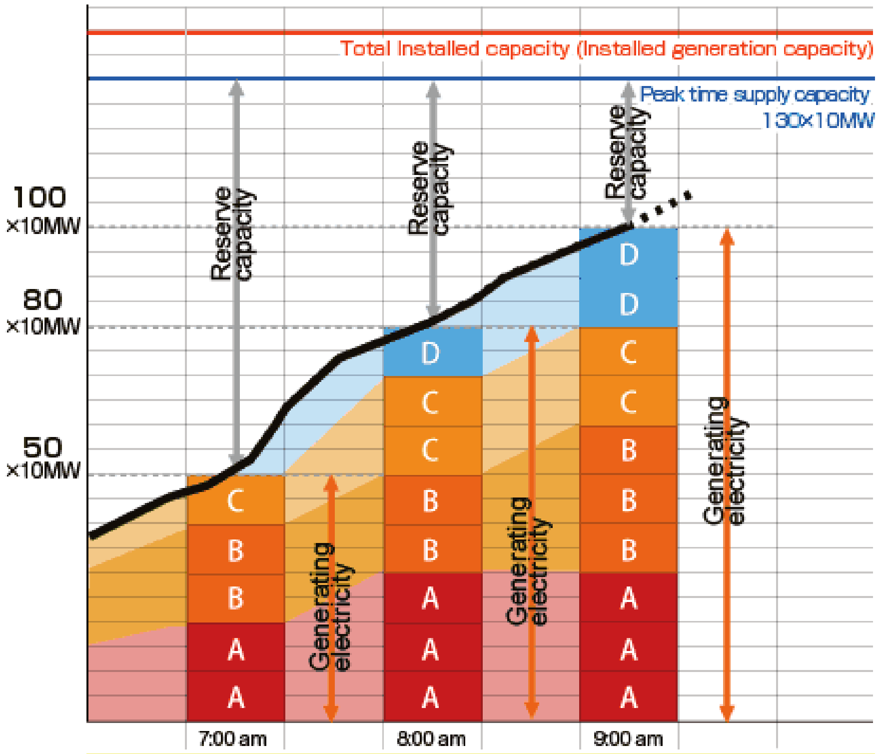


Image of the adjustment to electricity output

In fact, electricity is hardly consumed as forecasted. Taking into consideration the difference in response time at each plant before starting generation/increasing output, the output is adjusted in real time by monitoring electricity consumption.



■ **Instructions issued for 7:00 am → 8:00 am**

Instruct A thermal power to increase the output: 20×10MW → 30×10MW
Instruct C thermal power to increase the output: 10×10MW → 20×10MW
Instruct D pumped storage to increase the output: 0MW → 10×10MW

■ **Instructions issued for 8:00 am → 9:00 am**

Instruct B thermal power to increase the output: 20×10MW → 30×10MW
Instruct D pumped storage to increase the output: 10×10MW → 20×10MW

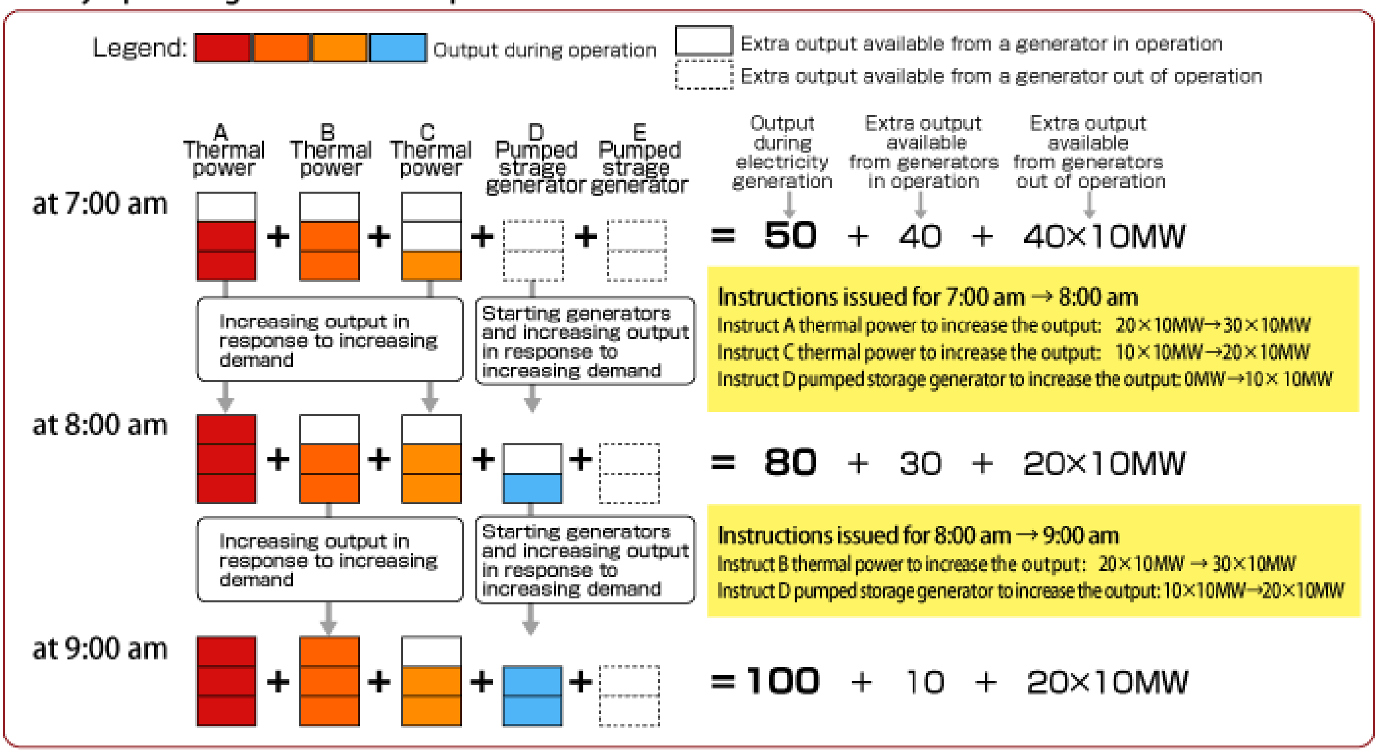
For ease of understanding how to adjust electricity generation output in response to the status of actual electricity demand, let's take an example of adjustment in the morning (7:00 am-9:00 am) …

This example is an operating plan for a certain day when peak time supply capacity is 130×10MW on 3 units of thermal power generators (A, B, C – 30×10MW each) and 2 units of pumped storage hydroelectric power generators (D, E – 20×10MW each).

※These output numbers differ from actual ones.

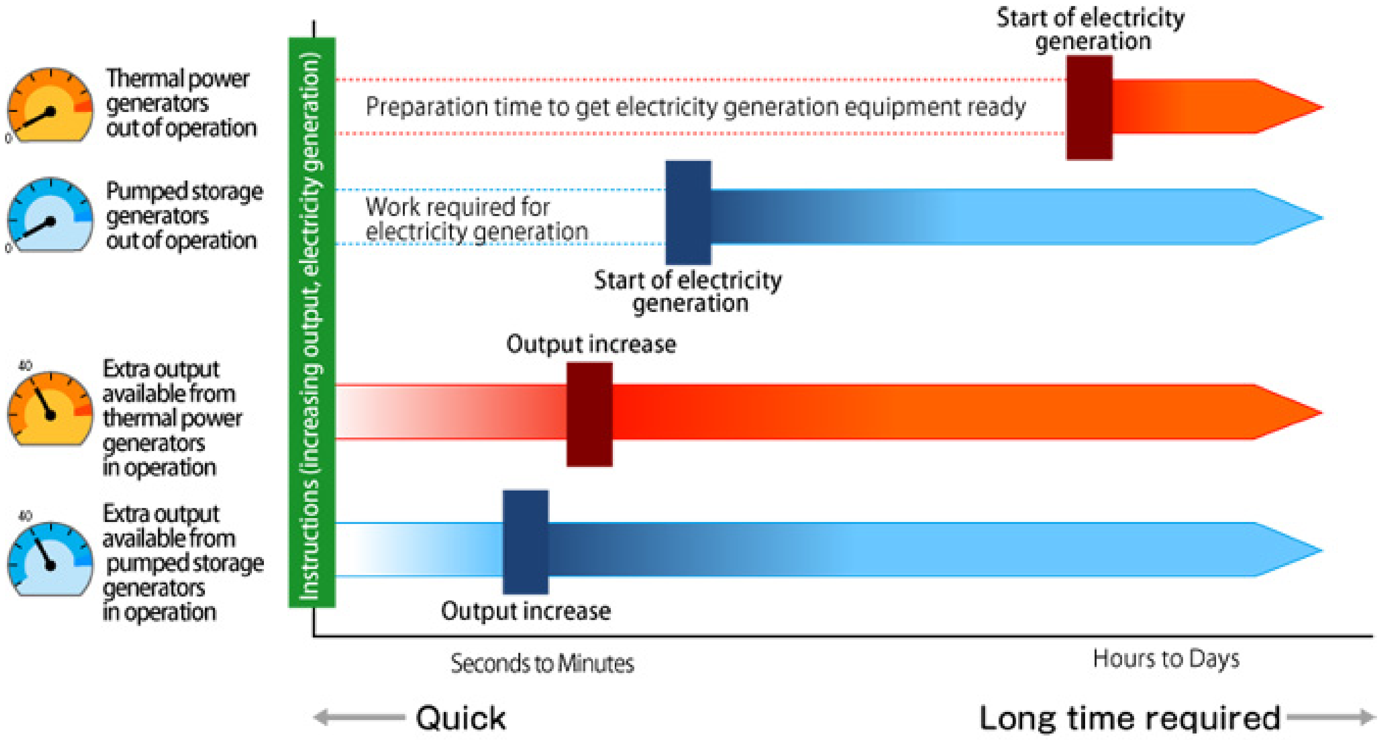
- Output status at each plant is indicated with 10×10MW -unit blocks stacked
- A Thermal power generator: Maximum 30×10MW
- B Thermal power generator: Maximum 30×10MW
- C Thermal power generator: Maximum 30×10MW
- D Pumped storage hydroelectric power generator: Max. 20×10MW
- E Pumped storage hydroelectric power generator: Max. 20×10MW
- Dotted lines: Forecasted electricity consumption
- Black solid lines: Status of electricity consumption (actual)

Hourly operating status at each power station



Difference in response time before starting generation/increasing output by generation system

■Pumped storage hydroelectric power generators can start generation/increase output in seconds to minutes
■Thermal power generators take time before starting generation (hours to days)



Where does excess electricity go?

There will be no excess electricity. It is because there is a control tower that adjusts electricity generation in response to the status of actual electricity consumption.

Reviewing what you have learned

● Snapshot of instructions for the output during the start-up hours in the morning

Adjusting the output from many generators for a short period of time—it is literally a race against time.

Image of the output increasing in response to the ramp-up electricity consumption in the morning

Power source mix in a certain day (image)

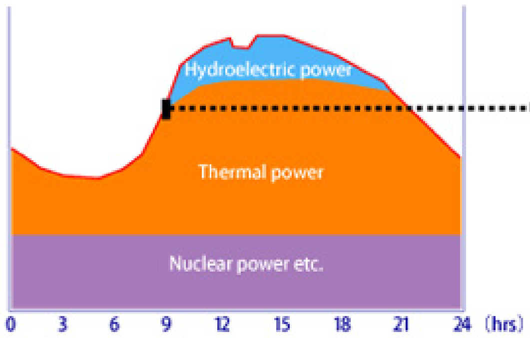


Image of instructions issued for about 5 minutes after 9:00 am

Time	Power station	Unit NO.	instruction (×10MW)
09:00:00	A Thermal power generator	2	25→35
09:00:16	G Pumped storage hydroelectric power generator		20→30
09:00:26	B Thermal power generator	2	90→100
09:00:26	B Thermal power generator	3	90→100
09:00:26	B Thermal power generator	4	90→100
09:00:30	B Thermal power generator	1	50→60
09:00:36	C Thermal power generator	1	90→100
09:00:36	C Thermal power generator	2	90→100
09:00:47	D Thermal power generator	1	50→60
09:00:47	D Thermal power generator	2	50→60
09:00:47	D Thermal power generator	4	50→60
09:00:47	D Thermal power generator	5	50→60
09:00:47	D Thermal power generator	6	50→60
09:00:58	H Pumped storage hydroelectric power generator		25→30
09:01:13	I Pumped storage hydroelectric power generator		0→15
09:01:40	E Thermal power generator	1	50→60
09:01:40	E Thermal power generator	3	50→60
09:01:40	E Thermal power generator	5	90→100
09:01:40	E Thermal power generator	6	90→100
09:01:52	F Thermal power generator	2	50→60
09:02:00	G Pumped storage hydroelectric power generator		30→40
09:02:03	H Pumped storage hydroelectric power generator		30→45
09:03:54	F Thermal power generator	3	90→100
09:03:54	F Thermal power generator	4	90→100
09:04:04	J Pumped storage hydroelectric power generator		0→20
09:04:50	K hydropower generation		10→30

*These output and other numbers differ from actual ones

The central load dispatching office, monitoring ever changing electricity consumption, is sending each power station detailed instructions for the output from their generators.

Because the output from generators is adjusted in response to the status of actual consumption as explained above, there will be no excess electricity.

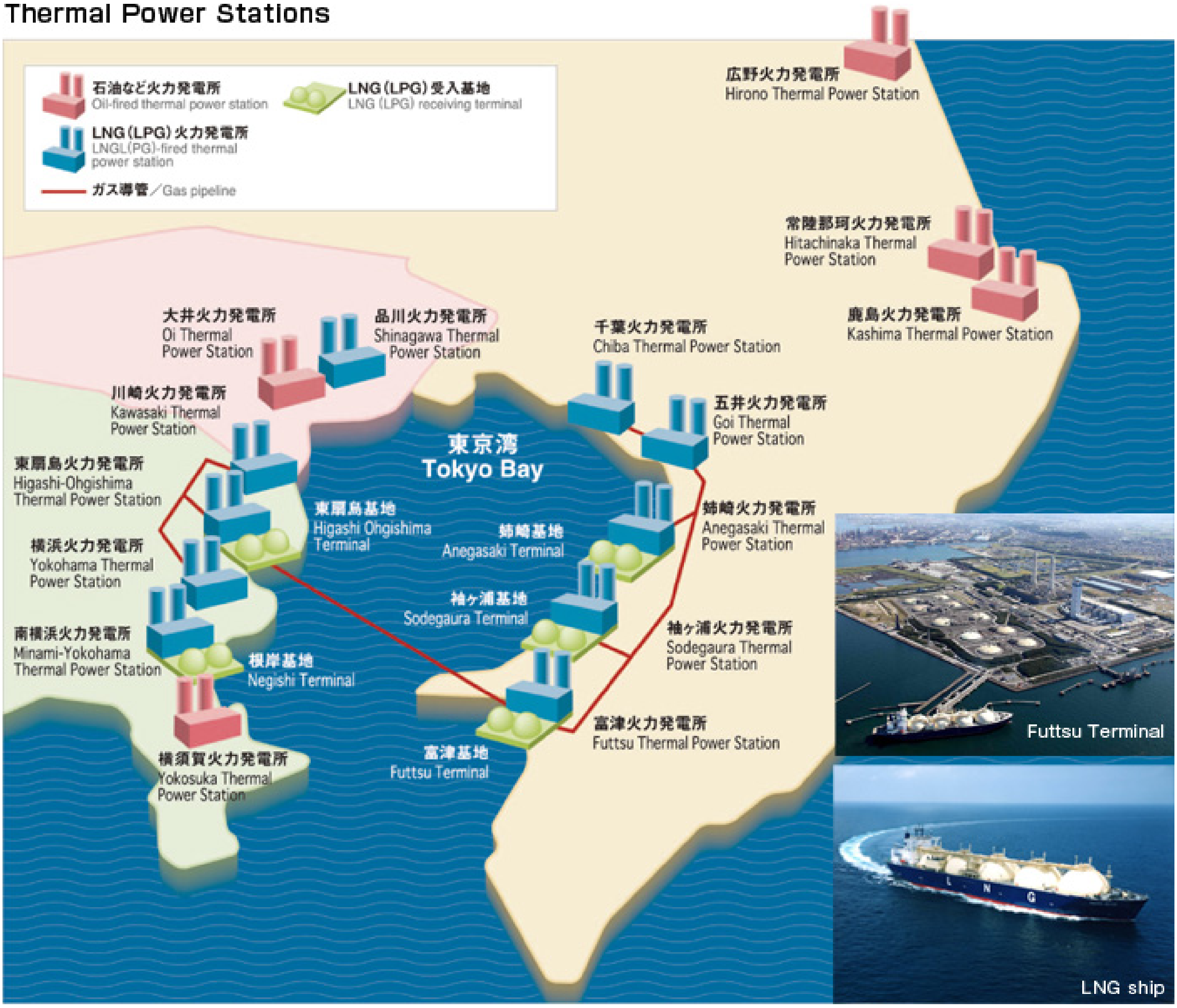
Fuel essential for thermal power generation

There are also many ways to prepare fuel

● Thermal Power Stations and Fuel Receiving Terminals

◯Thermal power stations play a central role in stably providing electricity due to its ability to handle fluctuations in usage (demand) flexibly.
◯There are currently fifteen large-scale thermal power stations along the coast. Its fuel is received via specialized tankers or pipelines.

Thermal Power Stations



Fuel essential for thermal power generation

There are also many ways to prepare fuel

Keyword Concerning Thermal Power Generation Fuels - "Diversity"

○Utilizes a variety of fuels by utilizing their characteristics

Taking into consideration economic efficiency, environmental friendliness, and procurement flexibility; combinations of LNG (liquefied natural gas), petroleum, coal, etc. are used for thermal power station fuel.

*Procurement flexibility:
Delicate changes in transaction details and contracts (such as decrease and increase in procured volume) must be possible.

Fuel Characteristics and Their Roles in Power Generation

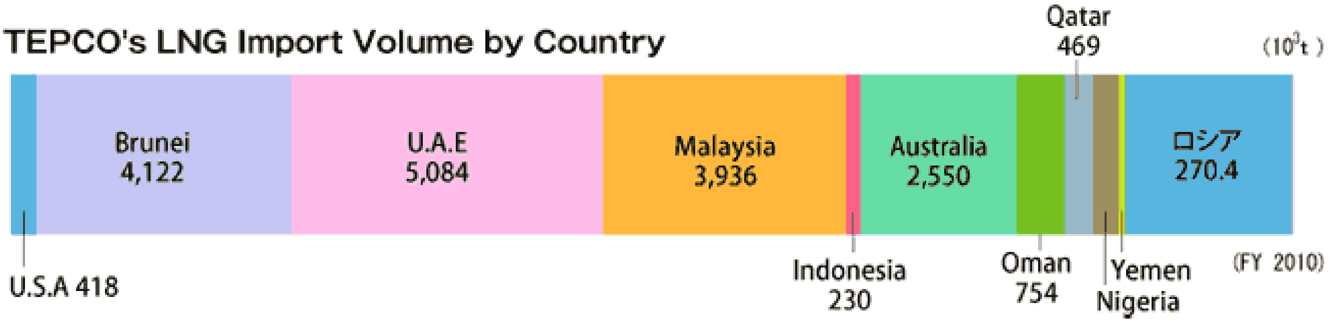
	Economic efficiency (price)	Procurement flexibility	Environmental friendliness	Roles in Power Generation
Petroleum	△	◎	○	Excellent procurement flexibility enables response to power demand that cannot be handled by LNG thermal power.
LNG	○	△	◎	Second to coal in fuel cost. This enables power generation corresponding to the power demand.
Coal	◎	○	△	Lowest fuel cost. As a base power supply, power can be generated at full output.

Changes in the Fuel Procurement Climate - Price Fluctuations

○Imported from many sources

Supplying countries, suppliers, and contract formats differ greatly depending on the type of fuel.
Because almost all of the fuel is imported from overseas, risk is spread out by not being dependent on a specific region.

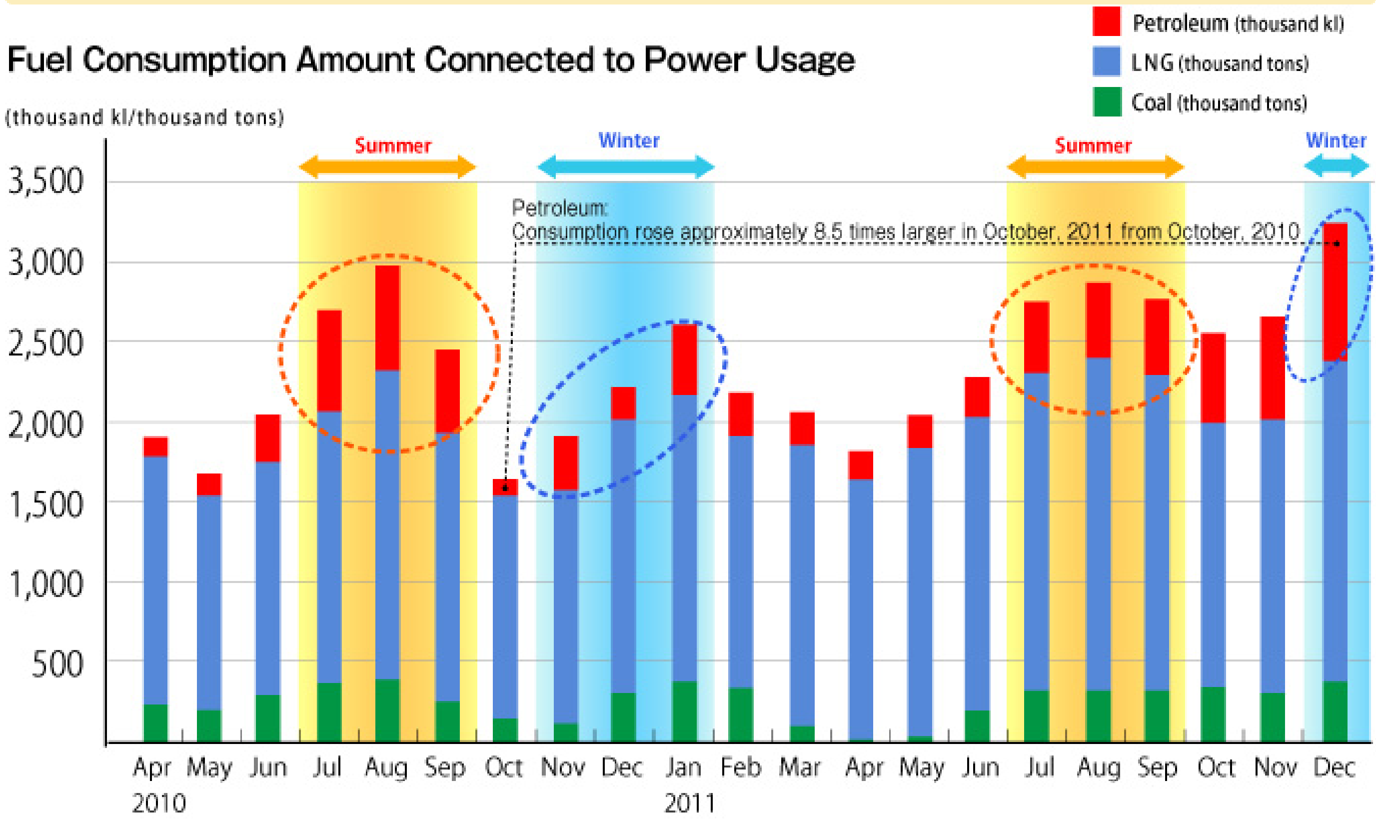
TEPCO's LNG Import Volume by Country



Another Key Factor With Regards to Fuel Preparation

- Electricity usage also varies greatly by season. Accordingly, preparation of fuel for power generation must respond to such fluctuations in demand with flexibility.
- Because thermal power generation (which uses petroleum) plays a central role in responding to fluctuations, monthly petroleum consumption has fluctuated up to approximately 8.5 times.

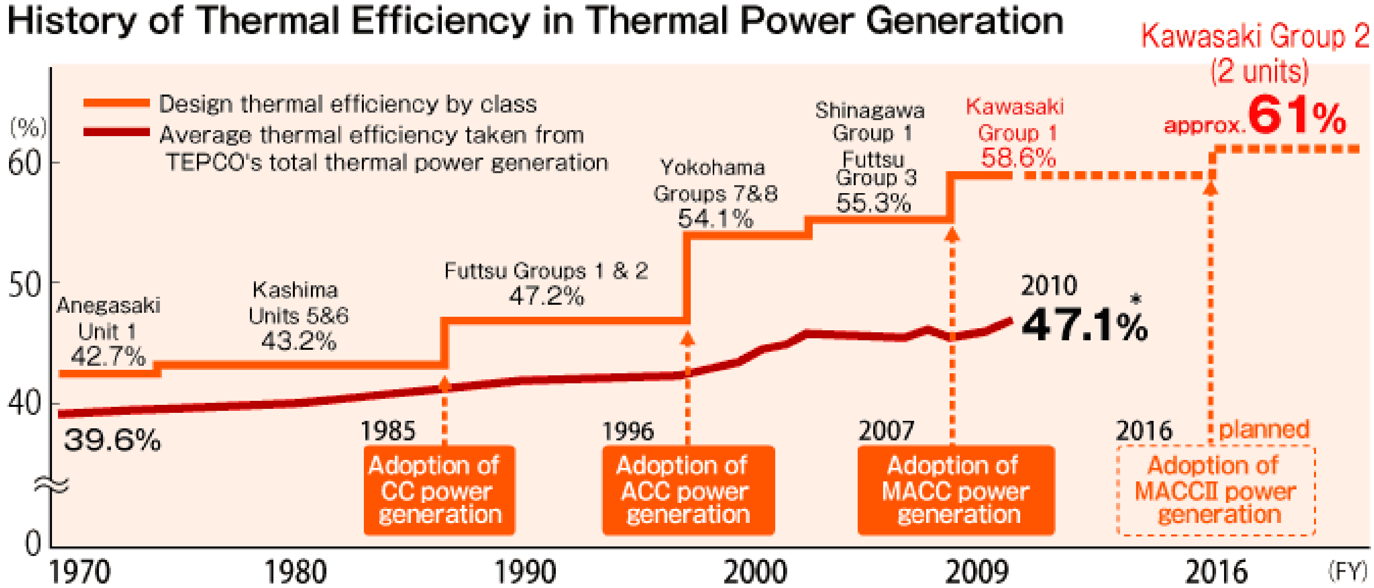
Fuel Consumption Amount Connected to Power Usage



★Column★ Using Fuel With Care - Bringing Higher Efficiency to Thermal Power Stations

◯In order to control fossil fuel consumption as much as possible, thermal power stations are working diligently to improve thermal efficiency.
They are doing so through methods such as adopting combined-cycle power generation, which is highly efficient.

History of Thermal Efficiency in Thermal Power Generation



* Lower heating values (LHV) were estimated from higher heating values (HHV), using the conversion coefficient from General Energy Statistics (FY2004).

※What is thermal efficiency?
Thermal efficiency is a numerical value used to represent power station performance.
It indicates the percentage of the consumed fuel's heat energy that was effectively converted to electricity.

◯As a result of thermal efficiency improvement efforts, we significantly reduced the fuel needed to produce the same amount of electricity.

◯Currently, MACC power generation (which has the highest thermal efficiency) can reduce fuel (LNG) consumption by approximately 25% more than conventional thermal power.

*MACCII power generation (adoption planned for 2016) is expected to reduce consumption by approximately 30% more than conventional thermal power.

Photo:
Kawasaki thermal power station

Fuel essential for thermal power generation

There are also many ways to prepare fuel

● Providing Power in a Stable Manner

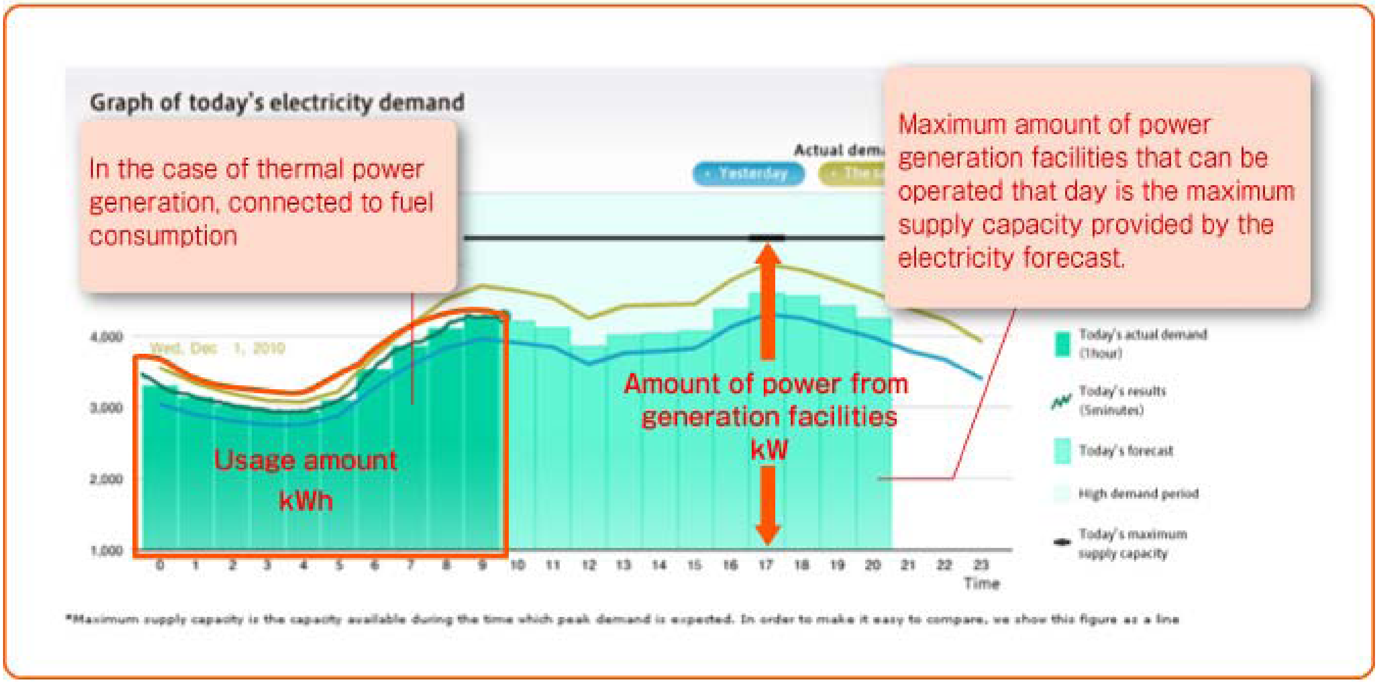
- ○In order to provide power in a stable manner, both the preparation of power generation facilities that can be operated on that day, as well as the preparation of fuel operate them are very important.
- ○Each day, the electricity forecast provides the amount of power from generation facilities (kW) available that day as the "maximum supply capacity". At the same time, stable and flexible fuel procurement that handles the power generation capacity (kWh) is also indispensable.
- ○Precisely for this reason, we conduct procurement that takes into consideration stability, flexibility, economic efficiency, and environmental friendliness; while forecasting power usage (demand fluctuations).

Careful connection of petroleum receiving equipment

From the coal storage to the power station via belt conveyor

Receiving LNG with safety as top priority

kW and kWh Provided by the Electricity Forecast



Reference Information

Necessity of blance between power supply and demand and power supply flow from power generation to customers.

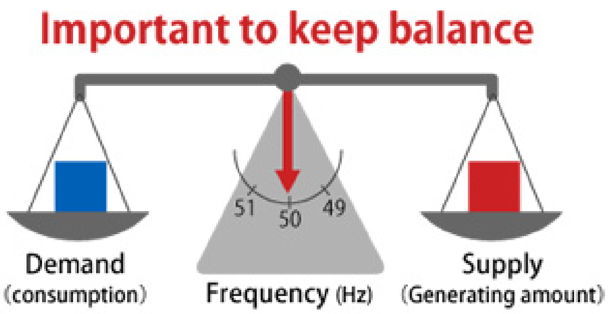
Nature of electricity

Electricity cannot be stored.

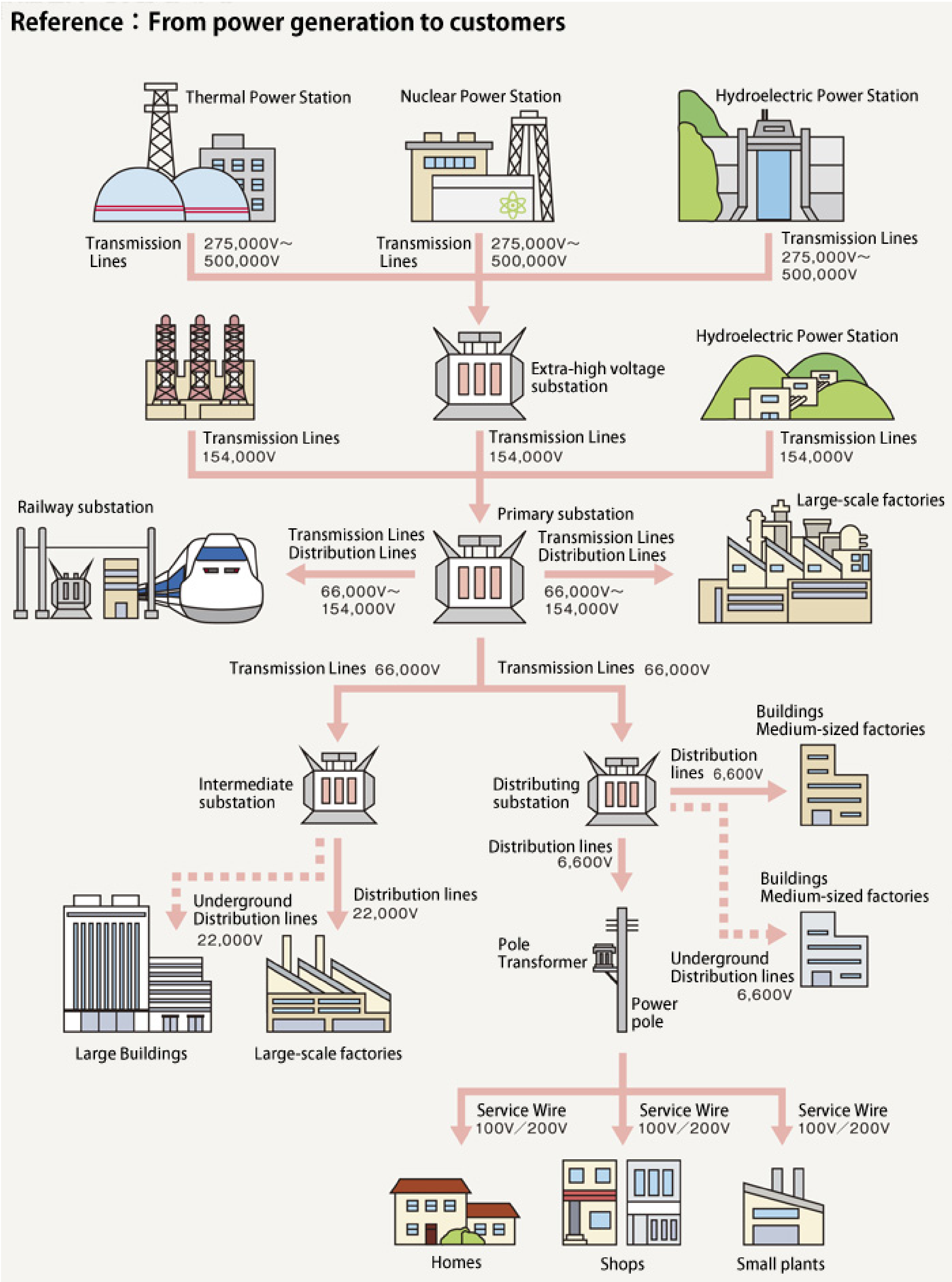
It is important to secure balance of generated amount and consumed amount.

If this balance is lost, frequency of 50 Hz, which accounts to the quality of electricity, cannot be maintained.

In order to maintain frequency, it is necessary to adjust generating capacity depending on the frequently changing demand (consumed amount), and to balance demand (consumed amount) and supply (generating amount).



From power generation to customers



Glossary

Electricity forecast related terms

"Last year's same day"
"Last year's same day" means the same day of the week of the same month and same week in a year ago, in principle.

The "Demand Forecast"
The "Demand Forecast" will be posted from December 1st to February 29th for the hours between 9:00-20:59 except on Saturdays, Sundays and Holidays.

Actual demand(1 hour)
1 hour average of maximum actual power demand

Actual demand(5 minutes)
Actual power demand in 5 minutes

Reference

$$\text{Rate of use (\%)} = \frac{\text{Amount of Electricity used (total demand)}}{\text{Amount of electricity possible to use (total supply capacity)}} \times 100$$

$$\text{Reserve capacity (\%)} = \frac{\text{Unused amount (reserved capacity)}}{\text{Amount of Electricity used (total demand)}} \times 100$$