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.

**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 8pm. 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.

*Maximum supply capacity is the capacity available during the time which peak demand is expected. In order to make it easy to compare, we show this figure as a line.

*This view is a sample image of electricity consumption.
**What is Forecasted Maximum Demand?**
Forecast of demand at peak time, forecasted by utilizing several information such as weather forecast

<table>
<thead>
<tr>
<th>Forecasted Maximum Demand</th>
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<tbody>
<tr>
<td><strong>Weather forecast</strong></td>
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<tr>
<td>(fine, cloudy, rain etc.)</td>
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<tr>
<td><strong>Temperature forecast</strong></td>
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<tr>
<td>(Highest/Lowest)</td>
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<tr>
<td><strong>Actual electricity demand in the past</strong></td>
</tr>
<tr>
<td><strong>Characteristics of the days</strong></td>
</tr>
<tr>
<td>* Difference between weekdays and holidays etc.</td>
</tr>
<tr>
<td><strong>Maximum electricity demand in a day</strong>, forecasted by considering the impact from electricity saving and business condition</td>
</tr>
</tbody>
</table>

* 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 curve 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.

Maximum Demand 5,999
Maximum Demand 5,150

FY2010
Day of max demand in summer (Jul 23)
Day of max demand in winter (Feb 14)
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

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.
Pumped storage that is active at peak time

1. Electricity generated (= power supply volume) is determined by the volume of water in the upper reservoir.
2. To 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.
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.
Why does the supply capacity change?

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

**Thermal Power Plant A**

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

(Futtsu Thermal Power Station)

**Maximum supply capacity**
Maximum amount of electricity that is available in a certain day

- **Unit 1** 250MW
- **Unit 2** 250MW → 100MW Limitation
- **Unit 3** 250MW
- **Unit 4** 250MW → 0MW Maintenance Shutdown

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

* different from the real capacity

Does not always match
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.

Diagram of Combined Cycle power generation:

- **Air**
- **Gas turbine**
  - Use of the high-temperature exhaust gas exiting the gas turbine to heat water and make steam
- **Exhaust gas**
- **Steam**
  - Use of the force of steam to turn the steam turbine
  - The generator connected to the turbines makes 36 revolutions per second and produces electricity
- **Generator**

Combustion of fuel in compressed air to turn the gas turbine with the force of the combustion gas expansion.
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**

○ 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**

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

**Power purchase from privately-owned electrical power facility**

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

*exclusively established thermal power plant in kanto region
Kirimitsu (1,130MW)
Kashima (1,400MW)

- Kanto area 16,600MW
- Hydro/ New energy 1,200MW
- Jointly established thermal power plant 2,500MW
- Waste power / biomass generation 400MW

- 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

- 6,800MW
  TEPCO used to purchase electricity from privately-owned electrical power facility in kanto region (approx. 40% of the total).

- 9,800MW
  - 3,300MW
    Procurement of Power Producer and Supplier (PPS)
  - 6,500MW
    Used for owner's operation
    Power surplus procured by TEPCO in case of non-use

- 1,400MW
  - 1,600MW
    Procured by TEPCO in the last Summer
    by restarting dormant facilities
    *1,600MW including procurement from privately-owned electrical power facility outside kanto area
    (Clean Coal Power R&D Co., Ltd.)

- 3,300MW
  Procured 3,300MW (PPS)

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

### 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

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<td>Hydro Power Plant E (pumped storage)</td>
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*Output above differs from the actual ones

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**Commentary**

- **Summer (High demand for electricity)**
- **Winter (High demand for electricity)**
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

- **Monday**: Supply capacity during peak hours is 51.7 GW due to capacity decrease of hydro power (△-0.2).
- **Tuesday**: Capacity decreases to 51.5 GW due to troubles at generators (△-1).
- **Wednesday**: Capacity reduces to 50.5 GW due to capacity decrease of hydro power (△-0.3).
- **Thursday**: Capacity increases slightly to 50.2 GW due to the restoration of generators and hydro power capacity increase (△+0.3).
- **Friday**: Supply capacity reaches 51.5 GW due to purchase from other companies (△+1) and maintenance of generator (△+1).
- **Saturday**: Capacity drops to 49.5 GW due to purchase from other companies (△-0.7).
- **Sunday**: Supply capacity is 48.8 GW due to decrease in demand.

*On weekends, as power receipt from other companies (power purchase) decreases, and maintenance works on generators, etc. are implemented during demand less weekends, supply capacity decreases.*
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.

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.

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

**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.

**Power source mix in a certain day (image)**

- Hydroelectric power
- Thermal power
- Nuclear power etc.

- Reserve capacity
- Peak demand
- Maximum supply capacity (peak time)
- Installed generation capacity

- Long-term planned shutdown due to the aging degradation,
  Trouble and failure of facilities, Decrease in hydro generation
  due to less volume of river water, etc.
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.

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.
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)

- Thermal power generators out of operation
- Pumped storage generators out of operation
- Extra output available from thermal power generators in operation
- Extra output available from pumped storage generators in operation

Start of electricity generation
Preparation time to get electricity generation equipment ready
Work required for electricity generation
Start of electricity generation
Output increase
Output increase
Seconds to Minutes
Hours to Days
Quick
Long time required
Adjusting the output from many generators for a short period of time—it is literally a race against time.

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

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Economic efficiency (price)</th>
<th>Procurement flexibility</th>
<th>Environmental friendliness</th>
<th>Roles in Power Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum</td>
<td>△</td>
<td>☺</td>
<td>☺</td>
<td>Excellent procurement flexibility enables response to power demand that cannot be handled by LNG thermal power.</td>
</tr>
<tr>
<td>LNG</td>
<td>☺</td>
<td>△</td>
<td>☺</td>
<td>Second to coal in fuel cost. This enables power generation corresponding to the power demand.</td>
</tr>
<tr>
<td>Coal</td>
<td>☺</td>
<td>☺</td>
<td>△</td>
<td>Lowest fuel cost. As a base, power supply, power can be generated at full output.</td>
</tr>
</tbody>
</table>

**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

- **Brunei**: 4,122
- **U.A.E**: 5,084
- **Malaysia**: 3,936
- **Australia**: 2,550
- **Qatar**: 469
- **Indonesia**: 230
- **Oman**: 754
- **Yemen**: 270.4

(FY 2010)
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

(THOUSAND KILOLITERS/THOUSAND TONS)

Petroleum consumption rose approximately 8.5 times larger in October 2011 from October 2010.
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

- **1970**: Aneagasaki Unit: 1 42.7%
- **1985**: Adoption of CC power generation
- **1990**: Futsu Groups 1 & 2 47.2%
- **1996**: Adoption of ACC power generation
- **2000**: Yokohama Groups 7 & 8 54.1%
- **2007**: Adoption of MACC power generation
- **2016**: Kawasaki Group 2 (2 units) approx. 61%
- **2009**: Futsu Group 3 55.3%
- **2010**: Kawasaki Group 1 53.6%

*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.
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
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

- Thermal Power Station
  - Transmission Lines 275,000V~500,000V
- Nuclear Power Station
  - Transmission Lines 275,000V~500,000V
- Hydroelectric Power Station
  - Transmission Lines 275,000V~500,000V

- Extra-high voltage substation
  - Transmission Lines 154,000V

- Railway substation
  - Transmission Lines 154,000V
  - Distribution Lines 66,000V~154,000V

- Primary substation
  - Transmission Lines 154,000V
  - Distribution Lines 66,000V~154,000V

- Intermediate substation
  - Transmission Lines 66,000V
  - Distribution Lines 22,000V

- Distributing substation
  - Distribution lines 6,000V
  - Service Wire 100V/200V

- Large Buildings
  - Underground Distribution lines 22,000V

- Large-scale factories
  - Underground Distribution lines 6,600V

- Buildings Medium-sized factories
  - Service Wire 100V/200V

- Power pole
  - Underground Distribution lines 6,600V
  - Service Wire 100V/200V

- Homes

- Shops

- Small plants
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

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

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