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# Energy system benefits

## Midono Pumped Storage Power Plant, Japan

The Midono pumped storage is one of the nine operated by the Tokyo Electric Power Company within the Nagano Prefecture, Japan, that provides a range of energy system benefits, including voltage regulation, energy storage, black starts, improved efficiency and cost effectiveness.

### Overview

Pumped storage type power plants have been a feature of Japanese electricity systems since 1930 and contribute to the stable operation of a huge power network in Kanto distinct including the Tokyo metropolitan area. Tokyo Electric Power Co., Inc. (TEPCO) has 9 pumped storage power plants with approximately 10,000 MW total capacity, including one currently under construction. These stations provide peak load power sources, storage of electric power, spinning reserve, voltage support, ability to control reactive power and black start capability for power network recovery.

Pumped storage power generation uses two adjustment reservoirs located at different altitudes and connected by conduits with reversible pump-turbines. They utilize surplus electricity generated during low-demand hours and weekends to pump water from the lower adjustment reservoir to the upper adjustment reservoir for later use during periods of peak electricity demand and/or in the event of an emergency.

The Midono pumped storage is one of the 9 operated by the Tokyo Electric Power Company and is located within the Nagano Prefecture. Commissioned in 1969/70, the power plant contains 4 turbines with an installed capacity totaling 245MW.

### Scheme Specifications

#### Dam Name

#### Scheme operator

Tokyo Electric Power Company Inc.

#### Size of scheme (MW)

245

**Country**  
Japan

**Catchment area**

**River**

**Effective reservoir capacity**  
15.1 x 10<sup>6</sup>m<sup>3</sup> (upper)  
10.7 x 10<sup>6</sup>m<sup>3</sup> (lower)

**Construction years**  
1969/70

**Reservoir size**

**External Recognition**  
Nil

## Details

The Midono Pumped storage Power Plant provides the following benefits to the Japanese energy system:

- *Peak Load Power*

During periods of peak electricity demand, it is desirable to use a power source whose fixed costs are low even if variable costs are relatively high. Pumped storage power plants are economical in terms of fixed costs as they are constructed at a low unit construction cost per kW, and comprise long-life structures such as dams and conduits. Fuel costs are low, as the pumps utilise excess electricity produced by thermal and/or nuclear power plants, which are less responsive to changes in demand. This makes pumped storage electricity the most economical peak demand option

- *Storage of Electricity*

Pumped storage power plants combine well with existing thermal and/or nuclear power plants. The latter systems are cost effective for the provision of base-load electricity. The storage of water in the upper balancing reservoir provides the capacity to efficiently increase generation when the demand for electricity peaks, without altering the operation of the less responsive thermal/nuclear plants.

- *Hot Reserve Capacity*

Pumped storages provide rapid response to changes in electricity demand that occur in the event of a power station failure, minimising interruptions to electricity supplies.

- *Phase Modification and Frequency Control Functions*

Long transmission lines result in voltage rises and falls at the receiving end when the load is low or high, respectively. This is typically managed by means of shunt reactors and power condensers at substations, but electricity utilities can also use pumped storage power plants as synchronous phase modifiers to manage this problem.

- *Power Source for Black Start*

In the event of an emergency ( e.g. a total outage due to a major accident), many power plants require a black start, to charge the transmission lines and restore the power network system. Pumped storage power plants are well suited for use as such emergency power sources because they can be activated in 3 to 5 minutes and their rates of output increase are high.

## **Other aspects**

### Resource Use

Pumped Storage Power Plants, such as Midono, can enable Power System Operators to more efficiently utilise run of river power stations by storing water for later use.

### Cost Benefits and Economic Performance

Midono Pumped Storage Power Plant enables power system operators to cost effectively deliver electricity during periods of peak demand, negating the need to excessively run the less flexible thermal and nuclear power stations.

## **Further information**

Source: Hydropower Good Practices Workshop, Annex VIII - Examples for Good Practice Report, Villach, Austria, October 2005. International Energy Agency.

<http://www.tepco.co.jp/en/index-e.html>