

Flexible engine power plants in Japan provides reliable profits and supports grid

📍 Japan

As Japan works toward a major shift in its power mix, aiming for 40-50% renewable energy by 2040, the need for flexible generation to compensate for the fluctuations from sources like wind and solar is increasing. Engine power plants deliver the flexibility needed for this balancing role.

The 100 MW Sodegaura engine power plant

An example of a gas engine power plant integrated into Japan's market is the 100 MW Sodegaura power plant. Located in Sodegaura city in the Chiba Prefecture, this plant operates with ten Wärtsilä 34SG engines. The plant was built by Tokyo Gas Engineering Solutions (TGES) and is owned and operated by its parent company, Tokyo Gas. It is used as a balancer, responding to fluctuations in renewable energy supply and electricity demand.

The Sodegaura plant plays a key role in supporting Tokyo Gas's participation in and earning revenues from both the Japanese balancing market and the newly launched capacity market.

In Japan, engine power plants can make money through stacking multiple revenue streams.



Japanese expression	English	Required response time (from command)	Duration
Balancing Category III-2	Replacement Reserve for FIT	45 min	30 min
Balancing Category III-1	Replacement Reserve	15 min	3 hrs
Balancing Category II-2	Frequency Restoration Reserve	5 min	30 min+
Balancing Category II-1	Synchronized Frequency Restoration Reserve	5 min	30 min+
Balancing Category I	Frequency Containment Reserve (FCR)	10 sec	5 min+

JEPX day-ahead and intraday markets

1.

In these spot energy markets engine power plants can respond to prices. They can serve retail demand and sell excess electricity. The revenue stream comes from dispatch payments (yen/kWh).

Balancing markets

2.

The balancing market is designed to bridge the gap between energy demand and supply caused by fluctuating renewable energy. Engine power plants can participate in all the five categories of the balancing market i.e. I, II-1, II-2, III-1 and III-2. Revenue streams include availability payments (yen/kW) and directional dispatch payments (yen/kWh).



Capacity auctions

These markets secure firm capacity years in advance:

A) The OCCTO annual capacity auctions secure capacity about four years before commissioning. Awarded payments from OCCTO auctions can be volatile. Revenue comes from annual capacity payments (yen/kW).

B) The long-term decarbonisation power source auctions (LTDA) secure capacity about two years before commissioning. The LTDA offers fixed payments for 20 years to low carbon power sources.

3.

To understand the business potential of a 100 MW engine power plant in Japan, a simulation was done using real JEPX price data from 2022 to 2024. The study found that a 100 MW engine power plant in Japan would generate average returns but can achieve modest profits during supply shortages.

For instance, during a six-month period between April 2022 and January 2023, the operating profits of the engine power plant would have earned a third of the project's total investment cost.

The expected internal rate of returns (IRRs) for the simulated 100 MW engine power plant in Japan are ~8.2% when participating in OCCTO capacity auctions, and ~5.9% under the LTDA, which is structured to ensure a minimum 5% internal rate of return over 20 years if awarded.