MITSUBISHI POWER

CASE STUDY:

GRID SIMULATION CAPABILITIES

SAVING COST AND TIME WITH DATA

Power plant investors and operators need accurate data and insights to make informed decisions. Mitsubishi Power's grid and market simulation capabilities help customers visualize complex power systems and consolidate information for grid planning and portfolio optimization. Variables that we have investigated in such studies include power plant output, power generation flexibility and projected variable renewable energy expansion.

BENEFITS OF A GRID SIMULATION

- Enables more dynamic and accurate demand-supply analysis
- Identifies opportunities for more flexible generation and higher returns

ANALYTICS FOR INVESTMENT AND PORTFOLIO PLANNING

Enabling dynamic demand-supply analysis

Today, power supply must be both reliable and decarbonized. Use of cleaner fuels and advanced technologies must be balanced with energy security. Mitsubishi Power can analyze the interrelationships among factors such as power plant upgrades, renewable energy capacity and electricity demand to help power plant operators make better decisions about their investments.

Ramping up renewables is not straightforward as doing so too quickly increases the risk of power intermittency issues. Grid stability can also be affected by sudden changes in demand, potentially overwhelming transmission infrastructure and impacting consumers. Mitsubishi Power's grid simulation capabilities can generate relevant data for operators to match mid- and long-term demand-supply capacity.

Identifying opportunities for more flexible generation and higher returns

Power systems must be able to adapt easily to changes in demand, particularly if they are significant and unforeseen, such as in the aftermath of severe weather conditions. Our grid simulation can be applied for optimal balancing of power systems as well as visualization of the impact of incorporating more renewable energy into the grid. Guided by our analysis, grid planners can build more flexibility for capacity control by enabling peak-loaders and improving fuel-efficiency.

Our simulations can show how increasing the flexibility of fossil-fuel dependent power plants can influence renewable energy curtailment and even help to project the number of new power plants needed, thereby avoiding power plant overcapacity and reducing capital expenditure. Modeling the power market also makes it possible to evaluate the value and return of investment in power systems, including those for renewables.

"We can generate relevant data for operators to match mid- and long-term demand-supply capacity."

REAL-WORLD APPLICATIONS

Mitsubishi Power has conducted grid simulations that looked at capacity, costs and curtailment for several countries and regions, including Indonesia, Taiwan and Vietnam.

Indonesia

Mitsubishi Power examined how modifying capacity of gas turbines at two plants in Indonesia – Muara Karang and Tanjong Priok – would affect utilization rate and revenue. The simulation calculated the financial benefits of upgrading these power plants to achieve higher capacities, thus providing a model for power plant operators and investors to reference as they seek to balance gains in capacity with the EPC cost incurred for such upgrades.

In the model, values were assigned to denote financial benefit, with higher values signifying higher benefit. Profitability was highest when the capacity of Muara Karang was upgraded from 450 MW to 800 MW and the two units at Tanjung Priok were upgraded with capacities almost similar to current levels at 600 MW each. Other permutations of capacity expansion resulted in flat or even lower returns of investment from the base case.

Power Plant	Output of Power Plant [MW]			
	Case 1	Case 2	Case 3	Case 4
Muara Karang	600	600	800	800
Tanjung Priok	600x2	800x2	600x2	800x2

This phenomenon can be explained by the use of grid congestion variables in the model, which incorporates detailed transmission lines. Muara Karang was less influenced by grid congestion (usually due to larger capacity of neighboring transmission lines) so that the unit with larger capacity gained more income. On the other hand, Tanjong Priok was more affected by grid congestion and the unit with larger capacity could not transmit enough electricity, resulting in less income.

	Case 1	Case 2	Case 3	Case 4
Total Output [MW]	1,800	2,200	2,000	2,400
Total EPC Price [Million $]	900	1,020	960	1,080
Relative Comparison of 20-Year Rate of Return	1	0.596	1.069	0.905

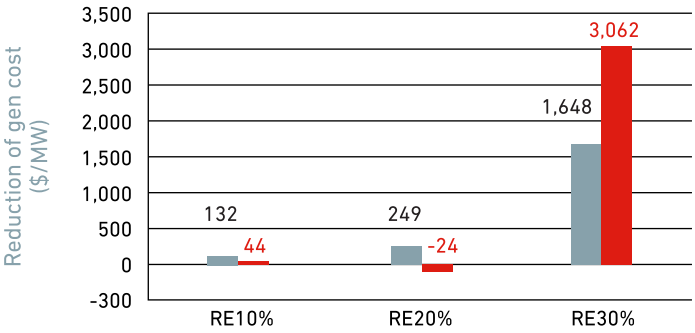
MHI is leading the market in constructing such grid models (called Nodal models) for more than 10 countries, including recent Nodal models for grids in the UK, Philippines and Vietnam.

Taiwan

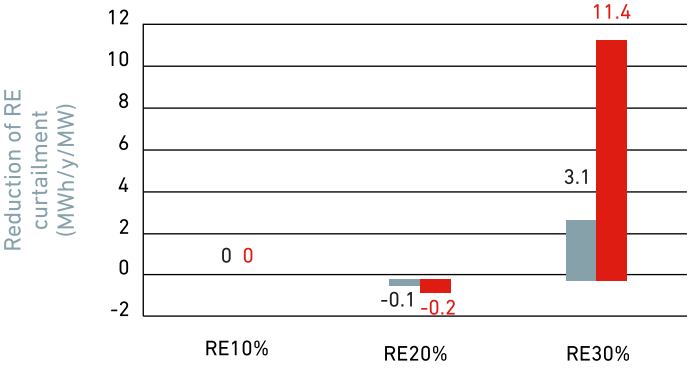
Mitsubishi Power ran a simulation to evaluate the effect of integrating increasing levels of renewable energy into the grid, with the aim of determining the best cost-optimized system to take advantage of existing assets when renewable energy is expanded. The simulation assumed flexibility upgrades to some gas-fired and coal-fired units in Taiwan, then compared the costs and benefits of running variable renewable energy (VRE) in the grid at either 10%, 20% or 30% (represented as RE10%, RE20% and RE30%), alongside those upgraded power plants.

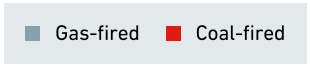
With the upgraded gas-fired systems, total electricity generation costs fell at all levels of renewable energy, with a peak of $1,648/MW reduction at 30% renewables. With the upgraded coal-fired systems, the cost reduction was also most marked at 30% renewables. This was because coal-fired units had higher efficiency at that level of renewables and could also reduce curtailment as coal-fired units are operated more frequently than the gas-fired units during the day.

Reduction in total generation costs



Reduction in RE curtailment





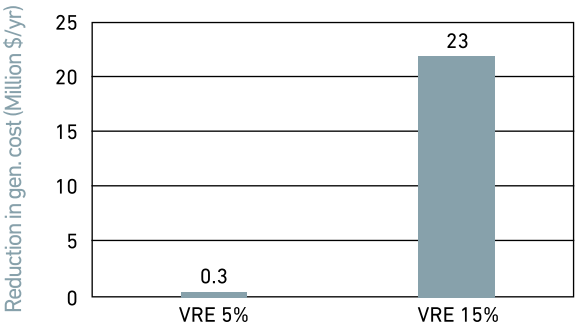
[1] Renewable energy curtailment is the deliberate reduction in output below possible production to balance energy supply and demand or due to transmission constraints, while VRE refers renewable energy sources not dispatchable due to their fluctuating nature, such as solar power. In this study, the VRE sources in 2030 were PV, wind, hydropower and bioenergy.

Vietnam

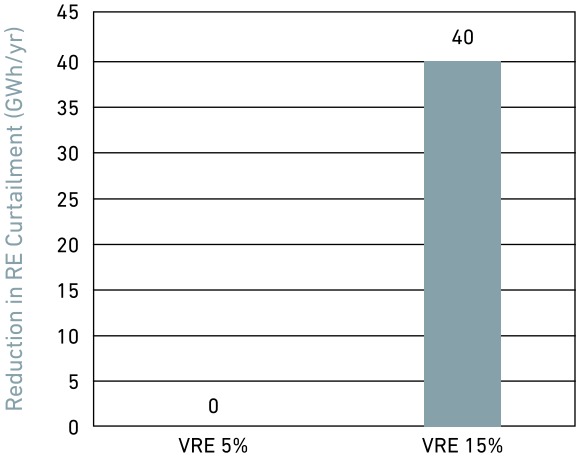
Mitsubishi Power conducted a study on gas-fired power plants in Vietnam to compare the total generation cost and renewable energy curtailment if the plants were upgraded to be more flexible and operated with different levels of variable renewable energy (VRE) in the grid.

Total generation costs fell the most with the higher VRE ratio (15%). Renewable energy curtailment also rose the most at 15% VRE. The simulation showed that upgrading gas plants would be best at 15% VRE instead of 5%, a data point potentially helpful in capital budgeting discussions for plant upgrades.

Reduction in total generation costs



Reduction in RE curtailment



About Mitsubishi Power Asia Pacific

Mitsubishi Power is a power solutions brand of Mitsubishi Heavy Industries, Ltd. (MHI).

Mitsubishi Power's products enable the decarbonization of energy and delivery of reliable power to more than 30 countries around the world.

Mitsubishi Power Asia Pacific Pte. Ltd. is headquartered in Singapore and supports business growth in key markets such as Bangladesh, Indonesia, Malaysia, the Philippines, Thailand and Vietnam. With more than five decades of experience in the region and over 2,000 employees, the company applies its deep knowledge of Asia Pacific's evolving energy needs to help power the region's development. Through its cutting-edge technologies, best-in-class products and strategic local partnerships, it is paving the way for countries, economies and communities in the region to transition to a low-carbon and sustainable energy future.