

# NAS Batteries: Harnessing renewables through ceramics

As demand for large-scale electricity storage gathers momentum, various rival technologies are jostling to capture market share. NGK president Taku Oshima explains how, with more than 10 years of proven commercial use, NGK's unique NAS<sup>®</sup> system is an ideal choice for grid-scale power storage.

With climate change a pressing concern, governments in Europe, North America, and Asia have been rushing to mandate the expansion of renewable energies, particularly solar and wind. These power sources, however, are notoriously unstable. Unlike thermal power, solar and wind—depending on weather conditions and time of day—are intermittent sources of electricity. This means that renewable producers risk wasteful over-generation and shortages of output that can destabilise the grid.

The key is to develop reliable, large-scale electricity storage systems that can store surplus electricity and release that power into the grid as needed. NGK's NAS system is a promising contender for this emerging market for energy storage technologies. NGK developed its large-scale battery system in the mid-1980s and put it into commercial use in 2002. Since then, NAS systems have been set up worldwide at over 190 locations. Combined, they provide 530 megawatts (MW) of output power and 3,700 megawatt-hours (MWh) of storage capacity.

## A Mature and Cost-Effective Technology

NGK developed its unique NAS battery, which is made of sodium (Na) and sulfur (S) electrodes separated by a fine ceramic electrolyte, based on its expertise in ceramics

manufacturing. The battery features a number of advantages: scalability, constancy of up to six hours or more of high electric power output, and durability of as many as 4,500 discharge cycles over 15 years. In addition, NAS batteries are compact, allowing for rapid and cost-effective deployment, and boast safety features proven through extensive field experience.

NGK's NAS systems, moreover, are the only grid-scale battery storage with over 10 years of commercial operation. NGK's NAS batteries are currently being used by 160 customers in Japan, providing an overall capacity of 250 MW for load levelling purposes. This is roughly equivalent to the load levelling generated by one pumped hydro facility. And in total costs per kilowatt-hour (KWh), NGK's technology has proven to be far less expensive than key rival battery technologies, such as lithium-ion or redox flow batteries.

NGK president Oshima believes that NAS batteries could become even more cost-effective. "We have been improving production efficiency and should be able, with sufficient and stable demand in the future, to lower the cost of NAS batteries to as low as that of pumped hydro, or around 23,000 JPY per KWh."

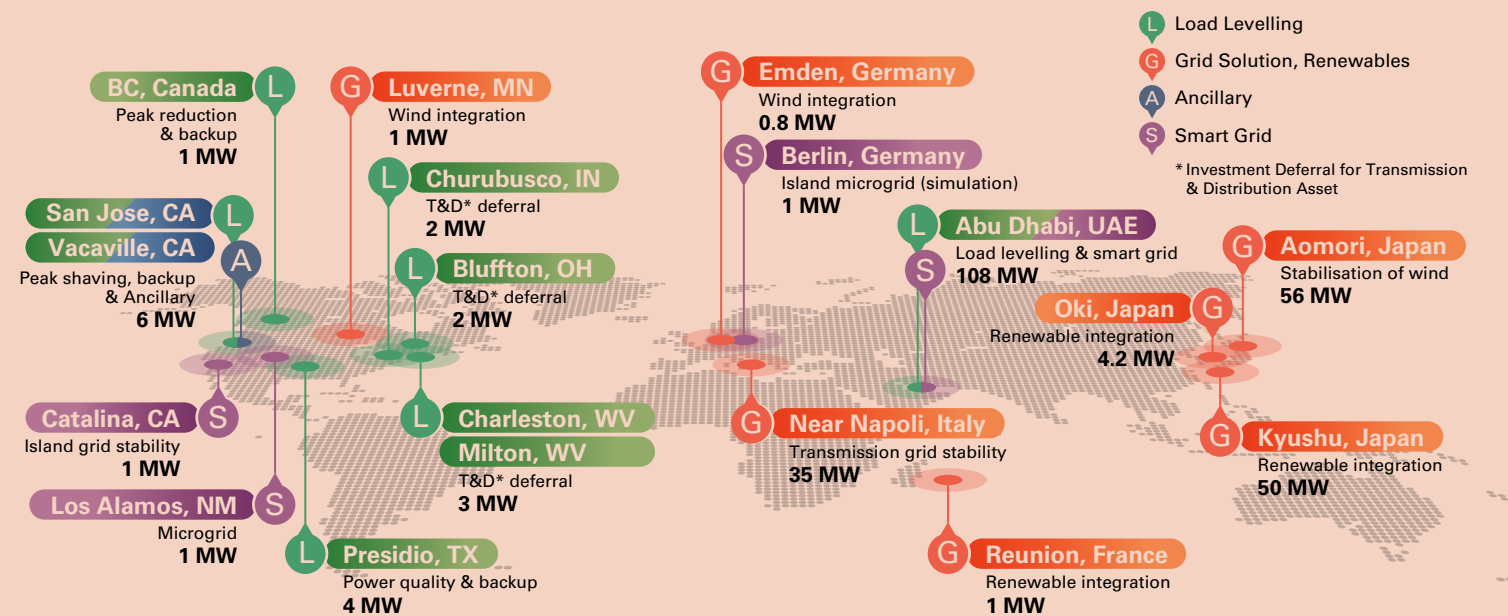
## From Renewables to Smart Grids

NAS systems have been deployed to meet diverse needs around the world. Facilities offering 108 MW of storage are being used in Abu Dhabi for the load levelling of thermal generation. In Italy, 35 MW NAS facilities operated by Terna store the surging supply of renewable energy generated in the south of that country for transmission across the grid to the large power users in the north, thereby reducing transmission congestion and the curtailment of renewables in the Italian grid.

NGK's NAS systems are also found at various wind and solar stabilisation sites

## NAS systems are the #1 choice worldwide

3,700 megawatt-hours effectively stored and utilised in 190 locations



NGK's NAS system is the world leader in grid-scale battery storage. The cumulative field experience of NAS systems far surpasses that of every other grid-scale battery system. NGK's NAS systems have been deployed for over 20 years, at over 200 projects, with total deployments of 3.7 GWh and 530 MW.

globally, including at the world's largest energy storage site in Kyushu, operated by Kyushu Electric Power. The Kyushu system was delivered by prime contractor Mitsubishi Electric and has output power of 50 MW and storage capacity of 300 MWh, equivalent to the needs of 30,000 households.

NAS systems also provide highly effective support for small grids, including microgrids, island grids, and remote location grids, that cannot depend on system-wide power to balance instability in energy generated from renewables. Notable is the system on the Oki Islands grid operated by Chugoku Electric Power, which was also delivered by Mitsubishi Electric. It is a unique, advanced hybrid system that combines NAS batteries' long-term output advantages and lithium-ion batteries' short-term output strengths. Among remote sites, a NAS system installed in a national park in British Columbia, Canada, provides 76 hours of clean backup power, or a maximum consecutive supply of 23.5 hours, for the local community during numerous outages.

## The Storage Market

The energy storage market for stabilising renewables, which includes technologies such as NAS batteries, is gathering momentum.

There is pressing need to soak up over-generation and to stabilise intermittent output, especially in the rapidly expanding renewables markets in Japan, Canada, the United States, Italy, Germany, and the Nordic countries.

Oshima explains that the key to market growth is whether governments agree not only to back the generation of renewable energy, as they are now, but also to develop policy supporting the further installation of energy storage. He believes that in the next few years the pressures and demands for storage will become inexorable. A number of projects backed by government funding, including facilities in Italy and Japan using NAS systems, point to the future.

## Leading the Pack

Currently, 99 per cent of stored energy capacity is in pumped hydro, but hydropower technology is constrained by geography and the cost and time to build a dam. Battery technologies for large-scale energy storage do not face such constraints and have lower initial investment costs. Containerised NAS systems, moreover, are readily deployable to meet surging renewables production of the sort occurring in many Western electricity markets. The world's largest NAS battery

storage system in Kyushu was deployed within six months of NGK receiving the order. That rapid delivery aided the local utility company to respond quickly to the run-away growth in its market of solar energy production.

Other new battery technologies, such as redox flow and lithium-ion batteries, are also vying for the emerging market. Redox flow batteries, though competitive in terms of power capacity, have lower energy density and higher costs than NAS batteries. Lithium-ion batteries, meanwhile, are not suitable for grid-scale, long-term energy storage. In addition, lithium is expensive to process, and global users recently have been scrambling to acquire supply, further pushing up lithium prices.

Originally developed for pumped hydro-electric storage in urban areas, NAS batteries are compact, scalable, low cost, and high capacity. They are therefore ideally suited for large-scale energy storage.

"As renewables expand globally, large-scale storage batteries will become a vital infrastructure to provide stable power to society," Oshima says. "With their outstanding track record and reliability, we expect NAS batteries to lead the pack in this future market."



The World's largest NAS battery storage system at Kyushu Electric Power