Sodium-Sulphur (NaS) Battery

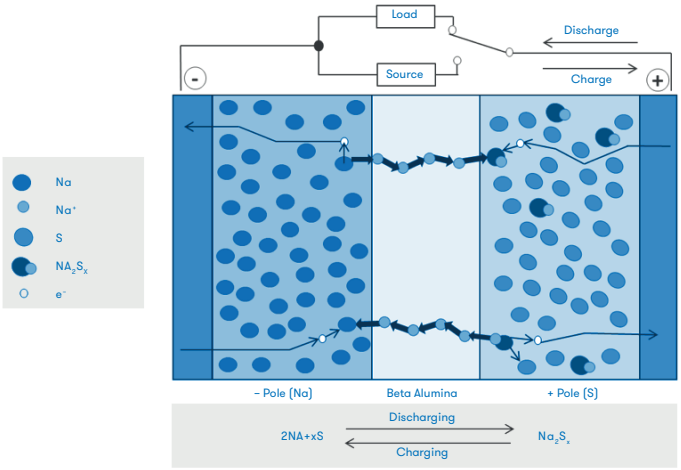
European Association for Storage of Energy

Electrochemical Energy Storage

1. Technical description

A. Physical principles

A sodium-sulphur (NaS) battery system is an energy storage system based on electrochemical charge/discharge reactions that occur between a positive electrode (cathode) that is typically made of molten sulphur (S) and a negative electrode (anode) that is typically made of molten sodium (Na). The electrodes are separated by a solid ceramic, sodium beta alumina, which also serves as the electrolyte. This ceramic allows only positively charged sodium ions to pass through. The battery temperature is kept between 300° C and 360° C to keep the electrodes in a molten state, i.e. independent heaters are part of the battery system.



B. Important components

The main components are the following:

- Elementary cell composed of electrodes, electrolyte and separator
- Modules
- Battery systems composed of a large assembling of modules and of a control system
- Power Conversion System (PCS)

C. Key performance data

Power range	200kW to 50 MW
Energy range	1.2 MWh to 400 MWh
Discharge time	6h at nominal power
Cycle life	Min. 4500 cycles
Life duration	15-20 years
Response time	Some millisec (if hot)
Efficiency	70-80 %*
Energy density	206 Wh/kg
CAPEX: energy	300-450€/kWh
CAPEX: power	2000-3000 €/kW

* The battery system auxiliary consumption for heating is not included in DC/DC round trip calculation.

D. Design variants

Different battery systems are possible according to the size, ranging from a case up to a container.

2. State of the art

Since around 1990, Na/-S batteries have been manufactured in Japan. Twenty modules of typically 50 kW and 300 to 360 kWh are combined into one battery, resulting in a minimal commercial power and energy range in the order of 1 MW and 6-7 MWh. NGK has developed a new design, in which 6 modules of 33kW/200kWh are combined in one 20-foot container. The minimal commercial power and energy range are 200kW and 1.2MWh, respectively.

NaS battery technology has been demonstrated at over 200 sites. More than 559 MW of stored energy suitable for 6-7 hours of daily peak shaving have been installed. The world's largest NaS installation came into operation in March 2016: a 50 MW/300 Mwh system installed in Buzen City, Fukuoka, Japan for peak shaving and balancing of solar power. Other notable projects include a 35 MW system commissioned by Terna in Italy in 2015 and a 108 MW system in Abu Dhabi.

To prevent fire incidents, a number of safety enhancement measures have been implemented, reaching from fuses and insulation boards to fire prevention and firefighting measures.

3. Future developments

Companies are working to achieve a longer cycle life (in years and number of cycles) as well as a larger discharge time range (4- 8 hours).

4. Relevance in Europe

While most of the installed base of NaS batteries is in Japan and in the USA, the first European projects have been installed in Reunion Island (France), Germany, and the UK.

The strategic relevance of the NaS technology remains peak-shaving or other energy intensive applications. Those applications are essential for transmission and distribution investment deferral or avoidance in continental grids and to avoid fuel costs of peak generation units in island on-grid applications.

5. Applications

Because of the operating temperature and the highly corrosive nature of the sodium polysulphides, NaS batteries are primarily suitable for large-scale non-mobile applications such as grid energy storage. Main applications include:


Stabilisation of wind farms and solar generation plants


Peak shaving


Time shifting

6. Sources of information

- NGK Europe
- ENEA Consulting
- ISEA RWTH Aachen
- A Review of Energy Storage Technologies (David Connolly, University of Limerick)