NGK Europe GmbH
a subsidiary of NGK Insulators, Ltd.

NAS batteries

World Bank Group - ESMAP
stakeholder consultation of the Energy Storage Partnership (ESP)
energy storage technology updates and feedback on global testing network
November 18th, 2020
NGK Insulators, Ltd.  

we create new value and contribute to the quality of life through **ceramic technologies**

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**material**
- thorough familiarity with mechanical, thermal, electrical, and physical properties of ceramics
- controlling ceramic pore size, crystal orientation, thermal conductivity, ion conductivity, and electrical resistance

**process**
- molding, firing and processing a variety of ceramic structures
- binding differing materials
- develop and manufacture various configurations from fine and complex three-dimensional shapes to one of the largest porcelain in the world (11.5m)

**production**
- development of our own techniques and equipment know-how for mass production manufacturing
- reduced power consumption by 30-50%
- analysis of big data into production management
- rapid incorporation of innovation in manufacturing

**evaluation & analytics**
- continuous learning from manufacturing experience
- advanced computer simulation
- image inspection for slightest defects detection

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NGK NAS batteries – WB ESP stakeholder consultation – 18.11.2020 - 2
NGK NAS® systems

Package unit 1.2MW / 8.64MWh

20 feet container 250kW / 1.45MWh

cell

module

X 224

X 192

X 40

X 6
### Our cell

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open circuit voltage</td>
<td>2.08V</td>
</tr>
<tr>
<td>Capacity</td>
<td>725 Ah</td>
</tr>
<tr>
<td>Energy density</td>
<td>414 Wh/l</td>
</tr>
<tr>
<td>Theoretical max. energy density</td>
<td>1000 Wh/l</td>
</tr>
<tr>
<td>Power density</td>
<td>38 W/kg</td>
</tr>
<tr>
<td>C-rate</td>
<td>1/6</td>
</tr>
<tr>
<td>Optimal temperature range</td>
<td>300°C - 340°C</td>
</tr>
<tr>
<td>Maximal temperature range</td>
<td>290°C - 360°C</td>
</tr>
<tr>
<td>Expected lifetime</td>
<td>4500 cycles / 15 years</td>
</tr>
<tr>
<td>Partial cycle</td>
<td>No memory effect</td>
</tr>
<tr>
<td>Self discharge</td>
<td>Heating when not discharged regularly</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Ø 9 cm / 5.3 kg / 54 cm</td>
</tr>
</tbody>
</table>

**Image:**
- [Image of NGK NAS batteries](image-url)
operation principle

during discharge
- **molten sodium** donates electrons to the external circuit at the anode
- the resulting ions $\text{Na}^+$ migrate to the cathode through the $\beta$-alumina solid electrolyte that separates the two liquid electrodes and that acts as a superionic conductors
- the volume of liquid at the anode therefore decreases
- arriving at the cathode, $\text{Na}^+$ ions combines with molten sulfur or nickel chloride which reacts with the electrons coming from the external circuit
- the volume at the cathode therefore increases

$$2 \text{Na} + x \text{S} \rightarrow \text{Na}_2\text{S}_x \text{ with } 3.3 \leq x \leq 5$$

or $$2 \text{Na} + \text{NiCl}_2 \rightarrow \text{Ni} + \text{NaCl}$$

during charge
- the reverse process takes place
characteristics

- abundant and cheap material
- no self discharge
- no memory effects
- long life
- very low degradation
- fast response
- high energy density
- compact system
- climate resilient
- no air conditioning
- minimal maintenance
- fully recyclable or reusable
NGK NAS batteries

600 MW / 4 GWh

India
200kW

≤ 1MW

≤ 5MW

≤ 35MW

≤ 50MW

≤ 150MW

> 150 MW

more than one location

Abu Dhabi
108MW

Belgium
200kW

Italy
34.8MW

Dubai
1.2MW

Nanjing
200kW

Jeju island
200kW

Buzen
50MW

TePCO's clients

Aomori
56MW

Hokkaido
18MW

North America
22MW

More than one location

La Réunion
1MW

Germany
6MW

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1MW

Germany
6MW
Abu Dhabi

108MW / 648MWh

- 12 x 4MW + 3 x 20MW
- 15 systems
- 10 locations
- 11 ISC

centralised control

- Centralized Integrated System Controller (CISC)
- monitors and controls all systems as one single plant
- multipurpose

national strategy

- long duration storage is a strategic component of the smart grid
- and contribute to the sustainability ambitions of the Emirate

the landmark system

- 2 x 20MW in one location
- 240 MWh
- 65 x 120m (fence)
- PV contributing to auxiliaries supply
NAS helps to produce 100% green hydrogen in South Korea

- to provide stable power supply to electrolysers from 100% wind energy
- NAS was preferred to locally manufactured lithium-ion batteries because it
  - is safer
  - has demonstrated longer life time and lower degradation in many projects over the last 16 years
  - is price competitive

a G-Philos project on Jeju island with BASF New Business GmbH
With ceramics,
we can create a brighter future for energy.
we can safeguard the environment and society.

Thank you for your attention

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