



NAS[®] Battery for Stationary Energy Storage

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India

 - **BASF**

We create chemistry

BASF Group: Facts & figures

BASF at a glance

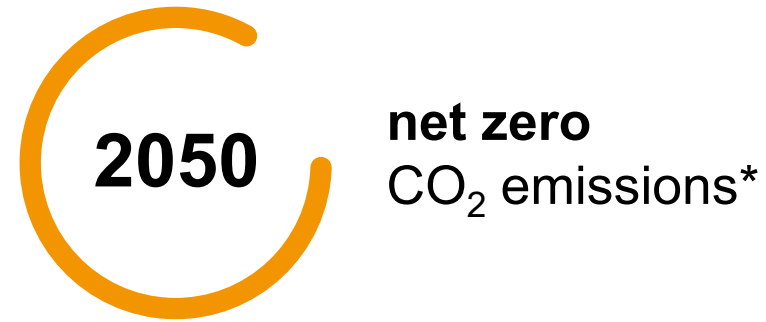
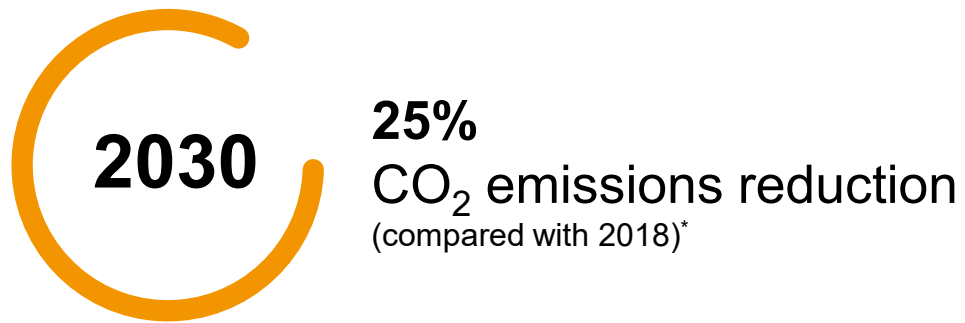
- Our chemistry is used in almost all industries.
- We combine economic success, social responsibility and environmental protection.
- Sales 2023: €68.9 billion
- EBIT before special items 2023: €3.8 billion
- Employees (as of December 31, 2023): 111,991
- 6 “Verbund” sites and 234 other production sites
- Around 80,000 customers from various sectors in almost every country in the world



We create chemistry for a sustainable future

BASF's journey to net zero 2050

BASF's emission targets



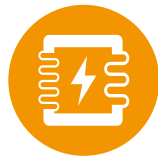
Our five strategic levers



Grey-
to-green



Power-
to-steam



New
technologies



Bio-based
feedstocks



Continuous
OPEX

Energy storage @ BASF

Batteries @ BASF

BASF is active in batteries on different levels of the value chain and with different technologies

Cathode materials for Li ion batteries (LIB) with focus on e-mobility

- BASF is investing into plants for cathode materials for LIB in Germany, Finland and China (as JV with Shanshan). Another production site is planned in Canada.

Battery materials recycling

- BASF will build a commercial scale battery recycling black mass plant in Schwarzheide, Germany

Sodium-sulfur (NAS[®]) batteries for stationary energy storage

- BASF is an exclusive distributor of NAS[®] Batteries, produced by NGK Insulators, Ltd, Japan, globally (except for Japan, UAE, Hungary, Taiwan)
- BASF Stationary Energy Storage GmbH is responsible for building up NAS[®] Batteries business at BASF



Joint forces for a brighter future

Strategic cooperation on sodium-sulfur (NAS[®]) batteries



Competence in ceramic,
experience in
**manufacturing and
deployment of NAS[®]
batteries**, >20 years` track
record



Years of R&D on sodium-
sulfur battery
technologies,
competence in production
**scale up, global
organization & sales
network**

**Sales
Partnership
Agreement**

**Joint
Development
Agreement**



NAS[®] Battery:

Key features

NAS[®] Battery: key features

6-8 hours duration



life time ~ 20 years



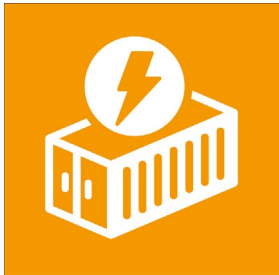
safe & reliable



**environmentally
benign**



high energy density



fast response



climate resilient

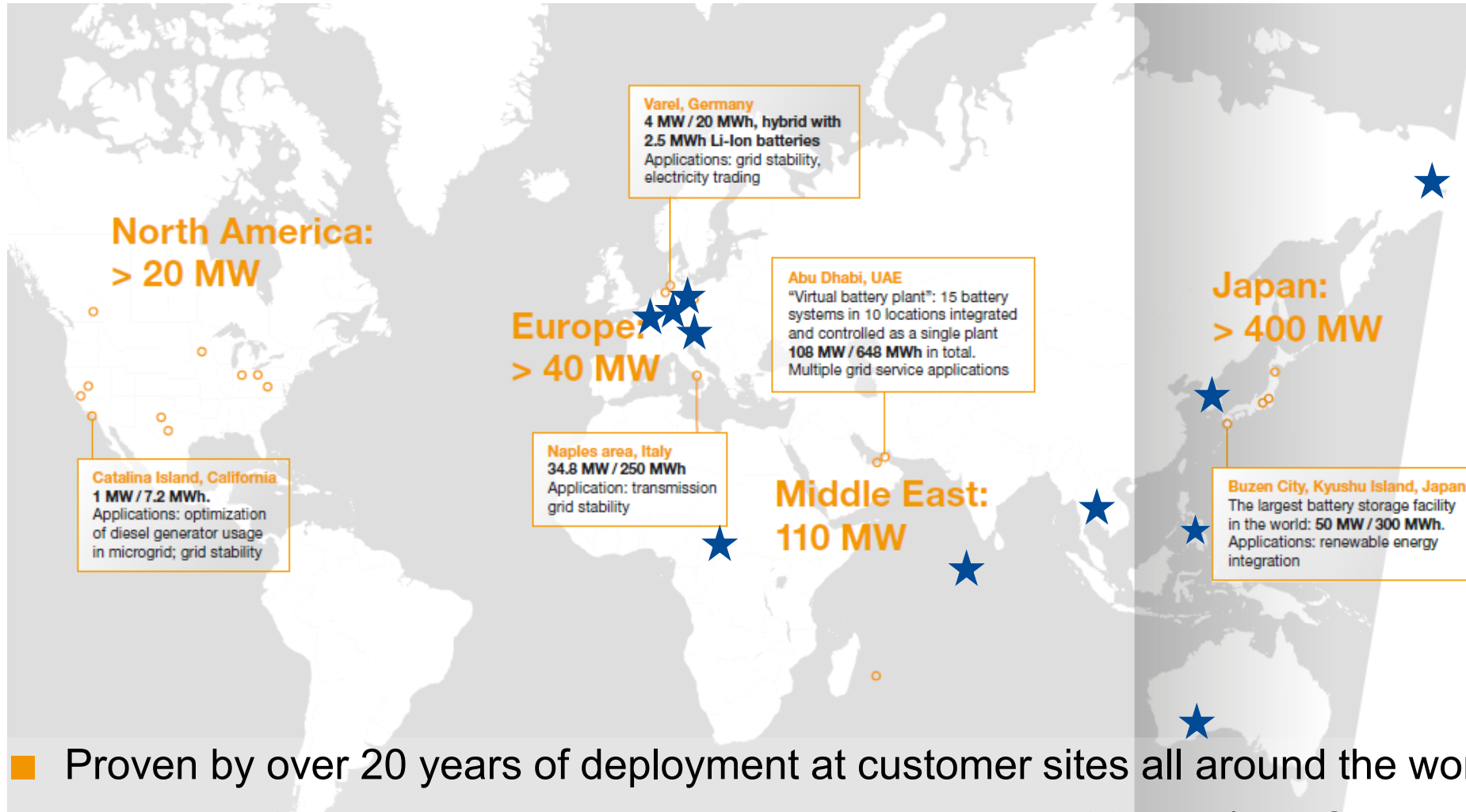


low maintenance



NAS[®] Battery: References

NAS[®] Battery: installation record



★ projects realized by BSES

- Proven by over 20 years of deployment at customer sites all around the world
- More than 250 projects with a total output exceeding 720 MW / 4,9 GWh

NAS[®] Battery: Applications

NAS[®] Batteries applications in various energy market segments



Power generation

- Renewable stabilization
- Fossil fuel peaker plants replacement

Grid solutions

- Investment deferral
- Ancillary services

Consumers

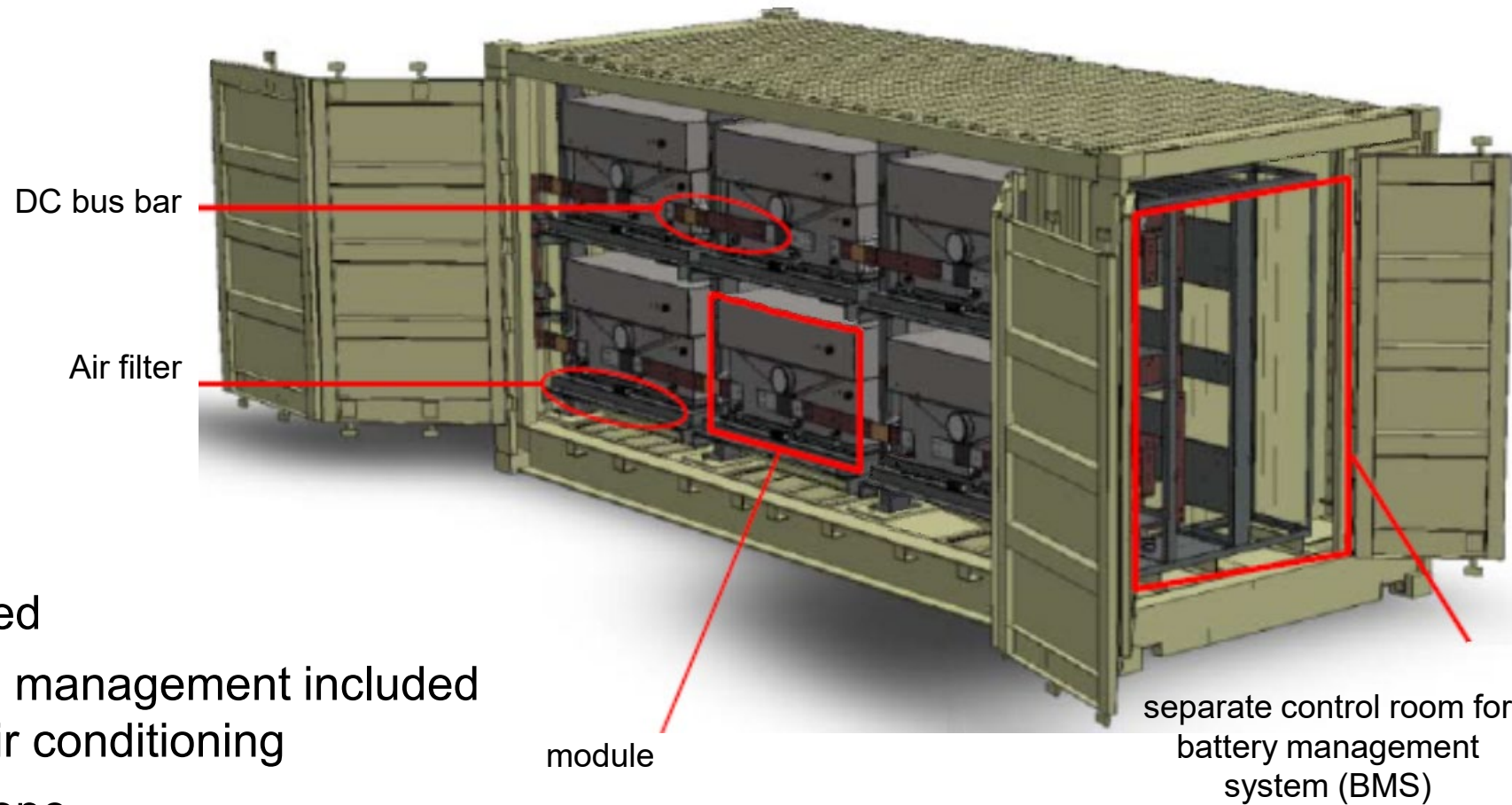
- Peak shaving
- Time of use shift
- Back up power and resilience
- Demand response

Microgrids

- Optimization of fossil fuel use
- 24/7 power supply with solar

NAS[®] Battery: System design

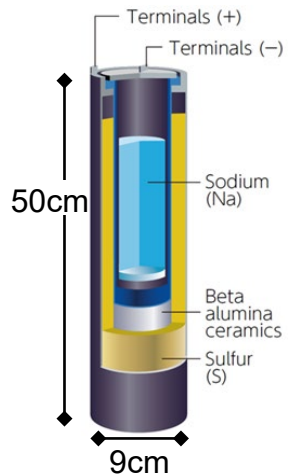
NAS[®] Battery System: containerized solution



- 20ft container
- BMS is included
- Active thermal management included
=> no extra air conditioning
- PCS not in scope

NAS[®] Battery system design

Battery cell



- 1.2kWh / 5.3kg
- ~2V
- C-rate 1/6 (0.17)
- Operation temperature: 290°C – 360°C
- Life time: 7300 cycles or 20 years

Battery module



- 33kW / 245kWh (max. 42kW)

Battery container



- 20 feet container / 21 ton
- max. 250kW / 1.45MWh

NAS[®] Battery: enhanced safety features

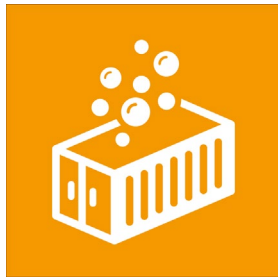
Fire exposure



890°C for 35 min.

- no material leakage
- no fire inside
- no cell damage

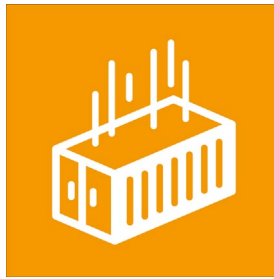
Submerge



3 days in water

- no material leakage
- no fire
- no cell damage

Module drop



2.3to from 3.1m

- deformation at point of contact
- module enclosure damaged but no cell damage
- no material leakage
- no fire

Short circuit



6.4kA

- internal fuse activated within 800ms
- no material leakage
- no fire
- no cell damage

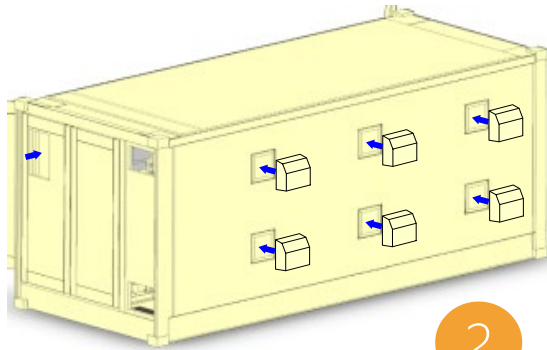
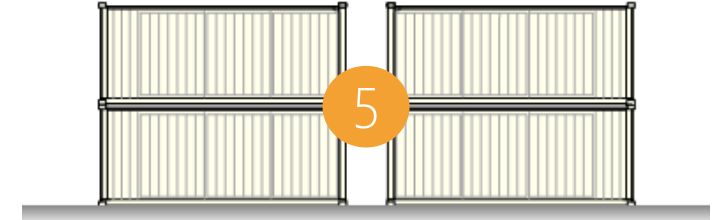
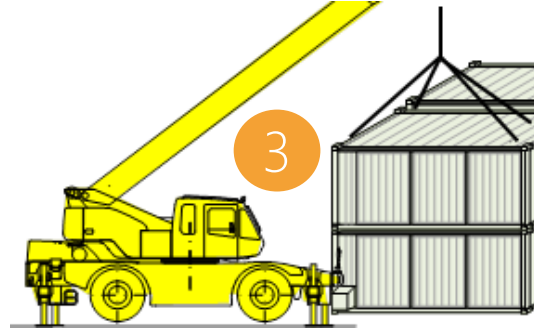
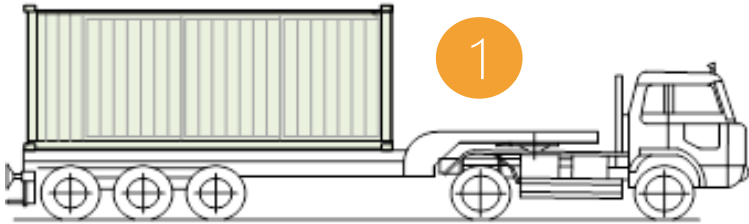
Self-extinguish



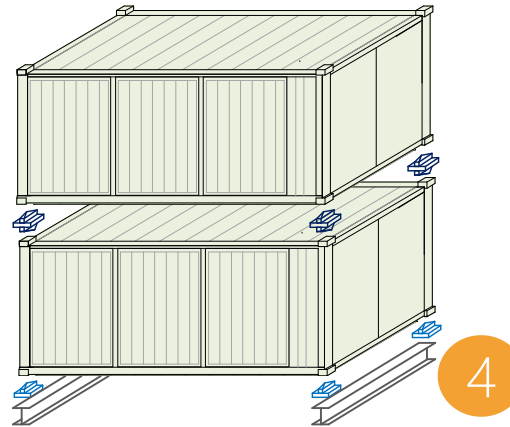
one cell ignited

- fire constrained to the ignited cell only, no spread to adjacent cells
- no material leakage
- no fire

Containerized NAS[®] Battery: installation



- assemble air outlet hood
- remove cushion materials for transportation above and under battery modules



- twist lock
- bottom stacker
- H-steel for the base



- external DC wiring
- communication with PCS
- air-conditioning for control room

NAS[®] Battery: environmentally friendly technology

ceramic: aluminium,
oxygen, sodium



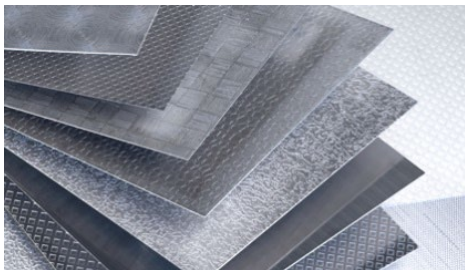
sodium



sulfur



steel and aluminium



carbon



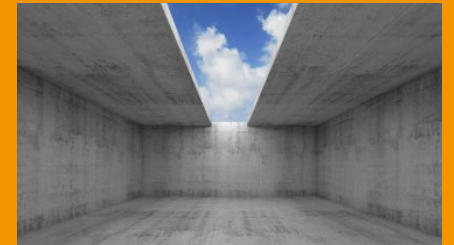
silica-based materials



fully recyclable
or reusable



metals & slag



➤ abundant materials, stable prices

NAS[®] Battery: total costs of ownership

CAPEX



- Battery system
- Installation costs

OPEX



- No air conditioning
- Low maintenance costs

Long life time



- Very low degradation
→ life time up to 20 years

End of life



- Recyclable or reusable raw materials

Initial investments are compensated by low OPEX, and paid off over long lifetime

NAS[®] Battery: Deployment examples

The largest NAS[®] Battery systems in the world



Photo: courtesy of NGK

location	Buzen City, Fukuoka, Kyusyu, Japan
capacity	50MW / 300MWh
containers	252
footprint	100 x 140 (m)
construction	6 months
commission	march 2016
grid connection	66kV
main purpose	renewable energy

1 st	– NGK; Japan 2016	300MWh
2 nd	– NGK; Japan 2008	245MWh
3 rd	– NGK; UAE 2018	240MWh
4 th		129MWh

Source : DOE Global Energy Storage Database / IHS Markit Energy Storage Project database

NAS[®] Battery:

Key messages

Key messages

■ We offer you

- ▶ **NAS® Battery system for long duration stationary storage**
 - High energy
 - Long lifetime
 - Safe & reliable
 - Environmentally benign
 - Proven by 20 years deployment at customer sites all over the globe
- ▶ **Service & maintenance over project lifetime** (optional)
- ▶ **Initial project development support:** technical layout and system configuration
- ▶ **Support through our local offices worldwide**



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