GridEdge and Sodium Nickel Chloride battery technology

Energy for a sustainable future
Australian and New Zealand distributor for Sodium Nickel Chloride battery
Gridyedge supplies Safe, reliable, recyclable energy storage batteries to guarantee energy security from household to grid scale.
• Sodium and nickel based battery
• Non-toxic materials
• Abundantly available materials
The composition of a sodium-nickel cell is as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ni</td>
<td>23%</td>
</tr>
<tr>
<td>Fe</td>
<td>24%</td>
</tr>
<tr>
<td>Na</td>
<td>8%</td>
</tr>
<tr>
<td>Cl</td>
<td>19%</td>
</tr>
<tr>
<td>Al</td>
<td>16%</td>
</tr>
<tr>
<td>O</td>
<td>9%</td>
</tr>
</tbody>
</table>

**Nickel** is present as active material, as cathode current collector and protective coating of steel. **Iron** is present as active material and as steel in the metal container. **Sodium** is present as active material and in the catholite. **Aluminum** is present as salt (catholite) and as oxide in the ceramic. **Chlorine** is present as active material and in catholite. **Oxygen** is present as oxide in the ceramics.
Product Characteristics

Specifications

- **Temperature Immunity**: (-40°C; +60°C)
- **Cycling Capability**: > 4,500 cycles - ESS (80% DOD)
- **Battery energy density**: 100-120Wh/kg, 150-190Wh/Lt
- **Shelf life**: (> 20 years)
- **No memory effect**

**Performances**

- **Intrinsically safe**, electrochemical safety
- **No gas emissions**
- **No flammable materials**
- **No fire/water flood reaction**
- **Industrial Process Control**
- **Tested in the field** (EV, TLC, ESS, ...)
- **BMS control**
- **Cell/Battery Mechanical case**

**Safety**

- **Zero Impact Battery**
  - NO dangerous materials
  - **100% recyclable**
  - NO pollution materials
  - NO gas emissions

**Battery Performances**

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**Electrochemical Reactions**

- Discharged: \(2NaCl + Ni \rightarrow NiCl_2 + 2Na\)
- Charged: \(NiCl_2 + 2Na \rightarrow 2NaCl + Ni\)
Inside a SoNick Battery

- Thermal insulation
- Heating elements
- Battery Management Unit
- Battery steel lid
- Thermal insulation
- Cells
- Mica (electrical insulation)
- Battery Steel container
SoNick Technology
The sodium nickel technology behind FIAMM SoNick battery

Energy density:
120 Wh/kg at battery

Outside temperature range:
-40°C / +60°C

Maintenance free.
BMS included.
Zero ambient emissions.
100% recyclable.
Long Life 4.500 NPC

100% coulometric efficiency
Proven Technology

• Volume production began in Switzerland, in 2006

• Many installations in Europe, USA and South Africa

• Results based on actual figures from “in-use” operating conditions
Long standing company

• FIAMM have been around, as a company, since 1942 so they are a stable organisation.

• FZSoNick is section of company that relates to SoNick batteries only

• Many battery companies are quoting figures that cannot be backed up as they haven’t been field tested

• Companies may not be around in a few years to back up large claims of cycle rates and warranties.
100% Recyclable

- Recycle program already in place in Europe and US, can easily be duplicated in Australia at the appropriate time.

- More than 20 tonnes of batteries have already been recycled

- Batteries can safely be put into current recycling processes in Australia
Recycling Process

• Nothing goes to Landfill

• The battery materials are recycled to produce stainless steel where the nickel and iron go into alloys

• The salt and ceramic are used to replace limestone for road beds.
Non-Toxic

- No toxic materials, either in its production or use.
- No outgassing so doesn’t need venting so not dangerous in use
- Sodium and nickel based battery which are both non-toxic and abundantly available
Wide operating range  -20° to +60°C

• If ambient temperature above 40°C - lithium ion and lead batteries will deteriorate

• Better alternative to many other batteries for Australia’s extreme weather conditions, particularly the Australian outback where temperatures can vary widely.
Doesn’t require cooling

• No extra operational costs needed for cooling

• No extra space needed for cooling

• No degradation of battery at temperatures above +40°C so battery life preserved
No Thermal Runaway

- Battery chemistry is mainly non-combustible salt
- Will not explode if overheated like lithium ion or lead can do
- BMS designed to not let batteries overheat
Safety Features

• BMS diagnostics disconnects the battery in case of serious failure
• Double stainless steel casing
Abuse testing of Sodium Nickel Battery

- Complete submersion in salt water
- Exposure to fire then water hose down
- Bullet impact
- High speed impact – both installed and during shipping
- Overcharge by over-volting
- Deep penetration into case followed by water exposure
- Being dropped from height
High energy density

• High embodied energy contained in the small footprint of the SoNick battery with 10 kWh in a battery of only 55cm x 50cm x 32cm
High energy drawdown rate

• Can use 150 Amps continuously for 4 hours
  (C4 values for 48V 9.6 kWh battery)

• Can handle Fast Charge and Discharge Rates
Different battery technologies are able to instantaneously draw down different amounts of power. Some are extremely limited on what appliances they can run at any one time.

- Lithium Ion: 2 kW
- Salt Water (Aquion): ~0.6 kW
- Bromide (RedFlow): 3.6 kW
- Gel Lead Acid: 5 kW @ 25% DOD
- FIAMM SONICK: 7.6 kW

Side-by-side size comparison of draw-down power of ~ 20 kWh battery application
Doesn’t degrade over lifetime

• SoNick will remain at full capacity over its lifetime

• End of life is classified as 80% capacity so will still perform well after this with reduced capacity.

• Lithium Ion and lead acid batteries degrade continuously from day 1 of manufacture.
Some battery technologies degrade quite significantly over their expected lifetime. For many batteries degradation can accelerate dependant on usage and if ambient temperature isn’t kept around 25°C.

Side-by-side size comparison of capacity after 10 years of ~ 20 kWh battery application
Easily transportable

• Safe to transport

• Most other batteries are either too heavy, too big or too dangerous to transport safely.

• Can be transported by plane if needed, unlike other batteries where plane transport is too dangerous or too heavy.
Long Design life

• Doesn’t deteriorate if not being used

• Can be stored unused for extended periods of time

• If 100% discharged will need preheating before use again
SoNick - High depth of discharge

• Recommended depth of discharge of 80%

• No battery damage or degradation if the battery is drained to 100%

• Recommended DOD of 80% is an arbitrary figure and will depend on the usage application. This is usually controlled by the inverter.
SoNick – Initial heating

• The SoNick battery operates at an internal temperature of 265 degrees C

• If battery is switched off and cooled, it will need to be reheated before using it again. This can be done either with solar panels, wind or diesel generator via an inverter, or using any 48 V charger using an external power source.
Low OPEX charges

• No maintenance required for SoNick batteries

• Batteries each have their own BMS. “Battery replacement can be done at any time by switching off the particular battery only and replacing it, without affecting the overall running of the installation.”

• Remote monitoring is available so any possible issues with batteries or installation can be identified remotely thus reducing time for personnel visiting installations to check on performance. “Many adjustments of batteries can also be made remotely.”
Comparison of Battery Cost per year over life expectancy for effective capacity equivalent of 5kWh including degradation

“Real Cost Of Ownership”

<table>
<thead>
<tr>
<th>Brand</th>
<th>Sodium Nickel Chloride</th>
<th>Lithium ION Nickel Manganese Cobalt oxide</th>
<th>Lithium ION</th>
<th>Lead GEL</th>
<th>Lead flooded</th>
<th>AVRULA Lead Ultra long life</th>
<th>Sodium Ion Salt Water</th>
<th>ZBM Zinc Bromide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost ($)</td>
<td>$500</td>
<td>$1,000</td>
<td>$1,500</td>
<td>$2,000</td>
<td>$2,500</td>
<td>$3,000</td>
<td>$3,500</td>
<td>$4,000</td>
</tr>
</tbody>
</table>

Total Battery Cost per year over life expectancy for 5kWh effective capacity factors taken into account:
- Battery cost
- Installation cost
- Maintenance costs
- Depth of Discharge
- Round Trip Efficiency
- Degradation expected
- Battery Capacity
- Expected Lifetime of battery
- Ambient temperature of 25°C
**Main tech characteristics:**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage Range</td>
<td>40 ÷ 54 VDC</td>
</tr>
<tr>
<td>Heat dissipation</td>
<td>107 / 110 / 117 W</td>
</tr>
<tr>
<td>Max Discharge Current</td>
<td>90 / 120 / 150 (200*) Amps</td>
</tr>
<tr>
<td>Bus Voltage Range</td>
<td>53 ÷ 60 VDC</td>
</tr>
<tr>
<td>Low Voltage Disconnect</td>
<td>40 VDC</td>
</tr>
<tr>
<td>Fuse Communication</td>
<td>200 Amps</td>
</tr>
<tr>
<td>Port Alarm Contact</td>
<td>RS485 or CAN / USB</td>
</tr>
<tr>
<td>Front</td>
<td>496 mm (19.5 inc)</td>
</tr>
<tr>
<td>Depth</td>
<td>558 mm (21.9 inc)</td>
</tr>
<tr>
<td>Height</td>
<td>320 mm (12.6 inc)</td>
</tr>
<tr>
<td>Weight</td>
<td>80 / 95 / 105 kg (177 / 210 / 243 lb)</td>
</tr>
<tr>
<td>Env. Temperature Range</td>
<td>- 20 ÷ +60 °C (-4 ÷ 140°F)</td>
</tr>
<tr>
<td>IP rate</td>
<td>IP 55</td>
</tr>
</tbody>
</table>

* Discharge current up to 200A for the new TL200 with bussbars

**Typical applications**

Telecom: on grid / hybrid / outdoor cabinets / central offices
Solutions for Energy Storage

MWh SYSTEMS
FIAMM Energy Spring

Industrial park, neighbourhoods, holiday villages
Inside a 20' container:

ENERGY SPRING 1: 1.2 MWh Batteries
ENERGY SPRING 3: 260 kWh Batteries + PCS

COMMUNITY & INDUSTRIAL
FIAMM Cabinet

Neighbourhoods

RESIDENTIAL
FIAMM All-in-One

House
Community & Industrial Application: FIAMM Cabinet

Community Energy Storage Solution: safe, compact, modular. 17 up to 75 kWh
MWh System Application: FIAMM Energy Spring

MWh System Energy Storage Solution: scalable, suitable for any place of installation.
With BOMBARDIER TRAINS

Location: Brasil, Canada, Malaysia, Saudi Arabia

UNIT: 6 110BO80 (110V 80 Ah)
98 trains. 5 projects
ENERGY: 4 MWh
CAPACITY: 15680 Ah

- Powering auxiliaries off-catenary
- Turn key battery and mounting designed by FIAMM
University in UK – Micro-grid Storage System

Location: UK

UNIT: 1Cabinet 103 (3 ST523 batteries)
ENERGY: 70 kWh
POWER: 20 KW

- Micro-Grid
- Technology Testing
- Energy Intensive Services for the UK National Grid
TERNA - Grid Services (Storage LAB)

Location: Ciminna - Sicily

UNIT: 4 Energy Spring 164 (256 ST523 620V 23,5kWh)
ENERGY: 4.15 MWh
POWER: 1.2 MW

- Grid Balancing
- Maximization of the power capacity transport of the Power Grid
- HV line Voltage Regulation

With TERNA
Energy for a sustainable future

Smart Micro-Grid Research Project (Horizon 2020)

Location: Tilos - Greece

UNIT: 2 Energy Spring 164 (128 ST523 620V 23.5kWh)
ENERGY: 2.4 MWh
POWER: 800 KW

With Technological Educational Institute of Piraeus (Greece), CEA (France), Younicos (Germany), WWF (Greece), Open Energy (UK) etc. for TILOS Island

- Smart-Grid
- Micro-Grid energy management
- Energy Intensive Services
- Maximization of RES penetration
- Grid stability
- Ancillary services to the main grid of Kos
T-MOBILE - Telecom Datacenter

Location: USA

With T-mobile

- High Density Facility Design
- Stand-alone System

UNIT: 48 48TL200 (48V 9,6 KWh) per site. 17 sites
ENERGY: 7,8 MWh
CAPACITY: 163200 Ah
# References

Sodium Nickel Batteries

## TELECOM
- MTN – RSA
- Eltek Valere – US
- Nokia Siemens – Finland
- Telecom Italia – Italy
- T-Mobile – US
- Cosmote – Romania
- Century link – US
- Telefonica – Spain
- Elcos – Italy
- AT&T – US
- Vimpelcom – Russia
- Ericsson – Sweden
- Saudi Telecom – Saudi Arabia
- Orreed – Qatar
- Zamtel – Zambia
- Ascot – Italy

## RAILWAYS
- PRASA/SIEMENS – RSA
- BOMBARDIER – Canada
- SCOMI – Malaysia
- Under Evaluation
  - SNCF – France
  - OMNI TRAX – US

## OIL & GAS
- ABB – CH
- Under Evaluation
  - Petronas – Malaysia
Sodium Nickel or salt battery

**Advantages**

1. Very good DOD 80% and good life.
2. No explosive gases
3. Compact
4. Light weight.
5. Fully recyclable
6. Best operating temperature of all batteries -20 to 60 degrees C
7. Doesn’t degrade
8. Extremely safe by design
9. Can easily add capacity