Using Metal-Hydrogen Battery Technology
To Drive Down Costs And Decrease Emissions In Operations

September 2022

Chad Spring
Senior Manager, Business Development
EnerVenue
+1 (720) 792-3886
chad.spring@enervenue.com
EnerVenue’s Metal-Hydrogen Battery Technology

- **DURABLE** 30,000 cycles, 30 years, 3 cycles/day
- **FLEXIBLE** Fast and slow charge rates
- **SIMPLE** Minimal OPEX with no augmentation
- **SAFE** No fire or thermal runaway risk
- **PROVEN** Refined by NASA and Stanford
Technology Timeline
Mature, proven technology used in outer space applications for 30+ years

1980s
- Metal-Hydrogen deployed by NASA
  - Mars Rover
  - Space Station
  - Hubble Telescope
  - 30+ years
  - 200 million cycles
  - 100,000 charge and discharge cycles

2017
- Stanford University
  - Stanford Professor Yi Cui refines NASA battery technology
  - New materials
  - Reduced costs
  - New catalyst

2020
- EnerVenue spun-out of Stanford’s business accelerator
  - Long life
  - No augmentation
  - 99% recyclable

2022
- EnerStation Launch
  - No heating or AC
  - No fire suppression
  - Simple utility and C&I solution
  - >7GWh customer signed MOUs

©2020-2022 EnerVenue, All rights reserved. Confidential and proprietary.
EnerVenue Ni-H₂ Battery

30+ years mature technology upgraded with new low-cost earth abundant durable catalyst and design improvements
**Most Durable and Reliable Battery Technology**

Ni-H2 batteries can operate in extreme temperatures for 30+ years, offering the longest cycle-life of any battery system.

<table>
<thead>
<tr>
<th>Challenge with Lithium-Ion technology</th>
<th>Advantage with EnerVenue technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire and explosion risk</td>
<td>No thermal runaway risk</td>
</tr>
<tr>
<td></td>
<td>No fire suppression need</td>
</tr>
<tr>
<td>High operating &amp; maintenance expenses</td>
<td>No augmentation \ No routine maintenance</td>
</tr>
<tr>
<td>Longer duration &amp; dispatch (2-12+ hr charge)</td>
<td>Flexible charge/discharge range C/2 to C/12+</td>
</tr>
<tr>
<td>Limited cycle life</td>
<td>30+ year lifespan \ ~30,000 cycles, 3 cycles/day</td>
</tr>
<tr>
<td>Harsh climates: hot deserts &amp; freezing winters</td>
<td>Flammable liquids and toxic materials</td>
</tr>
<tr>
<td>Restrictions on over-charge and over-discharge</td>
<td>High chemistry, adoption and technology risks</td>
</tr>
<tr>
<td>Excellent overcharge, discharge and deep-cycle</td>
<td>Operate in -30°C to 50°C ambient temperature</td>
</tr>
<tr>
<td></td>
<td>Non-toxic, no lithium, easily sourced</td>
</tr>
<tr>
<td></td>
<td>Proven in 30+ years of use in space applications</td>
</tr>
</tbody>
</table>

©2020-2022 EnerVenue, All rights reserved. Confidential and proprietary.
Validation from Distinguished Investors

EnerVenue Closes An Enormous Investment Round In A Great Sign For Grid-Level Storage Technology

Erik Kobayashi-Solomon Contributor Sustainability Investor in climate-change adaptation and mitigation businesses

I introduced EnerVenue to readers of this column in December 2020 and opined that its innovative re-formulation of Metal-Hydrogen batteries were the


Article link
EXPANSION TIMELINE

10 MWh
2022
INITIAL CUSTOMER PILOTS

100 MWh
2023
HIGH SPEED AUTOMATION LAUNCH

1000 MWh
2024
1ST PHASE GIGAFACTORY

5000 MWh
2025+
GLOBAL EXPANSION

©2020-2022 EnerVenue, All rights reserved. Confidential and proprietary.
Target Markets

Traditional energy storage technologies have a role to play in meeting the demands of the energy transition but are limited in their applicability by cost and safety concerns.
C&I Applications
The Swiss Army Knife of battery storage

**REDUCE COSTS**
- Shift electricity consumption from expensive to lower cost periods
- Generates power locally
- Reduces demand on the grid without disrupting business operations

**IMPROVE SUSTAINABILITY**
- Harness energy from renewable fuel sources
- Draws more electricity from autonomously generated solar power
- Slashes the amount of energy drawn from the grid

**IMPROVE RESILIENCY**
- Provides enough backup power to tackle any grid reliability issues
- Provides backup coverage by leveraging the solar energy stored
- Provides plenty of backup power to tackle any grid imbalances

**EARN REVENUE**
- Grants access to grid services, like Demand Response
- Minimizes the energy curtailment and generates additional revenue streams
- Generates revenue by selling energy surpluses into the energy market

©2020-2022 EnerVenue, All rights reserved. Confidential and proprietary.
Schlumberger Energy and Emissions Modeling

**Challenge:** To model commercial and industrial facilities’ energy usage to determine which onsite energy generation and storage technologies, lithium-ion or EnerVenue’s metal-hydrogen, yielded the best result while also reducing carbon emissions.

**Solution:** Schlumberger New Energy developed an optimization algorithm, *New Energy Screening Tool* (NEST), to consider carbon emission and financial impact by evaluating real-world electricity usage data.

- NEST looks at solar PV and wind capacity factors from real-world data from National Renewable Energy Lab (NREL) database
- Optimization algorithm accounts for grid electricity prices and optimizes for the lowest cost system and lowest emissions at any given time
- CAPEX and OPEX of each technology is analyzed based on usage
Example 1 – Hospital

Using NREL energy usage data with Schlumberger’s NEST optimization algorithm shows carbon emissions reductions and overall lifecycle costs of various renewable technologies

- Hospital use case - Texas, USA
- NEST model evaluates how onsite wind and solar PV generation paired with a battery energy storage system would help reduce need for grid power while also reducing CO₂ emissions

Energy Usage Plot Example With Wind And Battery Storage

©2020-2022 EnerVenue, All rights reserved. Confidential and proprietary.
Example 1 - Hospital

NEST evaluation output of different renewable energy and battery technologies

- Solar and wind systems paired with EnerVenue batteries results in 19% and 14%, respectively, lower lifecycle costs compared to those systems paired with lithium-ion batteries.
  - Due to EnerVenue’s longer life, no augmentation, ability to cycle more times, less maintenance.
Example 2 – Large Office

Using NREL energy usage data with Schlumberger’s NEST optimization algorithm shows carbon emissions reductions and overall lifecycle costs of various renewable technologies

- Office use case – Arizona, USA
- NEST model evaluates how onsite wind and solar PV generation paired with a battery energy storage system would help reduce need for grid power while also reducing CO₂ emissions

Energy Usage Plot Example With Solar PV And Battery Storage
Example 2 – Large Office
NEST evaluation output of different renewable energy and battery technologies

Total Lifecycle Cost Comparison (CAPEX + OPEX)
Annualized over 25 yr life

- Solar systems paired with EnerVenue batteries in this example results in ~20% lower lifecycle costs compared to those systems paired with lithium-ion batteries
  - Due to EnerVenue’s longer life, no augmentation, ability to cycle more times, less maintenance
- EnerVenue batteries paired with Wind is showing higher levelized cost
  - Because the NEST algorithm is optimizing for as little grid usage as possible with the maximum carbon reduction possible.
Thank You!

Chad Spring
Senior Manager, Business Development
EnerVenue
+1 (720) 792-3886
chad.spring@enervenue.com