Company and Technology Overview

October 2018
**Company Overview**

<table>
<thead>
<tr>
<th>Company</th>
<th>Technology</th>
<th>Manufacturing</th>
<th>Product</th>
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<tbody>
<tr>
<td>Founded in 2011</td>
<td>Iron flow battery technology</td>
<td>100,000 ft² facility in Wilsonville, OR</td>
<td>25 year design life</td>
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<tr>
<td>HQ in Wilsonville, OR</td>
<td>ARPA-E and US DOE heritage</td>
<td>Scaling to 1 GWh/year</td>
<td>Second generation technology – no maintenance module design.</td>
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<td>Key Investors:</td>
<td>IP protected (30+ patent filings)</td>
<td>Efficient &amp; scalable manufacturing</td>
<td>Unlimited cycling duty—does not degrade with use</td>
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<td>- BASF</td>
<td>5+ years of research, product development and field testing</td>
<td>Low automation capital costs allows for a flexible, distributed manufacturing model</td>
<td>Safest, cleanest battery available on the market</td>
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<td>- Presidio Partners, Pangaea Cycle Capital</td>
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<td>Worldwide sales through multiple sales channels</td>
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ESS Tech, Inc.
## Key Partners

<table>
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<tr>
<th>Organization</th>
<th>Partner Role &amp; Profile</th>
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| Sempra Renewables | Utility scale renewable / storage project partner  
Develops, owns, operates large scale solar, wind and storage projects |
| ARUP | Engineering partner  
Global engineering services with HQ in London; COE for energy storage in Australia |
| MITSUBISHI HITACHI POWER SYSTEMS | EPC partner for Americas for storage and hybrid generation/storage solutions  
Project development, own, operate (microgrids, storage, RE/storage) |
| BASF | Product development partner  
Global marketing and sales partner |
| CLEANSPARK | Microgrid controls partner  
Turnkey microgrid development |
| PXiSE Energy Solutions, LLC | Controls partner  
Advanced real-time controls for microgrid, utility grids, and grid services. |
| REC Solar | Solar & storage project partner  
Sales channel partner |
| Munich RE | Reinsurance provider  
Iron Flow Battery performance risk, ESS company risk |
### Energy Warehouse TM
- Standard 400kWh flow battery with 50kW and 100kW power options
- Fully integrated system (battery, inverters, BMS, communications interface)
- AC and DC configurations for standalone or RE integration
- Containerized design for easy installation and commissioning
- No fade performance regardless of duty cycle

### Energy Center TM
- “Battery in a building” for utility scale applications
- Up to 10 hrs of discharge at full rated power each cycle
- Customizable to meet power and energy requirements
- No fade, multi-cycle performance
- 96%+ plant availability
Energy Warehouse™ Platform

**Energy Warehouse™**

- Ship anywhere, fully containerized battery with 400 kWh storage
- 50 and 100 kW power configurations provide up to 8 hrs discharge (AC or DC)
- Turnkey design includes inverter, power electronics, and BMS
- Modbus interface integrates with 3rd party controls
- No hazmat, toxicity or flammability issues
- Easy to operate and maintain

**Easy to permit, install and commission**

ESS Tech, Inc.
Energy Center™ Platform

Scalable Design from 5MW to 1GW

Highlights

- Custom engineered design to meet specific power and storage requirements
- 250kW modular power train scalable design
- Operating Range: Up to 125F ambient with no AC required
- Low aux load requirements: ~2%
- Energy Density: 12 MW / 72 MWh / acre
- Capex: mid $200s / kWh (2020 delivery)
- LCOS: < $0.05/kWh
### Key Applications

<table>
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<tr>
<th>Product Fit</th>
<th>C&amp;I / Behind-the-Meter</th>
<th>Renewables Integration</th>
<th>Off-Grid / Microgrid</th>
<th>Utility Scale / Grid Support</th>
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<tr>
<td><strong>Notable Advantages</strong></td>
<td>Modularity Stackable for density Flexibility – add or redeploy units as needs change Easy to permit No hidden liabilities</td>
<td>Flexible cycling capability to meet evolving market conditions Flexibility to support distributed or centralized storage siting</td>
<td>Modularity for scale Flexibility – add or redeploy units as needs change No limits multi-gen source flexibility</td>
<td>Scalable from 5MW to GW scale Operate up to 50C ambient temps No AC or cooling water required Ultra low aux loads No fire risk No toxicity</td>
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**Key Advantage: Electrolyte**

**Low-Cost Abundant Electrolyte Materials**

- Iron
- Salt
- Water

**Features**

- pH similar to soda and wine, no toxic materials
- No toxicity, no fire risk, no hazmat risk
- Environmentally friendly, 100% recyclable
- Utilizes standard BOP components - easy to support and maintain
- Sealed, no maintenance electrolyte system design. No additives, no augmentation for life of equipment.
Key Advantage: Unlimited Cycling

40+ years simulated operation of electrolyte and power module

Multi-cycle test results conducted under ARPA-E program

No degradation in power output regardless of duty cycle or depth of discharge
Key Advantage: Performance

- Fast response (<1ms on DC bus)
- Constant Power Output to 80% DOD

Guaranteed Power Output
Guaranteed Energy Output

Bulk Energy Shifting
Ancillary Services
Key Advantage: Safety Profile

No hidden liabilities
No hidden soft costs for compliance or incidence response
No fire risk, no electrolyte safety risk to personnel
Competitive Comparison

Levelized Cost Analysis - 2020 CapEx Cost

LCOS calculated for renewable integration:
- 600MWh energy storage facility
- 4 hours of usable storage, 1 cycle per day
- 25 years of operation

Increased Cycles and Longer Duration Increases Value
- 2 cycles/day @ 4 hrs
- 2 cycles/day @ 5 hrs
- $0.037  $0.03

Li-ion Chemistries

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Current Macro Market Characteristics:

- The energy storage space is dominated by short duration, lithium-Ion batteries.
- Grid Operators, Utilities, industrial & Commercial customers know how to evaluate the characteristics of these batteries.

**Longer Duration Storage** is quickly becoming a requirement

**Longer duration, Iron Flow Batteries** have characteristics that are not normally evaluated and their benefits are often overlooked.

Required Evaluation Parameters for Technology Agnostic Decisions:

- Unlimited cycling (compared with single cycle/day lithium-ion)
- Zero Capacity Fade regardless of the number of cycles/day
- Extended operating temperatures (25-125 degrees F)
- Zero Capacity Fade during “idle conditions”
- Lowest Levelized Cost of Service with multiple cycles/day
- Ability to provide 4, 6, 8, or 10 hours storage duration on a single cycle

- No Hazardous Chemicals; No Hazardous Chemical Plan or Disposal Plan required; No shipping restrictions


Stone Edge Farms
Zero Net Energy Microgrid

System: 60 kWh
Use Case: Microgrid
Commissioned: 2015
Location: Sonoma County, CA

Project Overview
Zero net energy microgrid project. Stone Edge Winery, based in Sonoma, CA promotes sustainable practices (energy, agriculture). The winery has developed a multi-asset micro-grid system that has enabled it to achieve a zero net energy operation. ESS Energy Warehouse (EW) storage product was added early in the microgrid development to store solar energy generated onsite. This stored energy is in turn used to power irrigation pumping as well as a hydrogen generator that creates fuel used in transport vehicles and an onsite fuel cell.

In September 2017, Sonoma county experienced devastating fires which caused widespread power blackouts. Stone Edge was able to continue daily operations. Due to the success of the microgrid during the blackouts, Stone Edge is upgrading the ESS storage to the next generation to provide increased power and capacity (50kW/400kWh)

US Army Corps

System: 225kWh
Use Case: Off-grid
Commissioned: 2016
Location: Fort Leonard-Wood, MO

Project Overview
The US Army Corps utilizes the EW for integration with diesel generators in configurations intended to simulate forward operating base conditions. The EW grid forms and follows the base’s load, limiting the diesel generator use for energy storage charging.

The use of long-duration battery storage to optimize / reduce diesel genset operation has shown benefits of 30-40% fuel savings. The EW also provides the base with improved grid resiliency with ride-through capability and micro-grid operation during grid disturbances and utility outages. Additional benefits attributed to the EW include ease in deployment, ability to redeploy and commission as needs change and ability to operate in inhospitable environments without need for auxiliary equipment or resources.
ESS INSTALLATIONS

UCSD Microgrid

System: 400kWh  
Use Case: Microgrid  
Commissioned: 2017  
Location: UCSD, CA

Project Overview
The EW is being piloted under grant funding from the US government and intended to enable researchers to independently test the battery across a variety of different operating schemes to simulate both behind the meter and in front of the meter storage applications. The EW has been deployed within one of the most advanced and diverse micro-grids in North America and will be co-tested by the UCSD and PXISE Energy Solutions, the unregulated business arm of Sempra Energy.

A key focus of the research and test cases will be to demonstrate the use of the EW to provide multiple different benefits, including revenue generating services from a single asset. These tests will include response-time, frequency regulation, and dispatchable generation testing and will validate ability to discretely provide multiple revenue generating services in CAISO market.

DNV-GL

System: 400kWh  
Use Case: Renewable Integration  
Commissioned: 2017  
Location: Lubbock, Texas

Project Overview
DNV-GL will utilize the EW for bulk energy shifting with the wind turbines and solar PV on-site. ERCOT, the ISO responsible for the Texas energy grid, has an oversaturation of wind projects in relation to their current transmission infrastructure. This has been a major pain point for renewable energy developers and independent power producers, as their projects are frequently curtailed and experience high basis-risk from transmission congestion; negatively affecting project revenues. Bulk energy shifting will allow developers to take advantage of power pricing and energy demand not typically served by daily wind generation profiles, helping to alleviate the economic burden experienced from the current ERCOT constraints aforementioned.
Big Dutchman International GmbH

System: 400kWh; 8 hours storage
Use Case: Resiliency | PV + Storage
Commissioning: Q4 2018
Location: Germany

Project Overview
BD provides feeding and housing systems for poultry and pig farming globally. Services and offerings including energy solutions for energy savings and critical services backup. BD is evaluating the ESS energy storage technology as a low-cost and inherently safe system for integration with solar systems to offer as a combined system to its customers worldwide. Use cases include reducing or eliminating diesel generator backup at poultry facilities and reducing energy costs using PV + storage solutions for their customers.

Big Dutchman International GmbH, through its subsidiaries, manufactures feeding systems and housing equipment for pig and poultry management. It offers alternative egg production equipment, colony systems, poultry cages, equipment for poultry growing, breeder management systems, poultry and pig climate control systems, exhaust air treatment systems, residue treatment systems, biogas plants, and mixed feed production equipment. The company also provides BigFarmNet, a system that allows users to control, monitor, and manage various computers and controllers on their farm from a central location. It offers its products through sales representatives in Germany and internationally. The company was founded in 1938 and is based in Vechta-Calveslage, Germany. Big Dutchman International GmbH operates as a subsidiary of Big Dutchman AG.
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ESS PROJECTS UNDER CONSTRUCTION

US Marine Corps Camp Pendleton

System: 400kWh; 8 hours storage
Use Case: Microgrid | PV + Storage
Commissioning: Q3 2018
Location: Camp Pendleton, CA

Project Overview
ESS is providing energy storage system that will be integrated into a diverse microgrid installation featuring PV, CPV, diesel genset, flywheels and geothermal heat pumps. Dubbed the FractalGrid Demonstration, this microgrid will provide multiple benefits to the Marine Corps including resilient back-up capability to critical IT infrastructure, electricity savings through demand charge management and TOU arbitrage, and full islanding capabilities. The ESS battery will be integrated with the CleanSpark microgrid controller which will provide the overall microgrid optimization and control.

Marine Corps Base Camp Pendleton, the Corps’ largest West Coast expeditionary training facility, encompasses more than 125,000 acres of Southern California terrain. Camp Pendleton is one of the Department of Defense's busiest installations and offers a broad spectrum of training facilities for many active and reserve Marine, Army and Navy units, as well as national, state and local agencies.

Following recruit graduation, enlisted Marines receive basic infantry training at the School of Infantry-West before assignment to other units throughout the Corps. More than 38,000 military family members occupy base housing complexes. However, with a daytime population of 70,000 military and civilian personnel, the Marines, Sailors and their families rely on the surrounding communities for retail goods and services not available on Base.
ESS PROJECTS UNDER CONSTRUCTION

BASF Global Headquarters

System: 400kWh, 8 Hours Storage
Use Case: R&D Pilot
Commission: Q4 2018
Location: BASF Headquarters, Germany

Project Overview
BASF, the lead investor in ESS's Series B funding round, purchased the Energy Warehouse 50kW/400kWh for R&D testing at their global headquarters in Germany. The unit will be used to test a multitude of use cases, both behind and in front of the meter. Additionally, BASF and ESS recently entered into a strategic partnership under a JDA for global sales and technological improvements to the iron flow battery. The future testing conducted on unit will help further improve the power density of the electrolyte, round trip efficiency, and energy capacity of future ESS product offerings.

BASF is the global chemical industry leader, ranked 126 on the Fortune Global 500. They specialize in five segments: chemicals, performance products, functional materials and solutions, agricultural solutions and oil & gas. BASF employs more than 115,000 employees worldwide and generated $64.5 billion in revenue in 2017.
Pacto GD Brazil

System: 400kWh, 8 Hour Storage
Use Case: PV + Storage
Commission: Q1 2019
Location: Goiás, Brazil

Project Overview
ESS has been awarded a $1.3M grant from the USTDA to design and install the first Energy Warehouse 50kW/400kWh unit in Latin America for Pacto GD, a Brazilian solar developer. The Energy Warehouse will be utilized with a 100kW PV array for bulk energy-shifting. In addition, the project will enable the local end customer, to shed their reliance on the use of diesel generators during peak hours. The system will provide health, safety and noise reduction benefits, financial savings in fuel and maintenance, and reduce energy costs during peak demand.

Pacto Energia is a wholly owned subsidiary of 3F Capital, specializing in the development of commercial hydro, solar, and wind power generation. In its 17+ years in operation, Pacto Energia has built a renewable portfolio of more than 4 gigawatts in the Latin America market. Pacto Energia presents solutions to reduce consumption and costs with electricity for its customers.
Appendix: Recommendations For Considering Flow Battery