



hive

Energy Storage



DIGITAL POWER FOR THE DIGITAL AGE

For many years, industry observers have considered Long Life, High Capacity Storage Batteries to be the “Holy Grail” of the worldwide Solar Power Industry.

Ours is a ground-breaking, renewable energy storage solution. Our technology is safe, reliable and cost-effective – truly a Next Generation technology.





HiVE Energy Systems

- ❖ HiVE Energy Systems is Delaware registered, wholly-owned subsidiary of HNU Energy . It was born out of a commitment to provide an efficient, cost-effective and next generation energy system, fully integrated with Photovoltaic Energy Generation.
- ❖ It develops and markets **proprietary, large format lithium-iron phosphate (LFP) energy storage systems** for residential, commercial and utility-scale use.



HNU Energy

- ❖ HNU Energy is a US-based integrated group of engineering, design and technology companies that develop renewable energy technology and install innovative Solar Photovoltaic and Energy Storage Systems.
- ❖ Company was founded in 2006 with 3 people. Today it has 55 people on board with a large contracted project work force with confirmed pipeline of projects worth \$38M for 2018-2019.

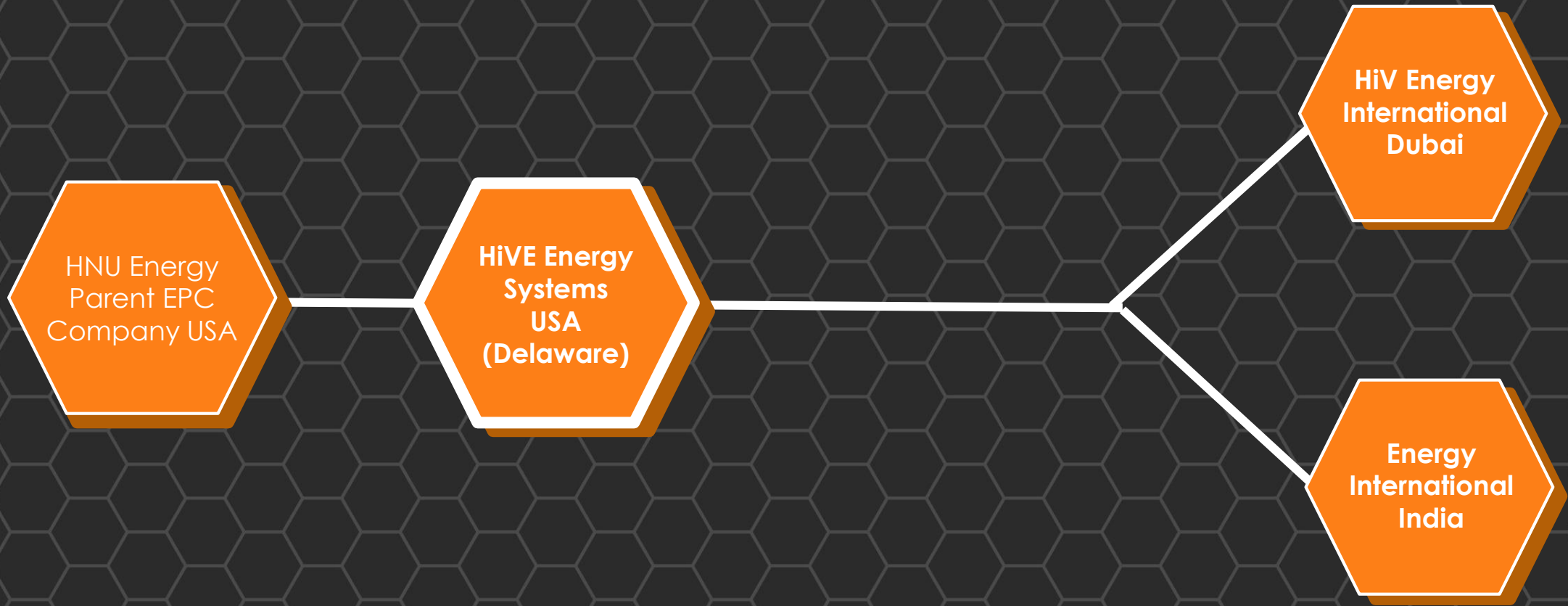


HIVE INTERNATIONAL LLC

- ❖ A vertically integrated company that focuses on renewable energy generation and storage, smart grid technologies and high-efficiency lighting products for residential, commercial, and utility users
- ❖ Strategically located at UAE to leverage the **early movers' advantage** as MENA region is waking up to the idea of meeting its' own requirement through abundance of solar energy and reduce fossil fuel dependence
- ❖ HiVE International LLC is presently targeting India, Middle East, Africa, Far East and Australia markets
- ❖ We have already generated a substantial pipeline that requires to be supplied through existing and planned production facilities



HIVE STRUCTURE





EXECUTED PROJECTS

- The Company has an extensive resume of energy storage installations as well as rooftop, ground mount and carport PV projects listed below:
- 2 MW EPC for Johnson Controls including UHMC, MHPCC, Kaanapali Alii, Maui Kaanapali Villas
- 1.25 MW installed for University of Hawaii including UH Hilo and UH Maui
- 1.5 MW of carports, primarily HNU's precast concrete carport system
- An extensive resume of grid-tied and off-grid battery energy storage systems (BESS) listed below:
- 11MW/4.4 MWh BESS for the Auwahi wind farm
- 1MW/1MWh BESS for MECO's Wailea substation
- 1MW/1MWh BESS design demonstration for the U.S. Department of Energy
- 100 kW/200 kWh BESS for the Maui High Performance Computing Center
- 375 kW/500 kWh battery for Hoku Nui Maui.
- 1MW/250kWh BESS each for the Hawaii Natural Energy Institute (HNEI), Hawaii Oahu and Molokai



Wind Farm BESS

- ❖ Design-build construction of the 11MW/4.4 MWh BESS for a 24MW Wind Farm. The installation consisted of (9) 55' containers containing battery modules, power electronics, switchgear, and chillers. The pictures below show the wind farm substation work site and a satellite image of the site.

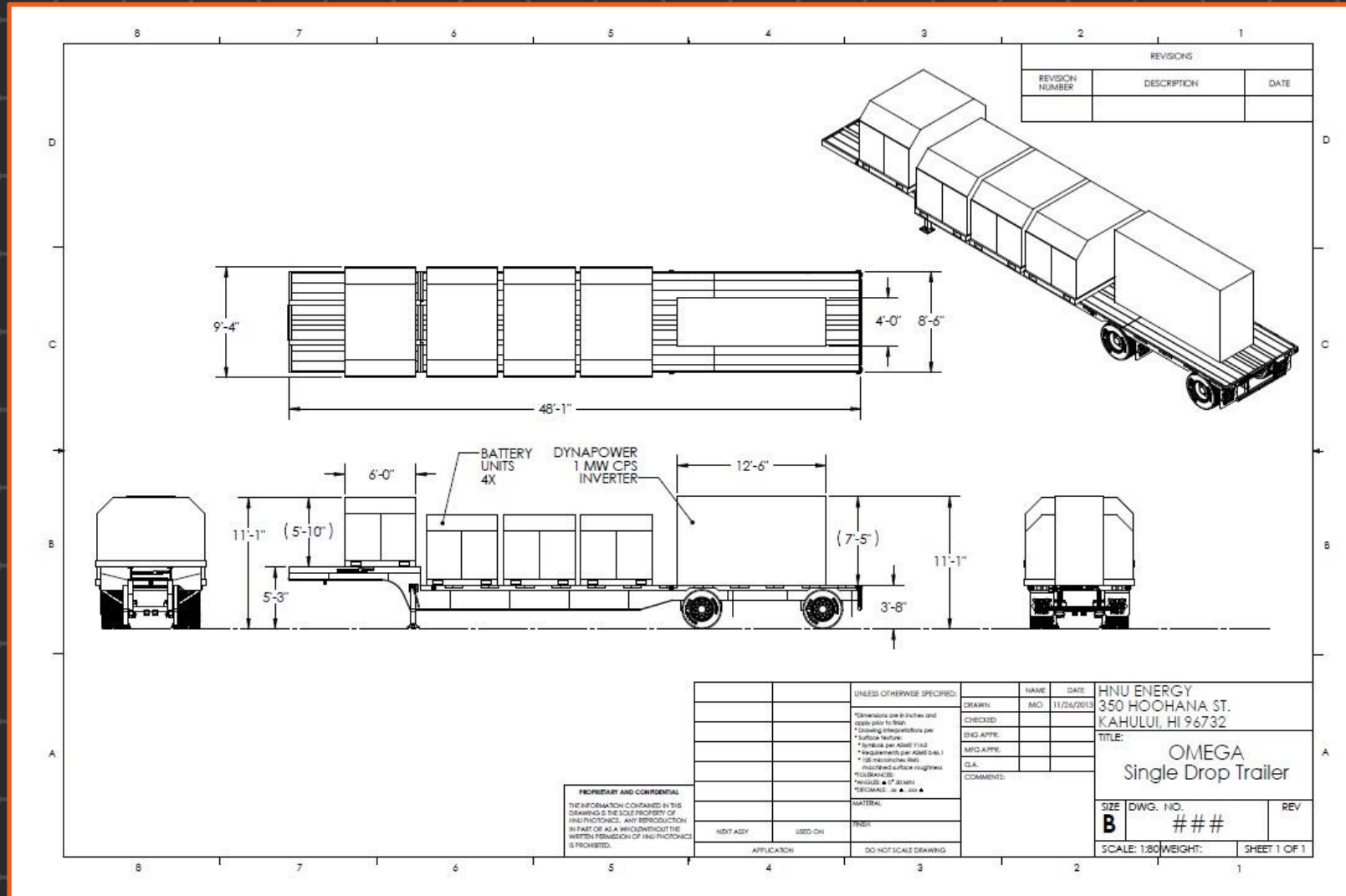


Utility Substations

- ❖ Selected as the design-build contractor for 1MW/1MWh BESS at Utility Substations. This BESS application peak shaves the top 15% of the evening peak demand (5pm - 9pm) to mitigate the need for additional generators. This project encompassed all aspects of installation and commissioning including SCADA. Batteries were large format, prismatic lithium iron phosphate. The below show the satellite image of the Substation and the 1MW/1MWh BESS.



U.S. DEPARTMENT OF ENERGY 1MW/1MWH BESS





THE PROBLEM



Every grid system in the world has been designed for unidirectional flow of energy, but distributed photovoltaic power generation has created troublesome bi-directional power flows.



All grids are also limited on how much intermittent power they can assimilate, a potentially limiting factor to future renewable energy growth.



Therefore most future energy markets for residential and commercial alternative energy will require on-site battery storage systems.



THE SOLUTION



Battery storage successfully integrates bi-directional energy flows in the grid and smoothes intermittency.



Competitively priced with superior performance, Energy Systems battery products will find ready market acceptance in every sector.



The Energy System is ideally suited for emergency backup power - for hospitals, first responder services, data centers, etc.



TODAY'S OPTIONS

- **Conventional Battery Banks**

- Based on outdated Lead Acid technology
- Short shelf life
- Prone to defects due to multiple batteries
- Short backup time
- Environmentally hazardous disposal
- Limited very high voltage applications

- **Back-up Generators**

- Noise and environmental pollutants
- Require fossil fuel
- Expensive to maintain
- High initial cost

LITHIUM IRON PHOSPHATE VS. LEAD ACID BATTERIES



	Li Iron Phos.	Lead Acid
Size, Weight	30% Less Space, 50% Lighter	Large Size, Heavy
Energy Density	High - 130Wh/KG	Less – 35Wh/KG
Useful Life	Up to 20 Years (8k – 10k cycles)	3-4 Years 3k – 5k cycles)
BMS	Advanced	Conventional
DOD	90%	50%
Maintenance	Min - Online tracking	Often and Manually

REVOLUTIONARY ENERGY STORAGE SOLUTION

One battery module caters to entire power requirement in most cases Shelf life of 10 to 20 years with up to 10,000 charging cycles Modular and flexibility for expansion Most advanced Electronic Management System Source-agnostic for charging Highly integrated complete storage platform and the total solution approach provides competitive pricing Introduction of purchase on credit scheme.





Benefits

- ❖ Fully integrated, compatible with all conventional inverters
- ❖ Proprietary “MAP” technology eliminates charge controller
- ❖ Incorporates lithium-iron phosphate chemistry
- ❖ Utilizes large-format cells
- ❖ Can easily migrate to better chemistry as it evolves

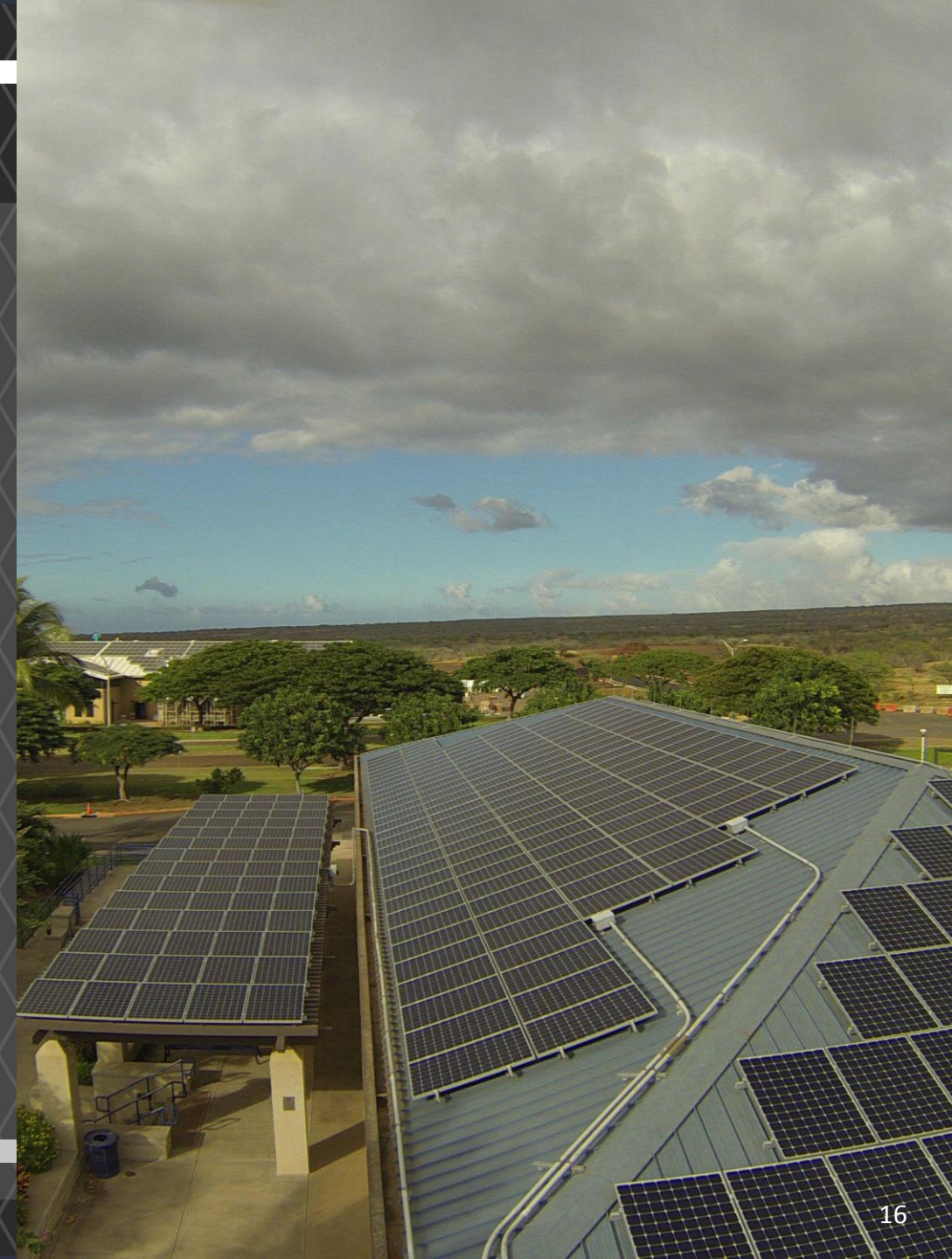


A unique battery management system

- ❖ Extremely durable, our battery can be disconnected under load over 10,000 times without degradation
- ❖ Provides quick response power at up to 2 C rate
- ❖ Outperforms all others in every performance metric
- ❖ String-Level Isolation provides superior safety (from 480V to 48V for

APPLICATIONS & MARKETS

- ❖ HiVE is Modular and Scalable:
- ❖ Utility, Industrial, and Commercial Scale Energy Storage
- ❖ Residential Off-Grid | Grid-Tied Selectable
- ❖ Power Smoothing | Grid Management
- ❖ Peak Shaving
- ❖ Load Balancing AND Load Shifting
- ❖ Backup Power | UPS
- ❖ Digital Energy Storage





INTERNATIONAL OPPORTUNITIES

- ❖ Australia and several European countries now require battery storage to grid-connect PV and other alternative energy sources.
- ❖ Dubai has raised its target for solar installations from 5% to 15%, requiring 3,000 MW of new PV by 2030 and considers storage as the “Holy Grail” of the solar power industry (Renewable Energy World, September 2015). Participation by Dubai in battery storage likely to trigger other GCC States to follow Dubai’s lead.
- ❖ Additional significant worldwide opportunities exist in regions that have inadequate grid infrastructure, including parts of the Middle East, India and Africa, as well as island regions.



US MARKETING OPPORTUNITIES

US STORAGE MARKET

- ❖ 221 **MWh** installed storage in 2016 (\$320M)
- ❖ Residential and commercial sectors represented 25% of added storage capacity in 2016
- ❖ Lithium-ion batteries achieved 97% market share
- ❖ 2017 growth projected at 90% (MWh) and 108% (\$)
- ❖ 2,562 MWh is expected to be added in 2022 (\$3.3B)
- ❖ 1,059% growth in units; 930% growth in dollar volume projected from 2016-2022
- ❖ Residential sector shows strongest growth potential over the next 5 years.

GTM Research, March 2017



THE WORLD MARKET



The world market for solar power storage will reach 6 GWh (\$19 Bn) in 2017. (IHS Research/IMS Research)



Non-hydro energy storage reached 2.3 GWh in 2017, 47% above 2016. A CAG of 60% is forecast to 2020 (Navigant, February 2017)



Residential energy storage is expected to grow from 95 MWh in 2016 to 3,773 MWh in 2025. (Navigant, 2/17)



COMPETITIVE LANDSCAPE

❖ **Tesla**

Less safe chemistry, Lithium Cobalt Manganese, lower C rate, many small cells, complex racking & cooling system

❖ **Sonen**

Re-packaging of Sony's lithium-ion battery consisting of hundreds of small cells in a complex racking system; expensive

❖ **E-Gear**

Less safe chemistry, 48V, heavy, many small cells, complex racking and cooling system

❖ **Adara**

48V, modular, expensive, Tesla technology

❖ **Sunverge**

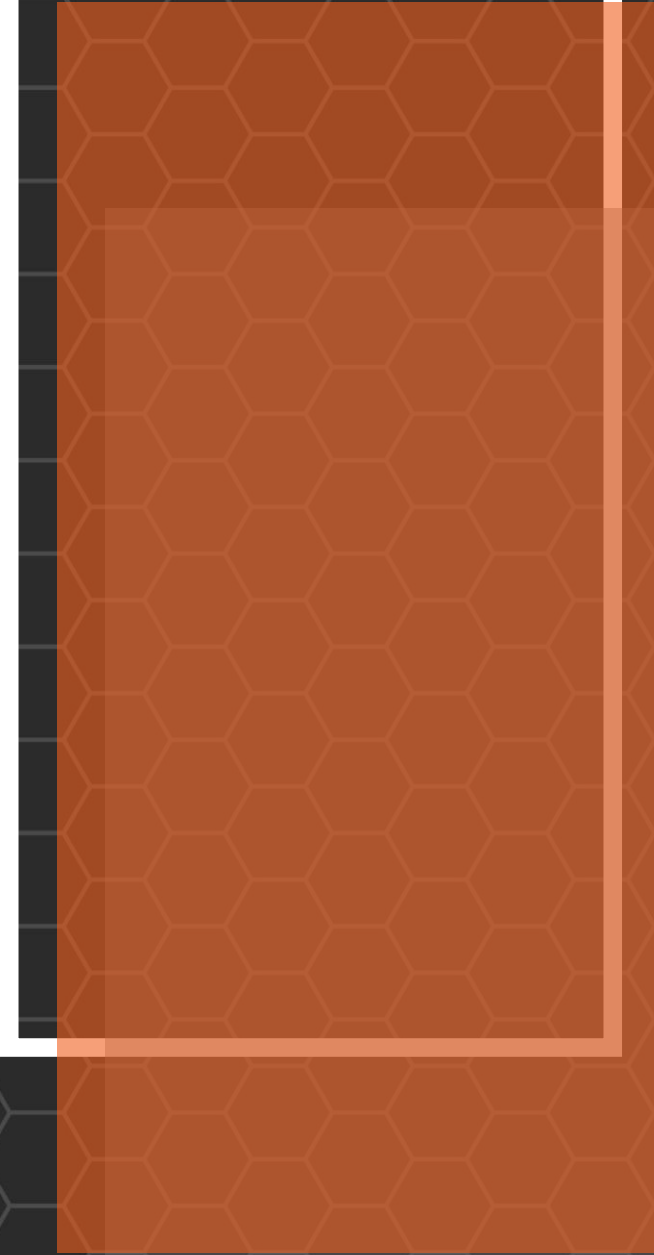
48V, modular, expensive, internal inverter, complex racking and cooling

❖ **Blue Ion**

Re-packaging of Sony's lithium-ion battery consisting of hundreds of small cells in a complex racking system; expensive



Commercial Applications



Industrial and Utility Applications





ENERGY INTERNATIONAL (DUBAI) INITIAL MARKET FOCUS

❖ **Dubai**

“Clean Energy Strategy 2050” 7% PV by 2020, 25% by 2030, and 75% by 2050. PV mandatory on rooftops in 2030.

❖ **Middle East**

GCC countries to achieve 50-fold increase in installed solar capacity 2015 – 2025. Saudi alone will add 9.5GW by 2030 (Frost & Sullivan, 1/17)

❖ **India**

18.7 GW of solar installed by end-2017; expected to add 11 GW annually for the next 5 years (BTI, May 2017)

❖ **Singapore**

Installed 421 MW of solar in 2016, 125% increase over 2015. “Growth prospects are tremendous in South-east Asia” (Straits Times, 3/17)



POTENTIAL MARKET DEMAND

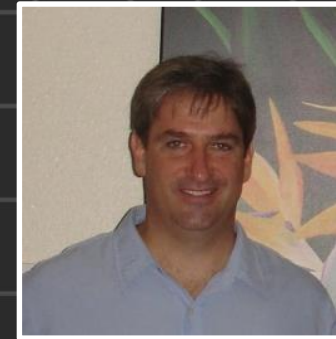
India

- ❖ 46% of Rural India suffers from more than 15 hours daily power outage
- ❖ 24% of population experience more than 30 outages a day of 15 minutes or longer
- ❖ The cottage and small scale industries in India suffer loss of production and rely heavily on expensive back-up generators
- ❖ India has made storage compulsory for all hybrid energy farms
- ❖ Data centers, hospitals, offices, commercial centers, public utility services, schools all need power back-up
- ❖ With financing schemes and leasing options HiVE will reach deep and wide in rural market



TEAM

Daniel O'Connell, Chief Executive Officer. Following a distinguished career in optics and renewable energy technologies, in 2006 Mr. O'Connell founded HNU with a mission of making renewable energy a viable alternative to future energy generation. Mr. O'Connell started his career in science 25 years ago in the field of solar energy. His mission is to use breakthrough developments to bring the highest efficiency technology to the community. He established business and research relationships with manufacturers and developed energy storage products and solar PV kit designs to maximize solar collection and storage efficiency, ultimately lowering the cost of renewable energy solutions for clients. Mr. O'Connell has numerous technical publications and is the named inventor on 17 patents. Mr. O'Connell received an M.S. in Optical Physics.



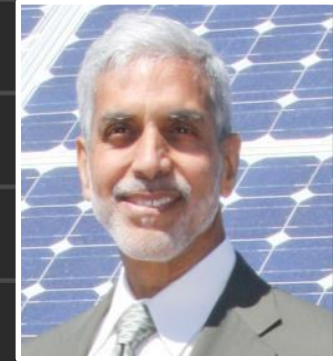
Michael Reiley Ph.D., President. With over 25 years of relevant experience including 5+ years of experience leading organizations with up to 150 staff and \$50M of annual revenue, Dr. Reiley has a unique blend of technical and management expertise to ensure successful execution of the proposed project. Dr. Reiley's former positions include: Research Analyst – MIT Lincoln Laboratory; Research Scientist – ERIM; Principal Investigator – Advanced Modular Power Systems; Applications Specialist – MHPCC; and Director, Hawaii Operations – Textron. Dr. Reiley is a certified Six Sigma Green Belt. He currently serves on the Board of Adaptive Technologies Corporation and Sapphire Systems Inc., and on the Chancellor's Advisory Council of the University of Hawaii, Maui College. Dr. Reiley also serves on the Board of Directors of several non-profits. Dr. Reiley holds a B.S. in Physics, an M.S. in Optics, and a Ph.D. in Electrical Engineering.





TEAM

Akhil Abbas Chief Technical Officer, P.E. After leading Sandia National Laboratories' energy storage program for 23 years, Mr. Akhil joined HiVE in 2017. Mr. Akhil is a nationally recognized expert in electricity storage, conventional and advanced micro-grids, distributed generation, photovoltaic power generation, and electric utility system planning. Prior to joining Sandia National Laboratories, Mr. Akhil was a Senior Energy Conversion Engineer with the Public Service Company of NM for 12 years. Other key roles and accomplishments include: member of the International Project Evaluation Panel for the 2015 Energy Storage Grant Call by the Energy Market Authority, Singapore; technical support to Hawaii Electric Company for 180 MW energy storage to support Oahu's grid during system contingency; lead author, DOE/EPRI 2013 *Electricity Storage Handbook*; development of energy storage strategies for the Hawaii Natural Energy Institute.



Tapan Bhattacharya, B.Sc.; B Tech (Civil); MBA; MLL&LW

Managing Director, HiVE International

An Energy, Projects & Business Development professional with 33 years of experience out of which 13 years in Middle East and UAE. Tapan has held senior management positions across India and UAE. Based at Dubai he now spearheads HiVE International in India, Middle East and Far East including Singapore. Tapan has been part of the Global Head Office of Suzlon Energy Limited, one of the world leaders in Wind Energy where he was involved in execution of wind farms on a turn key basis for IPPs and individual/corporate wind farm owners. His most recent assignment was with Global Technologies LLC as VP Projects and Investments that commercializes disruptive and environment friendly technologies from across the world. Tapan has a mandate to take HiVE outside US and is currently engaged in establishing HiVE in the region with private and government entities. He has successfully brought in several pilot projects besides creating a comprehensive pipeline of orders.





TEAM

Jack Naiditch, Executive Vice President Strategic Development and Legal Counsel. Mr. Naiditch is licensed to practice law in Hawaii and California, and specializes in business development, intellectual property, and commercial transactions. He co-developed four commercial wind farms in Hawaii totaling 151 megawatts. Mr. Naiditch worked with the risk arbitrage investment firm of Kellner DiLeo & Co. Mr. Naiditch also spent seven years working as an investment banker in New York specializing in mergers & acquisitions. Mr. Naiditch received a BS from UCLA, a JDL from the UCLA School of Law, and an MBA from the Anderson School of Management at UCLA.



Ryder Swatek, Vice President Construction, Principal RME, General Contractor. Mr. Swatek is a licensed General Contractor in Hawaii and the Principal RME for HNU Energy. He has 20 years of experience in general construction, project management, and contract administration. Mr. Swatek manages all of the Company's commercial PV projects and energy storage projects. He completed Maui's first affordable workforce housing subdivision featuring homes with PV systems. Mr. Swatek serves on Maui County's Subdivision and Engineering Standards Committee. Mr. Swatek received a Bachelor's degree from Lewis and Clark College and has been with HNU since 2010.





TEAM

Kyle Bickley Vice President Engineering, M.S., LEED AP. Mr. Bickley earned a Master of Environmental Science & Management from the Bren School of Environmental Science & Management at the University of California, Santa Barbara. Mr. Bickley supervises the installation of residential and commercial photovoltaic projects. Mr. Bickley has been involved in the installation of over three megawatts of commercial and residential photovoltaic and last year completed a 500kW PV plus 200kWh Battery project for the United States Air Force. He is currently managing a comprehensive project for the Air National Guard at Joint Base Pearl Harbor Hickam to take the F-22 Maintenance Hangar off-grid with energy efficiency measures, PV, and a 250kWh HiVE battery.



Zbigniew Drozd, Ph.D., Lead Electrical Engineer, Professional Engineer (PE), LEED Accredited Professional, ICC Electrical Plans Examiner. Dr. Drozd has over 30 years of diverse electrical engineering experience, including: design and construction of power plants, industrial and commercial facilities and buildings; consulting engineer for several industries including power utilities, pharmaceutical, health care and educational; design of new as well as retrofitting existing facilities; and commissioning experience. Prior to joining HNU, Dr. Drozd was principal and founder of Volt Engineering, an electrical engineering consulting company providing a wide range of electrical engineering services for industrial and commercial clients. In 14 years at Oak Point Associates, Dr. Drozd was Senior Electrical Engineer- Head of Electrical Department where he supervised a team of electrical engineers in a multidiscipline, 60 employee architectural/ engineering Company.





THANK YOU