

Presented to North American Energy Markets Association

Use Cases and Value Propositions of Utility-Scale Energy Storage

Presented by:

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Agenda

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 - Solar Plus Storage Can Replace Fossil Plants, Reduce Emissions, AND Save Costs
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BrightNight Introduction



Delivering safe, reliable, high-value, low-cost energy products

Highest Value to Utilities



SAFE

Battery energy storage system specifications and design places operations, equipment, personnel and community safety as the top priority.



RELIABLE

Utilities can depend on receiving energy when it is supposed to be received.



HIGHEST VALUE

Deliver energy, capacity and ancillary products when they provide the highest value to the utility or customer.



CUSTOMIZED PRODUCTS / Services We work closely with customers to understand specific needs, preferences and constraints to deliver energy when customers actually need it through dispatchable products, firm

blocks and shapes, and other services (fast ramp and load following) - all from clean renewable energy.

With Lowest-Cost Energy Solutions

PRICE LEADERSHIP



Team members of BrightNight have set many records in LCOE in some of the world's most competitive markets.

ADVANCED TECHNOLOGY



BrightNight uses advanced tech in solar, batteries and software to deliver new value to customers at competitive prices.



SEAMLESS INTEGRATION INTO UTILITIES OPERATION

BrightNight is the only contact to the utility: from project inception through financing, construction and commercial operations.

In Fast-Growing Markets



United States Team track record: 17 GW

BRIGHTNIGHT



Asia Team track record: 3 GW



FAST-GROWING MARKETS

Global team (USA, Singapore, India and Bangladesh) expanding BrightNight's portfolio in some of the fastest-growing markets worldwide, with an initial focus on South-Southeast Asia and the US.

BrightNight is developing 10+GW in diversified regions







Energy Storage Use Case Overview Created by BrightNight Advisory Services





Storage Use Cases as Generation Resources



- > Energy Shifting:
 - Energy arbitrage, Clipping Capture, Curtailment Capture, Renewable firming, Renewable product shaping, and Renewable integration
- > Ancillary Services:
 - Frequency Response, Frequency Regulation, Ramping Capability, and Spinning Reserves
 - Voltage Support, Black Start, and Islanding
- > Capacity:
 - Peak capacity for resource adequacy



Source: NY Times

Storage Use Cases as Transmission and Distribution Resources

- > Transmission and Distribution Deferral
 - Particularly valuable in locational areas where transmission and distribution upgrades are costly or impossible
 - End of Radial line to increase reliability
- > Congestion Relief
- > Voltage Support





Source: EnEngineering.com (left), E-Education.psu.edu (right)



Customer Study 1: Battery Can Economically Capture Multiple Value Streams

Created by BrightNight Advisory Services



Energy prices are inherently volatile due to the variation and uncertainty of load and supply



DA & RT Prices (\$/MWh)



Energy price volatility creates arbitrage opportunities for storage



Storage in CA has had great energy arbitrage value in recent years



Annual Energy Arbitrage Revenue



Typical 4hr duration BESS performing energy arbitrage in DA OR RT market up to 365 cycles per year



Note: that the revenues are based on perfect foresight whereas in reality the revenues will likely be lower as the plant does not have perfect foresight.

Ancillary services have been a key revenue steam for storage in CA

- > Storage is eligible to provide all ancillary services, including regulation, spinning reserves, non-spinning reserves, and flexible ramping products in CA.
- > Currently battery storage primarily participates in the regulation market which has higher requirements for resource response time than other ancillary services market and is the most lucrative market.



2019 Frequency Regulation Hourly Prices in CAISO Regulation Revenues in CAISO Day-Ahead Market

BRIGHTNIGH

BRIGHTNIGH

\$140

2020

Storage is also eligible for resource adequacy value in CA

System RA Capacity Prices in California by Compliance Year



Capacity Revenues based on Average System RA Prices



Note: Assumes the average prices in each compliance year

Source: California Public Utility Commission, 2018 Resource Adequacy Report, August 2019

Battery storage has proven to be economically viable in California with multiple value streams from the wholesale market





> Revenue Stacking

- > Dynamic Dispatching
- BESS systems have been economically viable for last 3+ years



Case Study 2: Solar Plus Storage Can Replace Fossil Plants, Reduce Emissions, AND Save Costs Created by BrightNight Advisory Services



BrightNight worked with a utility to develop a clean energy solution to allow retirement of fossil plants

Utility Challenges:

Reliability issues due to load growth

Higher costs due to reliance on old inefficient and extremely expensive Peaker gas plant



Existing Fossil Capacity Generation Profile (254 MW Coal + 244 MW Gas Peaker)



Source: Wired

PV + Storage allows retirement of 244MW Peaker, reduces coal generation, and reduces carbon emissions by 15%

Benefits:

- > Reduced carbon emissions
- > Reduced costs
- > Reduced fuel price volatility
- > Provide frequency regulation
- > Local voltage support
- > Black start functionality



Source: Inhabitant.com

PV+ Storage + Coal Generation Profile (254 MW Coal + 200 MW PV + 100 MW-4Hr Storage)



PV + storage can displace gas and coal generation and lead to \$42 million (or 5%) of cost savings



Total Cost Savings



\$42 million

cost reduction on a net present value basis over 20 years

Summary:

- > Turned off expensive Gas Peaker
- > Realized ~\$42mm Cost Reduction
- > Lower Cost of Energy
- > Added Grid Reliability



Case Study 3: Co-Locating Solar, Storage, and Wind Can Optimize Transmission Utilization Created by BrightNight Advisory Services



BrightNight worked with a utility on co-locating wind, PV and storage that improves transmission utilization



- > Charge from PV
- > Charge from Grid

Solar and Wind are natural resources with complimentary production profiles





Summer Day



Spring Day

Dispatch of a PV + S facility around a Wind facility

- Pacific Northwest Wind Facility: 100MW
- 100MW, DC/AC Ratio 1.8 PV facility
- 50MW/4hr BESS AC Coupled







Co-locating wind and solar with storage can provide better utilization of transmission capacity



100% Allocated Transmission Capacity Utilization of Renewable Assets



Net Capacity Utilization Factor



- Transmission facility rates: \$30,000/MW. For the studied wind facility, it is \$11.58/MWh and PV facility is \$12.23/MWh
- Pairing Wind+Solar+BESS at a common POI not only provides cost savings realized via shared facilities but also enables greater utilization of transmission resources.
- Estimated savings are \$5.83/MWh (~\$3mm/year) by having co-located PV+Wind+BESS.



Types and Attributes of Storage Technologies: Sprinter, Marathoner and Ultra-marathoner



Energy Storage Technologies







Today		Tomorrow
Pumped hydro and lithium Flee battery		atteries, hydrogen, nal, mechanical?
Sprinter Storage	Marathon Storage	UltraMarathon Storage (seasonal)
 Fast charge capability High energy efficiency Load Shifting/Renewables Integration/UPS/EV Lowest throughput cost (\$/KWh-delivered) 	 Fast charge capability Moderate energy efficiency Load Shifting/Renewables Integration/UPS/EV Low capex and low throughput cost (\$/KWh) Low self discharge 	 Ultra Long duration discharge (days to weeks) Extremely long calendar life (20 years) Extremely low initial cost (\$/KWh-installed) Extremely low standby and self-discharge losses
Examples: Li-ion batteries, capacitors, fly-wheel	 Low standby/cooling losses Up to 48 Hours or longer Renewables Intermittency/EV range extenders Examples: Flow batteries, metal-air, thermal & gravity-based energy storage 	 Energy storage and power delivery can be in different locations Enable renewable penetration to ~100% Example: Hydrogen

Lithium-ion Battery Costing and Product Trends

- > LFP, NMC leading technologies in stationary storage
- > Market moving from Power-centric to Energy-centric systems, i.e. lower c-rates
- > Integrators moving towards outdoor rated telecom style hardware platform (500kWh-3MWh)
- > Battery suppliers finally moving towards liquid cooled solution
- > Integrators may pivot towards smaller power electronics (AC Block)



With system level costs falling as well



IHS Markit Prediction 4hr LiB in 2023: \$245/kWh



Green Hydrogen is Poised to Disrupt Energy, Mobility and Materials Markets

Green Hydrogen – Growing and Disruptive Market Size Goldman Sachs projects green hydrogen to be a 12 trillion-dollar market by 2050 >100GW for electrolyzer over the next 10 years Projected market size of >100 billion dollars

Massive reduction in GHG Emissions

Each GW of electrolyzer avoids nearly 1 million tons of CO2 emissions annually by generating green hydrogen and reducing the need for grey hydrogen.



Hydrogen – Cost Trends



Green hydrogen could beat fossil-fuel H2 on price by 2030



- Acceleration in cost, performance and durability
- Acceleration in green hydrogen projects across the world (GW scale growth)

2. NG cost of USD 0.12/kg

3. NG cost of USD 0.31/kg

Sources: SP Global, IRENA, Recharge News





Energy Storage selection considerations



Delivering dispatchable renewable solutions at industry-leading prices to utilities across a heterogenous resource mix





- Optimized Product Design through smart algorithms
 and ML
- Driven by Customer Needs and Use-case
- Meeting Resource Adequacy, target reliability metrics (ELCC, LOLE, LOLH, EUE, LOLP), market participation (DA, RT) requirements
- Enabling industry-leading LCOx and dispatchable renewable power plants





- Safe, Cost-effective and Available 24x7
- High Utilization of Clean Energy
- Dispatchable On Demand
- Customer and Value Focused Solutions







- > Energy Storage can provide multiple benefits to the electric system across generation, transmission, and distribution sectors.
- > Energy Storage coupled with renewables can bring economic savings, reduction in greenhouse emissions and enable the transformation of grid.
- Emerging long duration energy storage technologies can further increase penetration of renewables, reduce curtailment and address the intermittency and seasonal variations of renewables.
- Deep understanding of various storage technologies, selection and sizing through use case analysis, modeling and optimization are necessary to capture the full benefits of storage.





Please join us for an interactive virtual breakout session on March 4th



Meet with BrightNight storage experts and chat more about your specific questions and anything you want to know about storage!

When: Mar 4, 2021 02:00 PM Eastern Time (US and Canada) Register in advance for this meeting: <u>Zoom Meeting</u>

Mark Herrmann - Chief Commercial Officer



Mark Herrmann created the congestion management group at NRG Energy, the largest integrated generation and retail electricity company in the U.S., managing congestion and incremental trading opportunities on up to 50 GW of generation and 63 TWh's of load across 5 U.S. markets. Mark also brings 25 years of industry experience across roles in Commercial Operations, Trading, Finance, M&A, and Business Development.

Ron Kiecana – Sr. Vice President, Development



During Ron's 28-year career in energy, he has participated in more than \$3.6B of completed power generation projects. Prior to joining BrightNight, Ron co-founded IMG Midstream, which was the first company to develop and construct a 126 MW generation portfolio located near gas production areas.

Ramkumar Krishnan, PhD - Chief Technology Officer



Ram brings over two decades of education, leadership and expertise in the areas of renewable energy generation, energy storage, and conversion technologies. Prior to BrightNight, Ram led and advised several energy companies and helped launch commercial products. At NantEnergy (formerly Fluidic), Ram lead for 11+ years the product + R&D teams in the development of the gamechanging rechargeable and long duration metal air energy storage technology.

Previous roles: NRG Energy, Conectiv Energy, Pepco Holdings, Inc.

Previous roles: IMG Midstream, Terra-Gen Power, Cogentrix Energy

Previous roles: NantEnergy, CESA, Motorola, University of Washington

Akshay Ladwa – Vice President, ESS Engineering



Akshay brings more than a decade of expertise in battery energy storage across a wide spectrum of areas encompassing product development to multi-MW projects, leading engineering, procurement and deployment. Prior to BrightNight, Akshay was VP of Engineering at Wartsila overseeing deployment of storage and storage paired hybrid power plants across four continents.

Previous roles: Wärtsilä, Greensmith, GE, Insolare Energy

YingXia Yang, PhD – Director, Commercial Strategy



Dr. Yang is a passionate expert with more than ten years of research and consulting experience in the energy industry and deep expertise in technology economic and market opportunity assessment, power market design, and power system modeling and analyses.

Previous roles: EPRI, Brattle, Charles River Associates



Contacts

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