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Resilient and Sustainable Energy Storage Application Analysis for Military Installations

Moderator: Heidi Perham, RA*, NCARB, Client Account Manager, Black & Veatch

Speakers:

- Ruthie Fetscher, C.E.M., P.M.P., Senior Manager, Deloitte
- Andrew Linowes, C.E.M, Manager, Deloitte
- Doug Mackenzie, Energy Services Manager, Black & Veatch
- Dustin Rogge, PE, Microgrid Solutions Manager, Black & Veatch

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POLL QUESTION 1

What type of organization do you represent?

a) Government Personnel responsible for Installation Operations
b) DoD or Regulatory Agency responsible for Public Policy
c) Energy Company
d) Engineering Firm
e) Consulting
f) Other

SPEAKER

Ruthie Fetscher, C.E.M., P.M.P., Senior Manager, Deloitte

Some fun facts about me:

- **Sports Teams:** UVA Basketball
- **Vacation Spots:** Japan, Greece…but more recently the Jersey Shore
- **Did you Know I…** have traveled to Guantanamo Bay
- **Hobbies:** Cycling

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SPEAKER

Andrew Linowes, C.E.M, Certified Energy Manager, Deloitte

Some fun facts about me:

- **Sports Teams:** Washington Capitals
- **Vacation Spots:** Patagonia
- **Did you Know I…** have traveled to 5 countries in Central America
- **Hobbies:** Backpacking and Skiing

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SPEAKER

Doug Mackenzie, Energy Services Manager, Black & Veatch

Some fun facts about me:

- **Sports Teams:** USA Swim Team
- **Vacation Spots:** Small Mediterranean Towns
- **Did you Know I…** Installed a Microgrid at 15,000ft in the Himalayas
- **Hobbies:** Gardening

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SPEAKER

Dustin Rogge, PE, Microgrid Solutions Manager, Black & Veatch

Some fun facts about me:

- **Sports Teams** Missouri Tigers, Kansas City Chiefs and Royals
- **Vacation Spots** Most places with good beaches
- **Did you Know I…**have 58 nieces and nephews.
- **Hobbies** Boating and BBQ

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POLL QUESTION 2

What energy storage benefits are you most interested in?

a) Resilience & Reliability

b) Power System Stability

c) Economic

d) Incorporation of Renewable Energy

e) All of the Above

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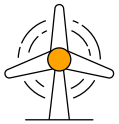
Military installations are facing increasingly frequent and severe disruption events

Technology and policy advancements in battery storage are changing the way military installations address energy security



Energy security solutions can leverage the cost competitiveness of renewables and energy storage to meet mission requirements

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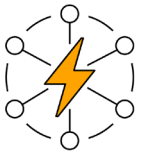
DoD Resilience Policy

- **National Defense Authorization Act (NDAA) 2021** establishes target power availability of 99.9%-99.9999%
- **2020 FEB - Policy: SECNAV: Installation Energy Resilience Strategy:** Benchmark availability for critical facilities ranges from 99.999% (five nines) to 99.9999% (six nines), i.e. no more than five minutes of down time per year
- **2020 FEB - Policy: Under Secretary of Defense: Metrics and Standards for Energy Resilience at Military Installations Memorandum**

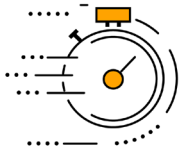
"Deliver Resilience: Achieve 100% mission continuity for Defense and Task Critical Assets and Infrastructure by establishing the capability to operate off grid for 14 days or a longer duration as determined by the Installation's Commanding Officer in consultation with the Mission Owner(s) by September 2025."

BESS Adds Speed

ENGINE GENERATION takes up to
60 minutes
to accept load - coordinating energization with facility - level standby generators



BESS
allows microgrid to accept load within seconds



This provides a
faster response
and more reliable system to support DoD Availability Policy

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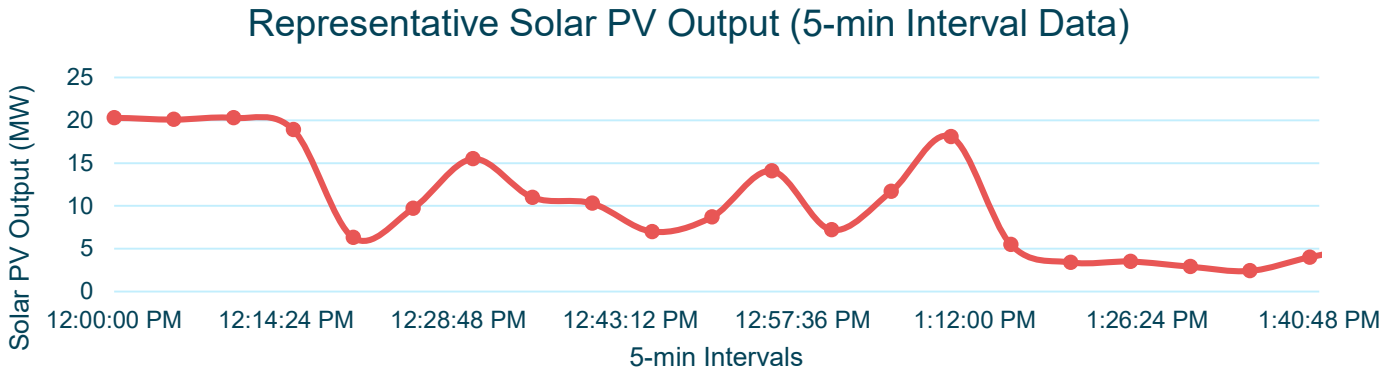
State & Federal Policies

- **Federal Energy Regulatory Commission (FERC) Order 841**, enables energy storage to participate in wholesale markets (energy, capacity and ancillary services).
- **FERC Order 2222**, allows behind the meter (BTM) distributed energy resources (DER) to participate in wholesale energy markets, including electric storage, distributed generation, demand response and energy efficiency.
- **State Pilot Programs**, e.g., Dominion Energy (VA): Grid Transformation & Security Act of 2018 allows investment of up to 30MW of battery storage pilot projects
- **Upcoming Policies**: Standalone investment tax credit (ITC) for energy storage (*Energy Storage Tax Incentive and Deployment Act*), and funds for R&D (*American Jobs Plan*)

Intermittency of Renewables



- Renewables by themselves don't meet DoD Resilience Objectives
  - Utility-scale solar PV systems can experience large fluctuations in power output due to weather
  - Smaller systems experience greater fluctuations
- Adding batteries leverages low cost of renewables and firms power for the DoD Mission

Ref: Solar Power Data for Integration Studies, NREL, 2006

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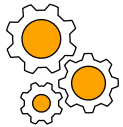
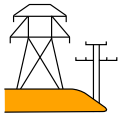
Energy Storage Enables Resilient Power

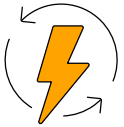
A critical technology for the military to:



Increase operational flexibility



Support the stability of their local power system with increasing renewable penetration



Provide fast response resilience and mission continuity during extreme events

Actively participate in the energy market

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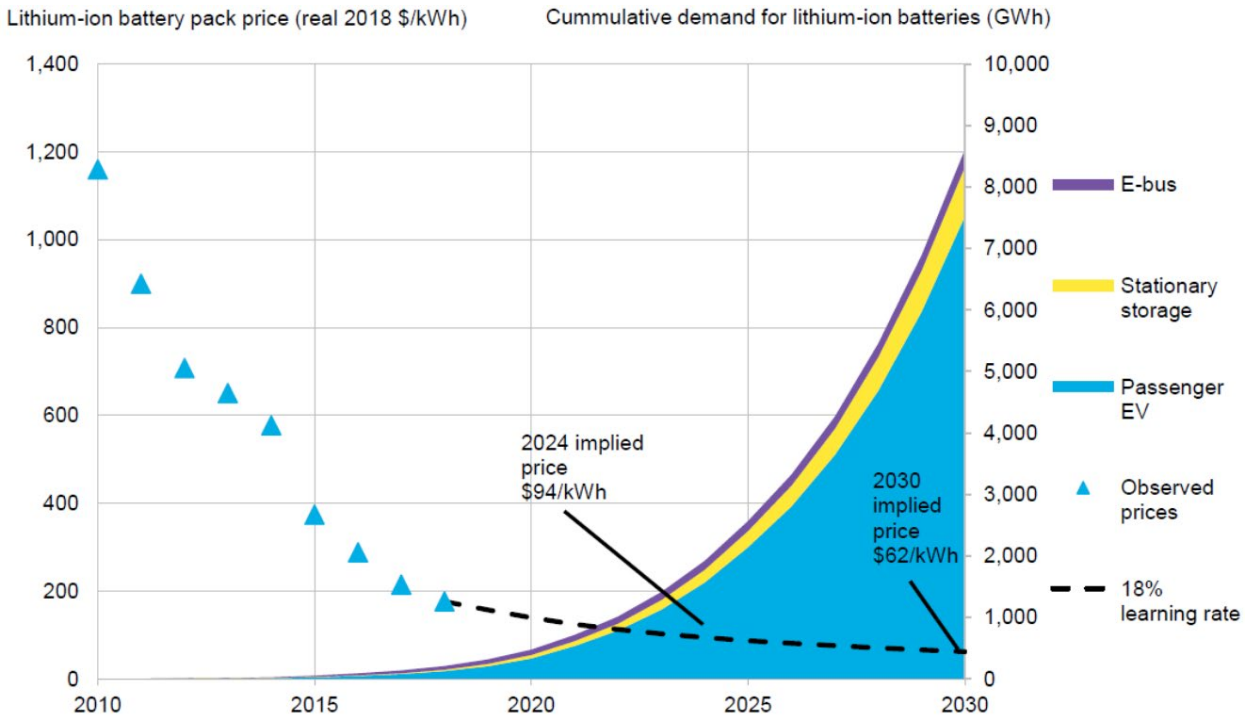
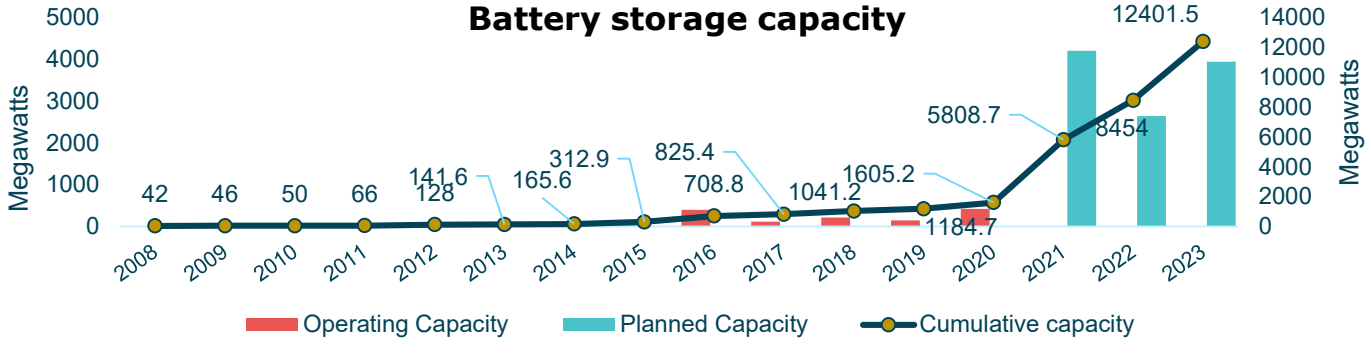
Lithium-ion Battery Price Trends

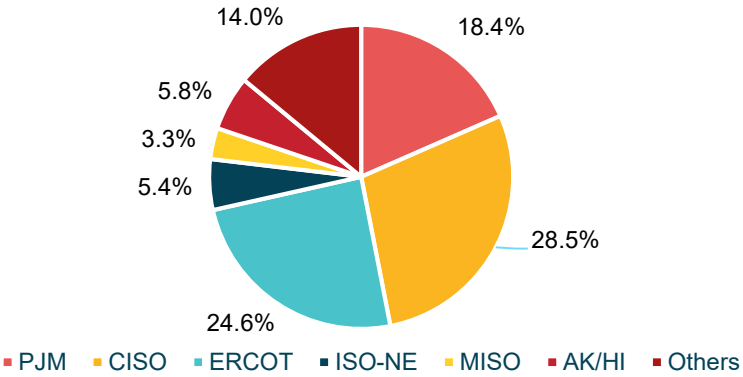


Ref: Electric Buses in Cities, BNEF, 2018

Forecasted Growth – Utility Scale



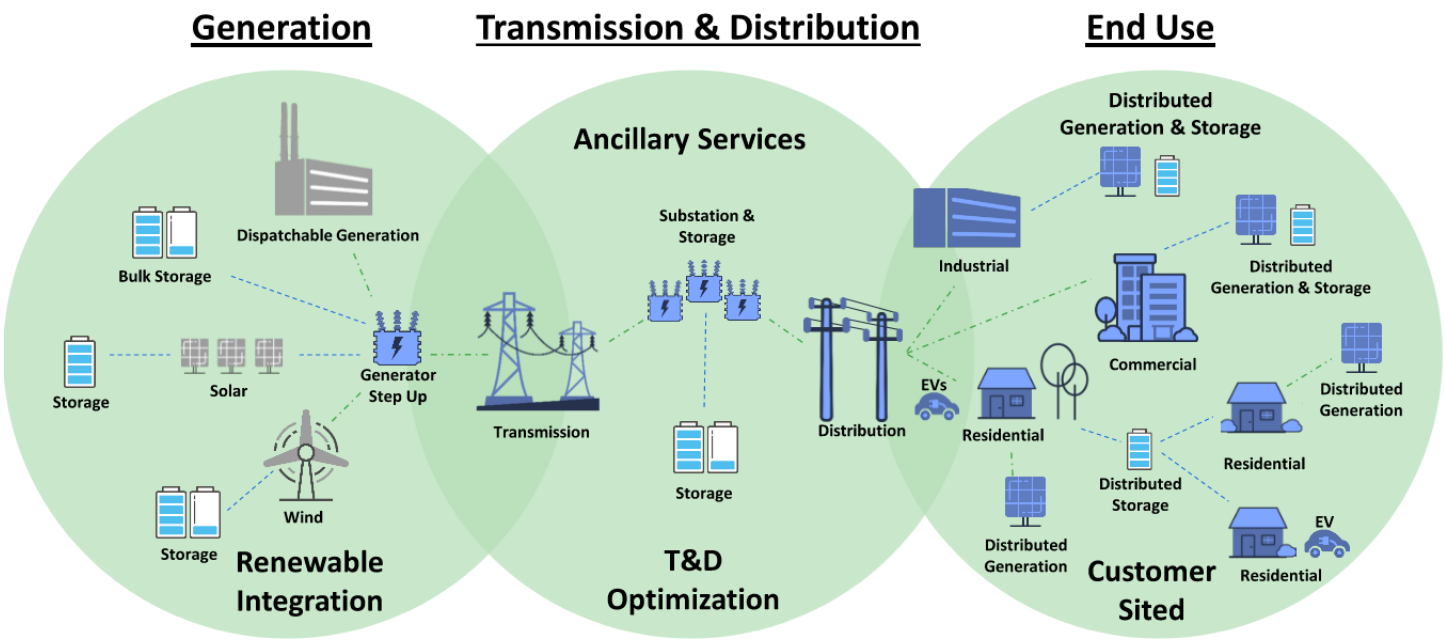
Regional breakdown of operating battery power capacity



Exponential growth in planned capacity is driven by price and policy trends

Ref: EIA Preliminary Monthly Electric Generator Inventory, February 2021; EIA, Electric Generator Report, Feb 2021

The Transforming Power System



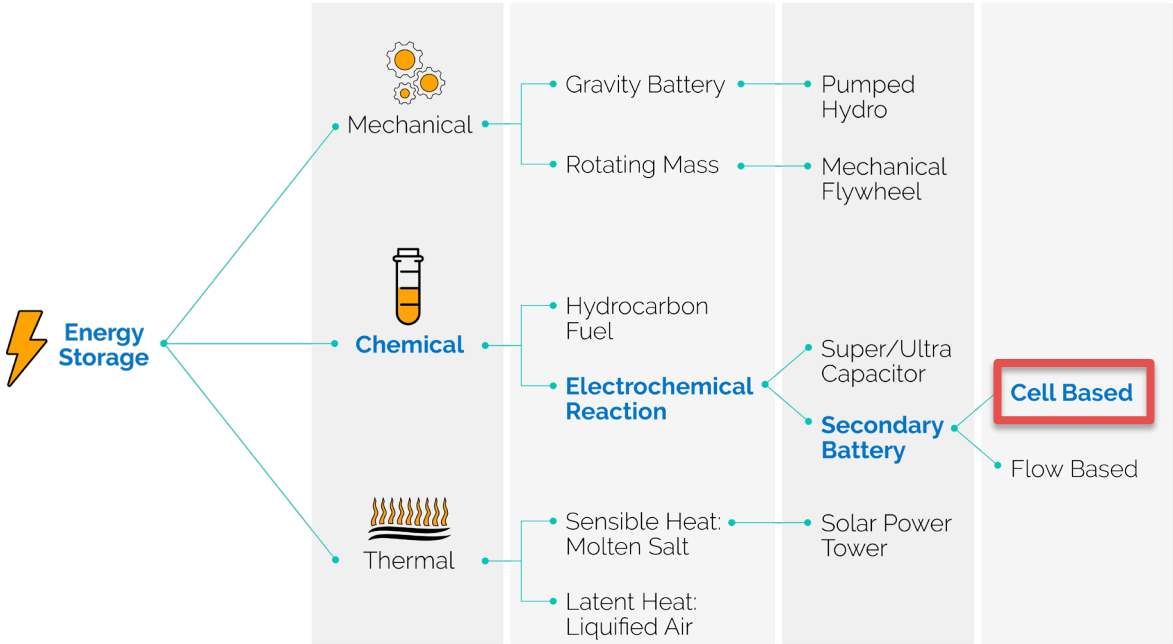
Storage provides flexibility, reliability, and resilience throughout the Power System

Microgrids with BESS for DoD

BESS enable resilient, flexible, and reliable microgrids

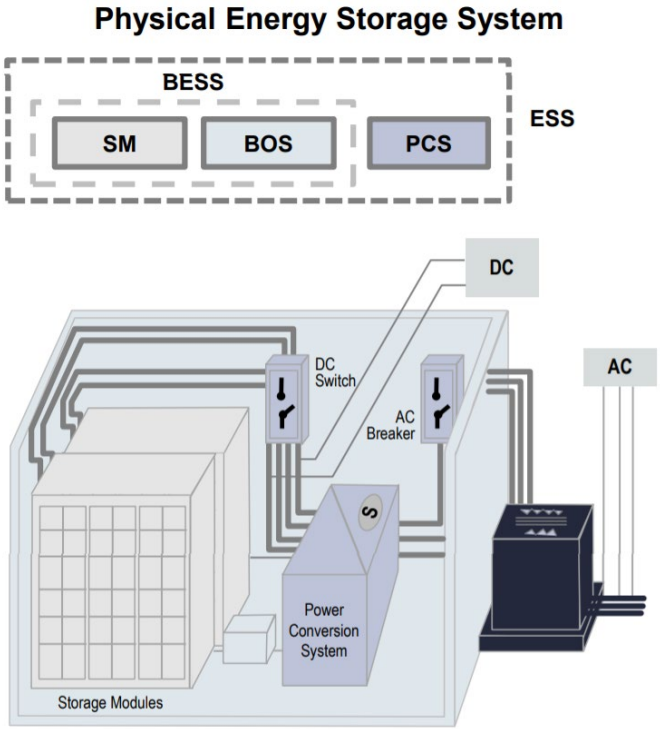
Ref: Flexgen Manual

Types of Energy Storage



Cell based batteries provide cost effective flexibility to serve DoD needs.

Typical Energy Storage System



System Layer		Component
SM	Storage Module	• Racking Frame/Cabinet • Battery Management System (“BMS”) • Battery Modules
BOS	Balance of System	• Container • Monitors and Controls • Thermal Management • Fire Suppression
PCS	Power Conversion System	• Inverter • Protection (Switches, Breakers, etc.) • Energy Management System (“EMS”)
EPC	Engineering, Procurement & Construction	• Project Management • Engineering Studies/Permitting • Site Preparation/Construction • Foundation/Mounting • Commissioning
Other (not included in analysis)		• SCADA • Shipping • Grid Integration Equipment • Metering • Land

Ref: LCOS, Lazard V4.0

Use-Cases for the DoD

USE-CASE	BENEFITS DOD INSTALLATION	BENEFITS UTILITY	ECONOMIC MECHANISM
Frequency Regulation	Yes	Yes	TBD
Spinning Reserve	Yes	Yes	TBD
Voltage or Reactive Power Support	Yes	Yes	TBD
Load Following	Yes	Yes	TBD
System Peak Shaving	Yes	Yes	Likely
Arbitrage	TBD	Yes	TBD
Load Management	Yes	Yes	Likely
Storing Excess Wind and Solar Generation	Yes	Yes	TBD
Backup Power	Yes	Yes	Unlikely
Transmission and Distribution Deferral	Yes	Yes	Likely
Co-located Generator Firming	Yes	Yes	TBD

Stacking Use-Cases to benefit both the installation and the local utility increases economic viability of BESS

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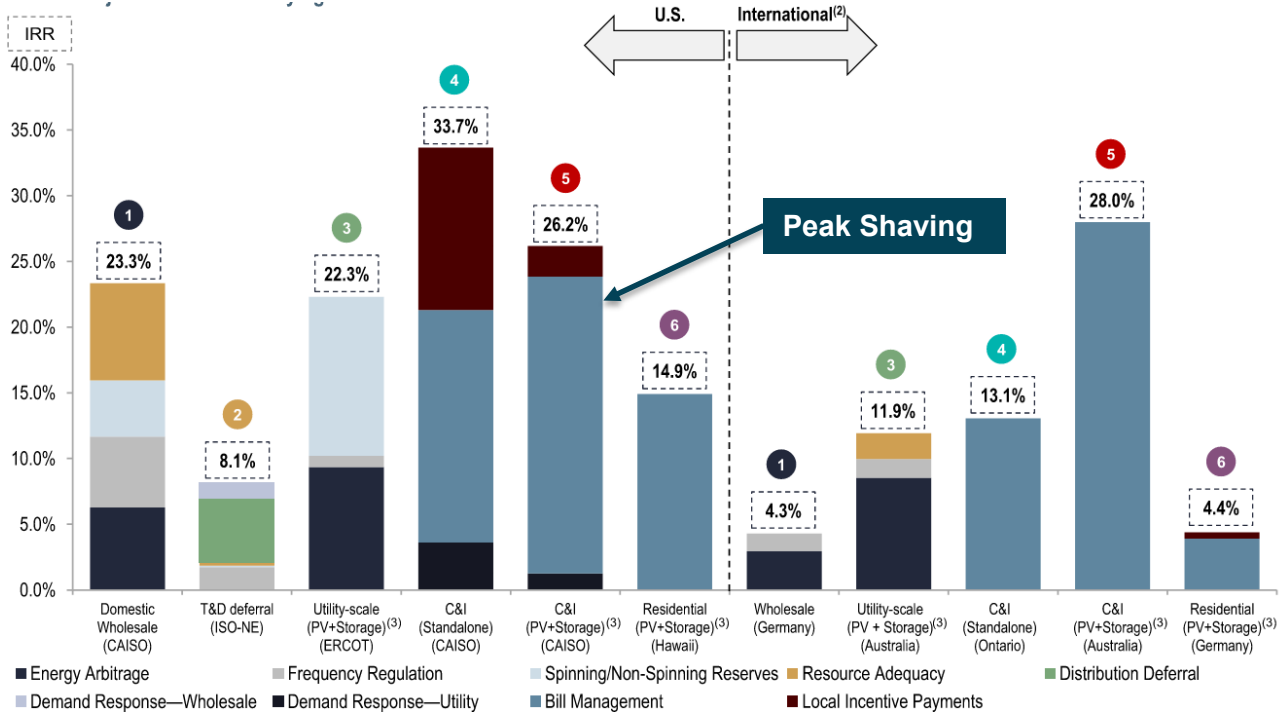
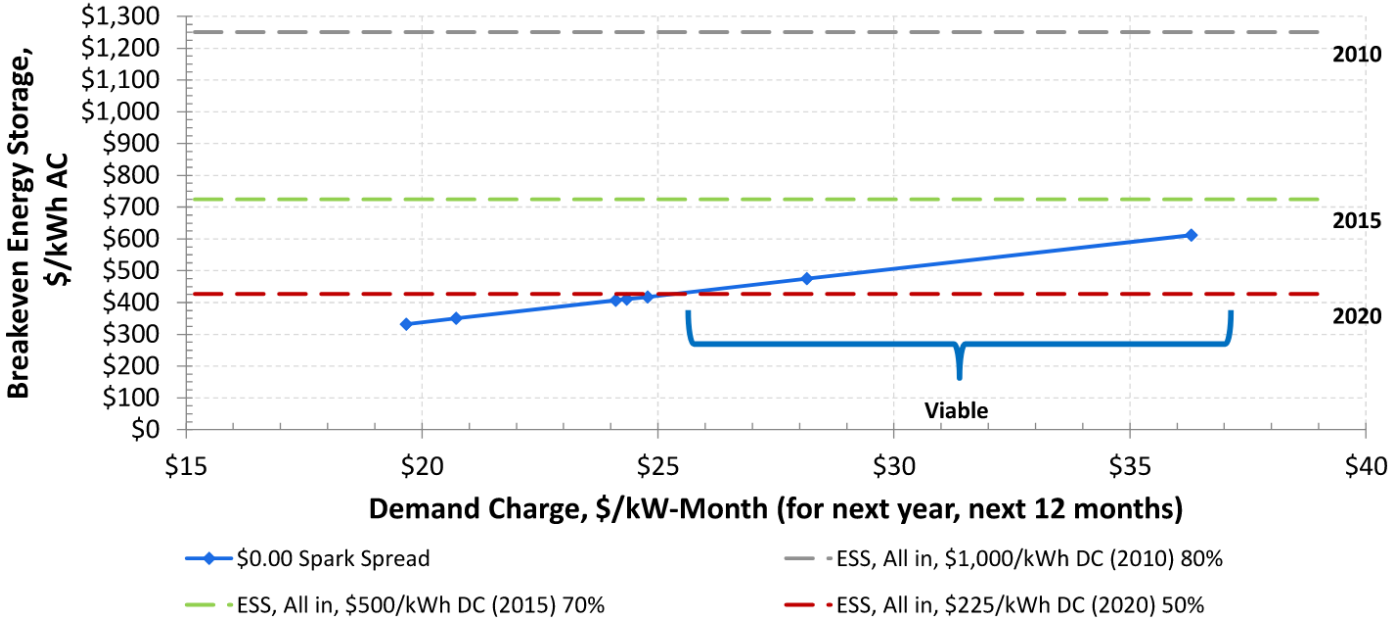
Use-Cases - Continued



Returns are driven by market structure and incentives

Ref: LCOS, Lazard, v6.0

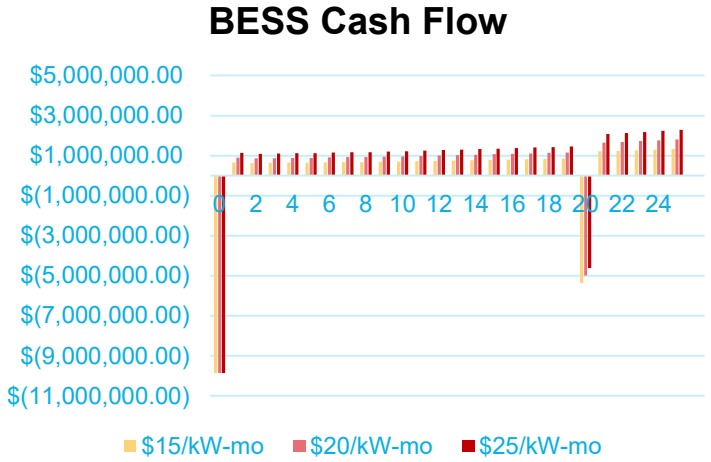
Peak Shaving – Economic Viability



Batteries pay for themselves in markets with high demand charges and peak power cost

Ref: Moody's Energy Storage Technology Economics (1/2017)
Ref: Bloomberg (12/2018)

Peak Shaving – Economic Viability



Variable		Cost
Equipment Costs	$	6,900,000
Civil/ Structural Costs	$	1,000,000
BESS Plant Cost	$	7,900,000
Contingency (10%)	$	790,000
EPC (10%)	$	869,000
Other Indirect Costs (3.5%)	$	304,150
Total Installed Costs	$	9,863,150

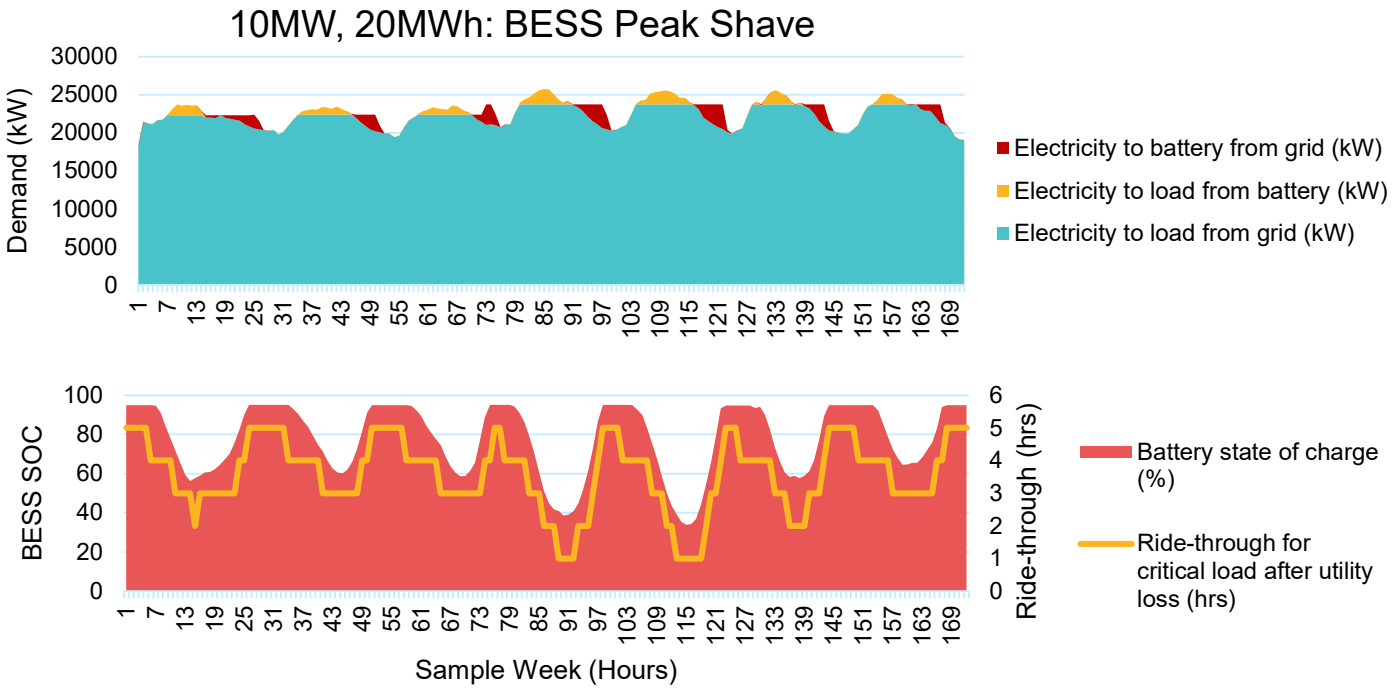
Variable	$15/kW-mo	$20/kW-mo	$25/kW-mo
NPV (25-yr)	- $3,038,418	- $29,333	$2,979,753
Straight-line Sum	$4,866,046	$12,506,667	$20,147,270

Sample Analysis:

BESS
10MW, 20MWh

PEAK DEMAND
25MW

Peak Shaving: Example Grid-Connected Use-Case



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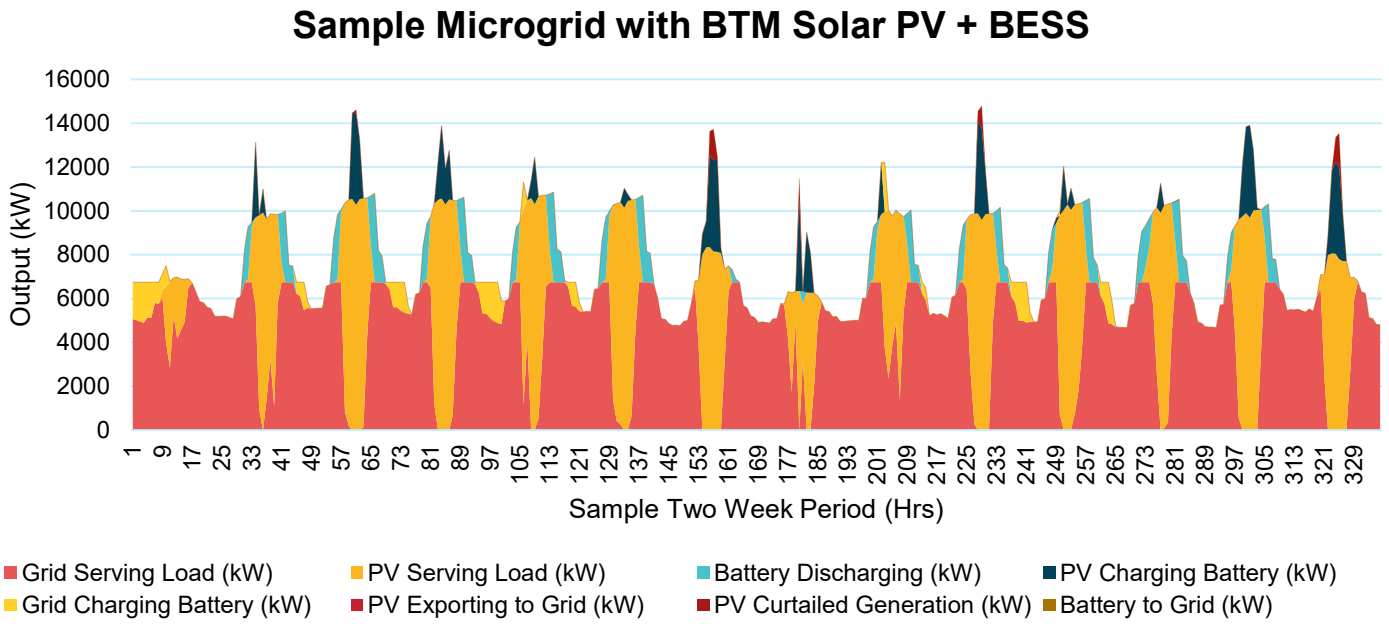
Sample Microgrid with BTM BESS



System Size: 10MW+ Peak Demand, 26MW Solar PV, 4MW, 24MWh BESS

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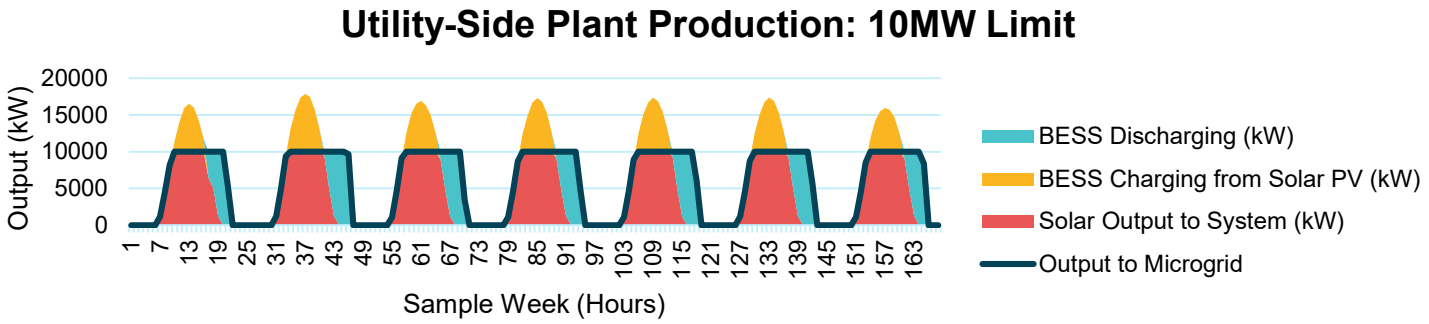
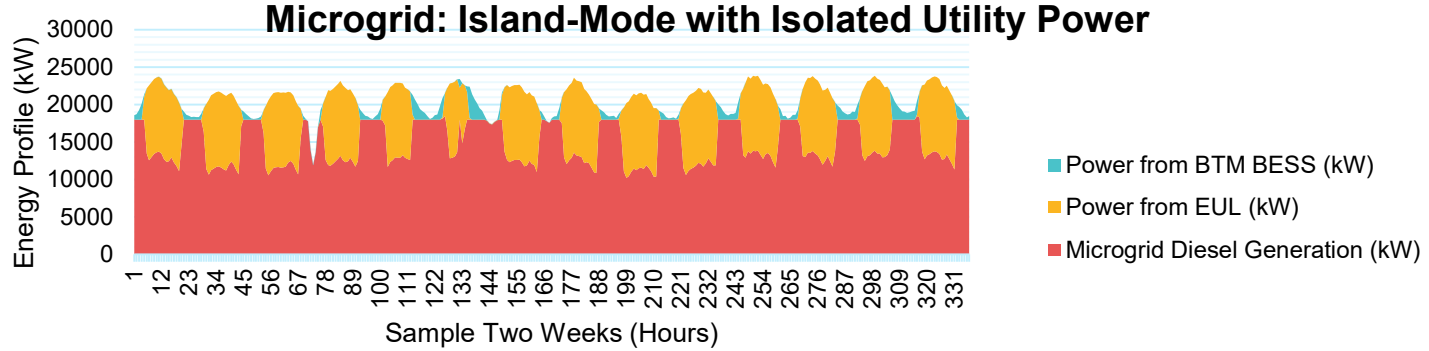
Sample Microgrid: Access to Outside the Fence-line Solar PV + BESS





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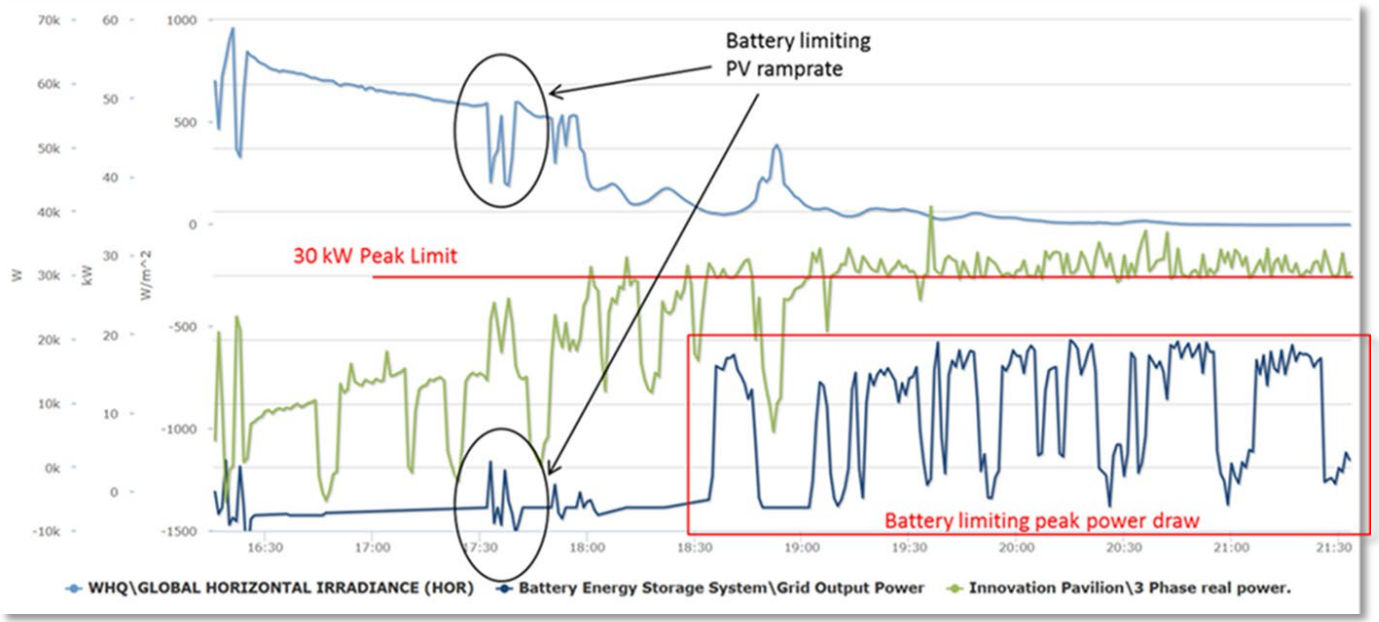
Solar PV Paired with BESS



BESS has a fast ramp rate to stabilize power output to utility or customer load

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Long Duration Energy Storage

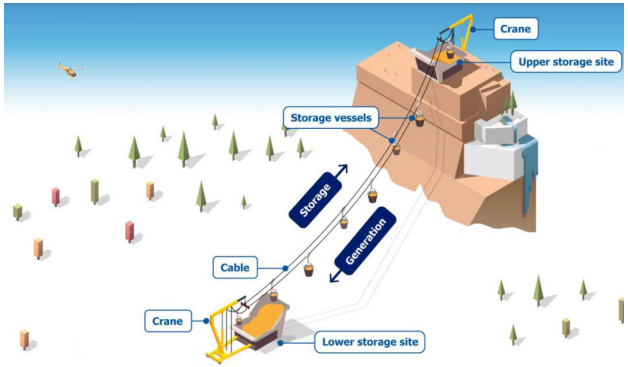
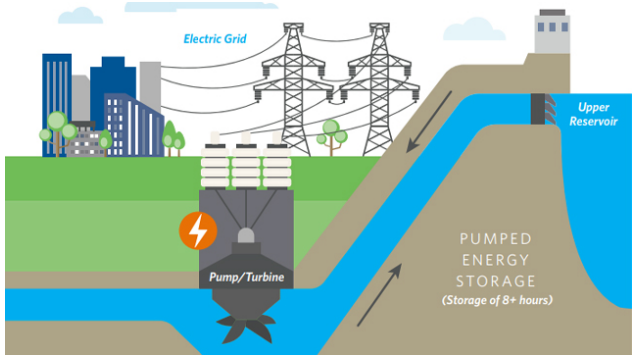
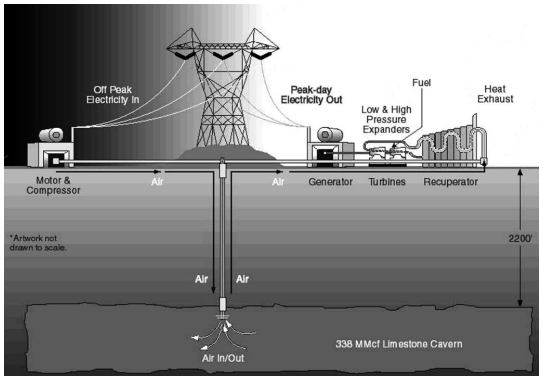


Illustration: IIASA



Ref: Black & Veatch



The Future of Energy Storage

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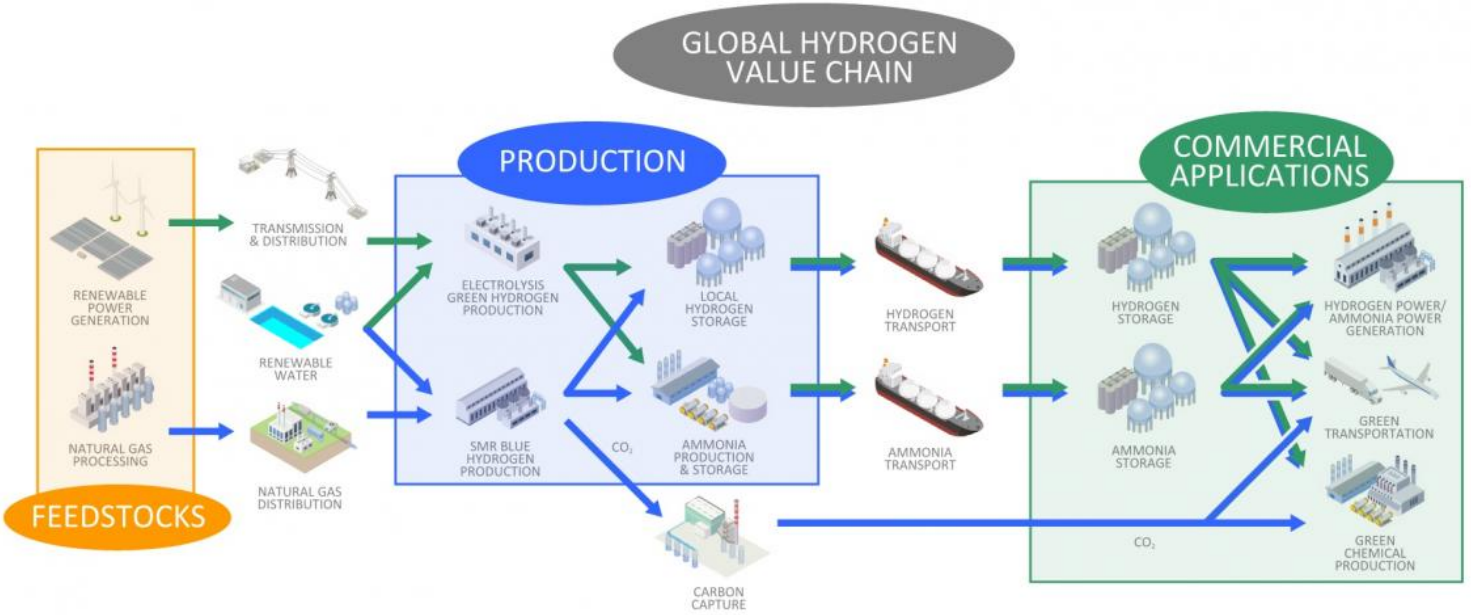
Hydrogen Energy Storage



Ref: Black & Veatch

Fleet Electrification

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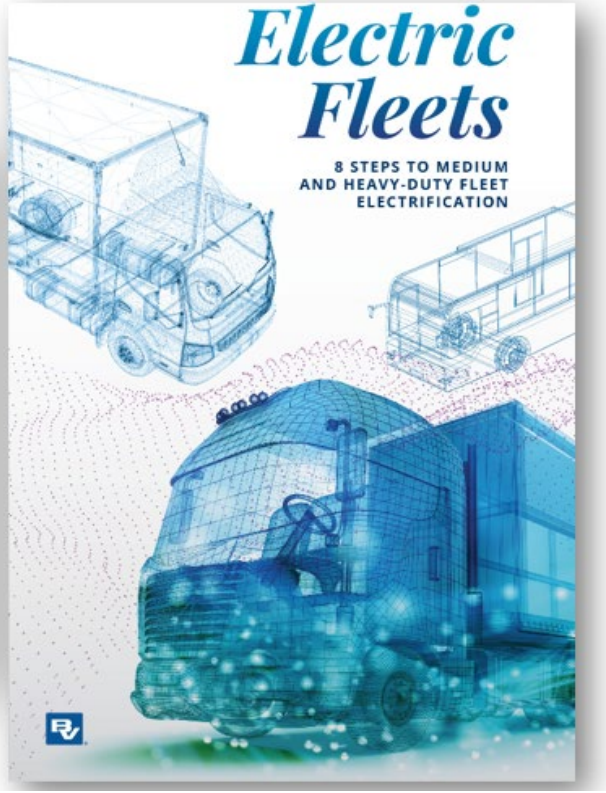
8 Steps To Fleet Electrification

1. Define Drive Cycles, Duty Cycles and Operational Considerations
2. Review and Select Technology Options
3. Understand Charging Loads and Power Delivery
4. Site Planning
5. Conduct Utility Coordination, Engineering and Design
6. Apply for Permit and Approvals
7. Distribution Grid Upgrades
8. Obtain Equipment, Construct and Commission



Ref: Electric Fleets, 8 Steps to Medium & Heavy-Duty Fleet Electrification, Black & Veatch

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Q&A AND FEEDBACK

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Ruthie Fetscher: rfetscher@deloitte.com

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