Changing Economics of Battery Storage

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12TH ANNUAL
Nebraska Wind & Solar
CONFERENCE & EXHIBITION

Submit Questions at Slido.com - Code #K126

Nebraska Wind and Solar

Kate Howling

Invenergy

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Energy Storage 101

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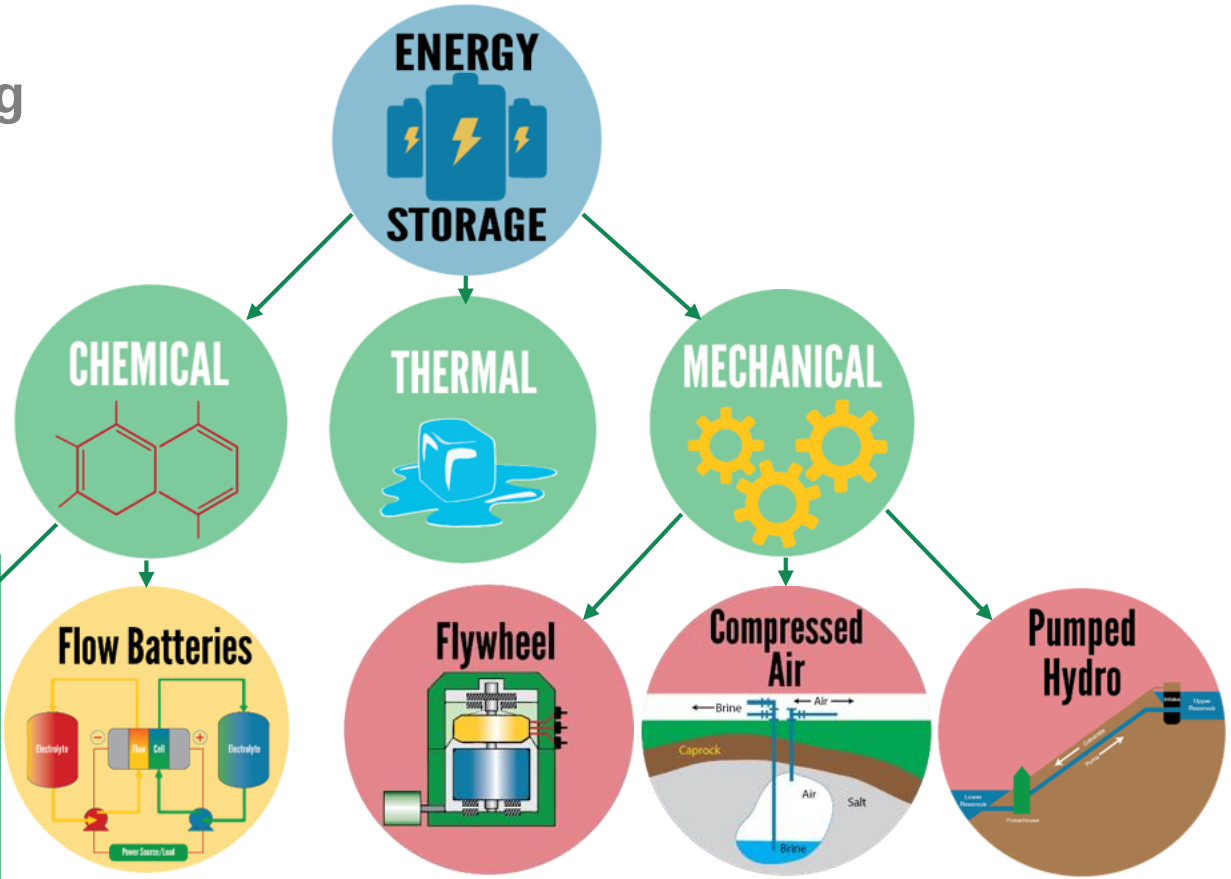
Energy Storage 101 Technology Overview

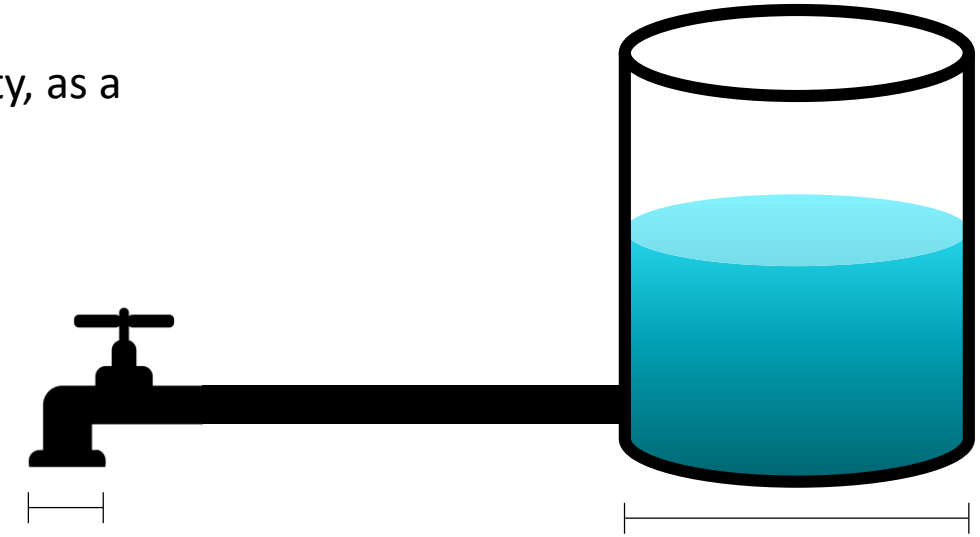
There are multiple methods of storing energy—most of the focus today is around **electro-chemical storage.**



For now, we are only building Lithium-Ion battery projects.

Energy Storage 101 Terminology

A battery stores electricity, as a tank stores water:



Amount of available energy at a given time = **State of Charge** (SOC)

Pipe size = **Power**
Units: Kilowatts (kW)
Megawatts (MW)

Power is limited by the size and number of inverters

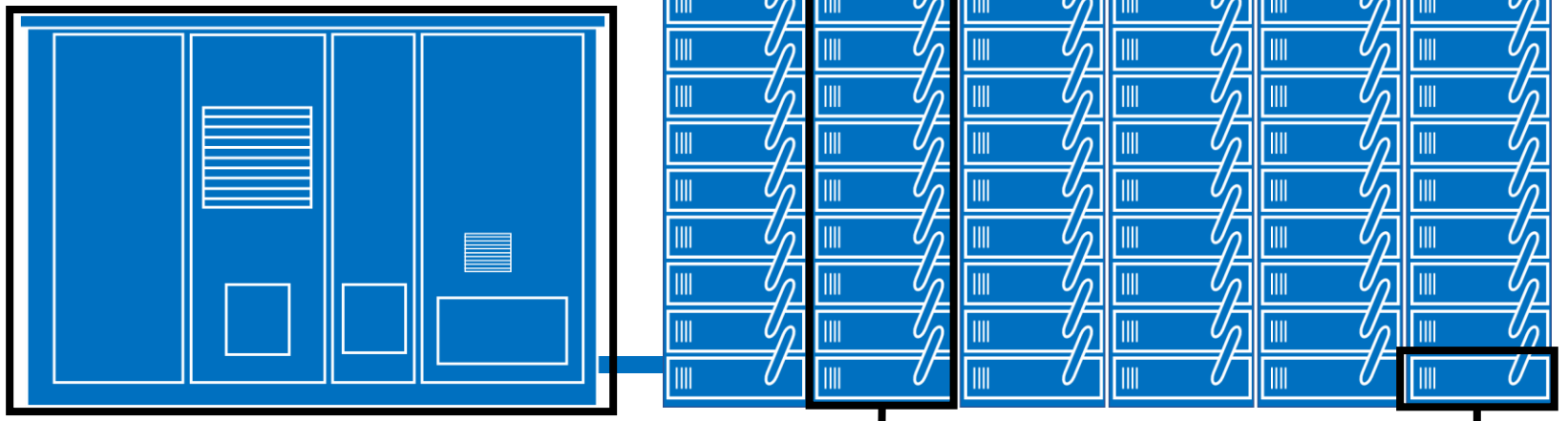
Size of tank = **Energy**
Units: Kilowatt-hours (kWh)
Megawatt-hours (MWh)

Energy is limited by the size and number of battery modules

Energy Storage 101 Terminology continued

DC Block

Inverter (a.k.a. PCS)



Each string has a **Battery Management System** (BMS) that monitors voltage, current, temperature, SOC, et.

The inverter rating dictates how much power can be charged or discharged to the battery (typically max charge power = max discharge power)

Multiple trays are wired in series to form a **Battery String** or **Rack**. Strings can be configured vertically in a single rack, across multiple racks, or horizontally.

The **Battery Tray** or **Module** is the smallest replaceable unit. It is filled with **Battery Cells**.

"Battery" = …almost anything, depending on who is speaking

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Storage Market

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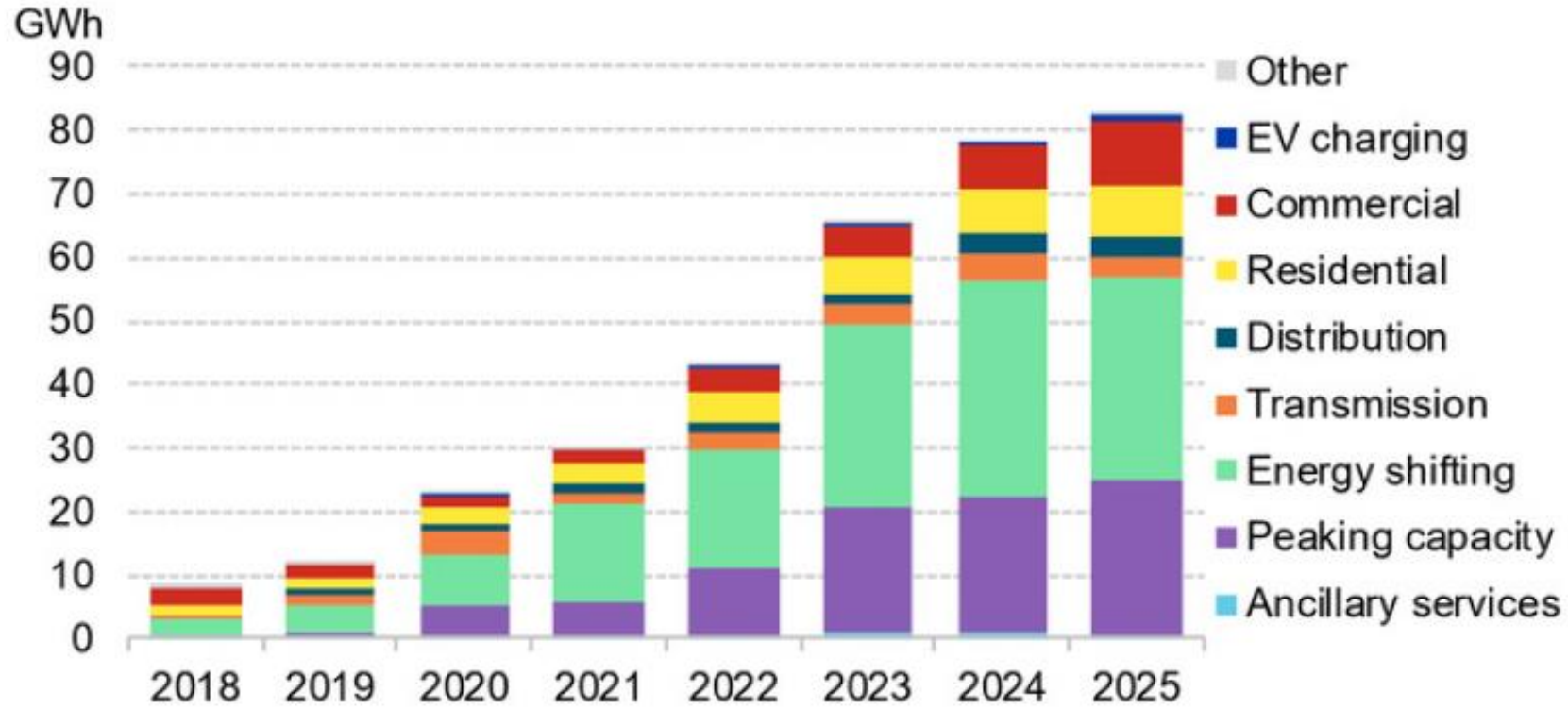
A Small But Rapidly Growing Market

Figure 13: Global annual installations by application based on energy capacity



Source: BloombergNEF

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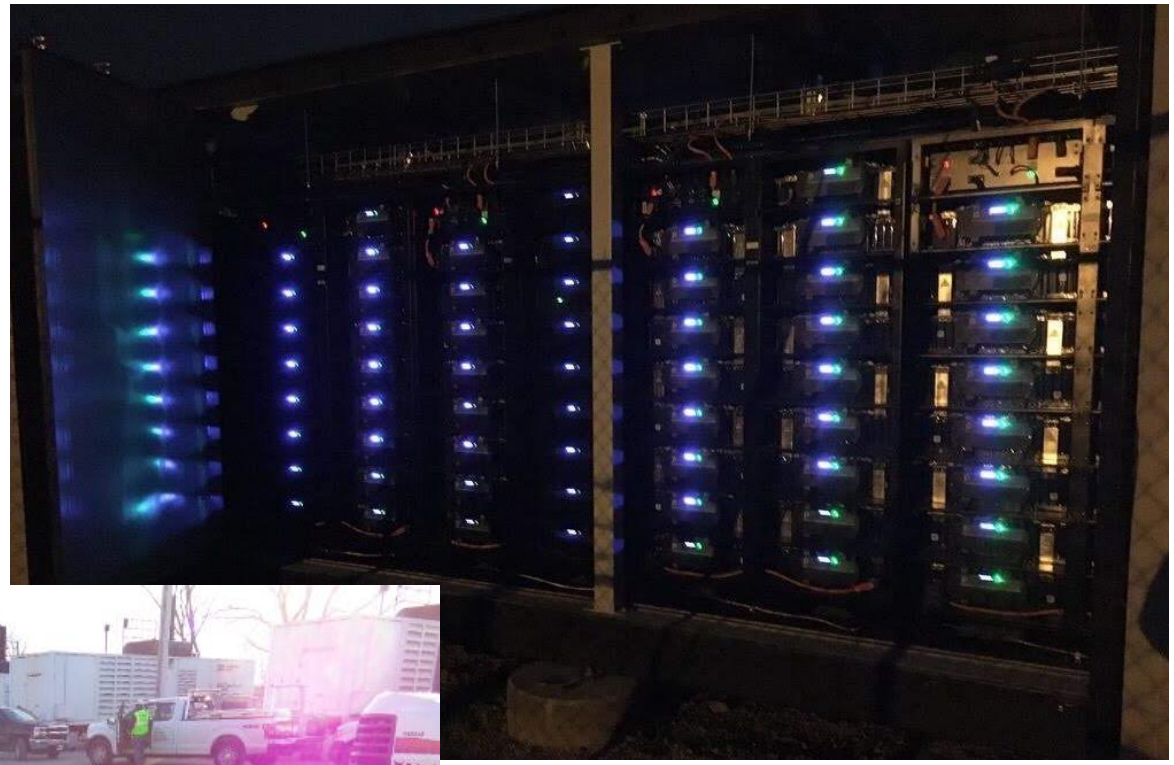
Energy Shifting and Peaking Capacity will be the most important applications (both require ~4-hour duration)

Use Cases

Case Study: MidAmerican Energy Storage



Invenergy installed 1MW/4MWh storage project in Iowa consisted of 2 battery enclosures, 1 inverter and 1 transformer. It was built in an existing yard

Project Highlights:

- **Competitive bid**
- **4 month timeline**
- **Storage pilot**

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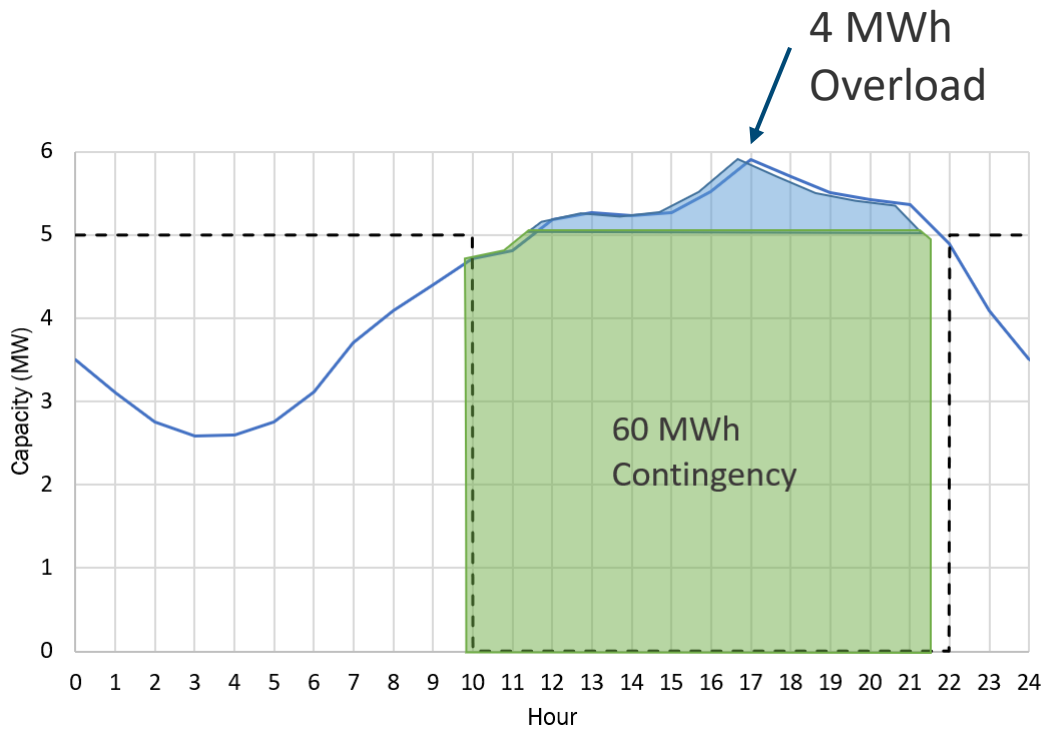
Case Study: Utility Transformer Back-up

- Large utility transformer is aging
- Batteries can provide N-1 contingency in the event of generator failure
- Benefit to utility:
  - Deferring cost of substation upgrade
  - Grid reliability
  - Voltage support



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Safety Slide

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Battery Safety: Mitigation and Management

- Battery controls prevent operation within temperature and voltage bands that would lead to battery damage
- Data monitoring allows operators to monitor anomalies
- Fire suppression aims to tackle one or more categories in the fire triangle
- Ventilation and fire detection prevent dangerous conditions within enclosure
- Battery suppliers perform standardized tests to certify safety

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Working towards a clean energy future

Join us.

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ENGIE North America

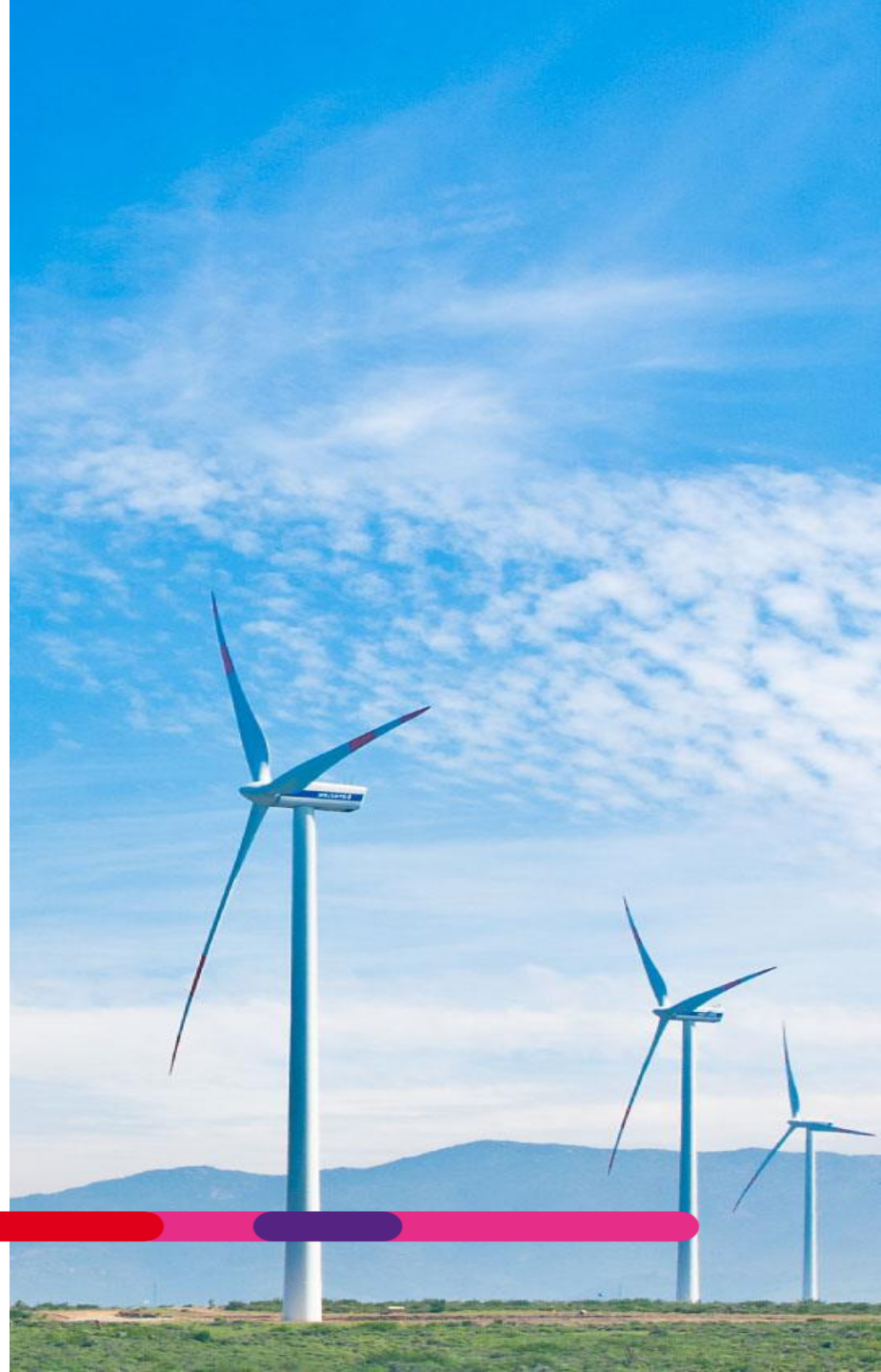
Nebraska Wind & Solar Conference | 10/30/2019

AGENDA

1. Background: ENGIE
2. Distributed Storage Today
3. The Future & Trends

01

Background: ENGIE



ENGIE: A Global Snapshot

ENGIE is the largest IPP in the world and has a global focus.

155,000
employees
worldwide

Operations in
more than **70**
countries

70 billion USD
revenues

11 billion USD
EBITDA

17 billion USD
investments over 2016-2018 including
1.2 billion USD
in innovation and digital

ENGIE North America
By the Numbers

- Manage approximately **12,700 MW** of generation
- Generating power from a diverse, low carbon fuel mix with **over 1,000 MW of onsite generation**
- Operating **renewable facilities** with a generation capacity of nearly 1,000 MW
- **No. 3 largest non-residential retail supplier** in US in 14 markets, including PJM
- **No. 1 LNG terminal player** in the United States serving New England market
- Help customers identify and achieve more than **$2.8 billion in energy savings**
- Managing more than **25 million sq. ft.** of buildings and active in **8 airports** in North America

ENGIE's distributed solar & storage approach is enabled by the seven cooperative principles.

1 & 2: Open and Voluntary Membership & Democratic Member Control

- Opportunity for co-op collaboration is greater with DG. Example: the members of Dairyland (WI) created "Distribu-Gen", to work on fuel cells. They used this group to coordinate development of a solar portfolio with ENGIE. This approach was bottom up to the G&T.

3: Members' Economic Participation

- ENGIE's co-op development process has created local jobs, increased member satisfaction, and reduced applications for NEM.

5: Education, Training, & Information

- Training and tours for schools and community groups

6: Cooperation Among Cooperatives

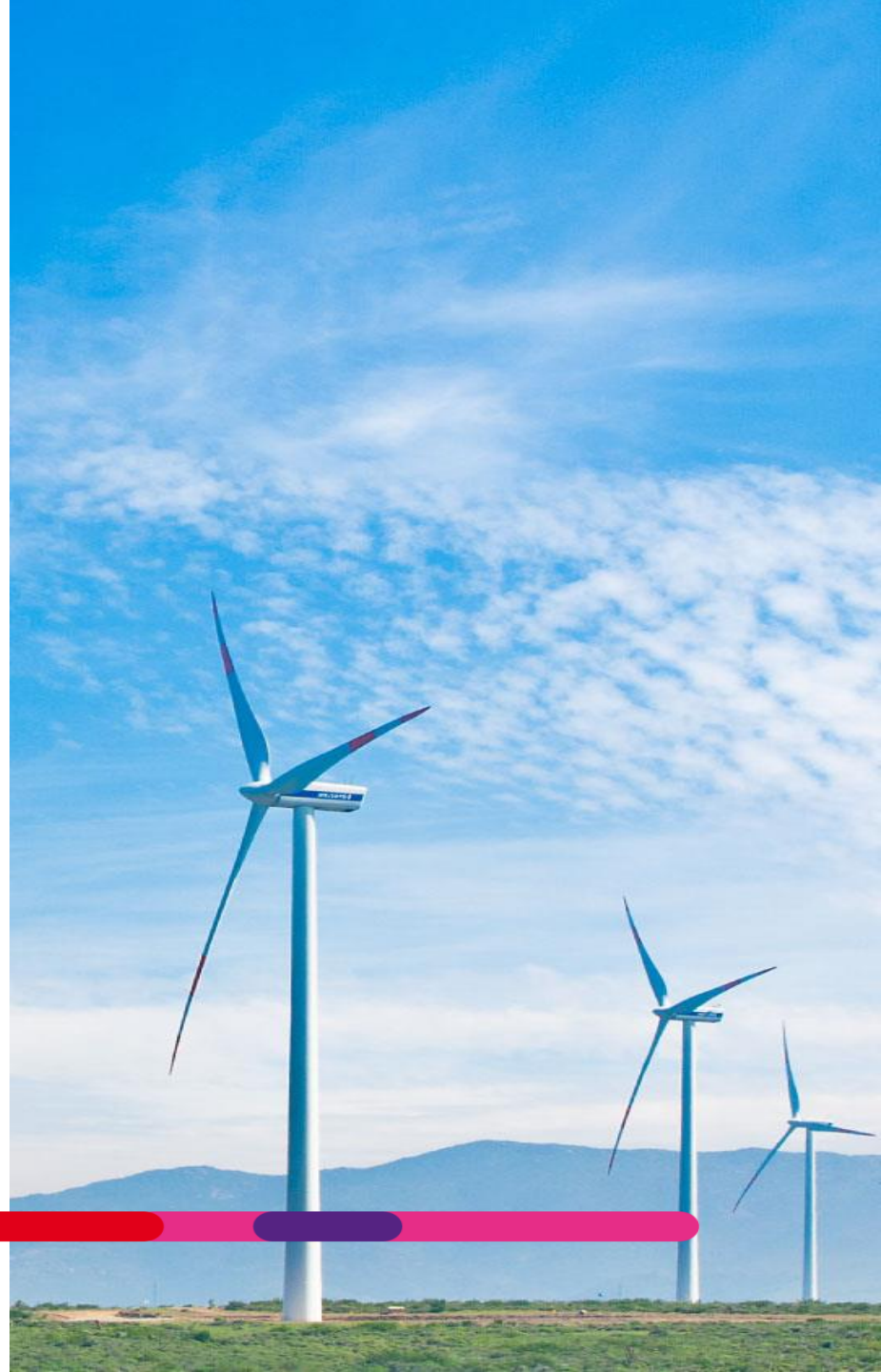
- G&T and member co-ops work together for their collective benefit; e.g. sharing the same contractual documents, etc.

7: Concern For Community

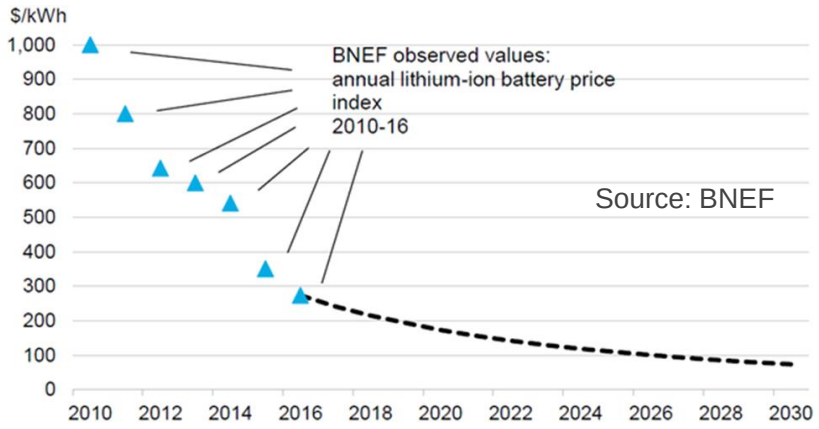
- Good paying local jobs, native habitats & pollinator gardens have positive impact on local agriculture, and clean energy is generated for the local consumers

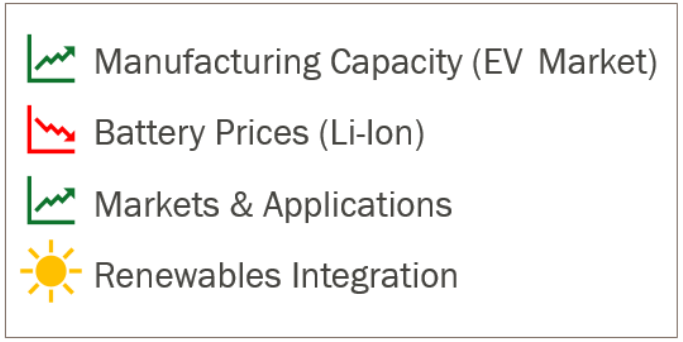
02

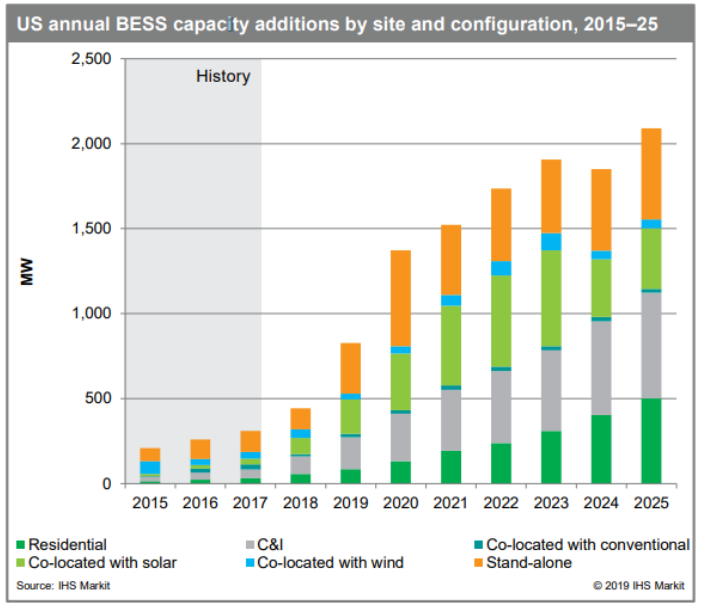
Distributed Storage Today



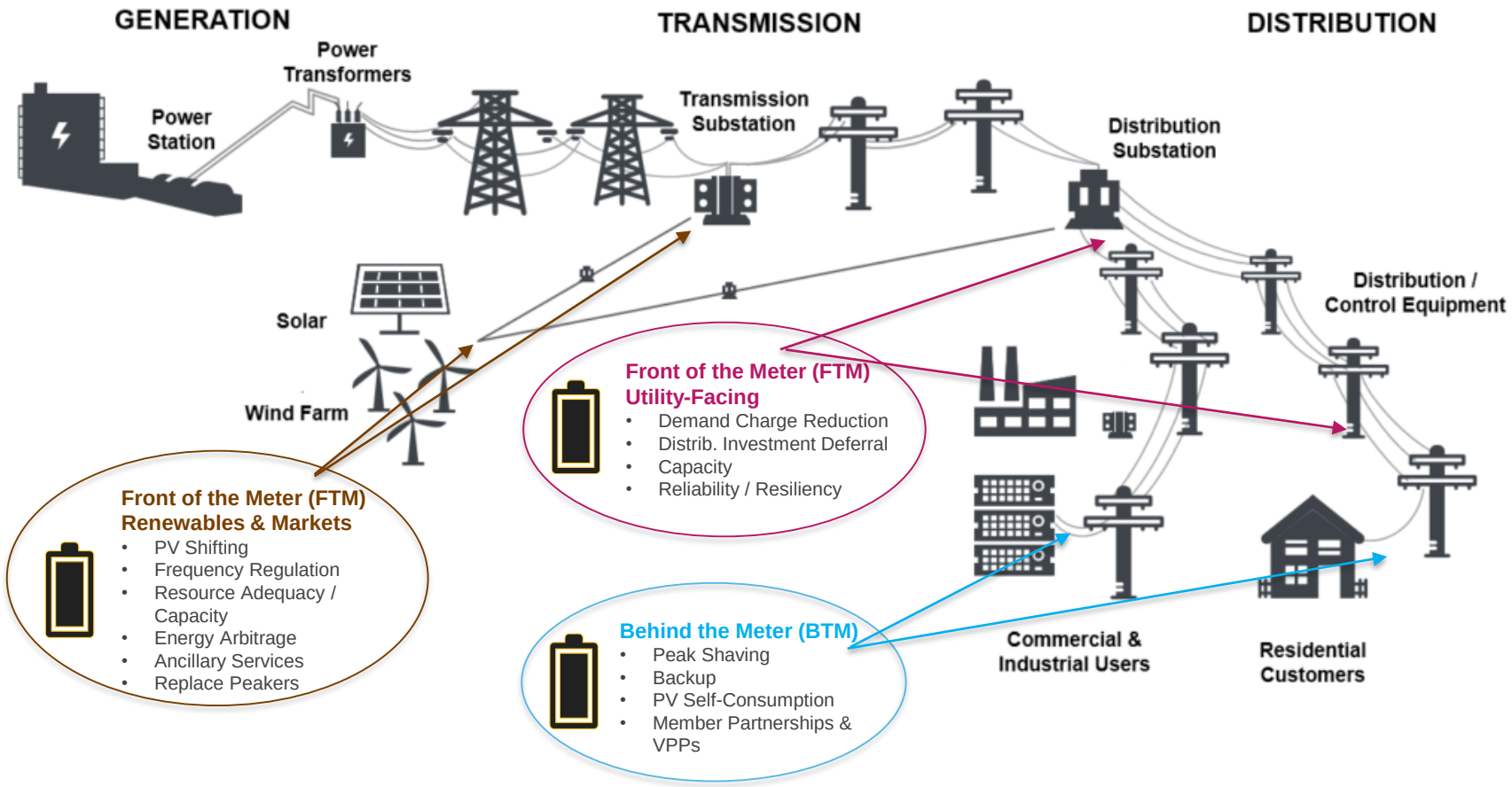
Energy Storage: Why Now?







Many Levels of BESS Deployment



Solar Plus Storage Market Drivers

1. **Tax Incentives**
   - Energy Storage (ESS) assets co-located (and charging from) solar projects can be eligible for the Federal ITC and accelerated depreciation
2. **Additional Use Cases**
   - Clipping re-capture (DC-coupled)
   - PV time-shifting (energy value)
   - PV firming (capacity value)
   - Reduced PV curtailment (in congested areas of DG network especially)
3. **Interconnection and shared costs**
   - ESS co-located with solar can have lower per-unit installation and maintenance costs compared to stand-alone
     - Shared inverters, transformers (DC-coupled)
     - Shared land & real-estate benefits (PILOT, etc.)
     - Shared interconnection costs (depending on grid limits)
     - Shared EPC mobilization
   - Lower maintenance costs may arise due to shared crews, plant-level monitoring, etc.

Distributed Storage: Case Studies

United Power – Community Battery, Longmont, CO (4.5 MW / 18 MWh)

- Analysis shows 25 MW (on a 450 MW peak utility) could be shaved over each of the 12 months with a duration of 4 hrs.
- Dispatch ~100 times per year to mitigate peak demand charges
- 100% capacity guarantee for 10 years, 15-year overall wrapped warranty
- United structured a community battery program (like community solar), members can purchase a “share” of kW reduction from the BESS as a reduction on their retail kW charges.

Mt. Tom – Solar + Storage, Holyoke MA (3 MW / 6 MWh)

- In February 2017, ENGIE built and commissioned the 5MW Mt. Tom solar array at a decommissioned coal plant.
- In 2018, ENGIE added battery storage to the solar project.
- The energy storage system enhances utility (HG&E)’s electricity system and helps keep electric rates stable by reducing rising capacity charges for the utility and its customers.
- ENGIE’s GridSynergy platform deployed for site control, monitoring.

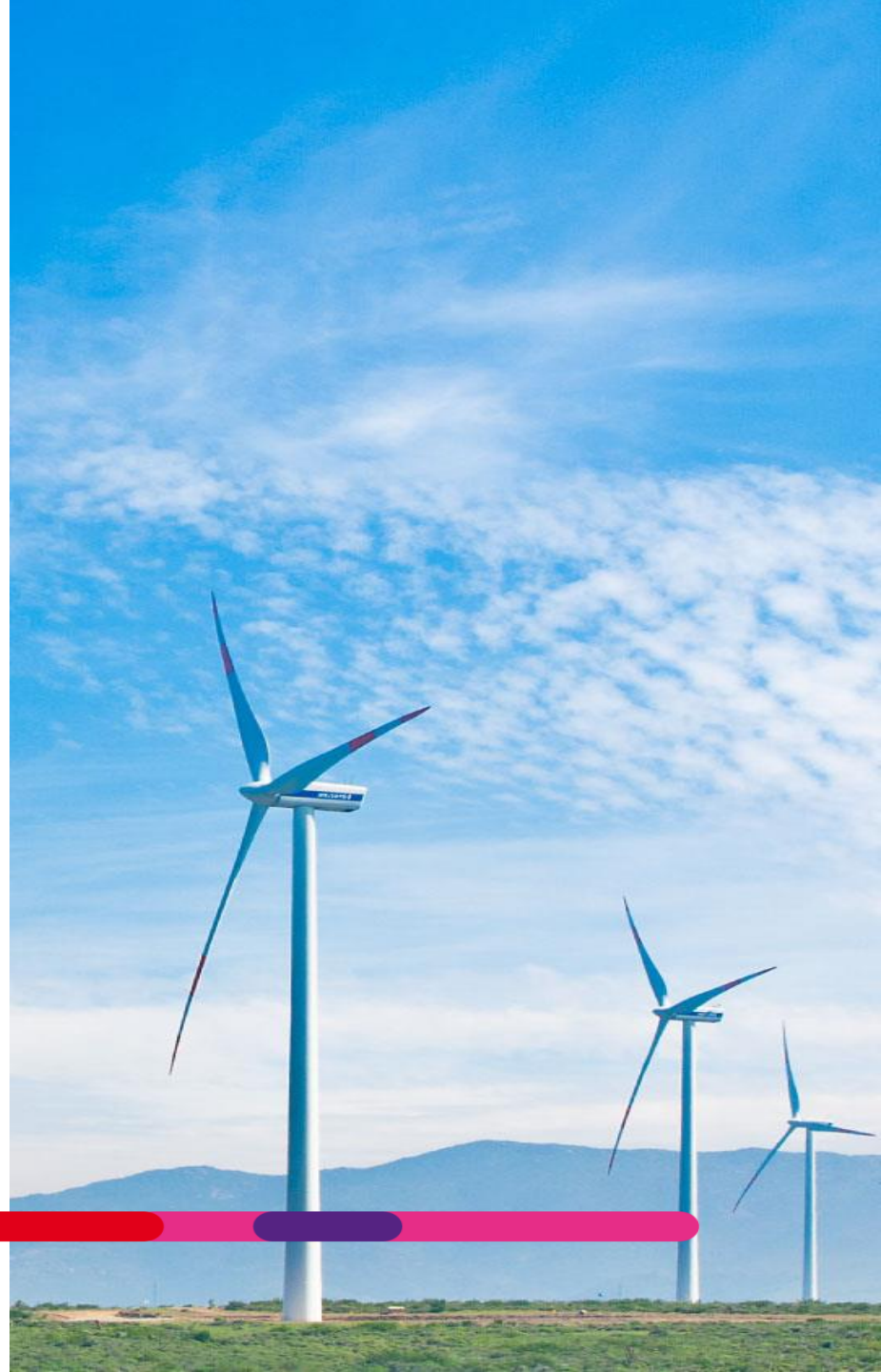
Various Co-Ops – Non-Wires Alternatives

- ENGIE is in discussions with a number of distribution cooperatives regarding ESS projects that provide reliability services (such as black start and backup of distribution on lost wholesale power service)
- Distribution and Transmission Asset deferral is among the most valuable use cases for ESS but is elusive (very location-specific)

Image to right: Central Rural Electric Co-Op, OK; Microgrid ESS

03

The Future & Trends



Next-Gen PV + Storage

We hear about integrating ESS with Solar; how can a utility unlock these benefits?

- Increase Energy and Capacity value of renewable generating asset
- Address duck curve
- Self-consumption of PV; DC-coupled Storage hits “prime time”
- Address transmission or demand charges with PV

It’s time for the industry to come together with innovative contract structures.

- First Solar & APS
- Guam Power Authority & ENGIE
- Western Farmers & NextEra Energy Resources

As a utility: Dig into the data and provide detailed feedback to your developer counterparties about *when* and *how* their assets can provide you the most value, and structure the contract around this!

Electric Vehicles; EV Charging

- Observed a dramatic shift in coop thinking in past 12 months
  - Pre-2019: No interest. “Tree huggers on both coasts don’t understand the longer commuting and general driving distances in rural America. EVs aren’t ready.”
  - Now: This is a potential opportunity to sell more power. What should we do?
- Evaluating numerous potential partners
  - Manufacturers & s/w providers (e.g. EVBox, ENGIE owned)
- Energy Storage can be co-located w/ level 2+ EV Chargers to reduce/mitigate the potential demand spikes.
- Other strategic cooperative-related benefits / strategies?
  - Consumers ordering residential chargers through their utility
  - Utilities might use bill credits or on-bill financing to help accelerate penetration
  - Wi-Fi connectivity to integrate into other DR programs
  - Operational software branded or skinned to look as though the EV charging portal comes from the utility
  - Sell more power, deploy ESS to seamlessly mitigate peak demand charges

Questions?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Able Grid Energy Solutions

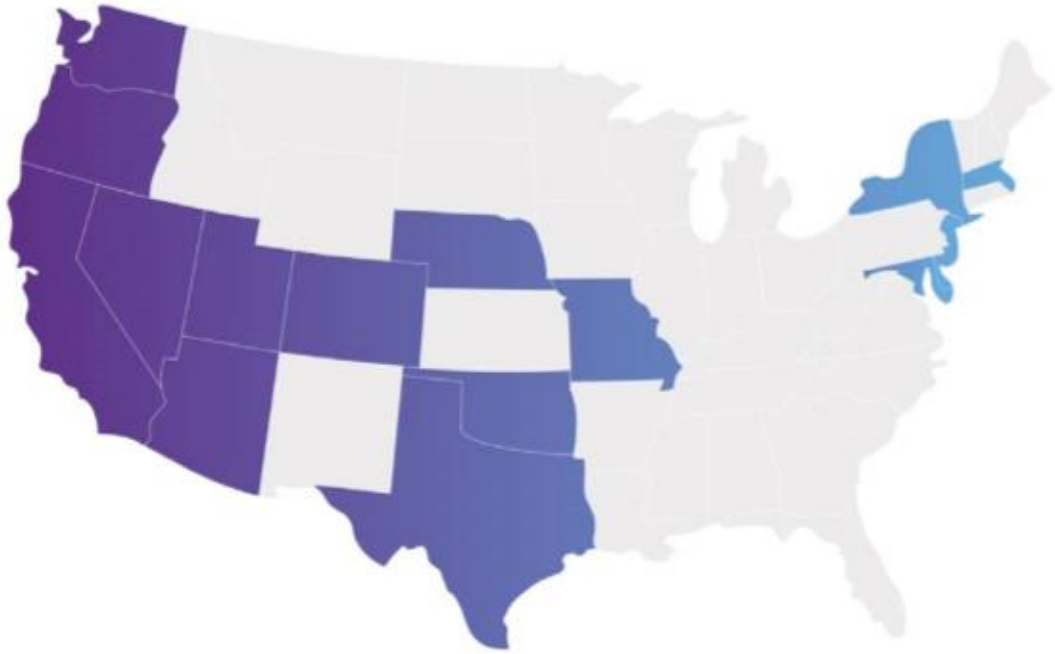
Independent Energy Storage Developers

October 30, 2019

ABLE GRID

Who Is Able Grid?

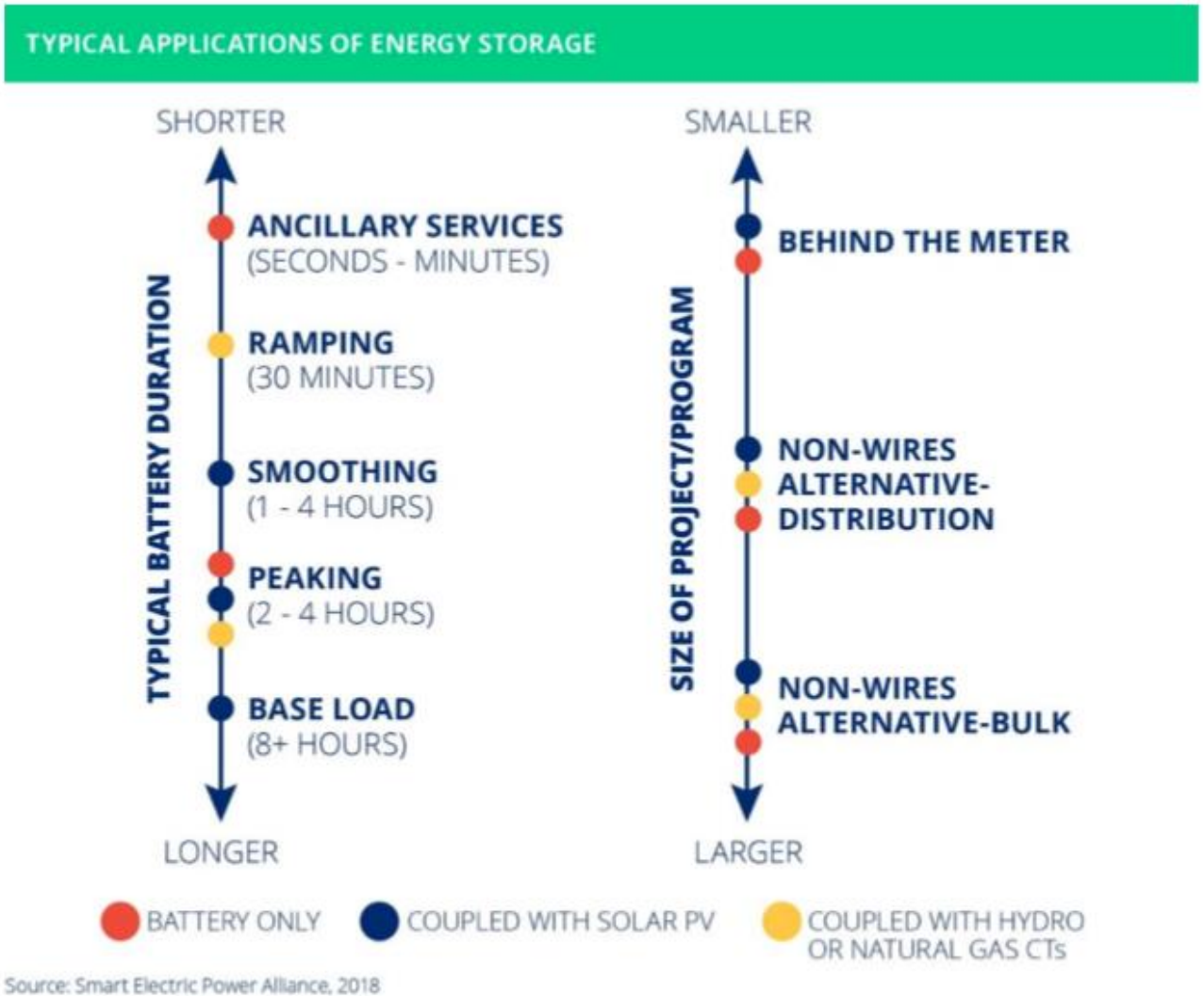
- Develop battery energy storage projects
- Stand-alone (not co-located)
- Large projects, 50 MW +
- Over 6 GW development pipeline
- Independent developer
- Based in Boulder, CO
- 14 employees



Why Stand-Alone Battery Energy Storage?

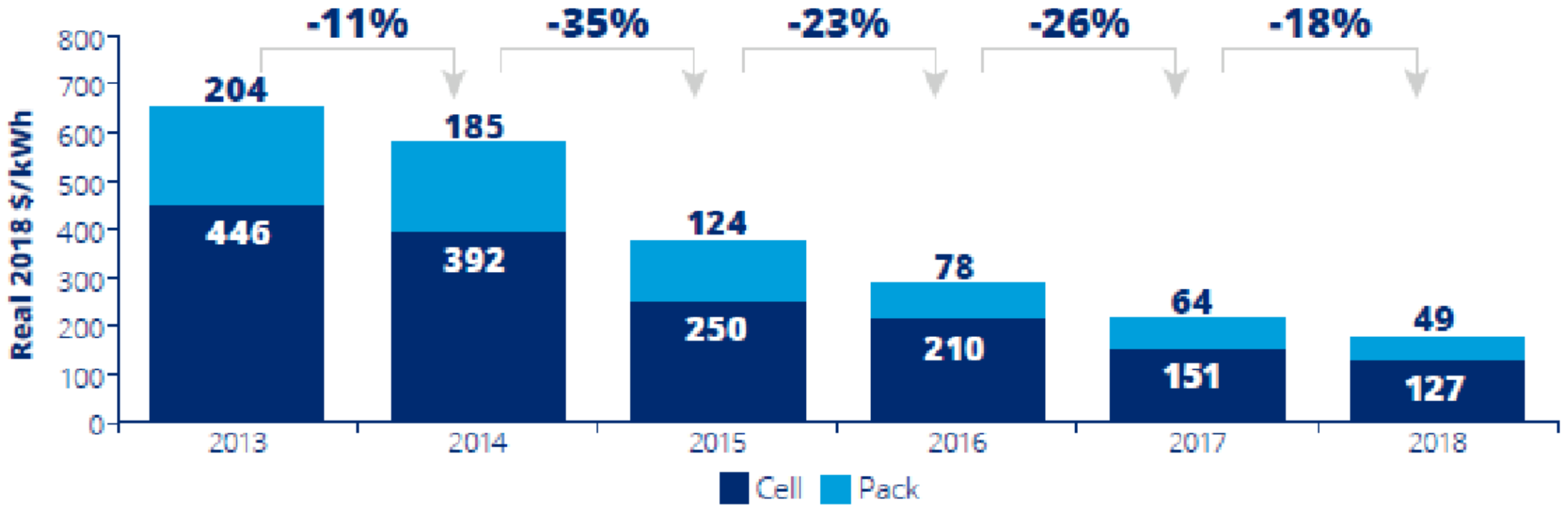
- "Bacon" to the electric grid
- Integrate renewable energy
- Flexibility
- Allow conventional generators to run more efficiently
- Mitigate volatility
- Defer investments in new transmission infrastructure

Battery Storage System Grid Services



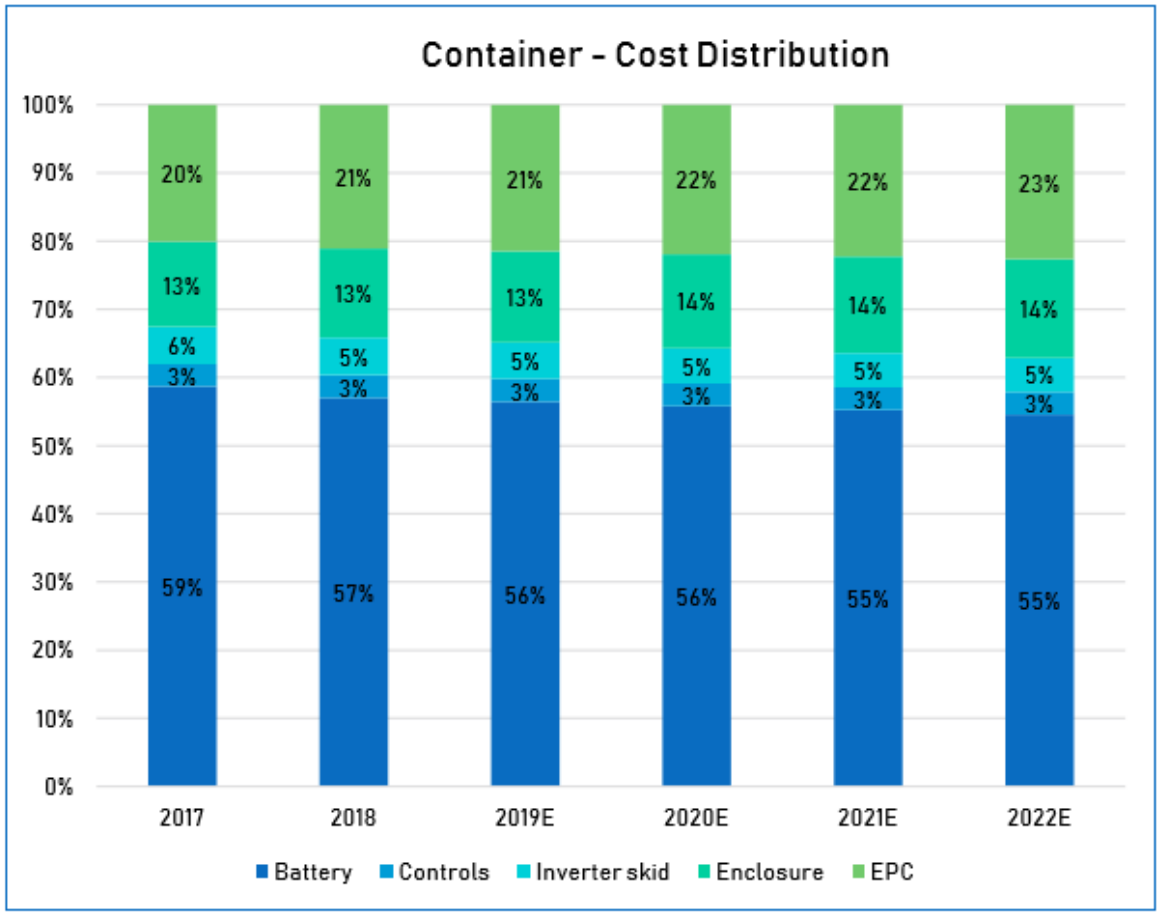
Battery Prices Declining Sharply

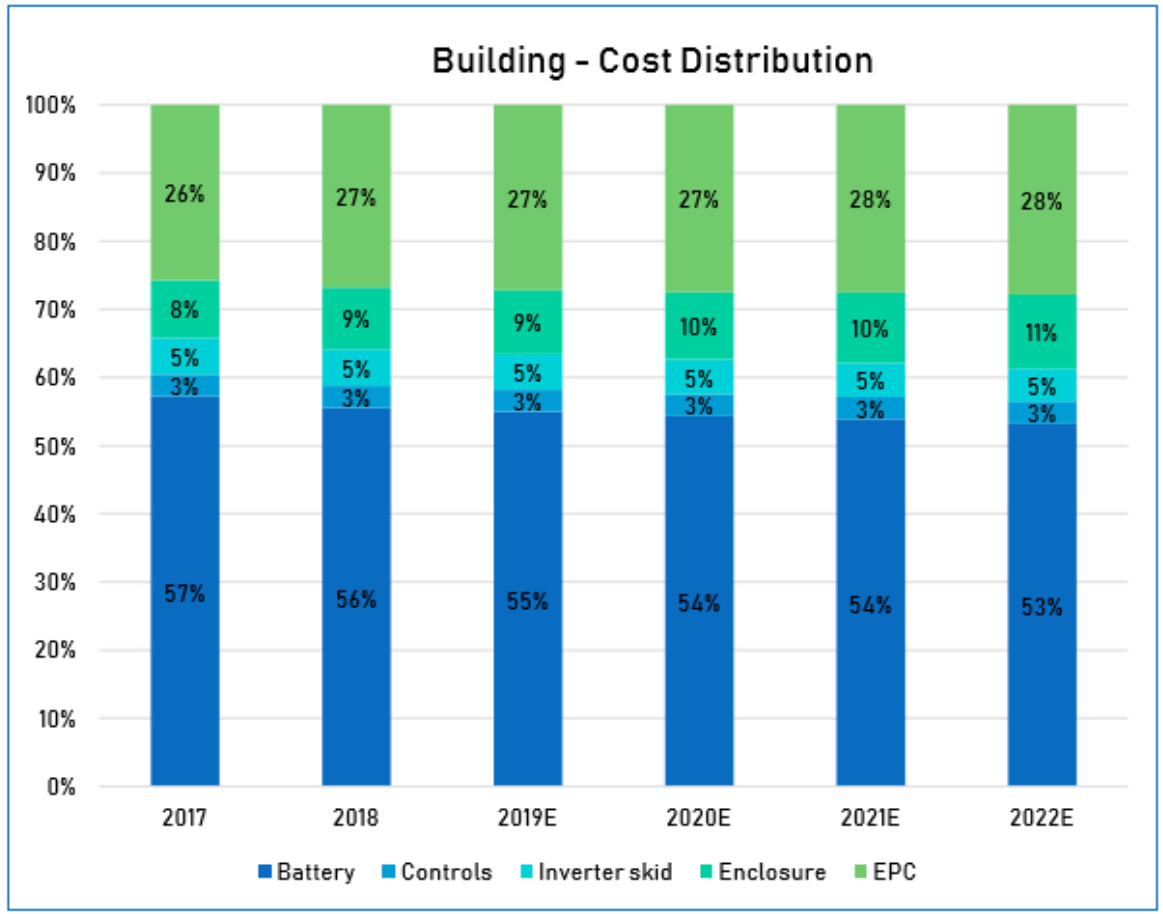
Figure 24: Lithium-Ion Battery Prices



Source: Bloomberg New Energy Finance, 2019

BESS Installed Costs





Thank you

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ABLE GRID

Fluence brings unmatched experience at scale from the partner you can trust

EXPERIENCE

10+ years of experience in energy storage from two proven industry pioneers

- World's leading storage provider
- Deployed or been awarded 56 projects, in 15 countries, 485 MW

SCALE

Complete technology and service offerings delivered worldwide

- Proven technology platforms that address full spectrum of applications
- Delivery & integration in 160 countries
- Comprehensive services including financing

THE RIGHT PARTNER

Deep understanding of modern power markets, customer needs, and local market challenges

- Collaborate with customers to solve their energy challenges
- Avoid pitfalls of inexperienced packagers and integrators
- Strong financial backing and industry staying power

Created and backed by two industry powerhouses

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Ingenuity for life

+

AES
we are the energy

Energy Market Mega Trends

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- Energy grids in the United States continue to decarbonize driven largely by economics rather than federal policy.
  - Coal usage continues to drop as the fuel becomes increasingly uncompetitive with cheap natural gas and renewables.
- Cheap natural gas and renewables are keeping energy prices low for the foreseeable future.
- Increasing renewables penetration is creating grid balancing challenges that grid operators have not faced previously.
- Aging energy delivery infrastructure is making the cost of delivering energy more expensive and is projected to increase significantly in years to come.
- **End-users are increasingly expected to become active prosumers of electricity to ensure power reliability and optimize energy spend.**
- **Aging workforce is creating challenges for utilities and end-users in managing a more complex energy infrastructure.**

Wind Energy Development in Southwest Power Pool

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SPP is the “Saudi Arabia” of wind: Kansas, Oklahoma, Nebraska, Texas Panhandle, and New Mexico

- 60,000-90,000 MW potential
- More wind energy than SPP uses during peak demand
- 17,700 MW capacity of in-service wind
- 53,056 MW wind in all stages of development
- Includes Generation Interconnection queue and executed Interconnection Agreements

“Utilities used to forecast load and dispatch generation. In the future, utilities will forecast generation and dispatch loads.”
– Shayle Kann Greentech Media

How Do These Trends Affect Nebraska

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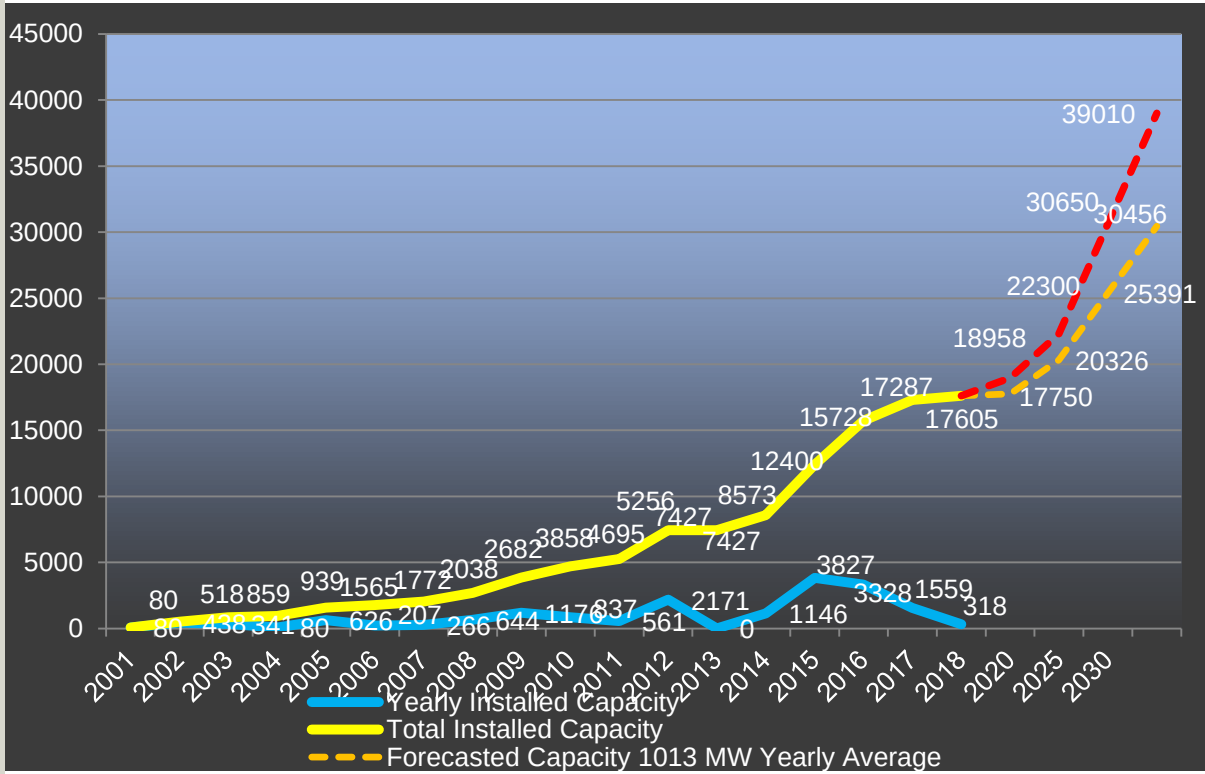
- Wind/Solar Development is threatened in SPP due to:
  - High renewable penetration - Wind can represent between 0 - 64% of the generation mix in NPPD depending weather conditions.
    - Large spread in wind generation makes it difficult for grid operators to maintain grid stability.
    - Wholesale electricity price in SPP was negative for 7% of the hours in 2017.
- Transmission and Distribution costs are growing and it is becoming harder to site new power lines to move renewable supply.
- Strategies need to be implemented to better balance intermittent renewable supply.
- **Price responsive and flexible strategies like energy storage & microgrids can support new generation development as well as save money for the consumer**

Projected SPP Wind Capacity Additions



Three Key Questions:

1. **What happens if renewable development reaches a point where the electric grid can no longer integrate more generation and traditional generation is no longer economic to operate?**

2. **Who is going to train the workforce of the future to not only provide renewable generation and energy storage, but also to manage flexible building and other demand side assets?**

3. **How can distributed energy solutions like storage help SPP integrate more renewables while providing significant value to electricity end-users?**

How Can Nebraska Be A Leader?

- Support a stand-alone storage Investment Tax Credit at the Federal level.
- Work with the Southwest Power Pool to develop tariffs that incentivize grid balancing and load shift capabilities (e.g. FERC 841)
- Make storage part of the planning process for new generation and transmission.
- Clarify the rules of third-party owned storage and generation systems both in front-of-the-meter and behind-the-meter.
- Compensate local resources for the benefits they can bring (i.e. resilience, transmission and distribution upgrade deferrals, etc).

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Pending Interconnection Requests at SPP By Fuel-Type

(75,396 MW TOTAL)