Why and How Energy Storage Works for Municipal Utilities Today

East Point Energy
Andrew Foukal, CEO & President

Objectives

1. Why does energy storage make sense?
2. How is an energy storage project developed?
3. What energy storage technologies exist today and what does the future hold?

What We Do

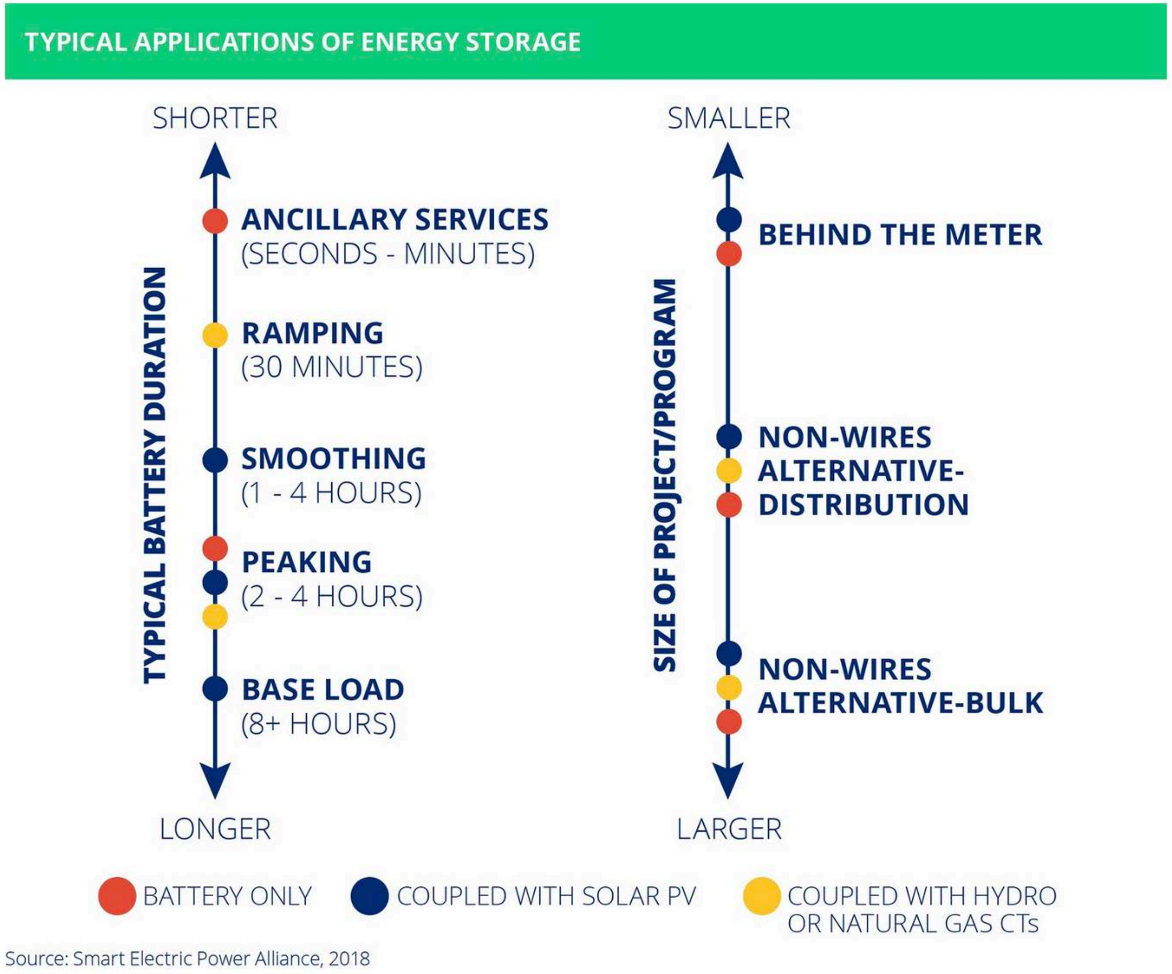
East Point Energy is an energy storage project development firm partnering with electric cooperatives, municipal utilities, and investor-owned utilities.

Technology and contractor agnostic - we find the right solution for each project

Management Team experience:

- 1 GW_{AC} + (over $1.5B) operating PV and wind projects
- 200 MW in NC, 35MW w/ ElectriCities members
- Over a decade of experience developing DER's

Why does energy storage make sense? Value



Energy storage is the bacon of the grid
=> it makes everything better

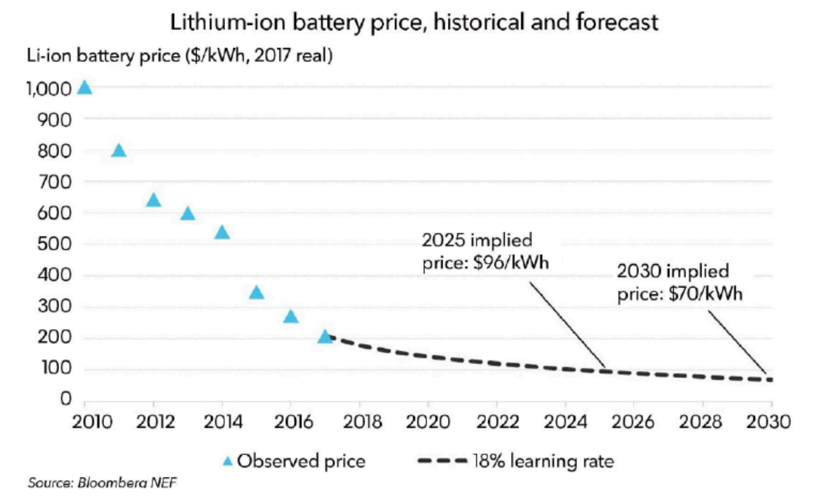
Why? Cost Declines create more value

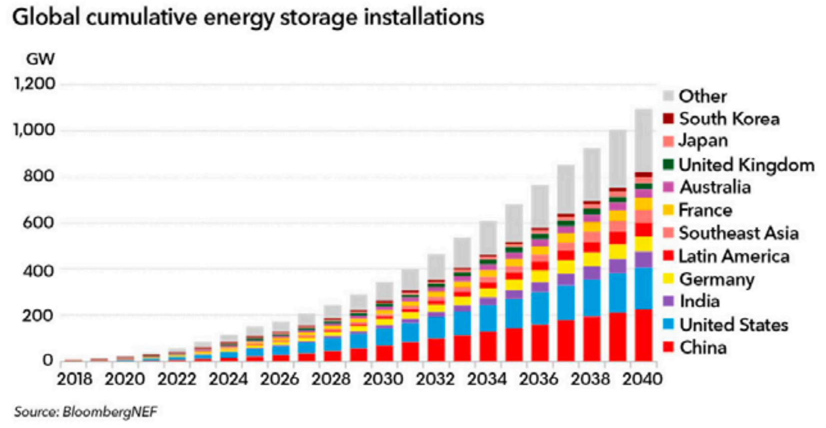
Cost:

- Decline of >80% from 2010
- Forecasted to continue to drop, but rate will slow
- Driven EV market

Growth:

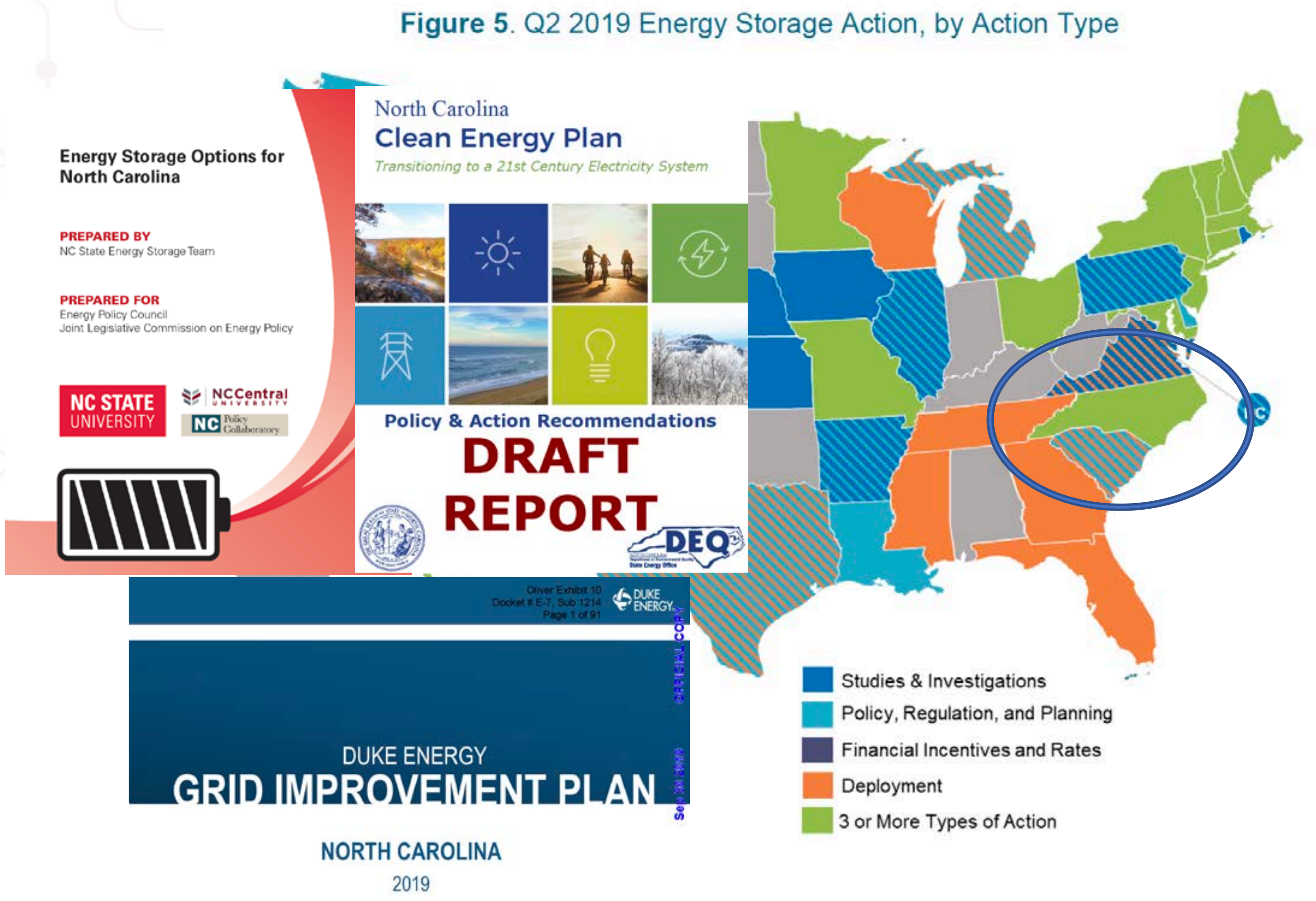
- >1,000 GW market globally by 2040
- ~2GW installed in US in 2020, >200% YoY





Why? Policy Momentum

1. Energy Storage Studies - *commissioned by state legislature in both North Carolina and Virginia*
2. NC Executive Order 80 - *Clean Energy Plan*
3. Duke Energy Grid Improvement Plan
4. Duke Energy 2018 IRP - *$500MM on energy storage*
5. VA Clean Energy Economy Act – *3.1GW energy storage by 2035*



How is an energy storage project developed?

Development → Construction → Operation

- Strategy & Financial modeling
- Site Feasibility
- Site Control
- Engineering
- Utility Interconnection
- Discretionary Permits & Tax
- Environmental Permits and studies
- Revenue Contracts
- Construction & Commissioning
- Operations, Maintenance, & Asset management

Determining Use Case

Load Shifting

"Beat the Peak"

Save $ on monthly and annual peak transmission demand charges

Upgrade Deferral

Defer the need to improve existing infrastructure

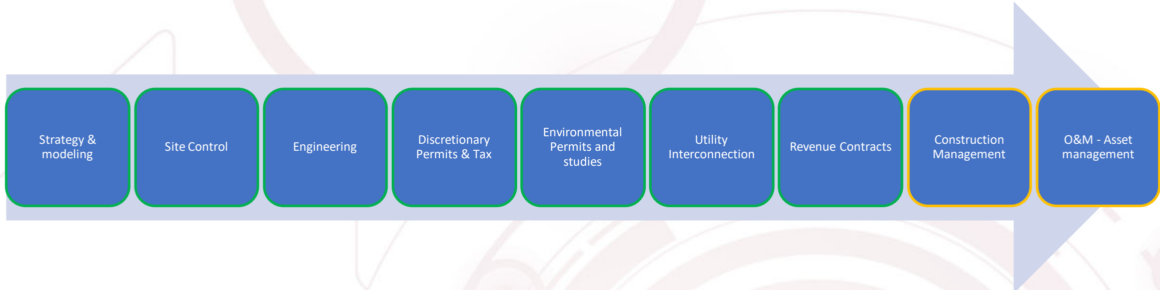
- Substations
- Distribution
- Transmission

Ancillary Services

Avoided cost of equipment to address:

- Voltage regulation
- Frequency support
- Black start
- Resiliency & Reliability

The value of an energy storage project increases if the value streams are stacked

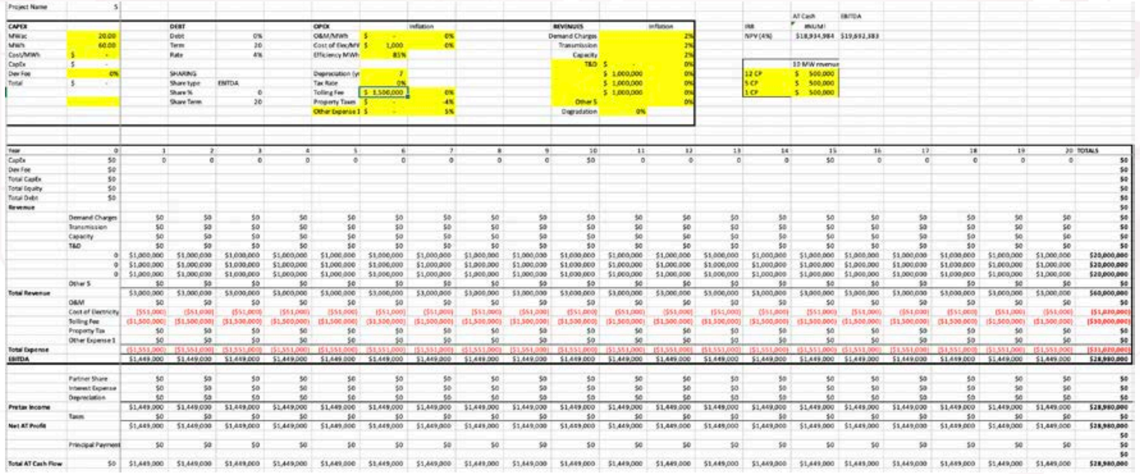


Financial Optimization

How can you maximize the value of the project?

- Optimizing capacity and energy (MW and MWh)
- Capex, Opex, tax treatment
- Risk management with extended warranties and performance guarantees
- Tariffs – existing and future risk
- Evaluation considerations: IRR, ROI, NPV of cashflow, equity payback, etc.

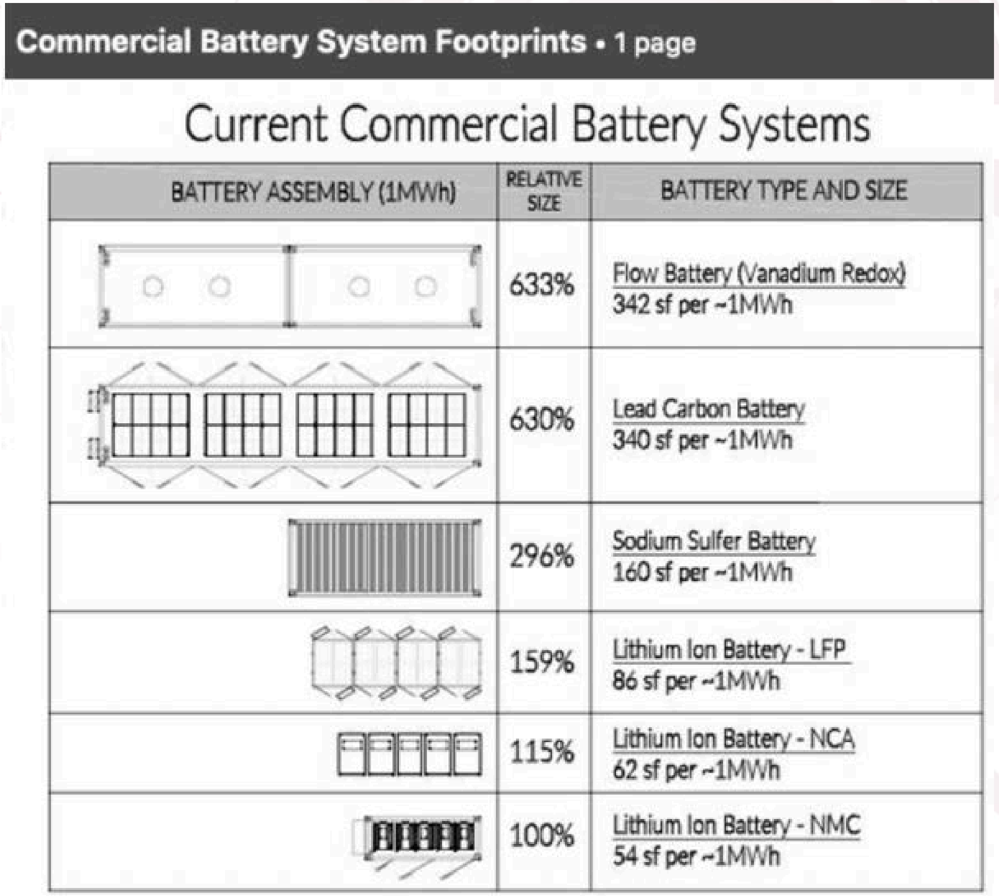
Where on my electrical system can I maximize financial returns?



*Sample ownership financial model (simplified cash flows)

Site Feasibility, Control and Area Considerations

- Ownership of land?
- Lease or purchase?
- Easements required?
- Title issues? (Encumbrances, mortgages, etc.)
- Environmental – wetlands, floodplains, cultural resources
- Site area - energy density of different chemistries



Commercial Battery System Footprints • 1 page

Current Commercial Battery Systems

BATTERY ASSEMBLY (1MWh)	RELATIVE SIZE	BATTERY TYPE AND SIZE
	633%	Flow Battery (Vanadium Redox) 342 sf per ~1MWh
	630%	Lead Carbon Battery 340 sf per ~1MWh
	296%	Sodium Sulfer Battery 160 sf per ~1MWh
	159%	Lithium Ion Battery - LFP 86 sf per ~1MWh
	115%	Lithium Ion Battery - NCA 62 sf per ~1MWh
	100%	Lithium Ion Battery - NMC 54 sf per ~1MWh

Source: Indie Energy, 2019

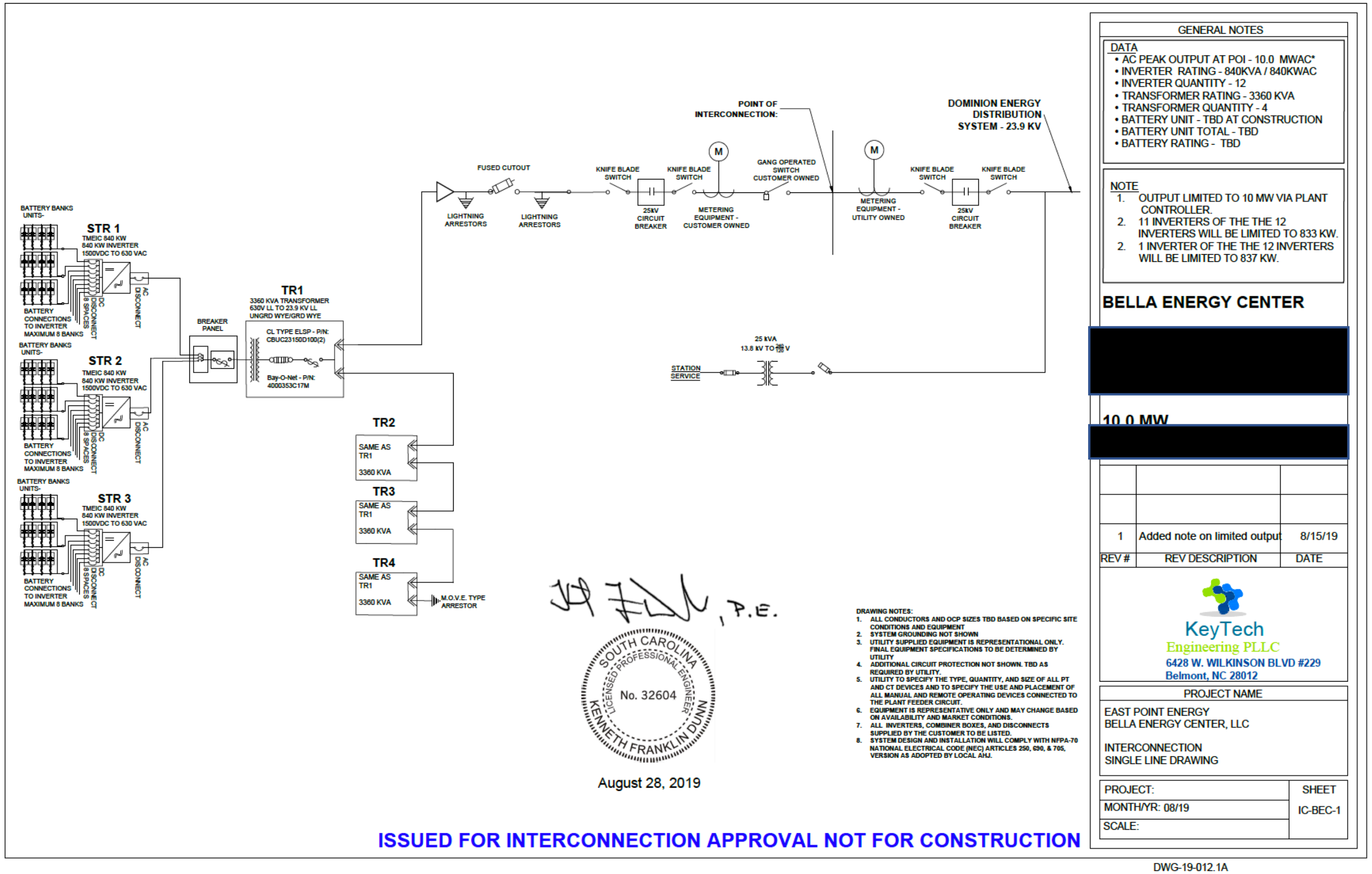
Engineering

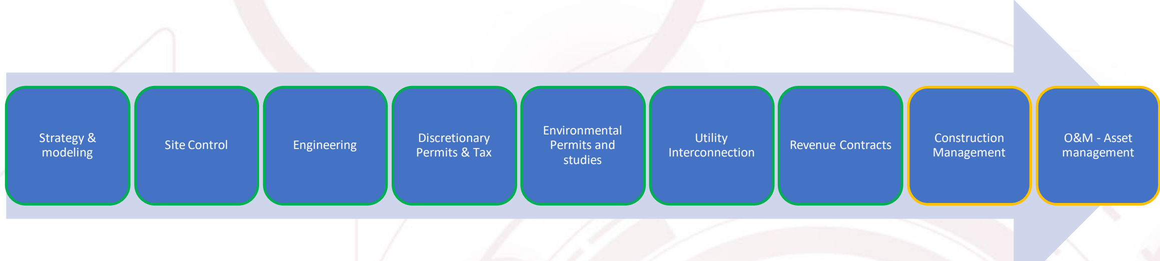
- Geotechnical
- Hydrology
- Electrical
- Mechanical (HVAC)
- Structural (foundations)
- ALTA Survey

Strategy & modeling | Site Control | Engineering | Discretionary Permits & Tax | Environmental Permits and studies | Utility Interconnection | Revenue Contracts | Construction Management | O&M - Asset management

Interconnection

- In parallel with grid
- Standard interconnection package:
  - Metering
  - PT/CT’s
  - Recloser
- DC voltage 1,000-1,500V
- AC voltage 480-600V
- Step-up transformer
- Roundtrip Efficiency ~85-90%





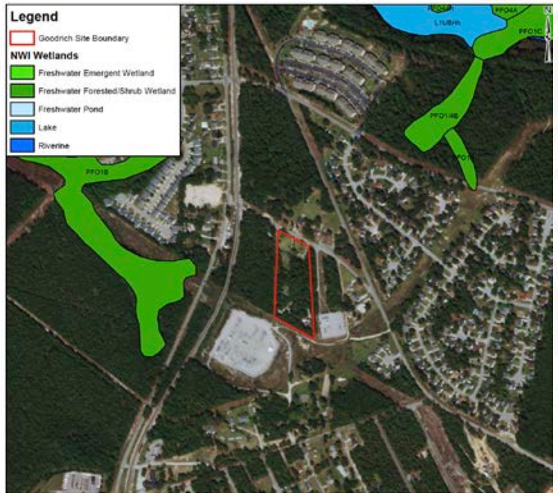
Permits and Environmental Studies

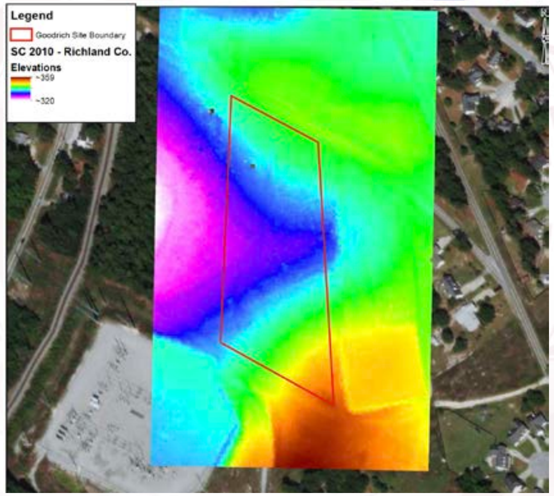
Jurisdictions:

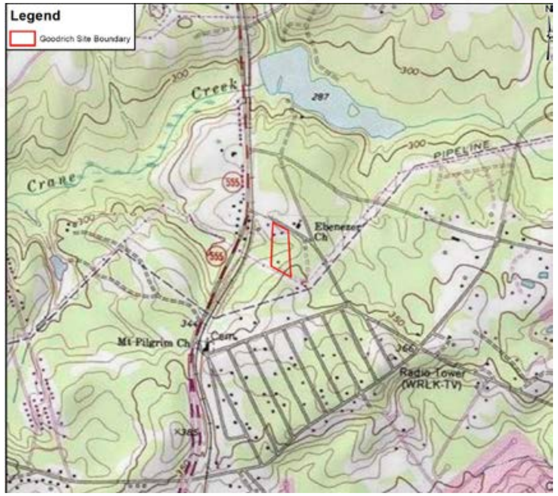
- Federal
- State
- Local – county
- Local – municipality

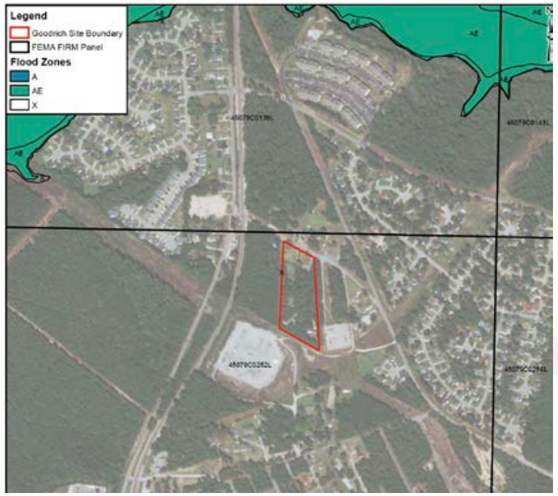
Common Name	Scientific name	Federal Status	Survey Window
Bird			
American Wood Stork	*Mycteria americana*	T	February 15 – September 1
Bald Eagle	*Haliaeetus leucocephalus*	BGPA	October 1 – May 15
Red-cockaded Woodpecker	*Picoides borealis*	E	April 1 – July 31
Mollusk			
Carolina Heelsplitter	*Lasmigona decorata*	E, CH	March - September
Plant			
Canby's Dropwort	*Oxypolis canbyi*	E	February – March
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	E	Mid May – September
Smooth coneflower	*Echinacea laevigata*	E	Late May – October

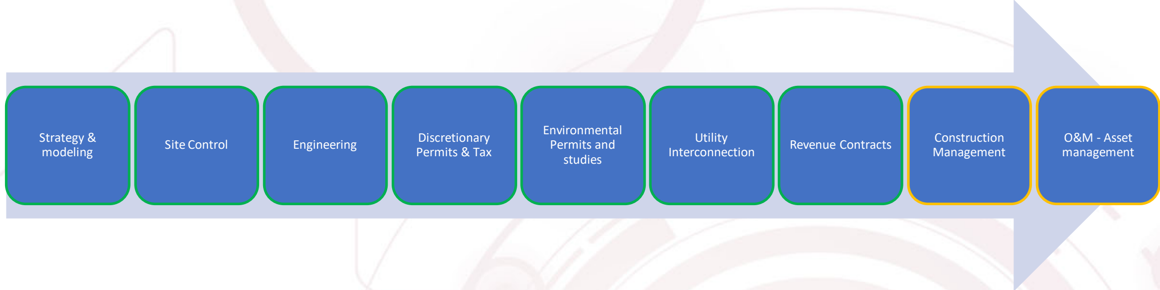
BGPA = Bald and Golden Eagle Protection Act T = Threatened











Revenue Contracts

Direct Ownership

- Requires a capital investment and/or loan (CFC, etc.)
- Largest opportunity for utility to capture current and future revenue streams
- Most autonomy with battery usage

Tolling Agreement

- No capital cost to utility
- 3rd party owned
- Utility has rights to call on battery for a fixed ”tolling” fee
- Value to utility is the difference between the demand charge and the tolling fee + cost to charge
- Long-term contract

Shared Savings

- No capital cost to utility
- 3rd party owned
- Value to utility is the difference between the demand charge and utility’s portion of the savings
- More complex (setting a baseline, etc.)
- Long-term contract

Strategy & modeling | Site Control | Engineering | Discretionary Permits & Tax | Environmental Permits and studies | Utility Interconnection | Revenue Contracts | Construction Management | O&M - Asset management

Construction and Commissioning

Long lead items:

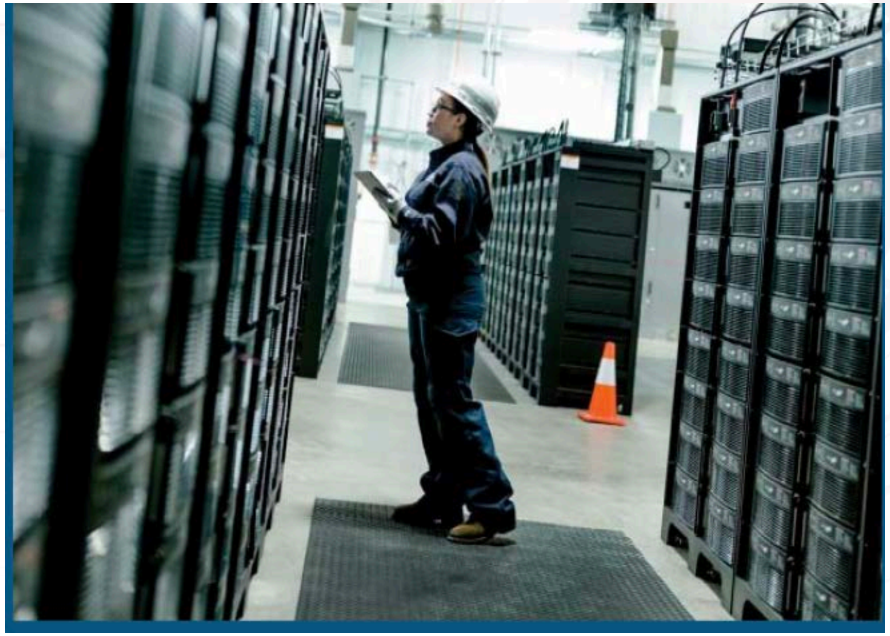
- Batteries (~4-5 months)
- Step-up transformers

Installation:

- Minimal assembly on site
- Civil
- Electrical

Commissioning

- 3rd party witnesses commissioning



Source: Duke Energy, 2019

Sterling Municipal Light Department, MA

- 2 MW/4 MWh in MA
- Li-ion chemistry
- Operating since 2016

Vermont Electric Cooperative

- 1 MW/4 MWh in VT
- Li-ion chemistry
- 10-yr lease

Rappahannock Electric Cooperative (REC)

- 2 MW/8 MWh in VA
- Li-ion chemistry
- COD of 2020
- Value streams:
    - Transformer deferral
    - Load shifting
    - Resiliency

Current Li-ion Chemistries

NMC

- Most commercially available
- High energy density
- Better for shallow cycle applications (volt/freq. support, etc.)
- LG Chem, Samsung, Panasonic

LFP

- Lowest energy density (~1.5x)
- Lower cost, more BOS
- Safest chemistry
- Better for deep cycle applications (load shifting, etc.)
- Lower nominal DC voltage
- CATL and BYD

NCA

- Highest energy density
- Space constrained sites
- High cost
- Primarily Tesla/Panasonic product

Chemistries and technologies on the horizon…

Redox Flow

- Oxidation-reduction reaction of ions of vanadium, etc.

Solid State

- Similar to traditional Li-ion batteries
- Solid electrolyte

Thermal Storage

- Cryogenic storage
- Chill air to liquid
- Liquid air heated to generate pressurized gas propel turbine

Redox Flow Batteries

Advantages

- Low degradation, long service life
- Versatile – can address short and long duration storage
- Safety – low potential for runaway thermal event

Disadvantages

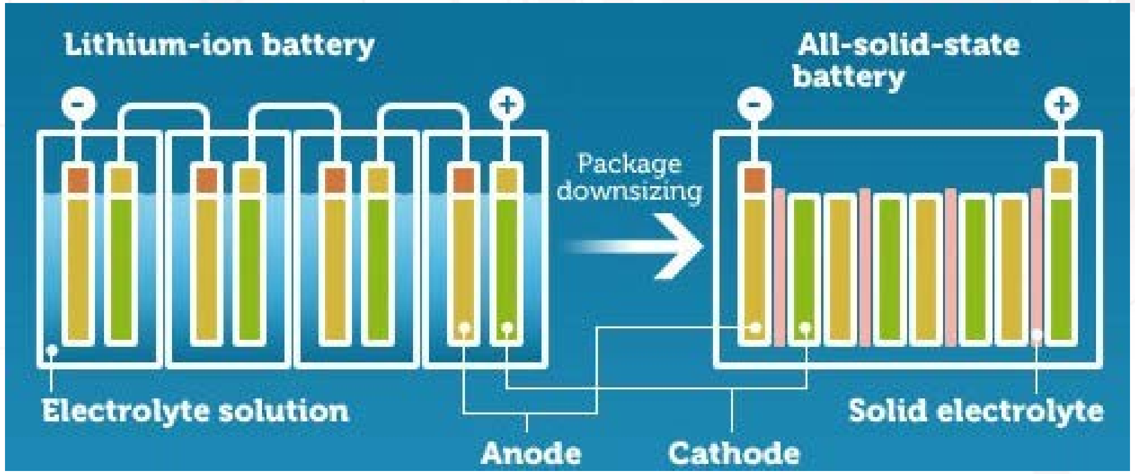
- Complex – need for pumps and secondary containment vessels
- Low energy density - 6x space vs NMC
- First generation commercial projects

Type	Description
Vanadium redox battery (VRB)	VRBs use two vanadium electrolytes (V2+/V3+ and V4+/V5+), which exchange hydrogen ions (H+) through a membrane.
Polysulfide–bromine battery (PSB)	Sodium sulfide (Na_2S_2) and sodium tribromide ($NaBr_3$) are used as electrolytes. The sodium ions (Na+) pass through the membrane during the charging or discharging process.
Zinc–bromine (Zn–Br) battery	Solutions of zinc and a complex bromine compound are used as electrodes.

Solid State Batteries

Advantages

- Charging – charges 6x faster than liquid cell
- Increased energy density vs NMC
- Longer cycle life
- Low leakage currents
- Safety – Non-flammability



Disadvantages

- Cost is unclear
- First generation commercial projects

Cryogenic Storage

Advantages

- Energy density similar to NMC
- Long duration
- Less geographical constraints vs other long-term energy storage
- Zero emissions and benign materials

Disadvantages

- First generation commercial projects
- Impractical for small scale energy storage
- Low round-trip efficiency
- Permitting requirements for the height of the equipment

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