Energy Storage & Demand Response

A "swiss army knife" in the utility's pocket

October 30th, 2020

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Mission Statement

The N.C. Clean Energy Technology Center, at N.C. State University, advances a sustainable energy economy by educating, demonstrating, and providing support for clean energy technologies, practices, and policies.

The Center provides services to the businesses and citizens of North Carolina and beyond relating to the development and adoption of clean energy technologies. For the last 30 years, the Center has worked closely with partners in government, industry, academia, and the non-profit community.

Programs

- Renewable Energy
- Clean Power and Industrial Efficiency
- Training
- Clean Transportation
- Policy and DSIRE Insight

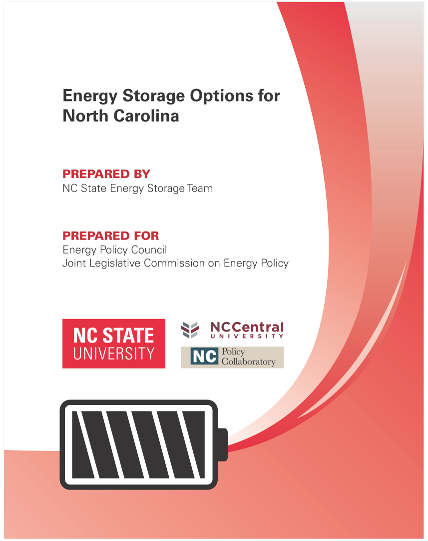
TVA's Power Supply Flexibility Program

- A new program that allows local power companies (LPC) with long term agreements with TVA to develop their own flexible load-side distributed energy generation helping to reduce emissions.
  - Eligible resources include solar PV, CHP, and natural gas generators.
  - Each LPC may develop up to 5% of their "energy", where energy is the average hourly capacity usage, initially based on fiscal years 2015-2019, or one megawatt, whichever is greater.
  - Solar PV is allowed a technology factor of 0.4 due to its lower capacity factor.
  - LPCs are credited for energy produced at TVA's wholesale power rate
- A total of approximately 800 MW could be developed if all 154 LPCs across the Valley participate and develop their maximum allowable capacity with resources other than solar.
- Approximately 2,000 MW could be developed if all 154 LPCs across the Valley participate and deploy only solar to develop their maximum allowable capacity
- Currently at least 141 LPCs have signed long term agreements (20 years)

Information available at TVA's Environmental Review Process webpage
https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews/Flexibility-Proposal

Experience with Storage

- Energy Storage Study (NC House Bill 589)
- Community Solar for the Southeast
- Solar Plus for Electric Cooperatives



Powered by SunShot
U.S. Department of Energy

SPECs
Solar-Plus for Electric Co-ops

Energy Storage Study

- Prompted by NC House Bill 589 supported solar rebate and widespread solar adoption on the grid
- Identify the feasibility of energy storage in NC, including:
  - Grid services
  - Economic impact
  - Policy implications
- Notable Findings - Relevant to TVA region
  - Lithium Ion batteries will be/are cost effective for distribution needs such as capacity deferral & peak shaving at substations, and reliability
  - Peak shaving and energy time shifting projected to be cost effective by 2030
  - Frequency regulation is one of the largest cost positive ventures (no cost signal or market in NC or TN)
  - Storage effective with high solar penetration when enabling low cost energy shifting

Community Solar for the Southeast

- Goal of accelerating community PV solar at municipal and electric coops across the southeast
  - Funded by DOE’s SunShot Initiative
- A techno-economic model was developed to support decision making
- Completed analysis 9 distribution utilities
- 4-5 utilities moving forward with projects
- Seeing batteries a growing interest to pair with solar
  - Fayetteville (NC)
  - Shenandoah Valley Electric Coop (VA)
  - Cobb EMC (GA)
  - 2 more considering it in NC

Fayetteville Solar & Storage

- Solar - 1,100kWdc (880kWac)
  Storage - 560KWac, 2hour
  - Solar is fixed with 19 inverters & 330W PV modules
  - Battery storage is capable of 495kWac sustained output
- Economics
  - Wholesale power contract is comprised of energy & coincident peak demand charges ($21.09/kW)
    - Solar provides energy & peak reduction when aligned with generation (summer months)
    - Battery provides demand reduction based upon predicted monthly coincident peaks
  - Community solar subscription (battery not included) - $20 for 1st panel & $10/panel for all others with a $1.52/month per panel
  - Additional funding included Renewable Energy Portfolio Standard (REPS) funding & State Weatherization funding to assist LMI customer subscriptions

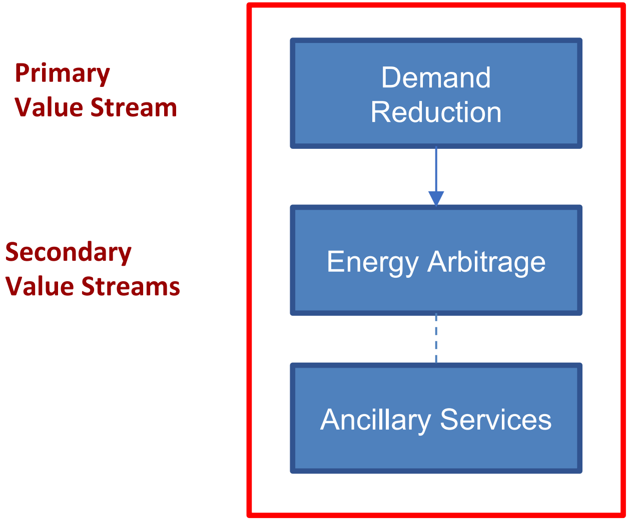
Fayetteville Solar & Storage

- Current operations
  - Solar energy generation above modeled
  - Battery and solar on separate inverters to allow independent operation
  - Battery system integration and dispatch caused trouble in first several months
    - Since then they have seen a much more successful dispatches at peak
- Lessons learned
  - Commissioning is essential to get battery integrated to each utilities system and operational to meet the needs
  - Document utilities requirements including interconnection safety, controls and operator training
  - Site maintenance and monitoring is essential to keep the system operational at the required performance and this should be budgeted for (whether additional staff or a service contract)
- Fayetteville is currently considering adding an additional 1,500kW of storage to reduce peak further

Solar Plus for COOPs

- SPECs project aims to help optimize the procurement and operations of local battery storage projects for local electric cooperatives
  - Funded by NREL's solar energy innovation network (SEIN)
  - Investigates RFP/RFQ best practices, existing policies, contracts and business models, and early stage decision making model
- Modeling is a natural continuation of Community Solar work that integrates battery storage and value stacking more effectively
  - The early stage is currently in development
  - Aims to provide user and utility team with intuitive understanding of battery economics
  - Simplifies value stacking, sensitivity analysis, and gap analysis

Value Stack for Distr. Utilities



- Value stack depends on the wholesale contract, markets, and utility needs
- Common value streams include
  - Demand reduction
  - Energy Arbitrage
  - Local Ancillary Services
  - Infrastructure Deferral
- Capacity resource characteristics
- Battery design based on the systems intended use (kW vs. kWh)

Gap & Sensitivity Analysis

- Gap Analysis - Identifying the gap between existing and potential economic value streams
- Exploring how varying economic parameters change project economics

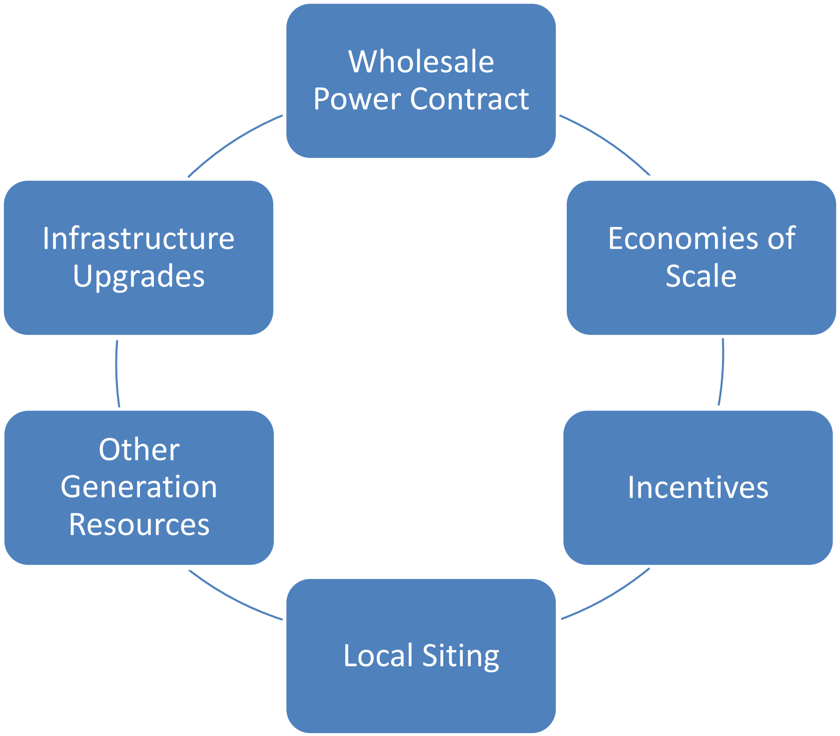
Impact of TOU Rate & Battery BESS on the Utilities NPV

TOU Rate Energy Differential ($/kWh)

			5	4	3	2	1	0	-1	-2	-3	-4	-5
		$ (1,006,401)	$ 0.0338	$ 0.0360	$ 0.0383	$ 0.0405	$ 0.0428	$ 0.0450	$ 0.0473	$ 0.0495	$ 0.0518	$ 0.0540	$ 0.0563
5	Battery BESS Price ($/kWh)	$ 0.0150	$ (451,074)	$ (527,966)	$ (604,857)	$ (681,749)	$ (758,640)	$ (835,531)	$ (912,423)	$ (989,314)	$ (1,066,206)	$ (1,143,097)	$ (1,219,988)
4		$ 0.0160	$ (485,248)	$ (562,140)	$ (639,031)	$ (715,922)	$ (792,814)	$ (869,705)	$ (946,597)	$ (1,023,488)	$ (1,100,380)	$ (1,177,271)	$ (1,254,162)
3		$ 0.0170	$ (519,422)	$ (596,314)	$ (673,205)	$ (750,096)	$ (826,988)	$ (903,879)	$ (980,771)	$ (1,057,662)	$ (1,134,554)	$ (1,211,445)	$ (1,288,336)
2		$ 0.0180	$ (553,596)	$ (630,488)	$ (707,379)	$ (784,270)	$ (861,162)	$ (938,053)	$ (1,014,945)	$ (1,091,836)	$ (1,168,727)	$ (1,245,619)	$ (1,322,510)
1		$ 0.0190	$ (587,770)	$ (664,662)	$ (741,553)	$ (818,444)	$ (895,336)	$ (972,227)	$ (1,049,119)	$ (1,126,010)	$ (1,202,901)	$ (1,279,793)	$ (1,356,684)
0		$ 0.0200	$ (621,944)	$ (698,835)	$ (775,727)	$ (852,618)	$ (929,510)	**$ (1,006,401)**	$ (1,083,293)	$ (1,160,184)	$ (1,237,075)	$ (1,313,967)	$ (1,390,858)
-1		$ 0.0210	$ (656,118)	$ (733,009)	$ (809,901)	$ (886,792)	$ (963,684)	$ (1,040,575)	$ (1,117,467)	$ (1,194,358)	$ (1,271,249)	$ (1,348,141)	$ (1,425,032)
-2		$ 0.0220	$ (690,292)	$ (767,183)	$ (844,075)	$ (920,966)	$ (997,858)	$ (1,074,749)	$ (1,151,640)	$ (1,228,532)	$ (1,305,423)	$ (1,382,315)	$ (1,459,206)
-3		$ 0.0230	$ (724,466)	$ (801,357)	$ (878,249)	$ (955,140)	$ (1,032,032)	$ (1,108,923)	$ (1,185,814)	$ (1,262,706)	$ (1,339,597)	$ (1,416,489)	$ (1,493,380)
-4		$ 0.0240	$ (758,640)	$ (835,531)	$ (912,423)	$ (989,314)	$ (1,066,206)	$ (1,143,097)	$ (1,219,988)	$ (1,296,880)	$ (1,373,771)	$ (1,450,663)	$ (1,527,554)
-5		$ 0.0250	$ (792,814)	$ (869,705)	$ (946,597)	$ (1,023,488)	$ (1,100,380)	$ (1,177,271)	$ (1,254,162)	$ (1,331,054)	$ (1,407,945)	$ (1,484,837)	$ (1,561,728)

LPC Storage Considerations

- Value of Storage & Solar
  - Cost certainty
  - Contract savings
    - Demand
    - Energy
    - Infrastructure deferral
    - Reliability & resilience
  - Environmental benefits



LPC Planning Approach