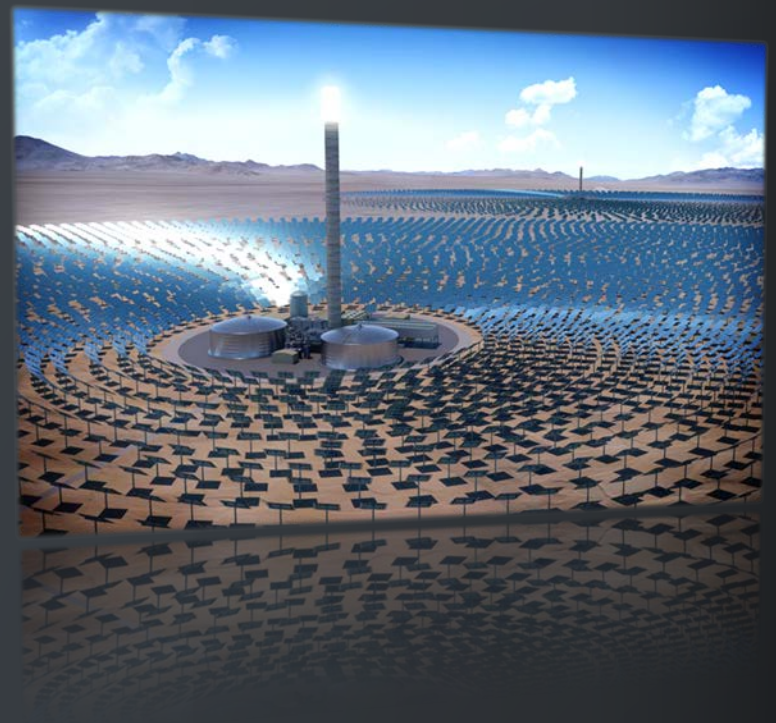


Austin Energy Storage & Dispatchable Renewables Update

Electric Utility Commission

Khalil Shalabi

Vice President Strategy Technology and Market Operations

October 15, 2018

Item 12

Austin Energy Storage & Dispatchable Renewables Update

Discussion Topics

Resource Planning

Austin Energy conducts resource planning on a periodic basis to ensure the latest technologies and processes are leveraged to meet our goals in a cost effective manner

Primer on Storage

Integrating energy storage with renewable generation at the utility-scale level is critical for a clean energy economy

Austin Energy Efforts

Austin Energy is an international leader in the advancement of energy storage technology and renewable energy

Austin Energy Storage & Dispatchable Renewables Update

Resource Planning

Resource Planning *is an approach used by utilities to plan for meeting* ***future energy demand*** *in the most* ***cost-effective*** *way.*

The Austin Energy Resource, Generation and Climate Protection Plan to 2027 outlines the City Council's strategic goals for the utility's environmental and economic leadership and represents a combined, extensive effort of the Austin community.

Characteristics of Austin Energy's Resource Planning

- Based on quantitative analyses of risks, costs and opportunities
- Flexible and dynamic to respond to changing conditions
- Built on a foundation of previous actions

Austin Energy Resource Plan

The Austin Energy Resource, Generation and Climate Protection Plan to 2027 – Emerging Technology and Energy Storage section states:

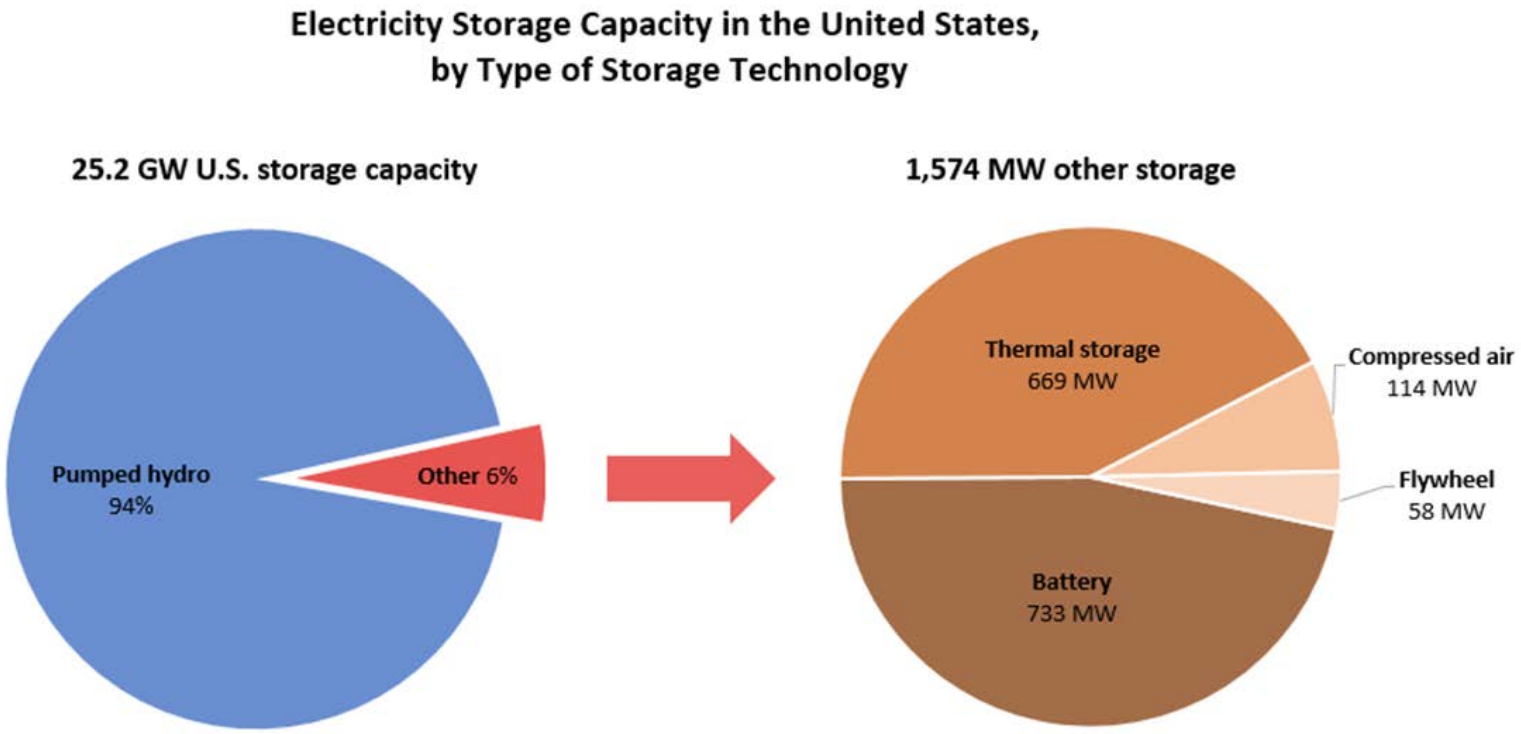
- Commit to achieving 30 MW of local thermal storage by 2027, and a minimum of 10 MW of electric storage by 2025 … *develop roadmap based on lessons from SHINES*
- Study the costs, benefits, risks and potential rate impacts of achieving a more aggressive electric storage goal … 50 and 100 MWs by 2027
- Study the technical and economic feasibility of emerging technologies, including *dispatchable renewable energy technologies**, battery storage, compressed air energy storage (CAES), aggregated demand response, and Vehicle-to-Grid

**renewable plants such as Concentrated Solar that are similar to thermal plants in their dispatch operating capabilities*

Austin Energy Storage & Dispatchable Renewables Update

Primer on Storage

Types of Storage



Source: U.S. Department of Energy Global Energy Storage Database (March 1, 2018)

Austin Energy Owned Energy Storage	
Thermal	18 MW
Battery	3.19 MW*

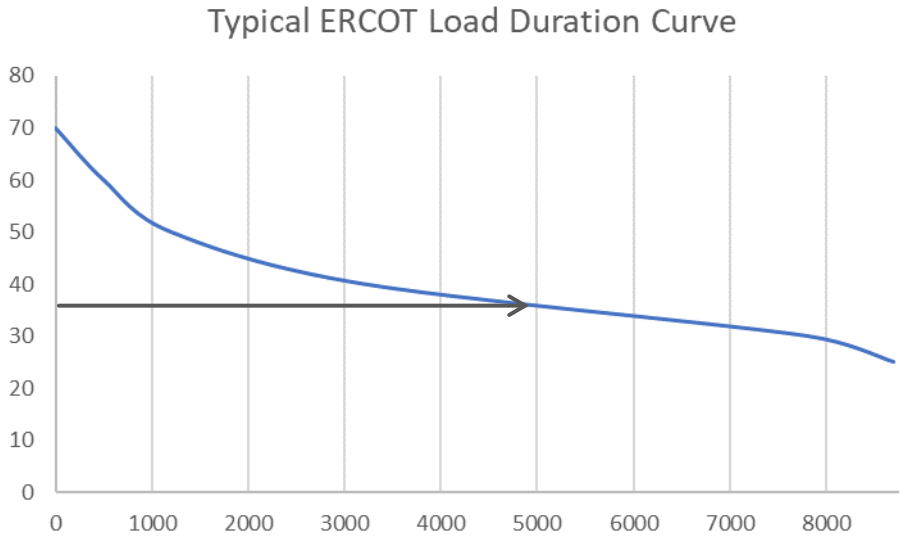
**By year end 2018*

By 2025, Austin Energy looks to achieve:

10 MWs of Electrical Storage &
20 MWs of Thermal storage

The History of Storage in the Electric Industry

- Current storage capacity can store less than a 10% of total US electric production and about 1% of total renewable energy production
- Without significant storage, electricity is the only commodity where supply and demand must match perfectly every second of the day
  - System is built to peak demand with margin
  - Contributes to a low utilization factor



About half of total system capacity is only used for half the total hours in the year

The History of Storage in the Electric Industry

Recent advancements in Li-Ion technology driven by the Electric Vehicle industry offers new possibilities in storage

1. High storage density requiring a smaller footprint
2. Modular
3. Instantaneous response allows for digital controls and multiple use-cases
4. Declining costs
5. However is limited in duration

Austin Energy Li-Ion Batteries at the Kingsbery Substation as part of the SHINES project

Where Storage Can Be Used

Behind the Meter

- Can help a customer manage costs while offering resiliency in case of an outage

Distribution Substation

- Can help a utility increase its reliability, power quality and manage cost

Wholesale – Coupled to Solar and Wind

- Can help firm up renewables (dispatchable renewables)
- Provide reliability and arbitrage off peak and on peak prices

Austin Energy Storage & Dispatchable Renewables Update

Austin Energy Efforts

Storage Efforts at Austin Energy

Comprehensive Consultant Study

- Studies multiple use cases for storage and dispatchable renewables

SHINES

- The #1 Department of Energy funded project in the country to test multiple storage use cases on the Austin Energy distribution system

Annual Request For Proposal Process

- Tests the market for proposed projects of Solar + Storage and Wind + Storage

Thermal Storage Buildout

Consultant Study – September 2018

Analyzed many different business models for

- Storage
- Solar + Storage
- Wind + Storage
- Gas Turbine + Storage
- Compressed Air Energy Storage & Concentrated Solar

Study looks to compare Internal Rate of Returns on various business models

Example Case Study: Behind the Meter (BTM) Customer Sited Storage

A BTM 1-hour battery that performs:

- 4-Coincident Peak (CP) Mitigation: charges at the flat retail rate and discharges during CP and near-CP events to reduce 4-CP related charges
- Responsive Reserve Service (RRS): Is registered with ERCOT and bid into the Day Ahead Market for specified periods as a price taker and is compensated with revenue from RRS capacity payments
- Volt / VAR*: provides load or feeder reliability
- Resiliency: provides resiliency for the load for a specific duration of time

**Volt-ampere reactive*

SHINES Use Cases

Application	Benefit
Utility Peak Load Reduction	Lower Transmission Cost of Service (TCOS) Obligation
Day-Ahead Energy Arbitrage	Price differences creates economic value
Real-time Price Dispatch	Economic value from real-time price spikes
Voltage Support	Reduce losses & defer investment in other voltage control equipment
Congestion Management	Increase local grid reliability
Demand Charge Reduction	Customer's demand charges reduced

**American National Standards Institute*

Request For Proposal Responses

Strong response to our RFP

- 26 companies
- 45 unique projects
- Over 275 proposal variations

Multiple ownership structures

- Solar coupled with storage as a fixed $/MWH
- Solar coupled with storage with a fixed capacity payment
- Stand alone storage as a fixed capacity payment
- Stand alone storage as a build and transfer

Predominately Lithium Ion chemistry

Ranges in size and duration

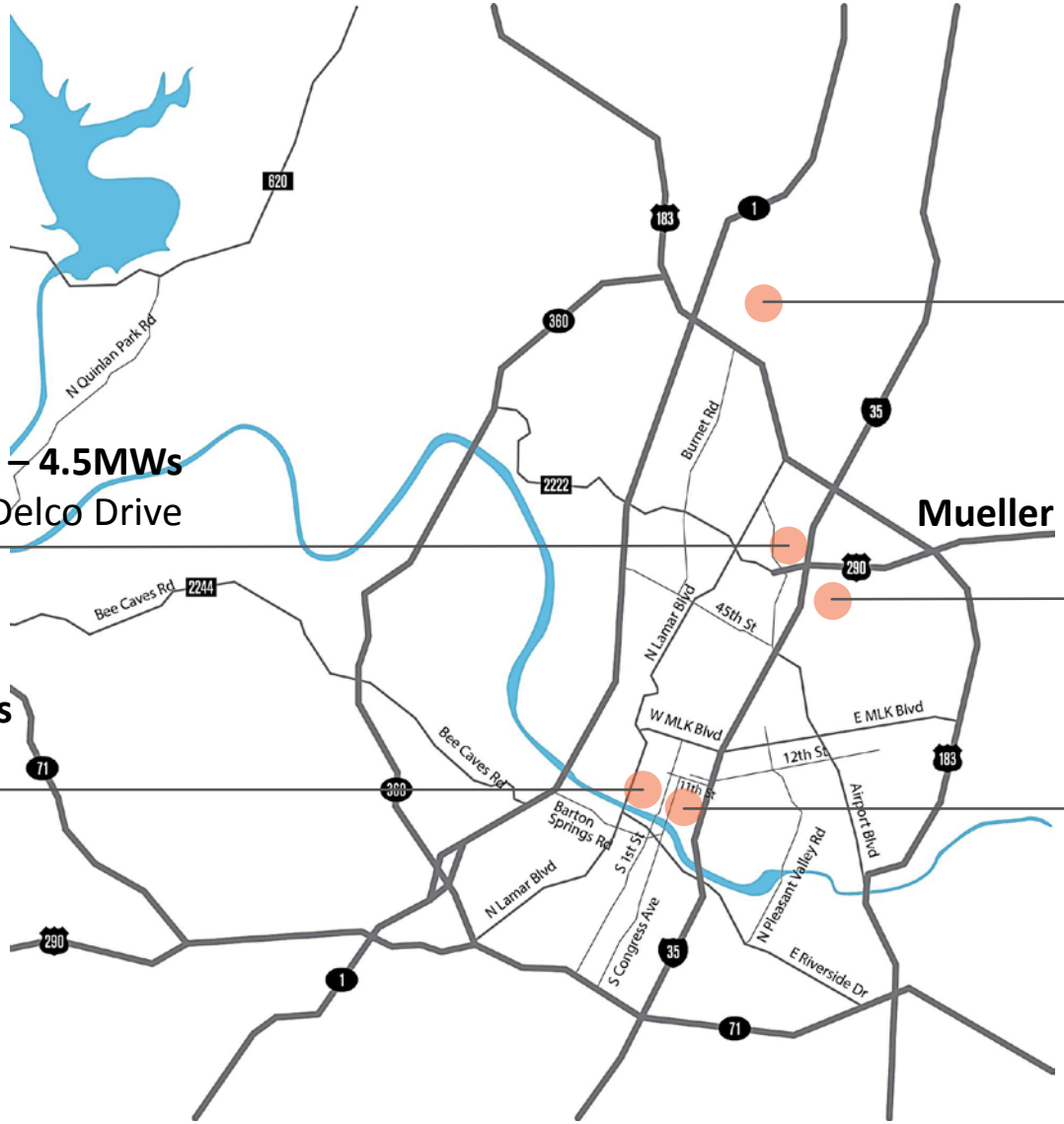
- 10 MW to 100 MW
- Durations of less than 1 hour to 4 hour (or longer)

Source: 350massmetrowest.org

District Cooling Thermal Storage Locations

Future ACC Plant – 4.5MWs
6018 Wilhelmina Delco Drive

Paul Robbins – 4 MWs
300 San Antonio Street



Domain – 4MWs
3120 Kramer Lane

Mueller Energy Center – 2MWs
4901 Lancaster Drive

DCP-2 – 8MWs
410 Sabine Street

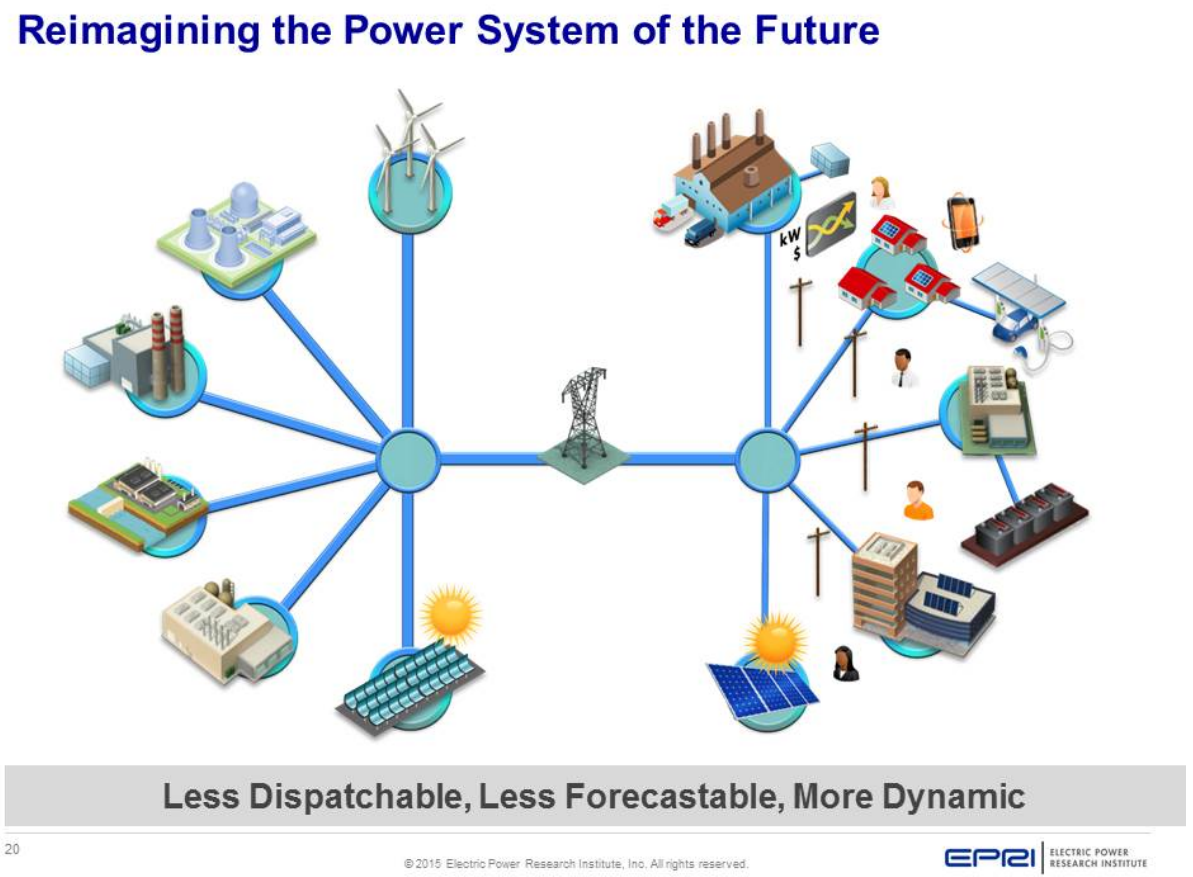
Moving from a Traditional Power System to an Integrated Grid

The integrated grid is…

- Dynamic
- Increased low marginal priced energy
- Has excess energy not necessarily at the right time

The grid will need…

- More electrification
  EVs, Indoor agriculture, heat pumps
- Flexible loads
  Data Centers, Water treatment plants
- Storage
- More control and visibility
- Capacity to handle growth

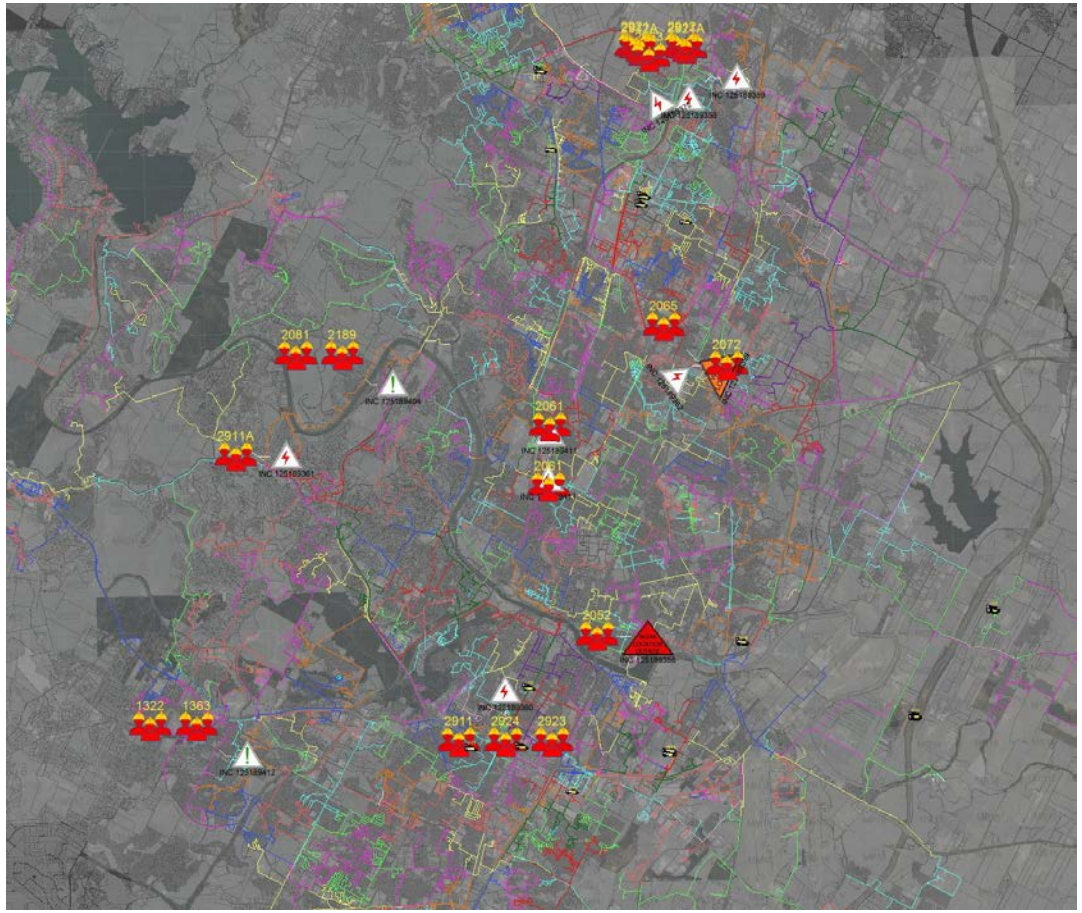


Storage as Part of an Advanced Distribution System Technology Ecosystem

Austin Energy is building an industry leading technology backbone on the distribution system

- Deployed an Advanced Distribution Management System (ADMS) integrated with its Advanced Metering infrastructure
- Provides first of a kind visibility and situational awareness into the distribution system
- The ability to plan, analyze, restore and control remotely and automatically

Future storage assets can be leveraged by these technologies as control capabilities evolve



Geospatial view of AE's ADMS system

Preliminary Results on Dispatchable Renewables

Concentrated Solar

- Studying cost and operations of several projects built in the US
- Studying cost and operations of recent international builds
- Collaborating with National Renewables Energy (NREL) Lab on a cost and operations model sited in Texas
- Maintaining open communications with interested stakeholders

Compressed Air Energy Storage (CAES)

- Have received and analyzed bids from multiple RFPs
- Meet on a frequent basis with interested developers
- Analyzed as a scenario in the previous resource plan and to be included as a scenario in the upcoming plan

Next Steps

1. Develop roadmap for storage deployment based on learnings from SHINES, studies, and RFP responses including dispatchable renewables
   - What type and how much storage should we deploy?
   - When should the storage be deployed based on future cost curves and ability to leverage this technology?
   - Which use cases best advance AE's goal to increase reliability, deliver customer value and clean energy?
2. Perform studies as detailed by the AE 2016 Resource Plan
3. Continue with Thermal Storage build as part of the district cooling system

Customer Driven. Community Focused.SM