EE362G Smart Grids:
Austin Energy Smart Grids – Part 2

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Presentation Outline

- Load Control
- Distribution Automation
- Distributed Energy Integration and Austin SHINES
- Integrated Asset Management
- Summary of AE Smart Grid Initiatives
- What are the New Challenges
- Where are We Headed
- Smart Grid Communication Network (SGCN)
- AE Wireless Communication
- Homework

Load Control

Austin Energy's Green Building Program

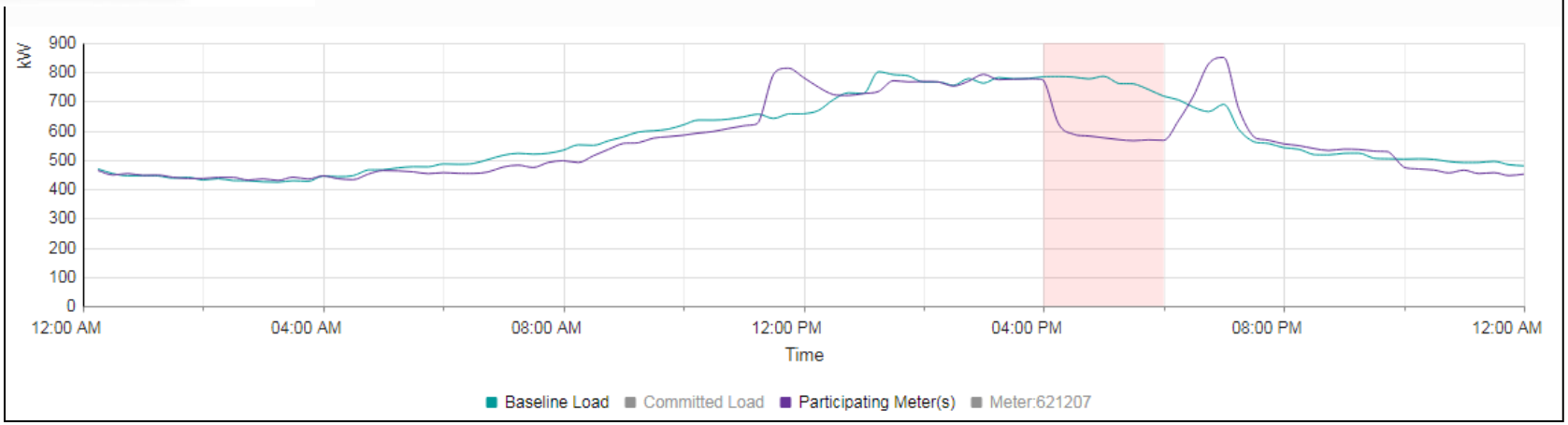
- Rebates and Incentives
- Lighting, HVAC, Load Management, Building Envelope

Energy Profiler Offering (Load Profiler Curtailment Module)

Account ID: 6088400000
Account Name: COA- TLC - 721 Barton Springs Road
Contact Info: Display
Date of Event: 08/23/2018
Start Time of Event: 16:00
End Time of Event: 18:00
Status: Completed Reset Event
Curtailable Load: 0 kW
Incentive: 1.45 $/kWh
Date Settlement Calculated: 08/24/2018

Back | Delete | Baseline Dates... | Recalculate

Curtailment report - Thursday, August 23, 2018



AE Demand Response

Power Partner Thermostat

Load Cooperative

Power Savers Thermostat

AE Demand Response

Auto-DR

Water Heater Timer

Emergency Response Service

The GridOptimal Initiative

- The GridOptimal Initiative is a multi-year effort among utilities, governments, and industry led by the New Buildings Institute (NBI) and the United States Green Building Council (USGBC) to create a rating system to quantify a building's interaction or harmonization with the grid

Passive Design Elements

- Overhangs
- Envelope
- High-efficiency HVAC Systems

Active Dispatchable

- Automated Demand Response
- Peak Load Shifting Strategies
- Load Co-Op

Distributed Energy Resources

- On-site Solar Generation
- Batteries
- Electric Vehicles and Vehicle
- to Grid

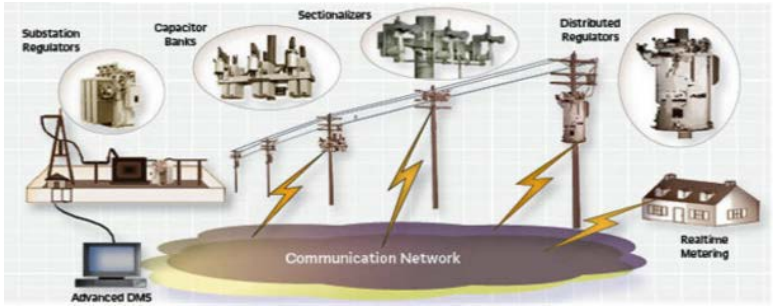
Distribution Automation

VVO/CVR

- ❑ Currently 97 distribution feeders active w/ 42 more planned

Fault Location, Isolation, Service Restoration (FLISR)

- ❑ Fault location on 200 feeders
- ❑ Installing reclosers, remote operated switches, and other D/A



Advanced Distribution Management System (ADMS)

- ❑ Upgrading to Schneider version 3.8, DERMS, Field Client, DERMS, AE Call

SCADA/ EMS

- ❑ OSI to replace antiquated ABB system

Intelligent Electronic Device (IED)

- ❑ RTU-less Architecture using Data Concentrators
- ❑ Continuing migration from E-M to Microprocessor relays

Distributed Energy Resource Integration

Austin Energy 2027 Goals

Offset 65% of customer load with renewable resources

1000 MW of savings from energy efficiency and demand response

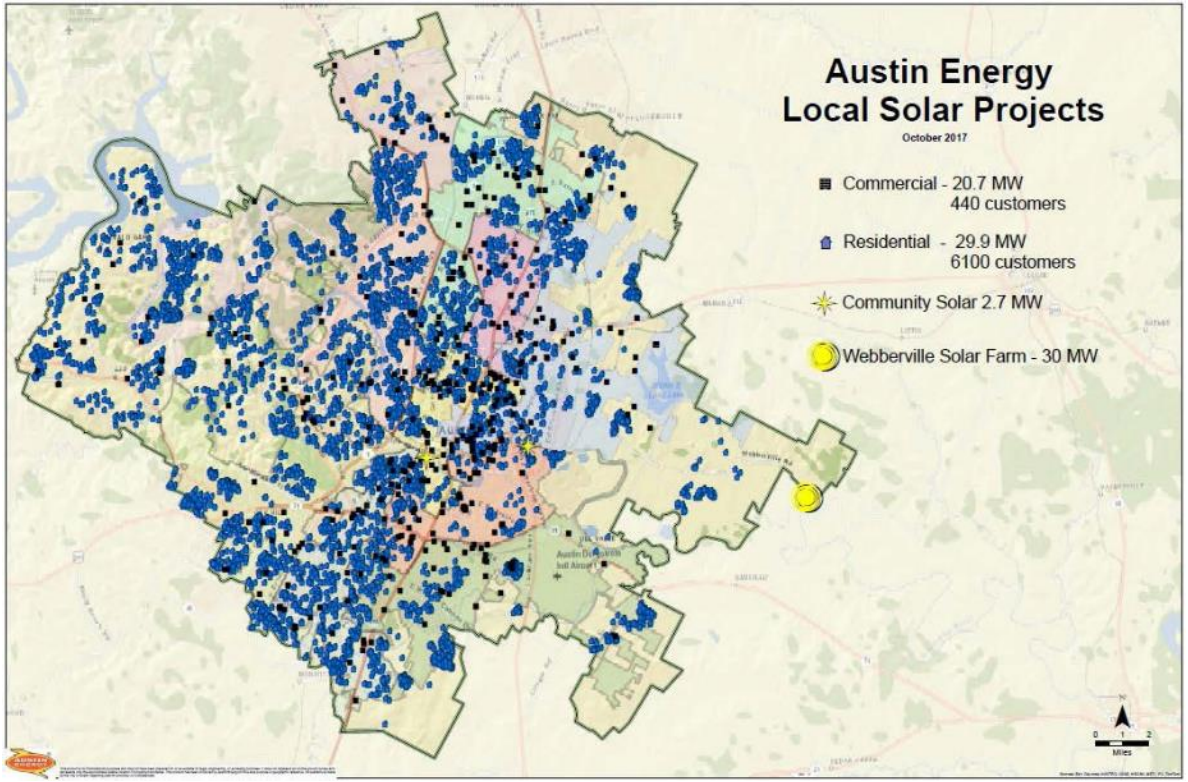
750 MW utility -scale solar + 200 MW local solar, including 100 MW customer-sited PV

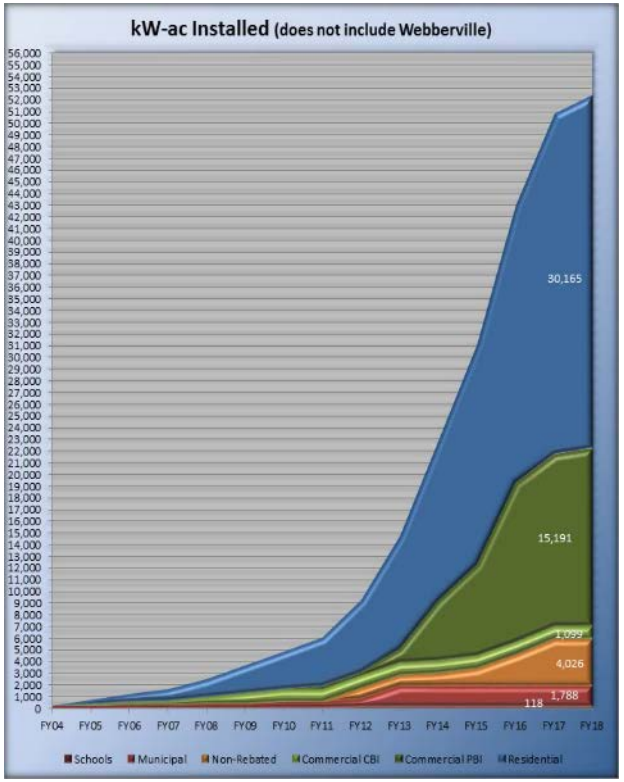
10 MW battery storage and 20 MW thermal energy storage

Net zero community-wide GHG emissions by 2050

All subject to meeting **Affordability Goals**:
<2% rate increase per year; Austin Energy rates in lower 50th percentile of statewide utilities

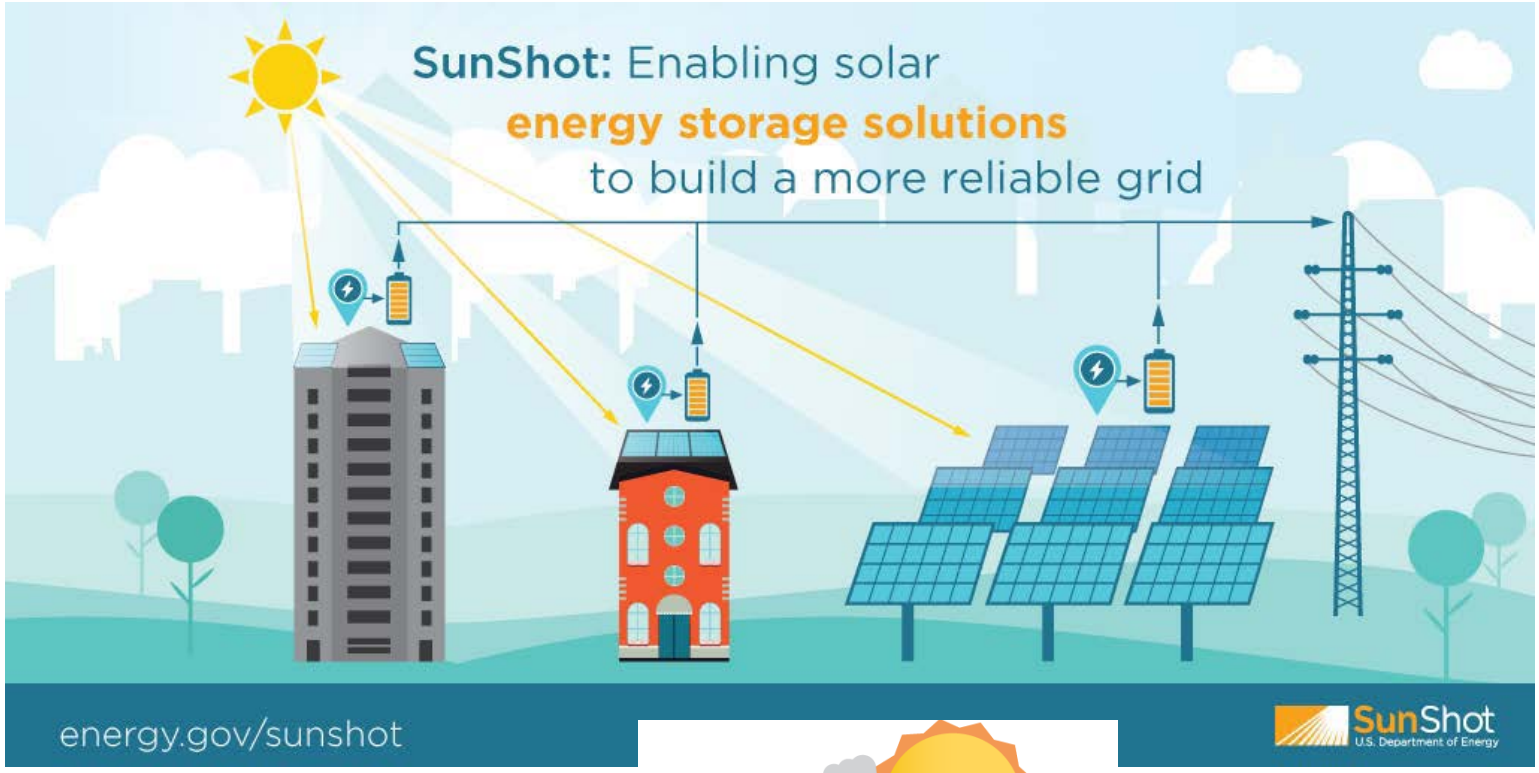
Local Solar Installations





Total AE local solar projects: about 80 MW

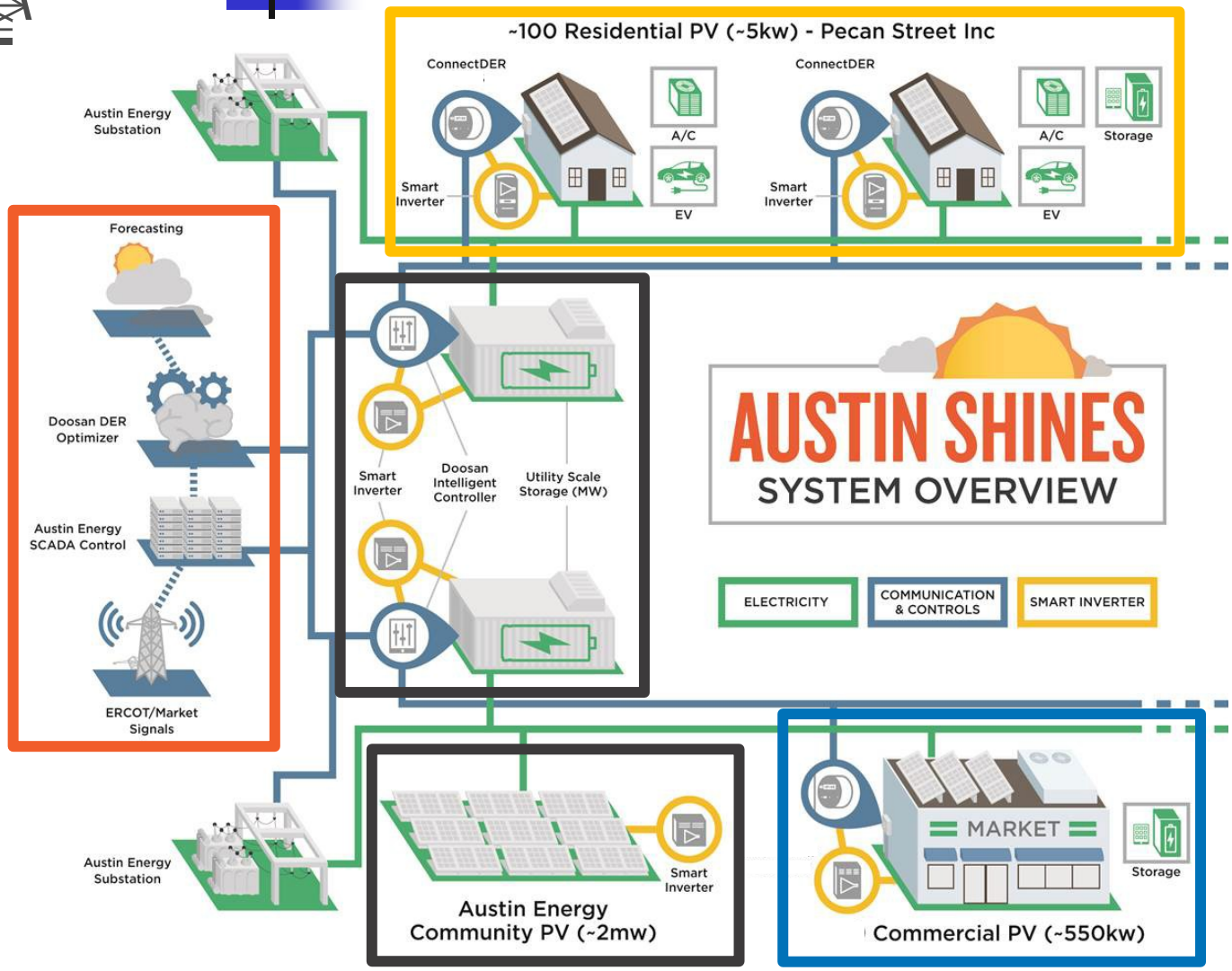
DOE SunShot & Austin SHINES



AUSTIN SHINES

Sustainable and **H**olistic **IN**tegration of **E**nergy Storage and **S**olar PV

Austin SHINES Concept



Utility Scale Energy Storage +PV

Commercial Energy Storage +PV

Residential Energy Storage +PV

DER Management Platform

Distributed Energy Resource Value Stacking

	Application	Benefit
MARKET	Utility Peak Load Reduction	Lower Transmission Cost Of Service obligation
MARKET	Day-Ahead Energy Arbitrage	Price differences create economic value
MARKET	Real-Time Price Dispatch	Economic value from real-time price spikes
RELIABILITY	Voltage Support	Reduce losses and increase PV generation
RELIABILITY	Distribution Congestion Management	Increase local grid reliability
CUST	Demand Charge Reduction	Customer and system benefit

Austin SHINES Partnerships

Austin SHINES Assets

Utility Scale

La Loma Community Solar
- 2.6 MW Photovoltaic solar

Kingsbery Energy Storage System
- 1.5 MW / 3 MWh Li-Ion battery storage

Mueller Energy Storage System
- 1.75 MW / 3.2 MWh Li-Ion battery storage
  7 Energy Storage Units (250 kW each)

Austin SHINES Assets

Commercial Scale

Aggregated Storage Installations at 3 sites, with existing solar (300+ kW)

- One 18 kW / 36 kWh Li-Ion battery storage
- Two 72 kW / 144 kWh Li-Ion battery storage

Residential Scale

Aggregated Storage Installations

- Six stationary battery storage systems (10 kWh each) at homes with existing solar
- One Electric Vehicle installed as Vehicle-to-Grid (V2G)

Utility-Controlled Solar via Smart Inverters at 12 homes
Autonomously-Controlled Smart Inverters at 6 homes

Vehicle-to-Grid (V2G)

Customer Value

Electric vehicle is charged and ready when owner needs it for mobility

Utility Value

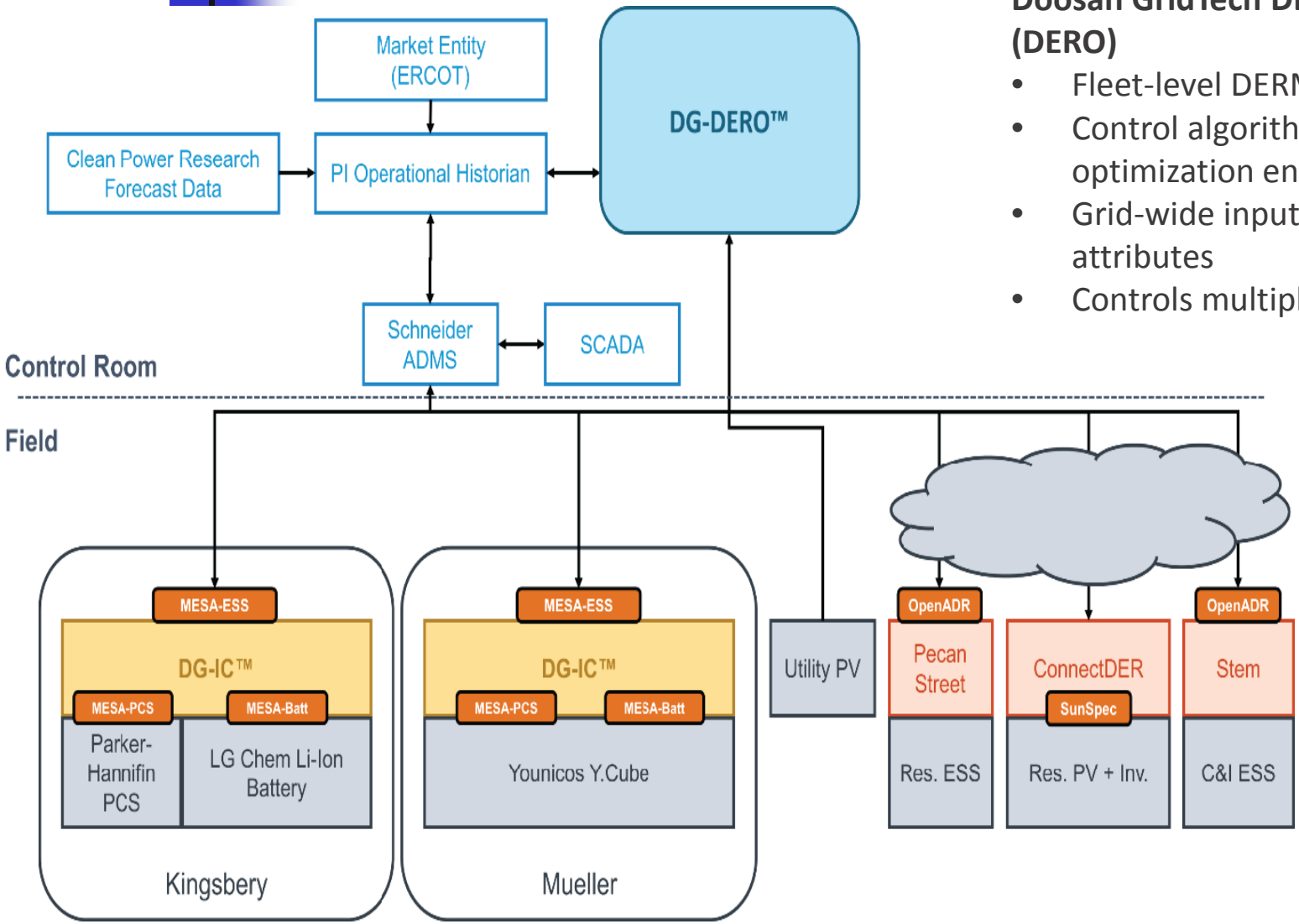
Utility able to shift charging load to the most opportune time

When needed, stored energy can be discharged to the grid to serve local load

Win-Win

V2G is another way to realize value in multiple ways

DERO in an Austin Energy Ecosystem – Centralized



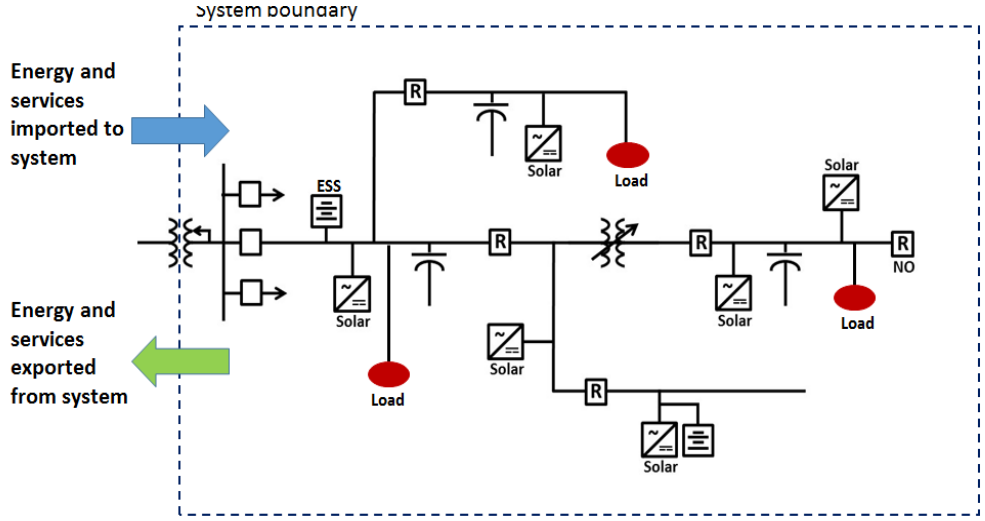
Doosan GridTech DER Optimizer (DERO)

- Fleet-level DERMS
- Control algorithms and optimization engine
- Grid-wide inputs and attributes
- Controls multiple DERs

System Levelized Cost of Electricity (LCOE) Methodology

System LCOE encompasses the cost and performance of all assets, within a defined distribution circuit.

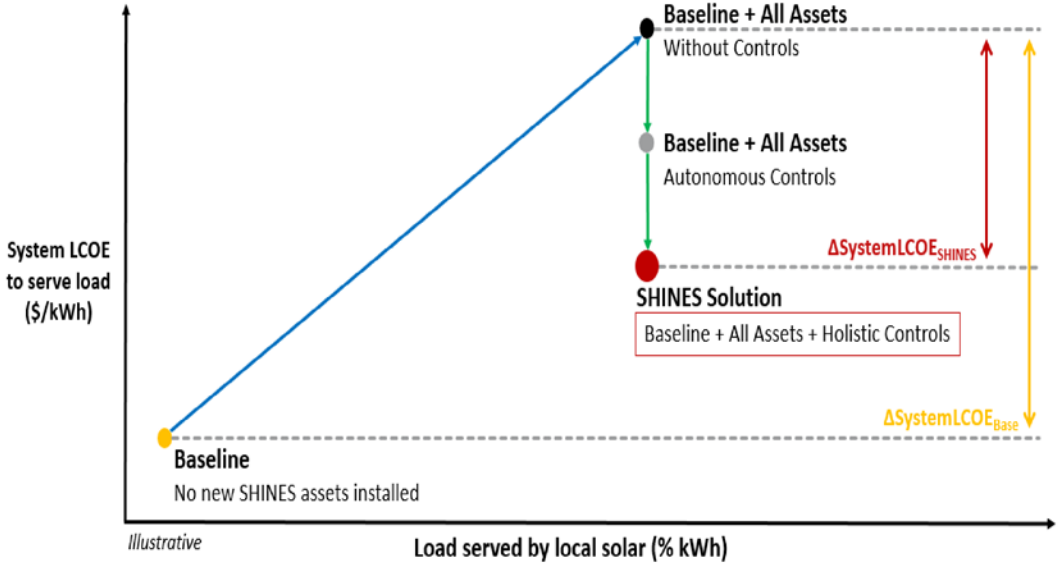
System-level boundary definition



Where, **SystemLCOE to serve load ($/kWh)** =

$$\frac{\left[\text{Capital cost of all equipment within system (\$)}\right] + \left[\text{Operating cost of all equipment within system (\$)}\right] + \left[\text{Net value of energy, capacity, and services that cross system boundary (\$)}\right]}{\left[\text{All load served within the system (kWh)}\right]}$$

System Levelized Cost of Electricity (LCOE) Methodology



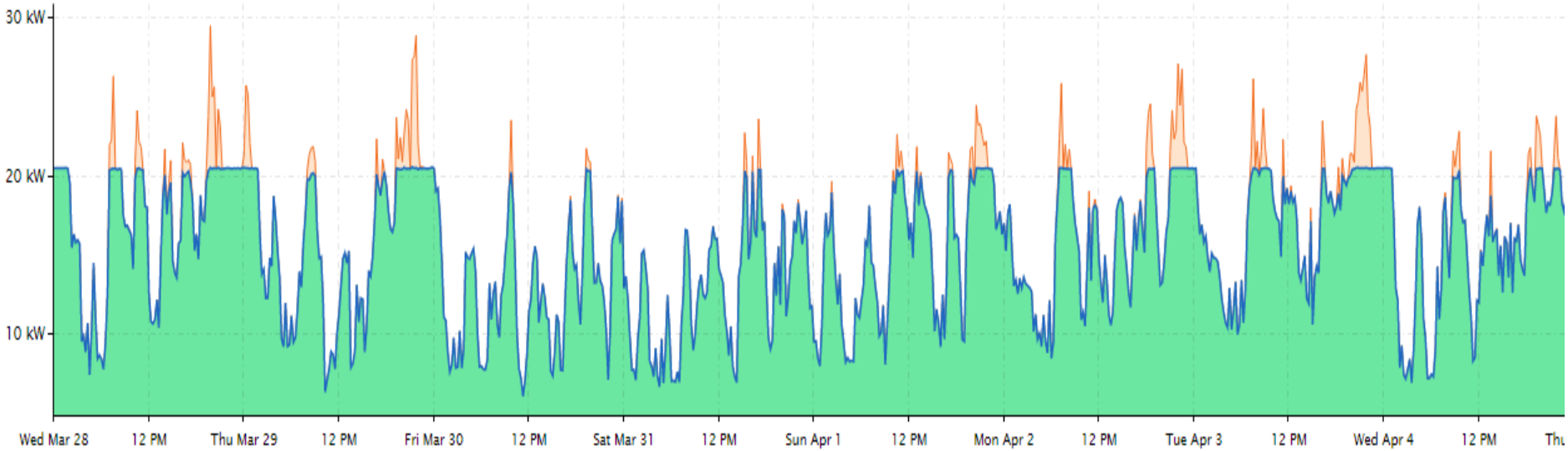
1. No individual asset is isolated
2. Dependent and supportive elements of a holistically integrated system
3. Collective contribution of diverse assets result in utility-grade performance

The Austin SHINES project has two key metrics for System LCOE:

1. $\text{SystemLCOE}_{SHINES} < \$0.14/kWh$
2. Modeled $\dfrac{\Delta\text{SystemLCOE}_{SHINES}}{\Delta\text{SystemLCOE}_{Base}} \geq 20\%$, at same solar penetration

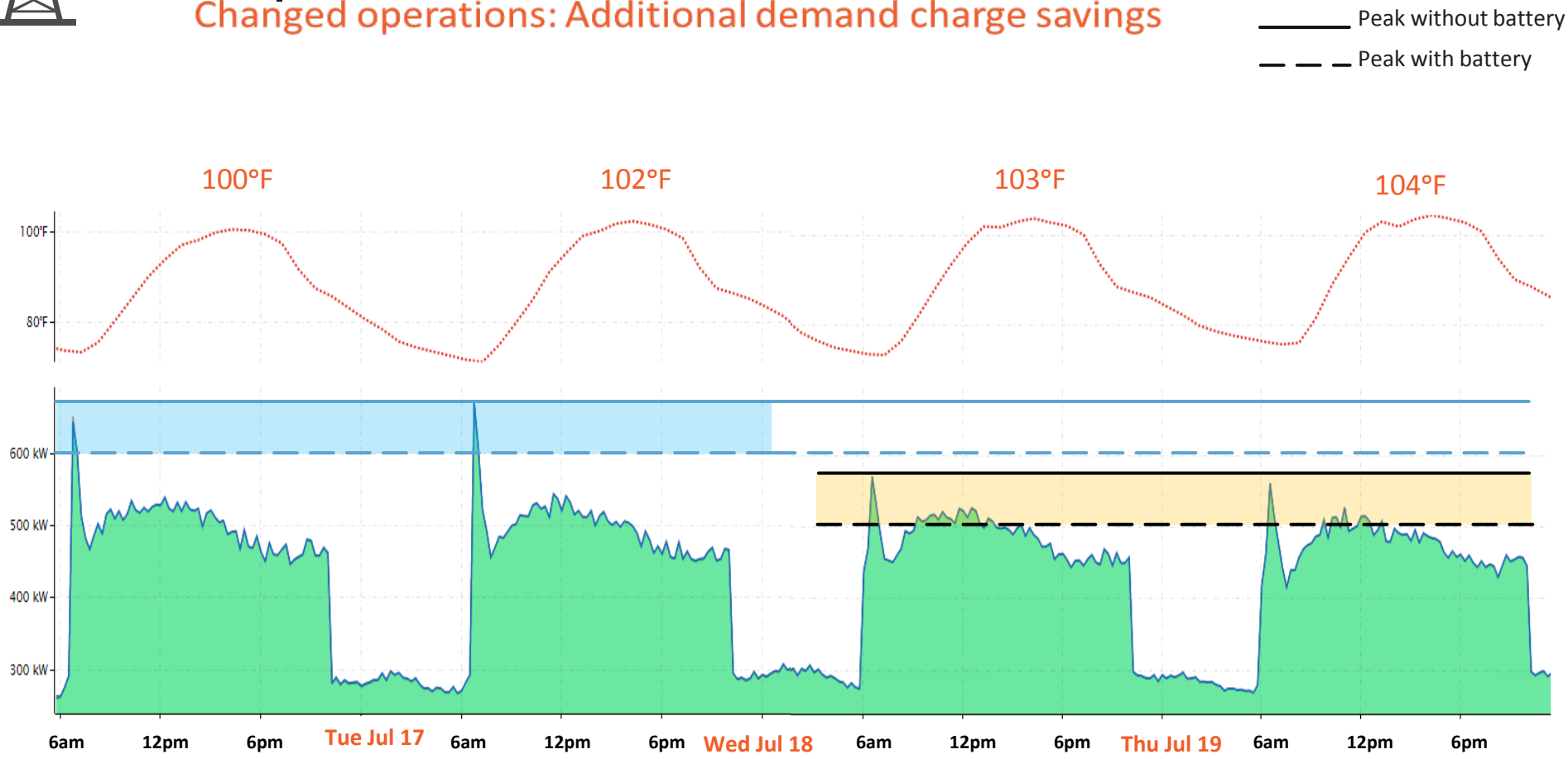
Demand Charge Management

Reducing electricity bills for commercial customers



Customer Value

Changed operations: Additional demand charge savings

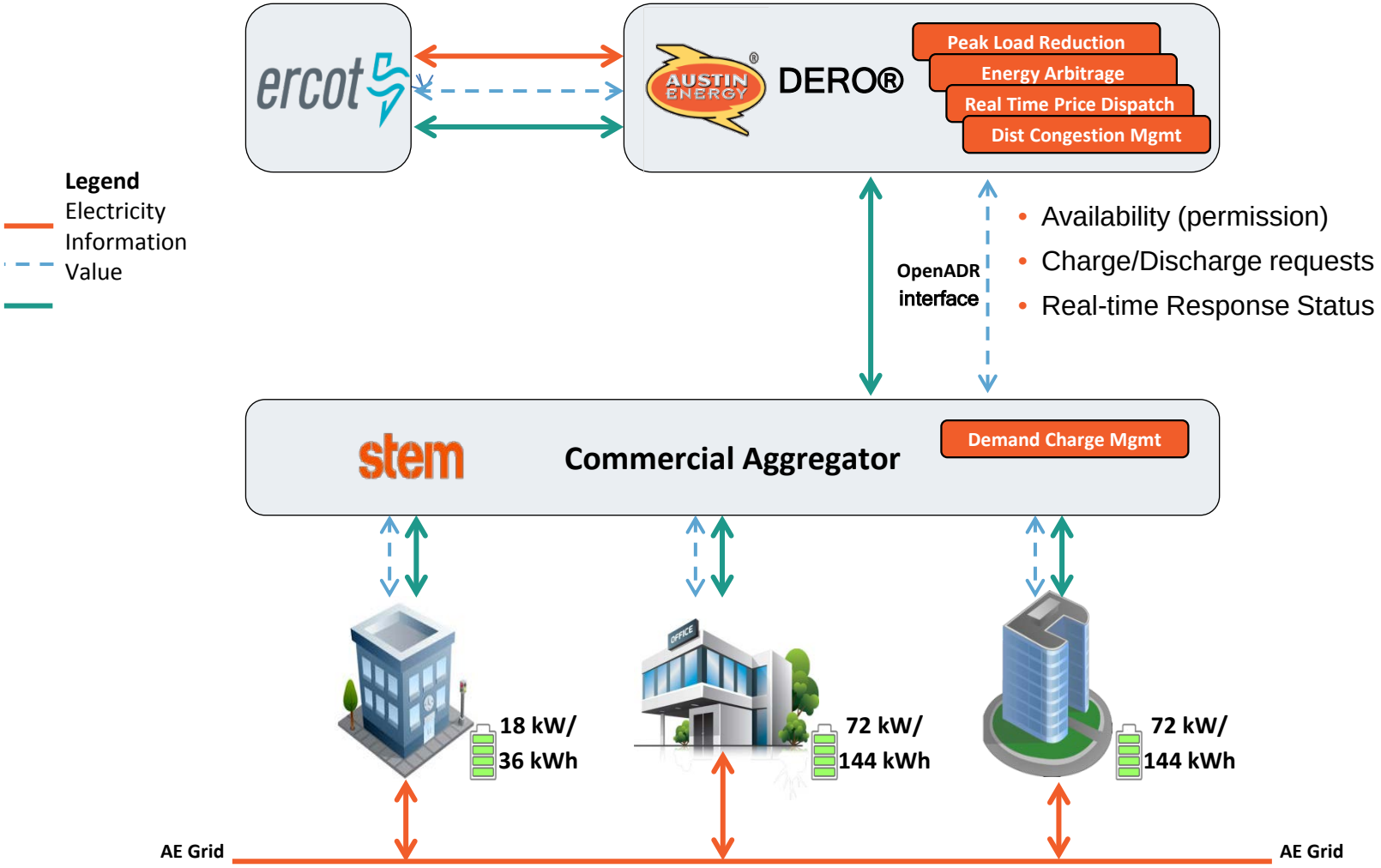


"We made a schedule change in our HVAC settings at that campus, and it looks like our morning spike is reduced by about 100kW!"

~Email received from one happy customer on July 18

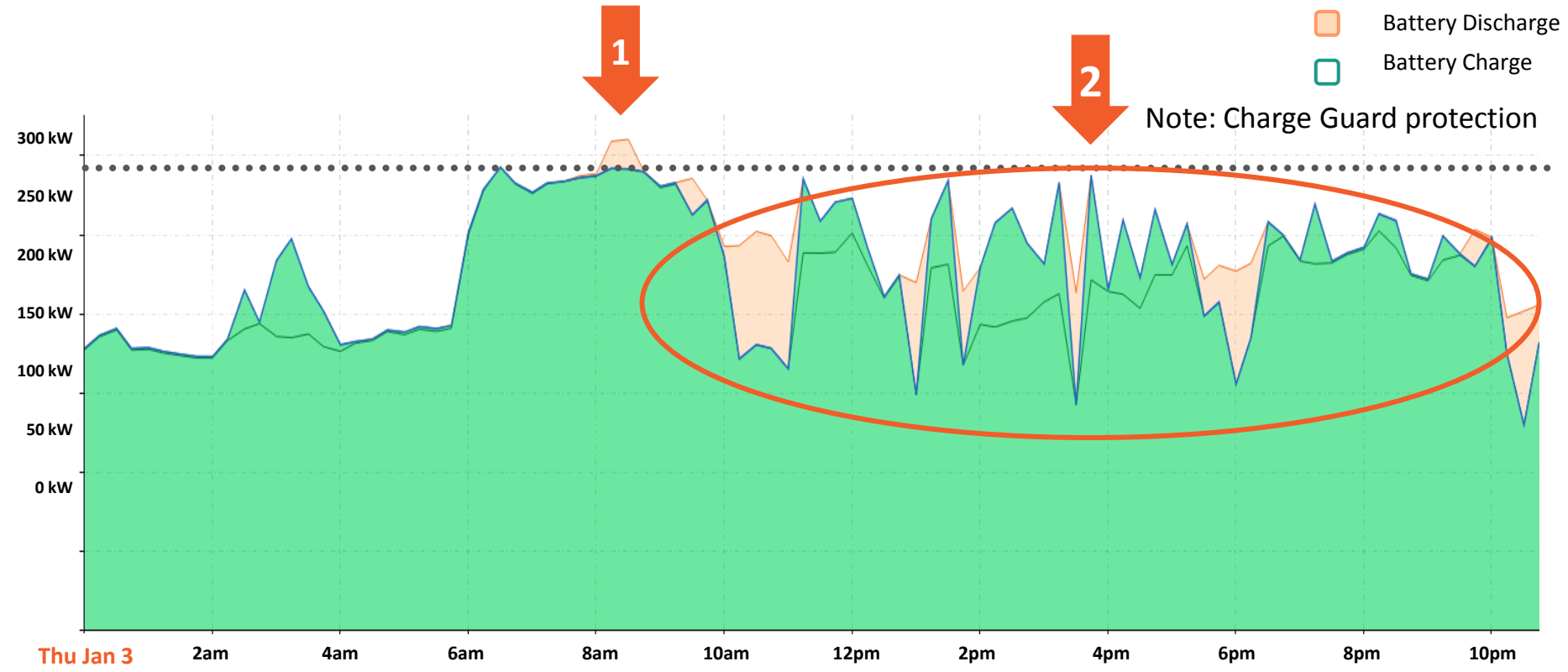
Control Platform

Defined Priorities and Two-Way Data Streams



Results

Commercial Aggregator and DERO Share Capacity



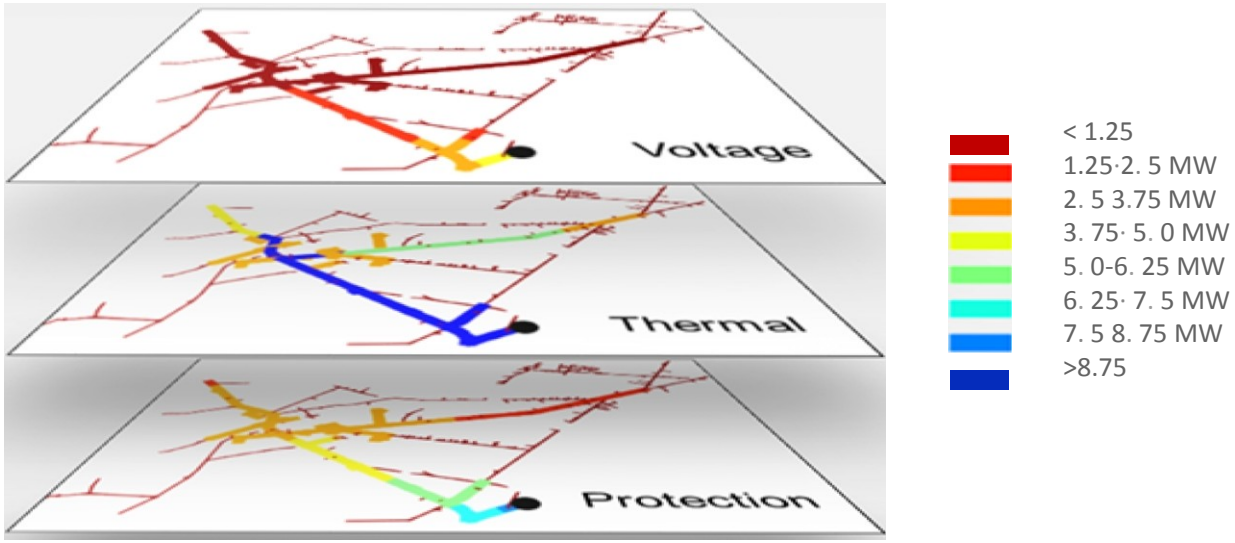
1 – Demand Charge Management

2 – DERO charging/discharging for additional value

Feeder Hosting Capacity

Impacts Considered

- Voltage
  - Primary overvoltage
  - Primary voltage change
  - LTC/Regulator tapping
- Thermal
  - Ratings for generating power
  - Ratings for demanding power
- Protection
  - Element fault current
  - Breaker relay reduction of reach
  - Sympathetic breaker relay tripping
  - Reverse power flow
  - Unintentional islanding



Integrated Asset Management

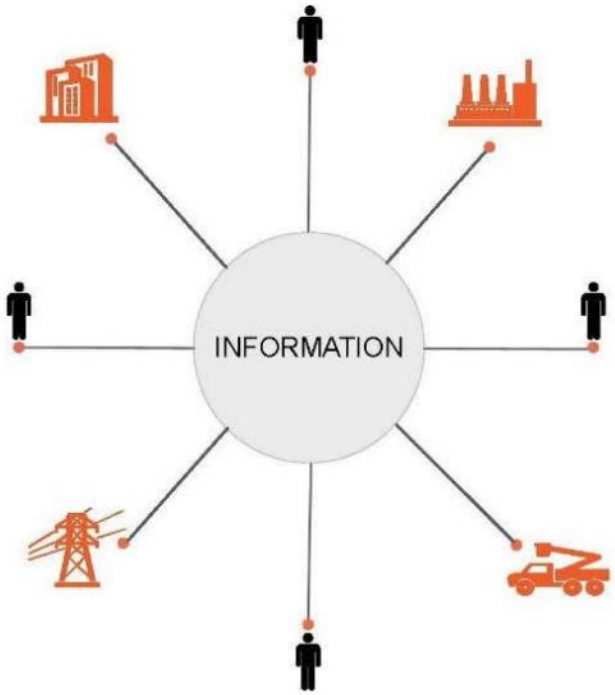
Asset Management – Improving Grid Reliability

COORDINATION

QUICK ACCESS TO INFORMATION

BIG PICTURE VISIBILITY

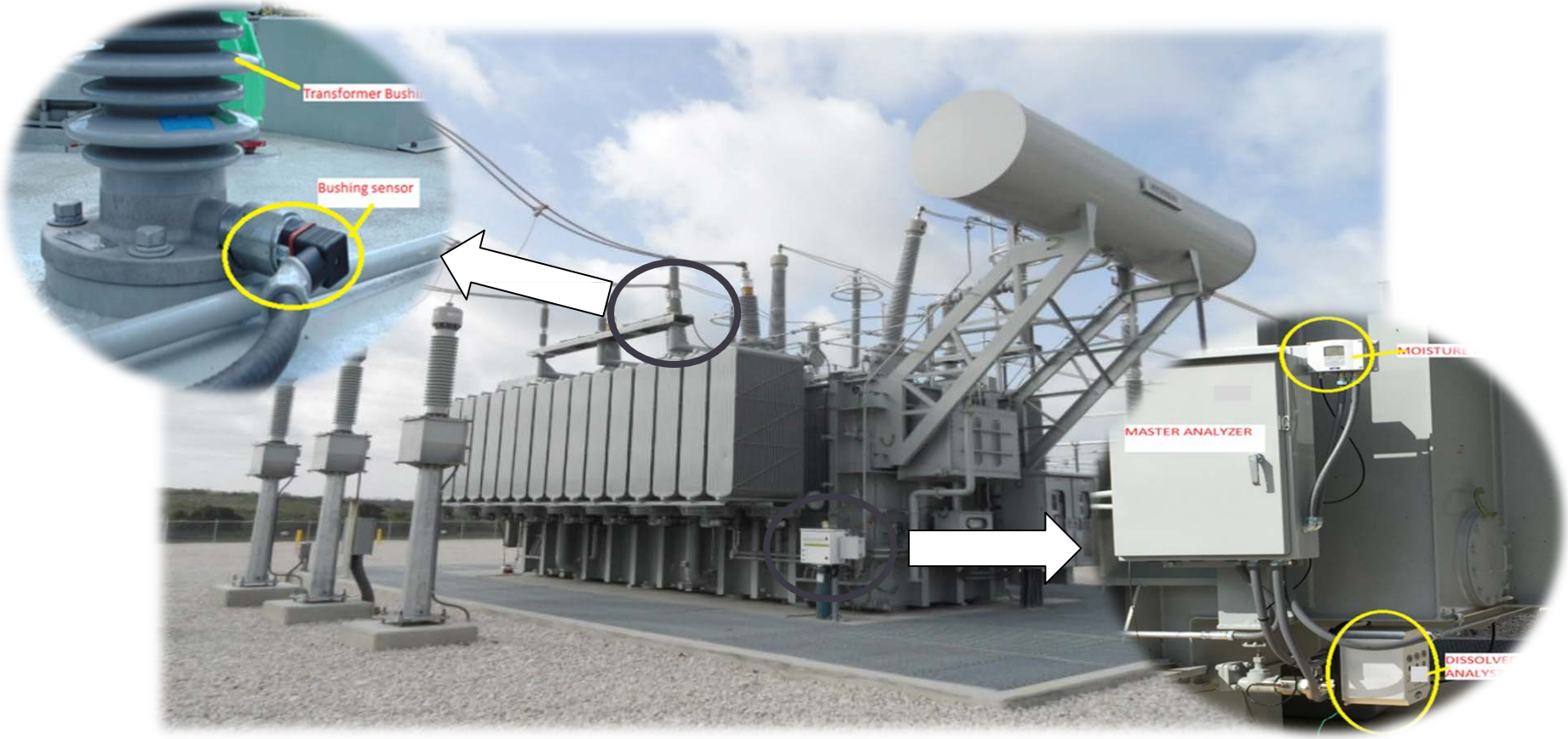
HIGHER RESPONSIVENESS



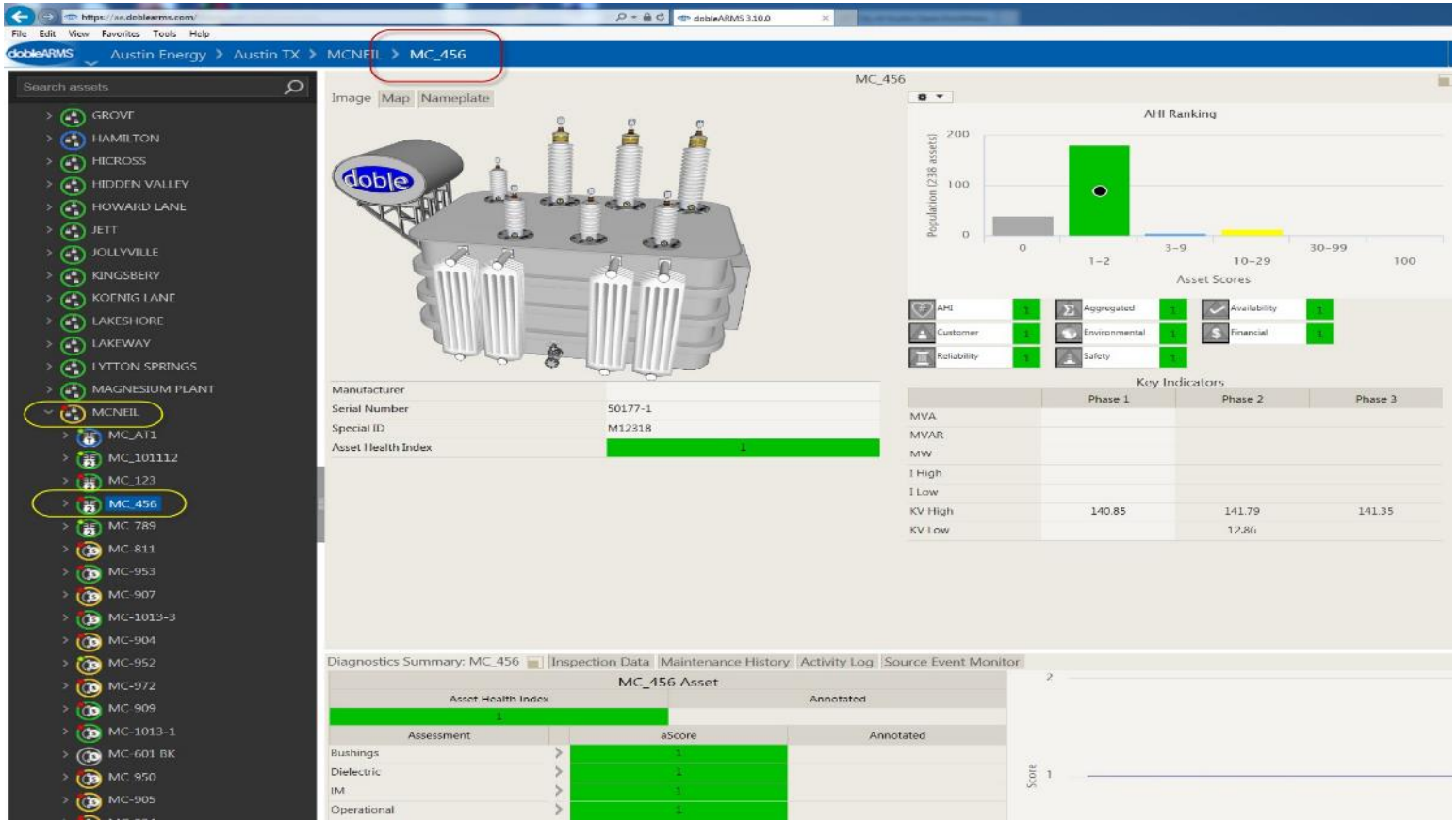
IMPROVED VISIBILITY

IMPROVED EFFICIENCY

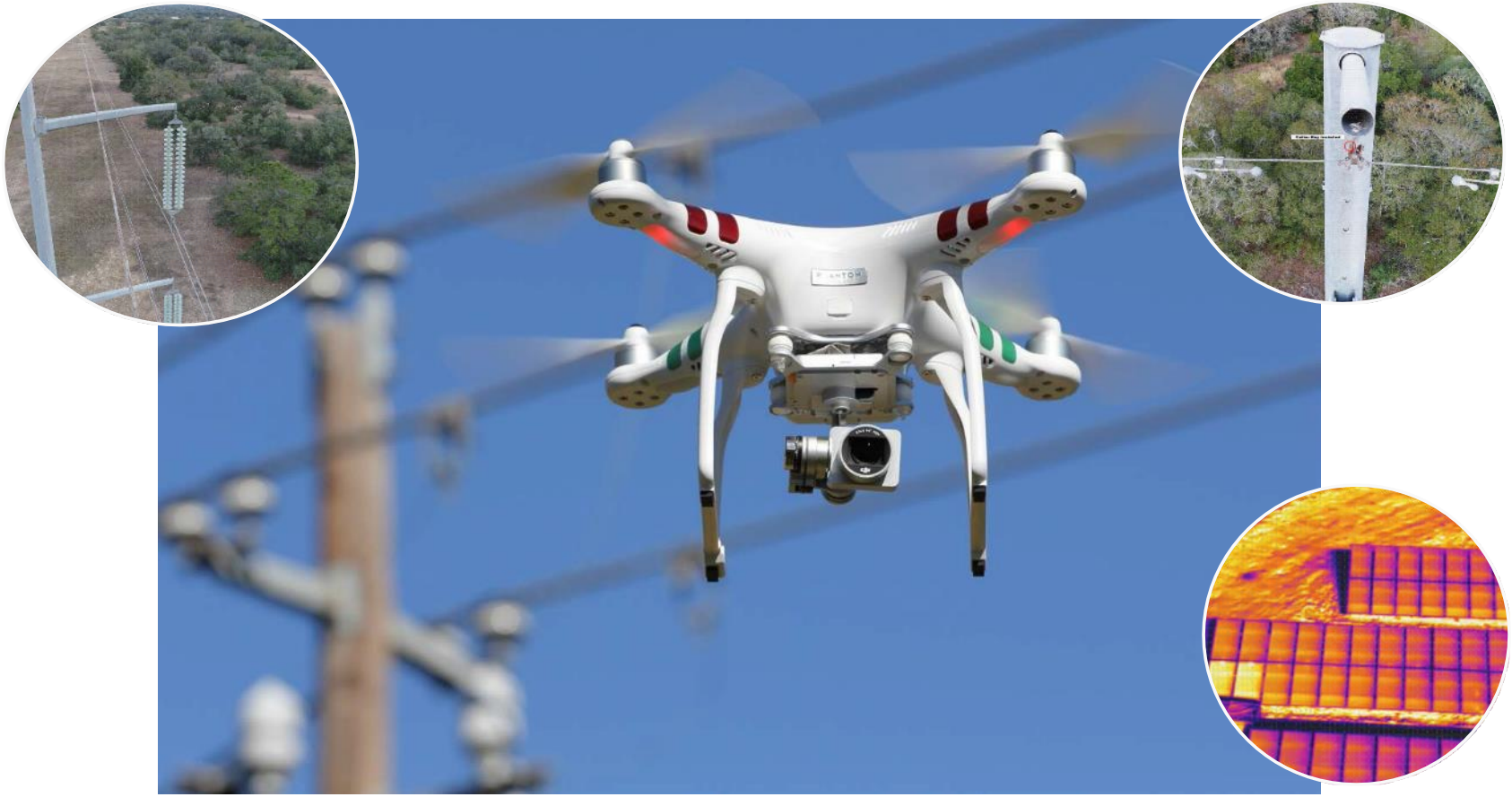
Conditioned Based Monitoring



Risk & Asset Health Index



The Future of Inspections



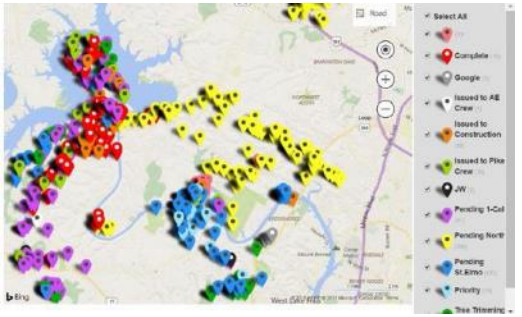
Other Initiatives

Geospatial Information System (GIS)

- Electric Office Upgrade
- Distribution assets modeled in GIS
  - 98% +/- of solar has been modeled in GIS
  - Transmission assets to be modeled in FY18/FY19
  - Downtown Network assets to be modeled in FY18/FY19+

Work and Asset Management + Mobile Solution

- Replacing STORMS with Maximo for Utilities

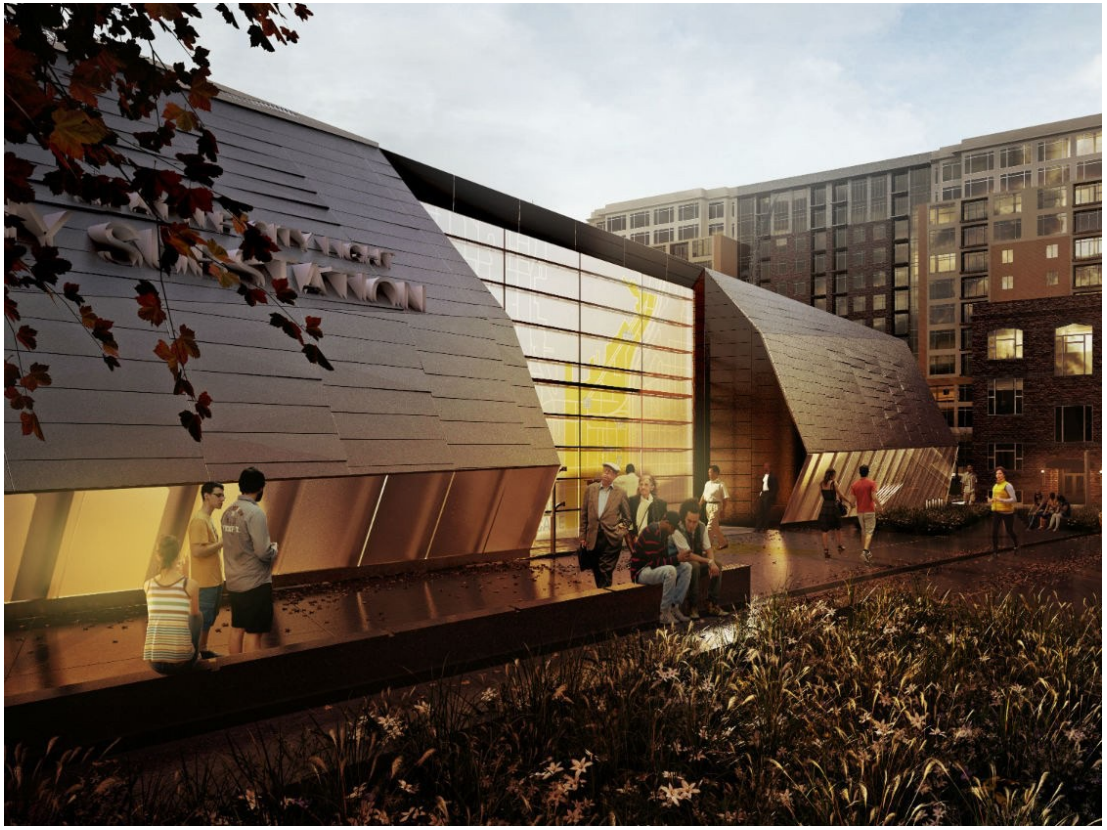


Pole Audit

- Annual pole audits identified distribution poles needing attention
  - Remediation performed where possible
  - Other rejected poles replaced per a priority system

So What? Why Does This Matter?

So What is Our Why?



Enriching the lives of our customers and communities by being their trusted energy provider, platform, and partner

Customer Collaboration Alignment

Advanced Metering Infrastructure (AMI)
- Flexible rate options
- Customer access to their energy usage and usage alerts
- Identification of product opportunities and more tools at the hands of CSRs

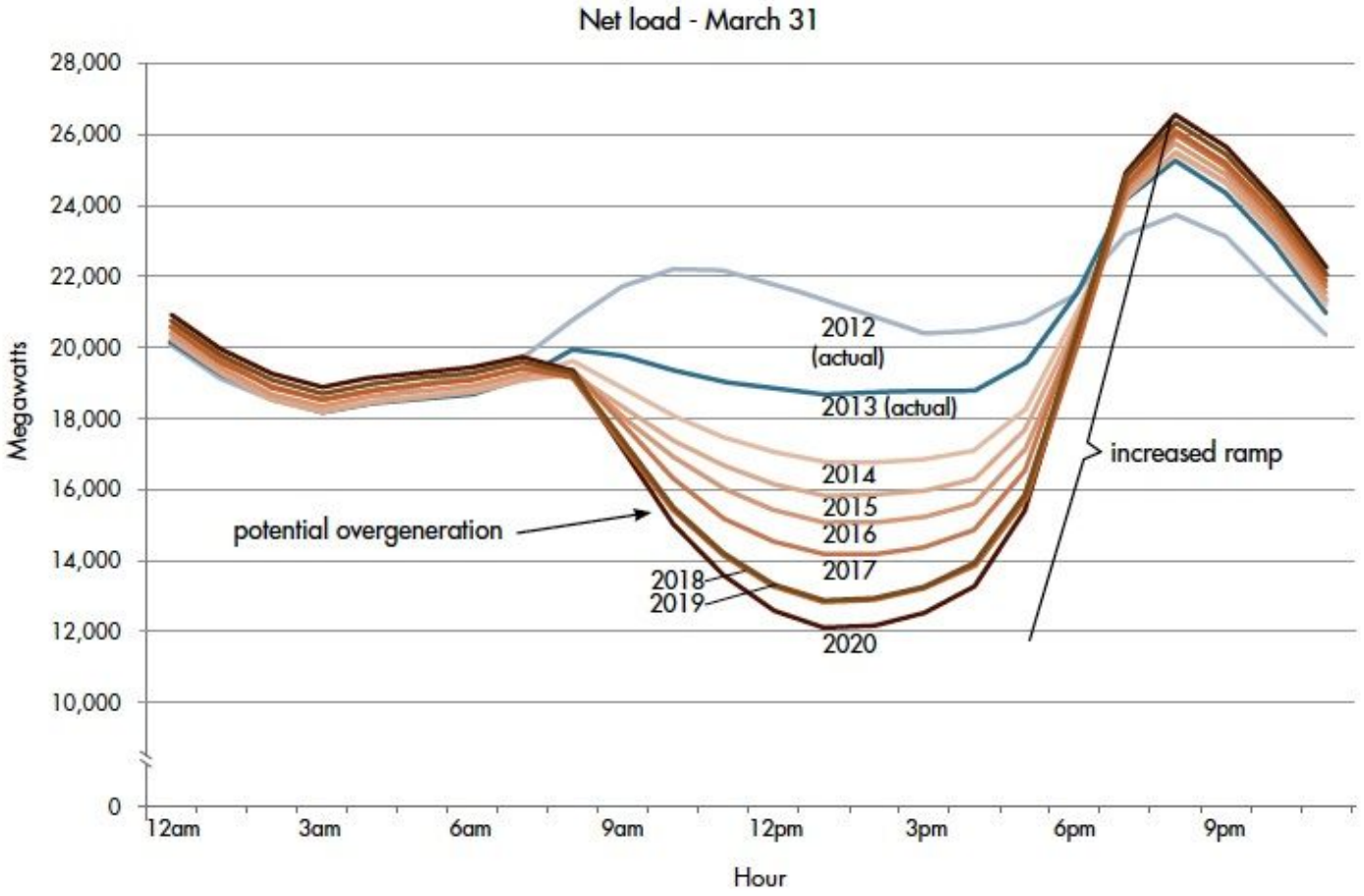
Grid Automation
- Two way outage communication/notification
- Reduced outage durations and increased resiliency
- Customer information and history in the hands of field personnel

Distributed Energy Resource integration
- Customer choice and flexibility
- Customer participation opportunities (e.g. community solar)
- Environmental and Social benefits of reduced carbon emission

Asset Management
- Improved reliability and better identification of customer problems
- Cost savings through operational efficiencies impacting affordability
- More granular customer outage history

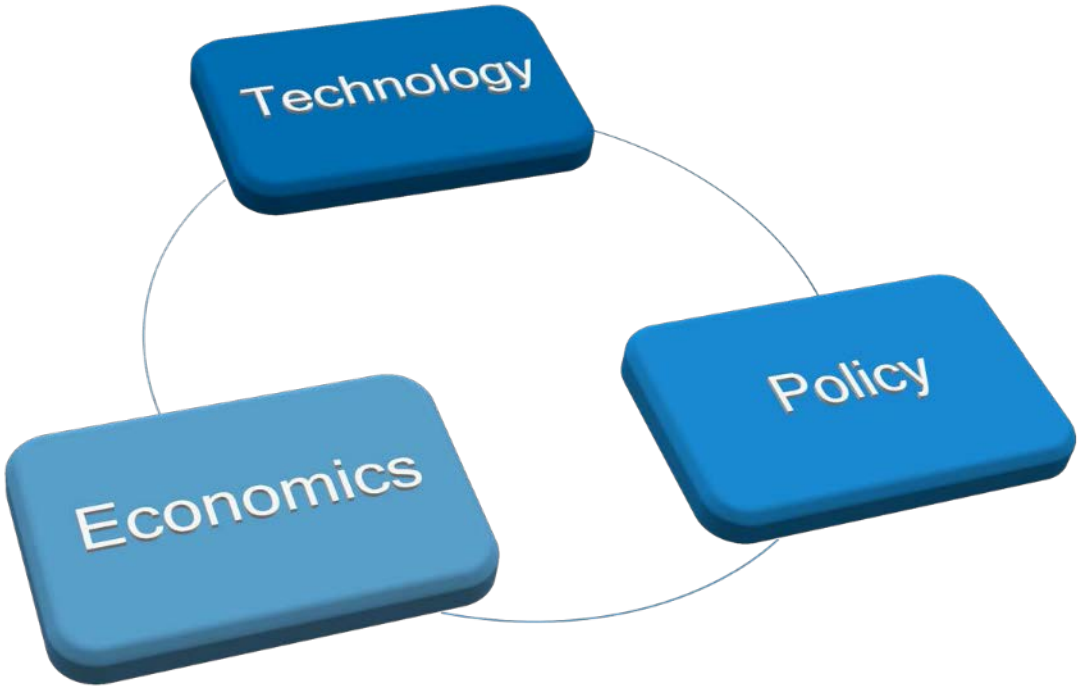
What are Some of the Challenges?

The “Duck” Curve



CAISO "Duck Curve" is a projection of the net load - including renewables

Grid Modernization Challenges



Where Are We Headed?

The Grid

- Enables the Future Energy Ecosystem and Increasingly Transactive
- AMI and ADMS Systems Ubiquitous
- Microgrids and Battery Storage will Increase but not Ubiquitous
- Grid Modernization Integral/Inseparable with Smart Cities

Customers

- Choice
- Convenience
- Communication
- Cost of Service Parity

Energy

- Continued Decarbonization and DERs will Effect Transmission Operation
- Markets will become even More Efficient
- Load Profile Flatten
- Increased Electrification Offset by EE, DR, DER

Business Model

- No Death Spiral with few truly “Off the Grid”
- New Business Model Resolved - Real Time Pricing
- New Market Participants
- Increased Dependency on Service Providers, Cloud Solutions, Outsourcing

Austin Energy's Paradigm

- Traditional Regulatory Construct
- Low and Very Stable Wholesale Market Prices
- Active and Engaged Stakeholders w/ Limited Market Understanding
- Policy Focus on the Environment and Affordability
- Austin Energy Functions as a City of Austin Department
- Customer Growth without Corresponding Load Growth
- Redundant, Reliable, and Robust Grid

Integration of Systems and Organization

- Advanced Distribution Management System (ADMS)
- Complex Two Way Smart Meters (AMI)
- Geographic Information System (GIS)
- Customer Care & Billing (CCB) Meter
- Data Management System (MDMS)
- Mobile Workforce Management (MWM)
- Work & Asset Management System (WAMS)

Final Thoughts

- Get Educated and Engaged
- Understand the Core Business is Table Stakes
- Customer Experience is Driving Change and the Standard is Amazon … at Least for Today
- Enable the Power of Many and Embrace Diversity
- Recognize not only the Need to Change but the Rate Required
- Solve Beyond the Classic Project Management Triple Constraint
- Safety is not a Program … Safety is the only Culture for Success

Smart Grid Communication Network

Smart Grid Communication Network

- Power System Communication Network
  - Protection System
  - SCADA
    - Smart Grid
  - Basic Telephone

Smart Grid Communication Network

- The key to achieving SG is to successfully build a Smart Grid Communications Network (SGCN) that can support all identified SG functionalities:
  - Advanced Metering Infrastructure (AMI),
  - Demand Response (DR),
  - Electric Vehicles (EVs),
  - Wide-Area Situational Awareness (WASA),
  - Distributed Energy Resources and Storage,
  - Distribution Grid Management, etc.

SCADA AE Network Current State

- Applications forced to conform to rigid legacy network architecture
- Inefficient hardware utilization
- Risk of a major failure is very high due to aging equipment
  - Severity: Previously entire sites have been impacted by failure of a single network device.
  - Rate of Occurrence: High rate of occurrence
  - Detection: Very low ability to detect a failure, or identify a root cause of problems quickly
- Risk of undetectable security breach is very high
  - Zero trust is implemented through firewalls. Most firewall rules are not managed by the Change Management process. Human error rate is very high with firewall changes
- Inconsistent Network management
  - No VLAN naming standards

SG Communication Requirements

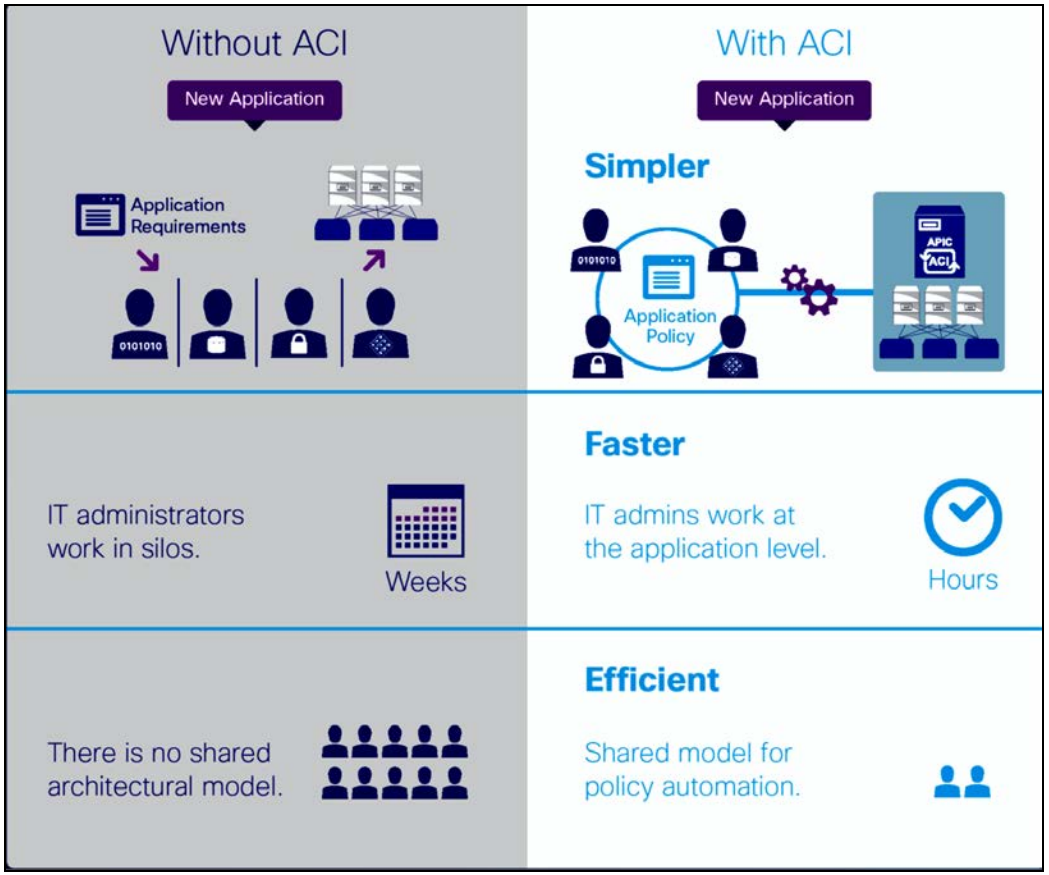
- Interoperability
- Sufficient Data Rate
- Reliability
- Latency

AE Requirements for a New Network

- Operational
- Reliability/Availability
- Security
- Scalability
- Programmability
- Integration

Why Application Centric Infrastructure (ACI)?

Application Centric Infrastructure is a type of networking that is based on the **application**. In an **application-centric** network, the network administrator manages a system for a specific **application** rather than managing individual servers and routers like they did in the past



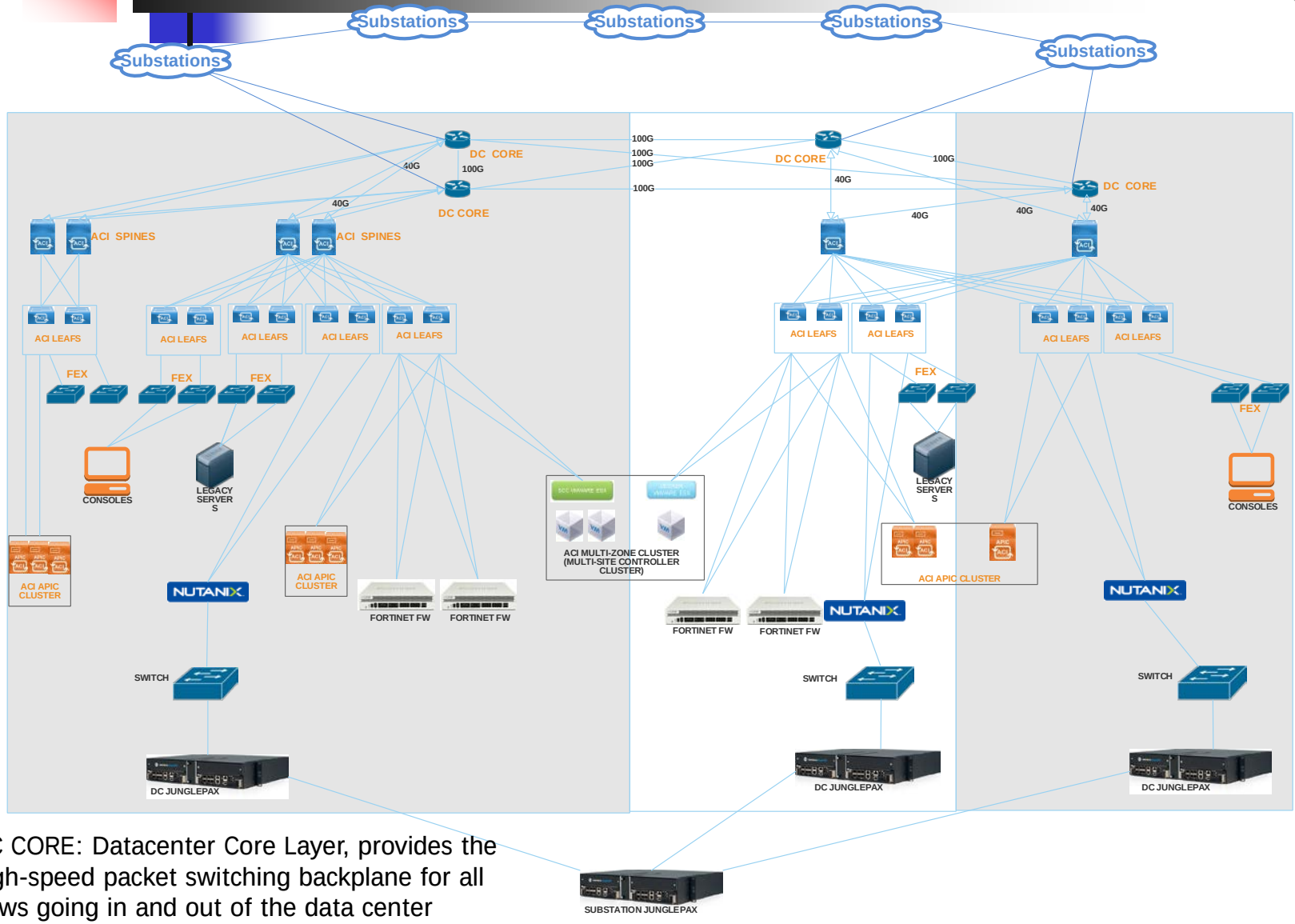
Why Cisco ACI?

- Cisco ACI is a Software Defined Network (SDN) Spine-Leaf Architecture and it is the only solution that satisfies all our Technical/Business Requirements.
- We chose a spine-leaf network architecture for the following benefits:
  - Industry recommended standard for next-generation physical datacenter infrastructures.
  - It improves total bandwidth availability
  - Simplifies network configuration and management
  - It is highly scalable
- We chose Cisco because the cost of switching to another vendor was prohibitive.
- Even without implementing micro-segmentation, ACI in pure network-centric mode, automates the provisioning of the spine-leaf network with minimal configuration.

Cisco ACI Multi-Site

- We chose Cisco ACI multi-site as our next-generation datacenter network platform because ACI Multi-site is the most highly Available Cisco ACI design and requires the Nexus 7000 series switch for seamless integration and automation of the ACI WAN interconnection.
- ACI Multi-site gives you the capability to extend segments across multiple sites without changing IP addresses.
- The Multi-Site infrastructure will not only be leveraged by the SCADA datacenter but it is positioned to be leveraged as the Core for the IT Datacenter whether or not ACI is deployed in the IT Datacenter.

SCADA ACI NETWORK INFRASTRUCTURE



DC CORE: Datacenter Core Layer, provides the high-speed packet switching backplane for all flows going in and out of the data center

Wireless Communications

- History
  - In August of 2009 AE installed the DC Systems Intelligent Communication Gateway (ICG) which provided the infrastructure needed to leverage our existing AMI wireless network (L+G GridStream) for communication with distribution automation assets scattered throughout the AE territory.
  - This mesh radio system does not carry DNP polling traffic in the traditional way – the ICG is needed to serve as a piece of ‘middleware’ that provides limited DNP interoperability.
  - Communication latency over the mesh radio system was excessive, resulting in a loss of confidence from an operational perspective.
  - In 2016, Verizon presented a service called an “LTE Access Point Name (APN)” service.

Verizon LTE APN

- AE APN network is divided into 4 ‘pools’ of addressed space:
  - 1 pool for SCADA system purposes;
  - 1 for ADMS purposes;
  - 1 for metering;
  - 1 for corporate network extension which is useful for corporate ‘mobile data’ purposes (mobility for GIS, ADMS, etc.).
- In January of 2017 AE began deploying equipment onto the AE Verizon Wireless network.
- Verizon APN is a private ‘VPN type’ service where LTE network bandwidth is carved out for AE’s exclusive and secure use.
- This is a high speed, IP based network that looks like an extension of AE’s existing network structure for wireless communications anywhere within AE’s territory. As an IP based network, devices can be very easily added to the Verizon network.
- Each end-point (recloser, cap bank, motor operated switch, line sensor) has an LTE modem and data plan with a defined number of ‘gigabytes’ allocated at a monthly charge rate.

Homework – Due March 7

1. Describe How Volt-VAR Optimization (VVO) improves efficiency?
   Hint: VVO is a component of most Distribution Management Systems
2. Calculate the power losses in a conductor with the impedance of 0.01 +j.05 ohms, on one side connected to a constant voltage source of 120V, AC, and the other side connected to a) a load of 4.0 +j1.0 VA, b) a load of 4.0 +j2.0 VA.
3. In the previous question calculate the power factor for the loads in parts a) and b). Describe the reason for the difference in losses. How can we reduce the losses in the above conductor for these loads?
   Hint: Consider what improves the power factor of a load
4. Why it is useful to install battery storage in combination with renewable energy resources?
5. Describe three benefits of ACI communication networks
6. Considering power system communication networks, is protection system more critical or smart grid functions? Describe why?
7. Provide one of the reasons Austin Energy chose Verizon LTE