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SPURRING INNOVATIVE IDEAS IN WIDE OPEN SPACES

Welcome

FORT WORTH, TEXAS MAY 7-10, 2017

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## Distributed Generation and Advanced Grid Impact on the Supply Chain Organization

STAYING AHEAD OF THE CURVE

# Distributed Generation and Advanced Grid Impact on the Supply Chain Organization

ZAC FRYER  
DIRECTOR OF MATERIALS AND LOGISTICS  
ARIZONA PUBLIC SERVICE



# Agenda

- APS Overview
- Our Changing Environment
  - Industry Trends
  - How Is APS Responding
- Supply Chain Challenges
- Supply Chain Response



# APS Overview



# Public Service Corporations

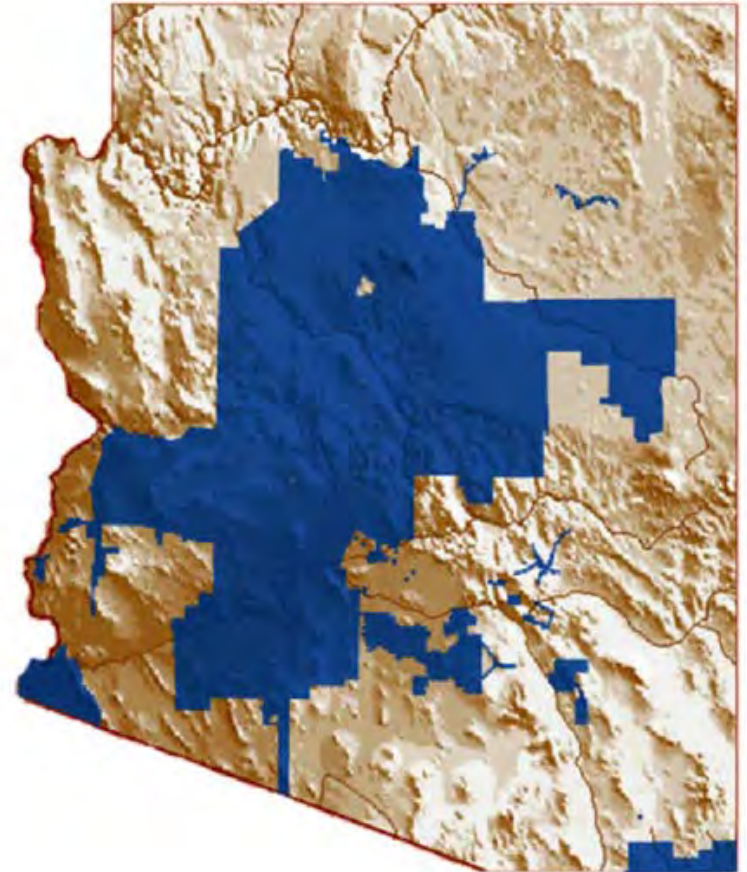
*Virtually all the challenges of a normal business but with additional “special” characteristics*

- Restricted service territory
- Broad service obligation
- Planning responsibilities
- Pricing and product restrictions
- Profit limits
- Pervasive regulation



# APS Service Territory Overview

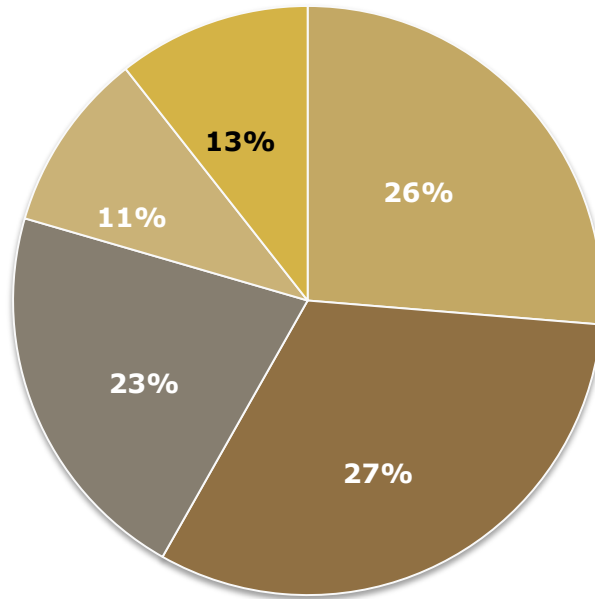
- Arizona's largest and longest-serving utility – since 1886
- Service Territory
  - 11 of 15 Counties
  - Over 1.2 million customer accounts (89% residential)
  - 34,646 square miles
- Investor-owned utility - subject to forms of public control and regulation
- Arizona's largest taxpayer
  - \$3.4B annual economic impact to AZ
  - \$1.4B in SCM Managed Spend
- Approximately 6,600 employees
- Peak load approximately 7,300MW



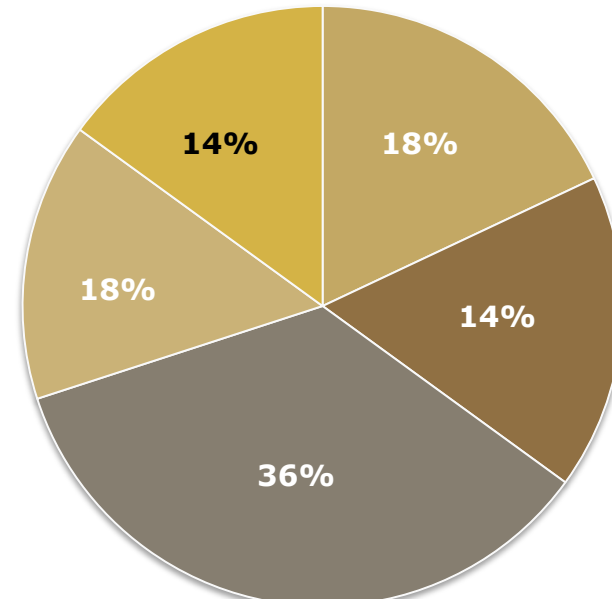


# Diverse Energy Mix

2017



2032



Growth in flexible natural gas generation to meet peak demand

- ▼ Nuclear
- ▼ Coal
- ▼ Natural Gas
- ▼ Renewable Energy
- ▼ Energy Efficiency



# Flexible Generation Resource Portfolio

	2017 RESOURCES	PPA EXPIRATIONS/ OCOTILLO STEAMERS	COAL REDUCTIONS	RESOURCE ADDITIONS	2032 RESOURCES
Nuclear	1,146 MW				1,146 MW
Coal	1,672 MW		-702 MW		970 MW
Natural Gas	4,623 MW	-1,297 MW		5,387 MW	8,713 MW
Renewable Energy	529 MW	-26 MW		183 MW	686 MW
Incremental DSM (EE + DR)	116 MW			979 MW	1,095 MW
Energy Storage	0 MW			397 MW	397 MW
<b>TOTAL</b>	<b>8,086 MW</b>	<b>-1,323 MW</b>	<b>-702 MW</b>	<b>6,946 MW</b>	<b>13,007 MW</b>
Renewable Energy with Existing Rooftop (Nameplate)	1,710 MW	-27 MW		3,315 MW	4,998 MW
Energy Storage (Nameplate)	4 MW			503 MW	507 MW

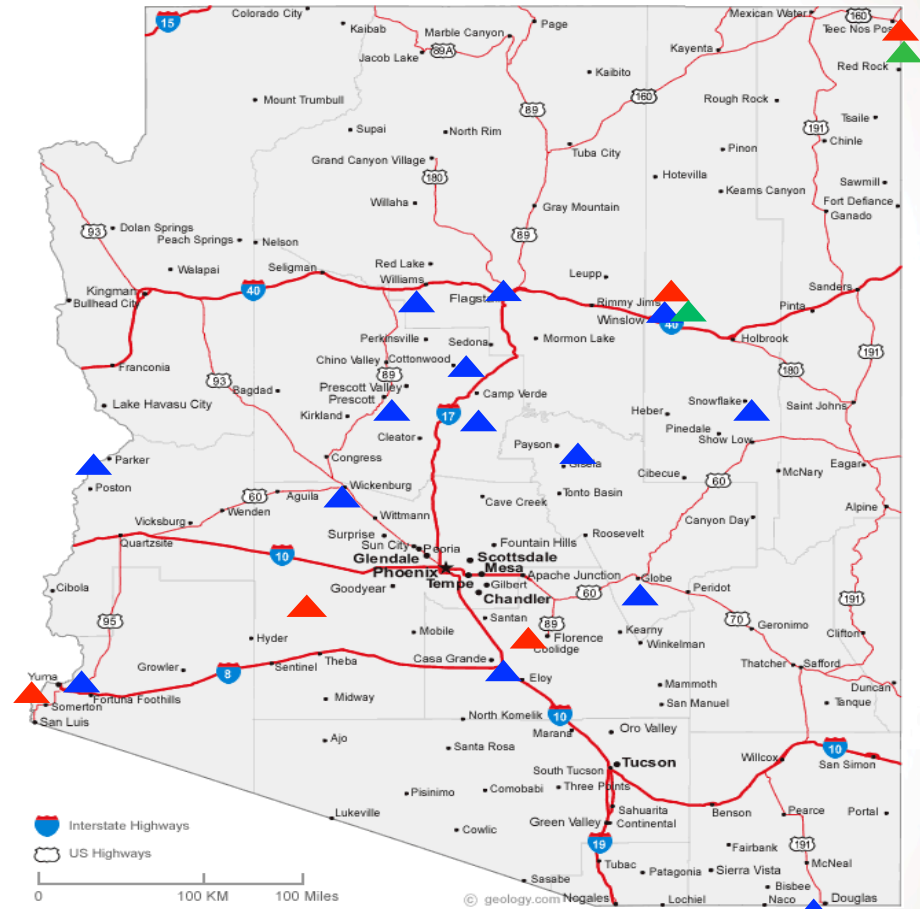
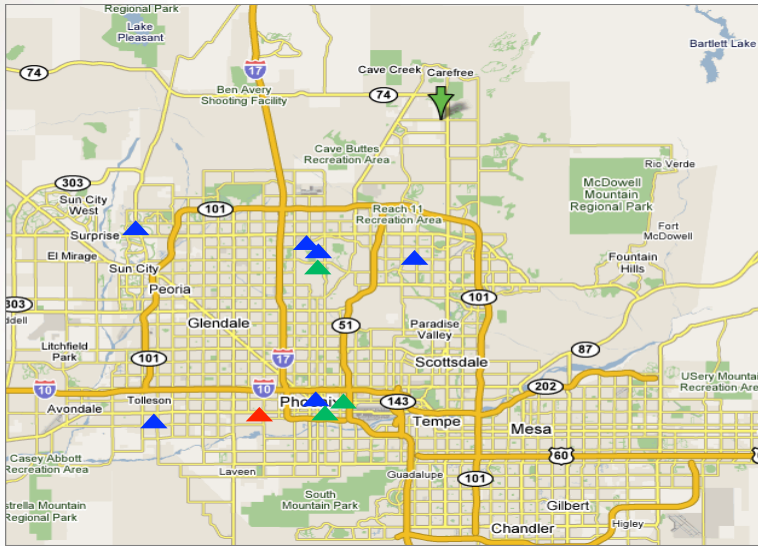
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# APS Supply Chain Service Territory



Legend	Count
▲ = TD&C Warehouse	23
▲ = Generation Warehouse	7
▲ = Procurement Groups	5



# Our Changing Environment

Staying Ahead of the Curve



# Industry Trends

# Our World is *Changing*

- Solar Growth
- New Technology
- Electric Vehicles



# Industry Trends

- Residential Solar
- Electric Vehicle
- Battery Energy Storage
- Customer Choice



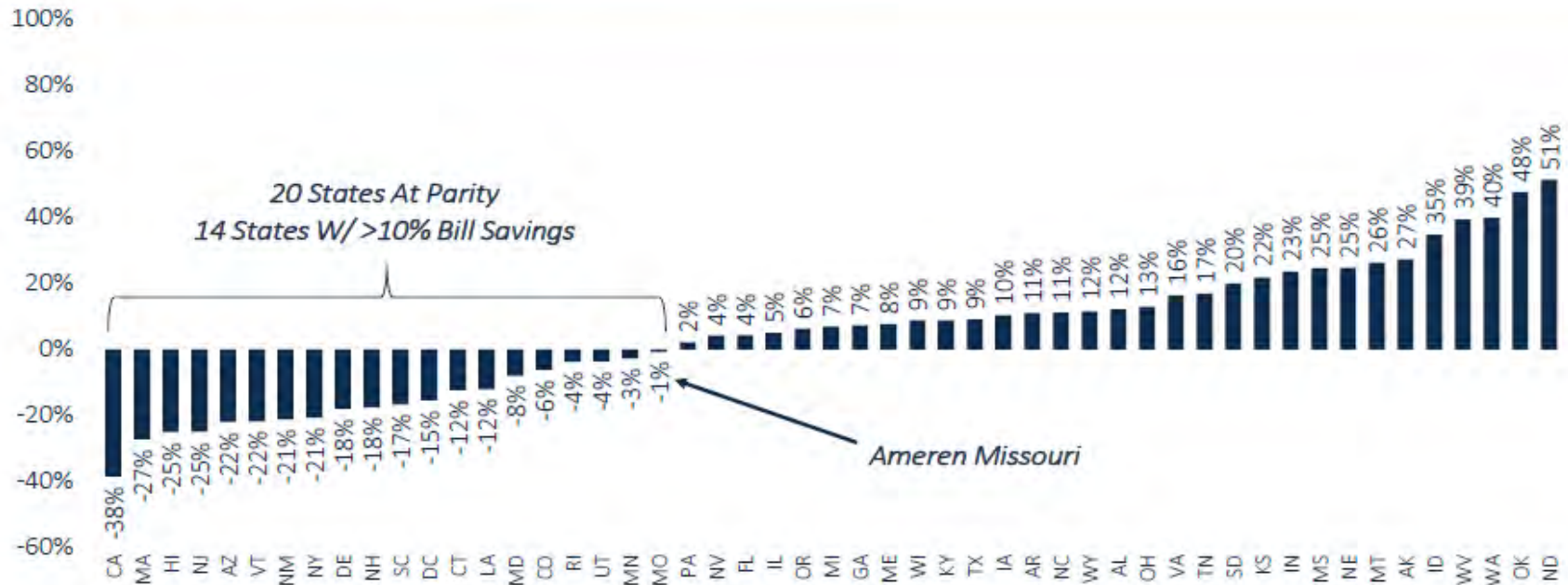
*...What is happening today?*



# What's Changing? - Residential PV

But There Are Still 20 States At "Grid Parity" Today

Year One Bill Impact From Solar (%)



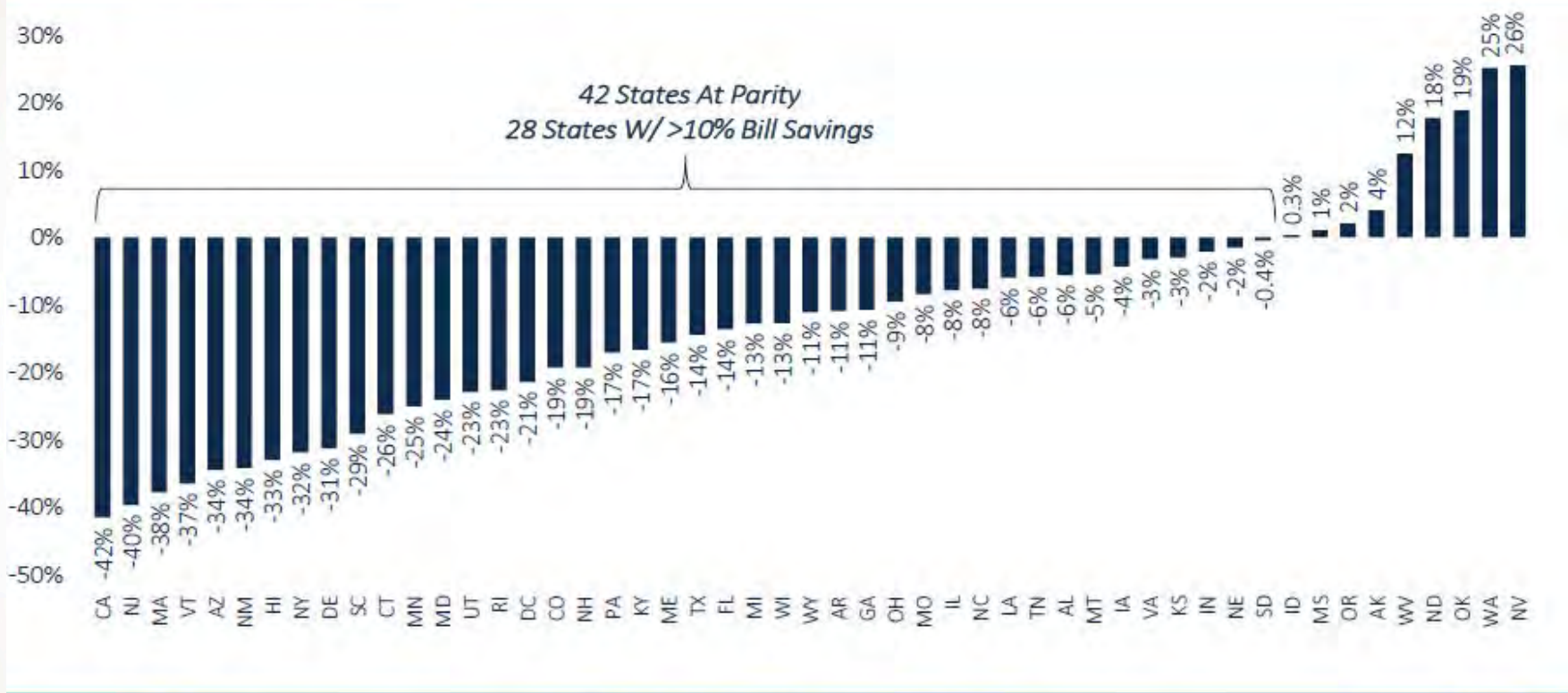
Note: Grid parity metrics account for all NEM and rate reforms currently in effect for modeled utilities.





# Future of Residential PV?

**Absent Rate/NEM Reform, 42 States Will Be At Parity By 2020**  
**Year One Bill Impact From Solar (%)**

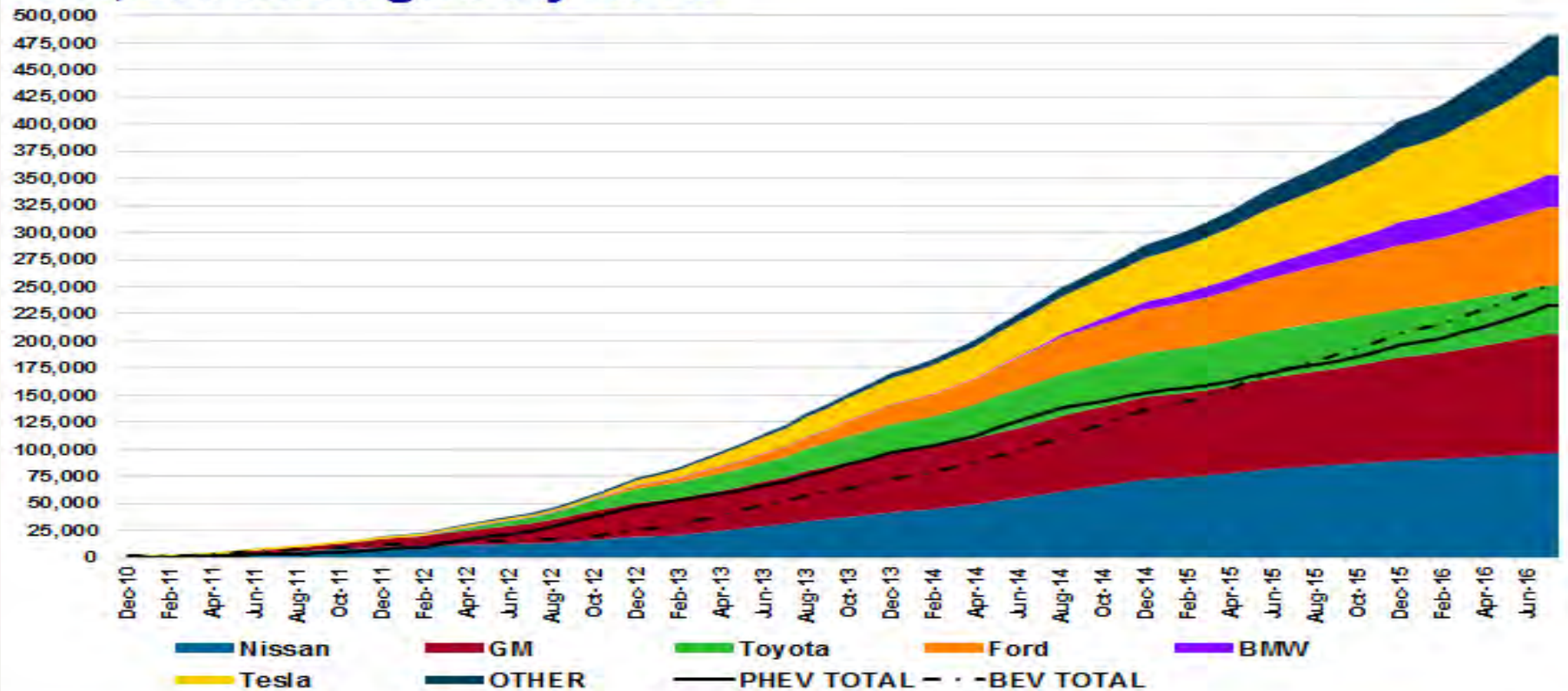


Honeyman - GTM Research | Source: GTM Research Residential PV Economic Attractiveness Report | gtmresearch 23



# Personal Electric Vehicle

## Cumulative US PEV Sales 482,000 through July 2016



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**EPRI** | ELECTRIC POWER RESEARCH INSTITUTE



# Battery Storage

## Battery Energy Storage to Exceed 2GW by 2021



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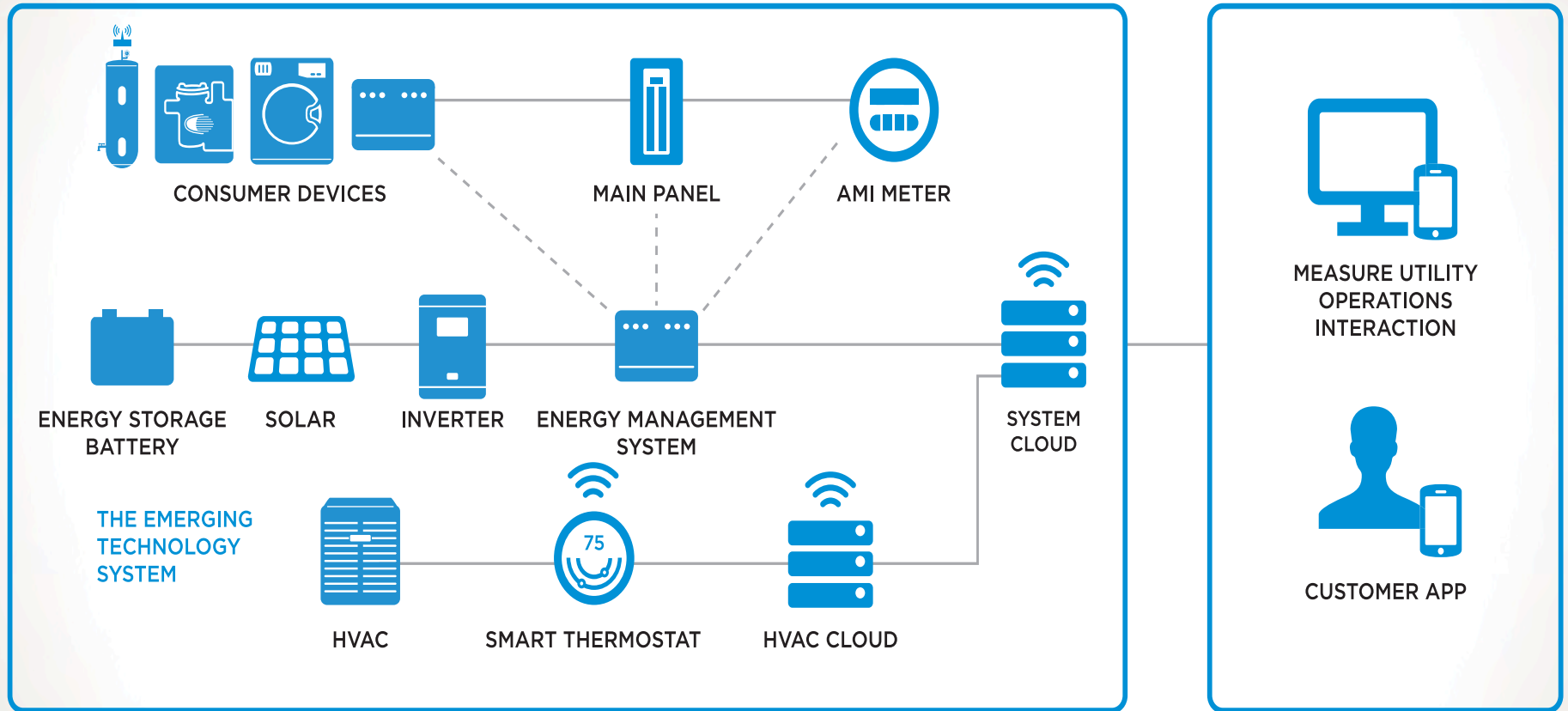
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Data provided by AES Corporation, largest fleet of battery based storage with 8 years of operating experience.

# Our Customers

## CUSTOMER ENERGY CHOICE IS THE NEW FRONTIER OF SYSTEM PLANNING



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# HOW IS APS ADDRESSING THESE CHANGES?

# What Are We Doing About It?

- Sustainable Rate Design
- Improving our Generation Fleet
- Grid Modernization
  - Technology Roadmap
  - Advanced Distribution Management System (ADMS)
  - Microgrids
  - Energy Storage



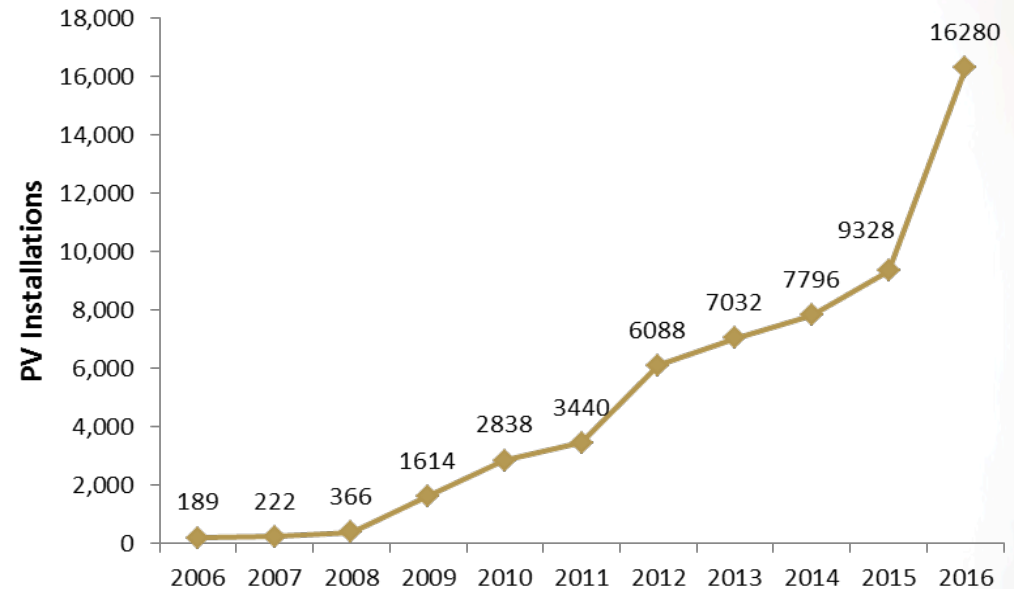
# Sustainable Rate Design

# APS Residential Rooftop PV Installs

Renewable Energy Standard  
(15% by 2025)

- 55,350 Residential Systems installed to date
- 1,600 Utility Owned PV systems
  - Solar Partner Program (SPP)
  - Smart Inverters Deployed
  - AMI Network for Distribution Automation
  - West Facing
  - Power Quality, Volt-Var
- Must Measure to Manage
- Cost shift = \$50M annually

Residential PV Activity  
*Installations by Year*





# The Solar Environment (Video)

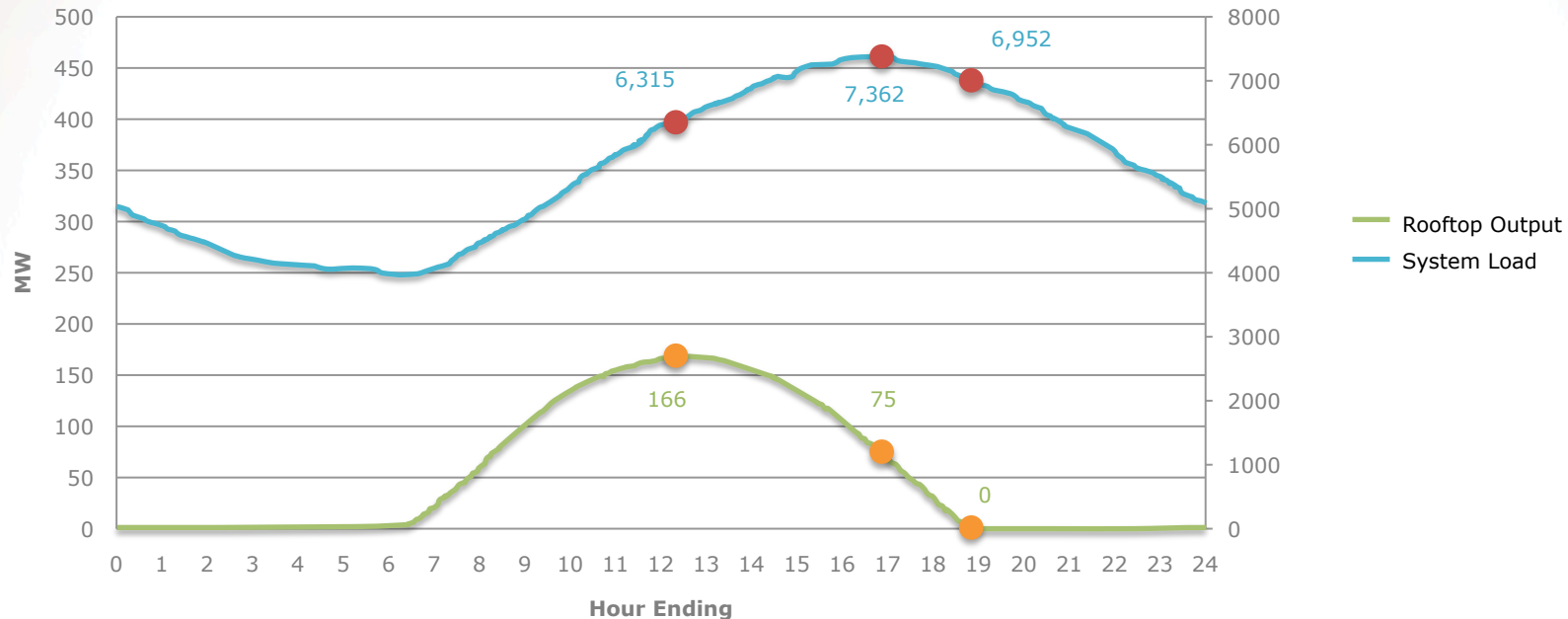
**A Modern Grid Benefits Everyone.....**

[Video Link](#)



# Solar Integration – Rooftop/Distributed

First, let's look at the total combined output of 30,000 rooftop solar units on APS customer homes:



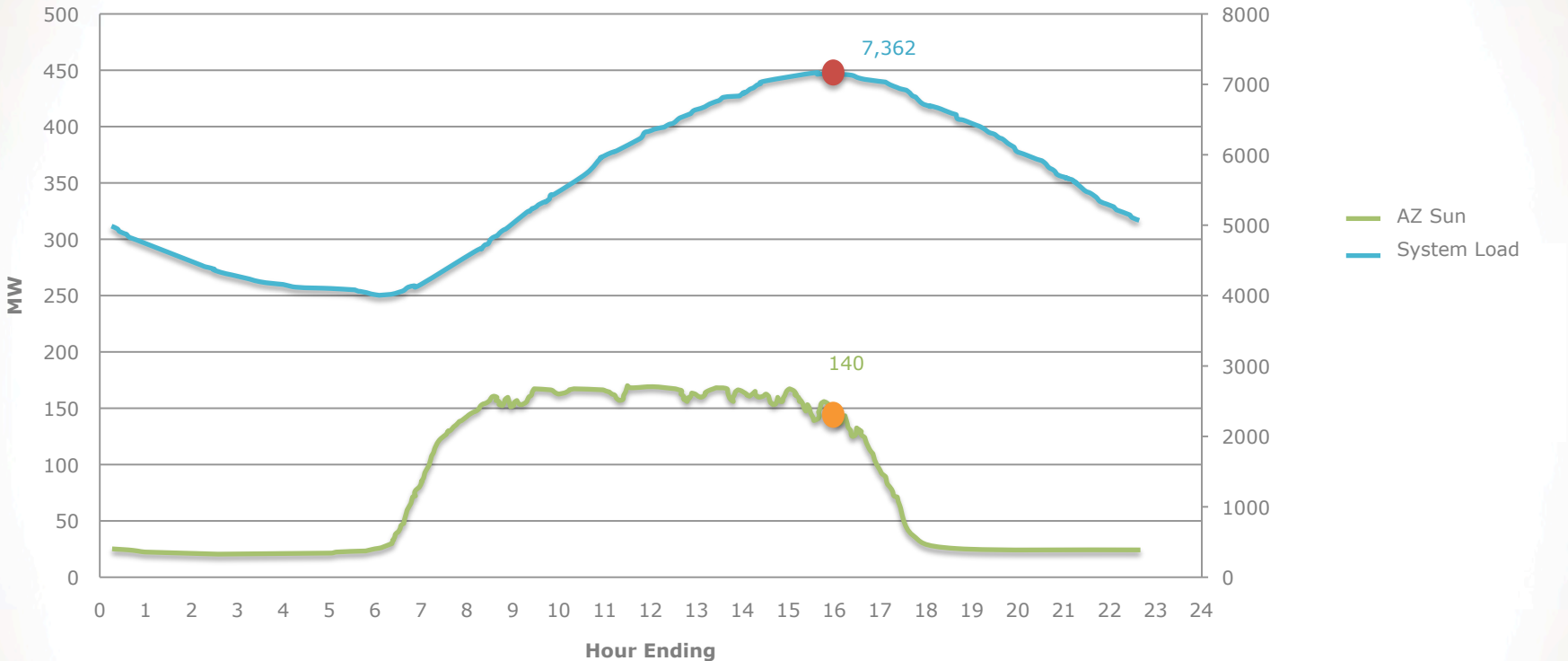
At noon, when customer demand is still increasing, rooftop solar peaks and begins to decline.

By 5 PM, when customer demand peaked, rooftop units had declined to only 38% of their power.

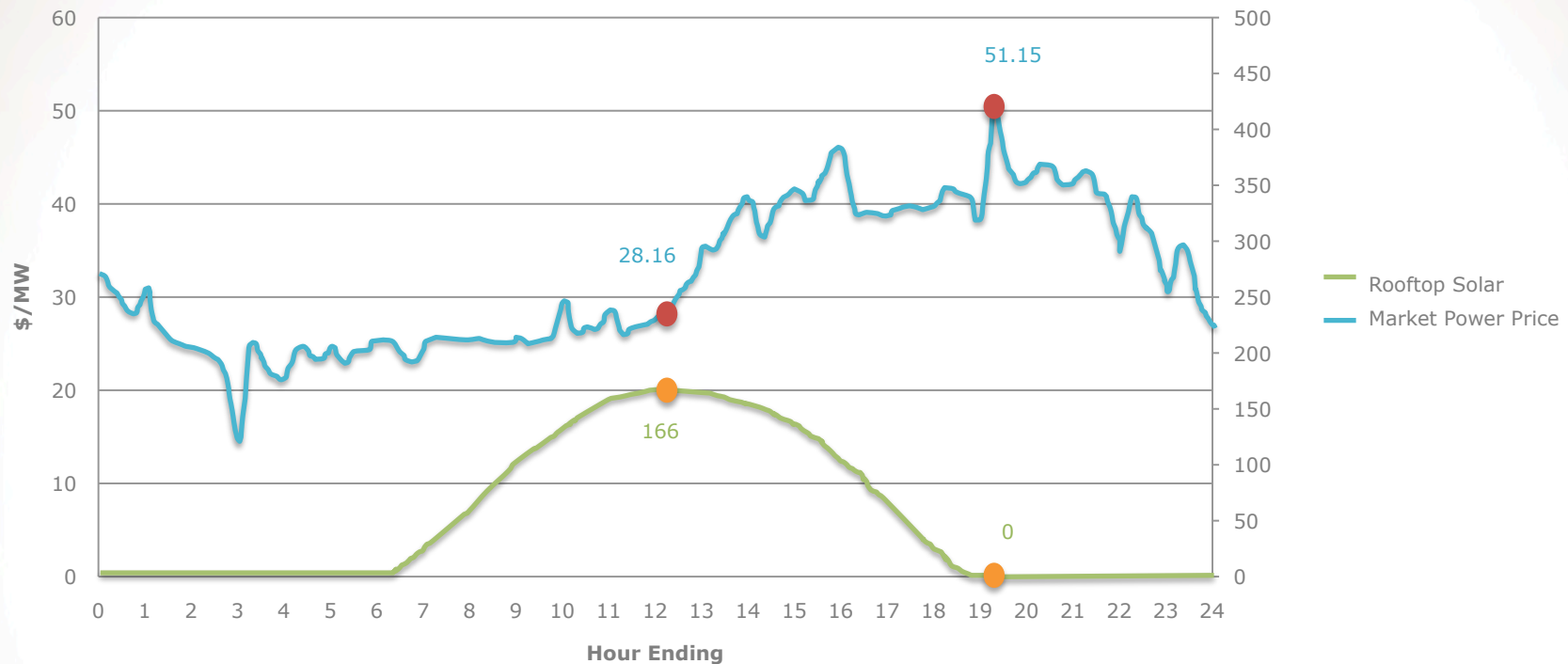
At 7 PM, rooftop output dropped to zero, but customers still needed 6,900 MW of power.



# Solar Integration – Utility Scale



# Wholesale Power Prices

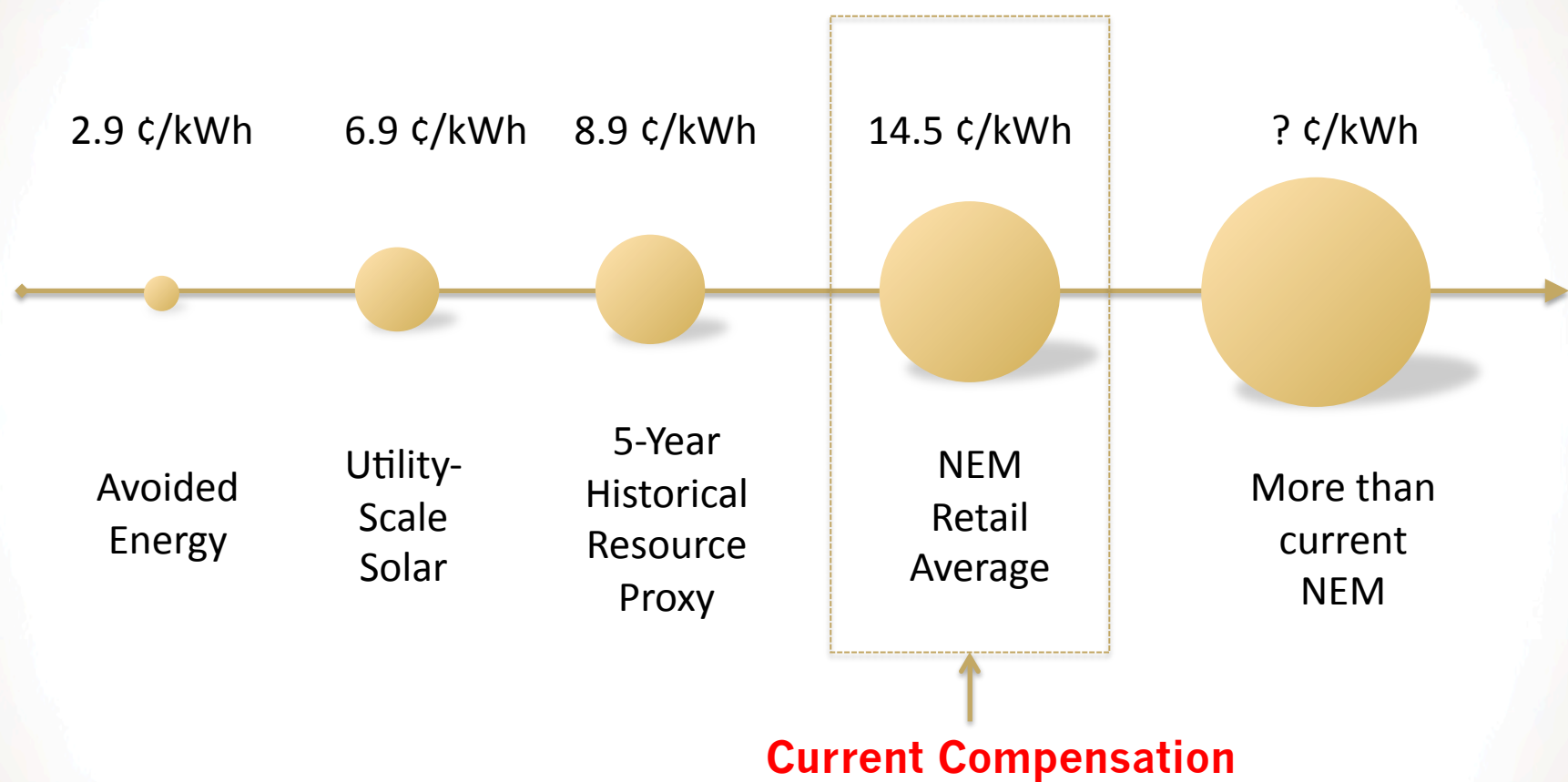


When rooftop solar production was at its highest, APS could buy power on the wholesale market for less than 3 cents per kilowatt-hour.

At 7 PM, when wholesale power was the most expensive (and valuable to customers), output from rooftop solar had dropped to zero.



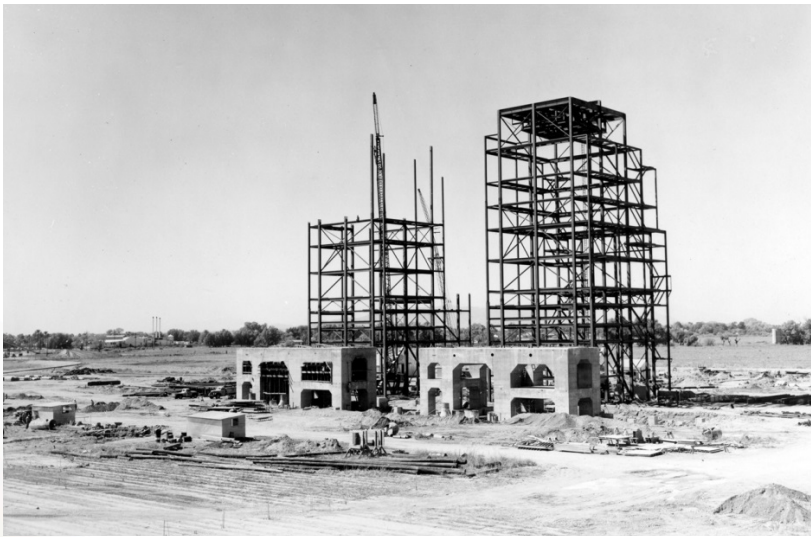
# How Much Should APS Pay For Distributed Generation?



# Enhancing Our Generation Resources

# Ocotillo Power Plant

- Two Westinghouse 110 MW gas-fired steam units in 1960
- Two Westinghouse 55 MW gas turbine units in 1970's
- Steam units used for base load



- Played significant role in bringing power to growing Phoenix area
- Outside of urban footprint on 126 acres

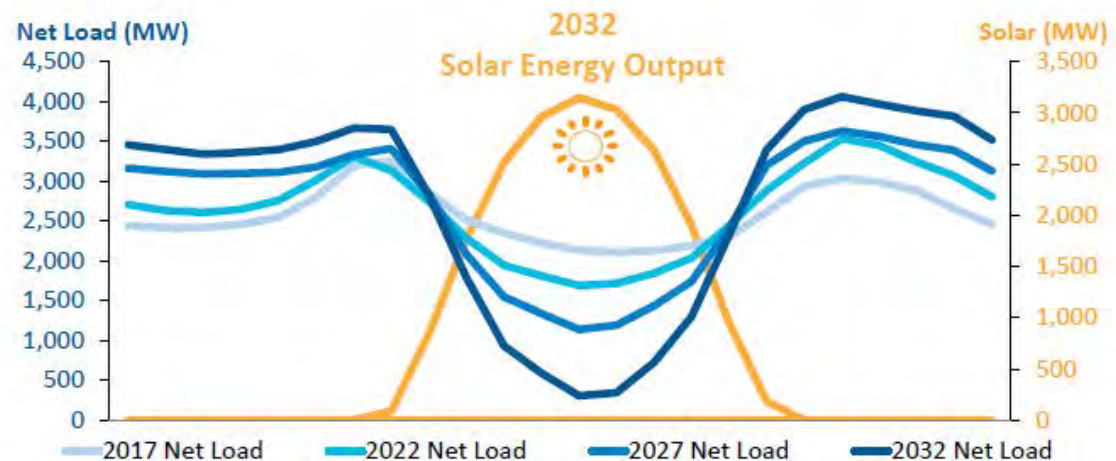


# Ocotillo Modernization Project

Now a need for more flexibility as well as reliability

- Replacing 2 steam generators with 5 fast starting gas combustion turbine units
- Each unit will have a capacity of 102 MW

Increasing Impact of Non-Curtailable Solar on APS Net Load Shapes





# Ocotillo Power Plant

## Future

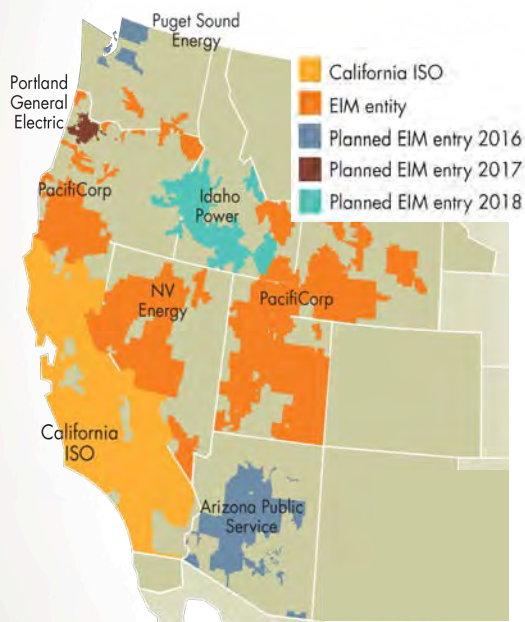


- Additional 330MW by removing the two 110MW steam units and adding five LMS100 GE aeroderivative gas turbines @ 102MW each
- On line in 6 minutes and at full load in 8 minutes
- Can turn down to 33% and maintain emissions compliance
- Uses less water and has fewer emissions

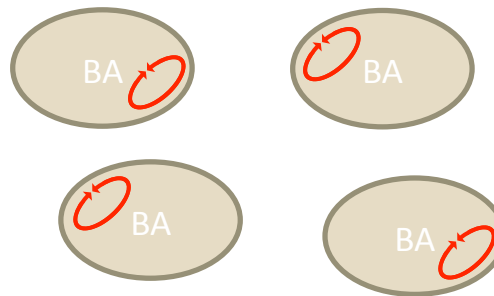


# Energy Imbalance Market (EIM) Background

- EIM is the California ISO's system that balances electricity supply and demand imbalances every five minutes with lowest cost energy available in a broader region across EIM entities with a more diversified portfolio of generation resources
- Through participation in this market, APS will preserve its autonomy, improve renewable energy integration
- Estimate \$7 to \$18 million production cost savings per year for APS customers

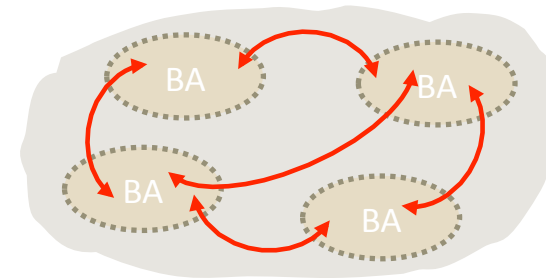


## Today: Each BA balances supply and demand



- Smaller pools of balancing resources: a less efficient way to manage risk
  - More expensive
  - More challenging to integrate wind and solar
- BA: Balancing Authority**

## Tomorrow with EIM: EIM offers balancing across BAs



- More diverse resource portfolio: more efficient
- Serving the next MW for least cost
- Increased flexibility and responsiveness for wind and solar integration

**Discipline, Accuracy, Visibility**



# Grid Modernization

# Grid Modernization

Integrated Volt/VAR Control (IVVC)  
991 Devices on 153 Feeders



Transformer Load Management Tool

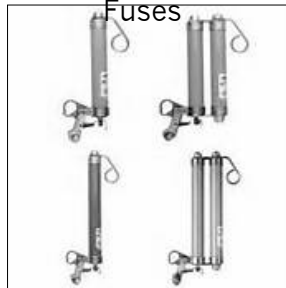


Communicating Fault Indicators (CFI)  
2,607 Devices on 568 Feeders



Integrated Operating Center with Advanced Distribution Management System

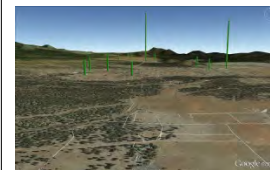
Fire Mitigation  
Expulsion Limiting  
Fuses



Network Protectors  
120 Devices



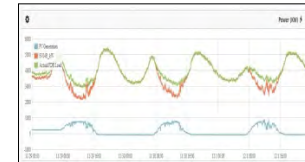
AMI  
1.2 Million Meters Deployed



Voltage Visualization

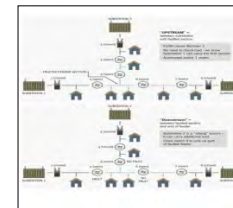


Energy Management System (EMS) Upgrades



Renewable Feeder Tool

Supervisory Controlled Switches  
710 Devices on 284 Feeders



Substation Health Monitoring  
579 Devices at 142 Substations

Synchrophasors  
15 Devices



**To date deployment:**

AMI – >1.2 Million Devices  
FLISR – 13 Feeders

CFI – 1271 Devices  
TOAN – 47 EHV Substations  
Synchrophasors – 15 Devices

Supervisory Switches – 142  
IVVC – 17 Feeders  
ELF Fuses – 29 Feeders

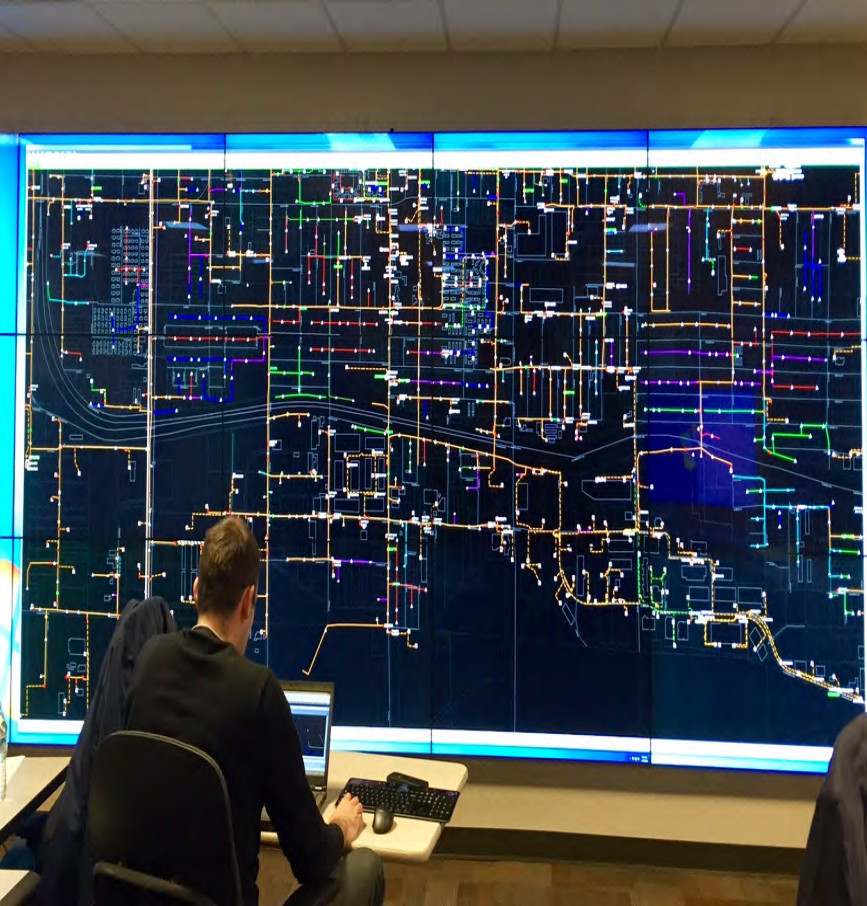
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# The Advanced Distribution Management System (ADMS)



**ADMS GO LIVE!**



# Microgrids

- Local Generation
- Increased Reliability
- Prevent localized outages



**Yuma Microgrid (MCAS)**



# Energy Storage

- Frequency Response
- Voltage Support
- Peak shaving



**Festival Ranch and McMicken Feeders (2 MW each)**



# Supply Chain Challenges

Staying Ahead of the Curve





# Adapting to Evolving Technology

- Deferred projects due to budgets
- New markets & suppliers being established
- New products and services being introduced
- Potential Increases in inventory value and volume
  - Increased obsolescence
- Higher risks with technology integration



# Generation Portfolio

- End-of-life perspective for coal units
- Need for quick start capacity
  - Entry into real-time market
  - Change of operating profile impact on maintenance
  - Changes to critical spares
- Increasing inventory value



# Supply Chain's Response

Staying Ahead of the Curve



# Alignment With Business Unit Partners

- Business planning
- Project planning
- Constant interface with Operations



# Strategic Use of a Key Supplier Program

- SRM program has been in place since 2012
- 22 Suppliers Represents 30% of APS SCM Managed Spend
- Suppliers are selected for their long term impact and support of APS process, technology, risk, and customer impacts
- These suppliers drive technological needs aligned with APS TD&C/ Generation
- Leader, Manager, and Executive level participation in program
- Annual Key Supplier Forum & Awards provides an opportunity for APS and our key suppliers to come together for a day of collaboration, sharing and learning which drives alignment to business plans and technological roadmaps
  - Supplier of the Year (SOTY) Awards for Performance, Safety, Customer Service, Value Add Relationship presented during Key Supplier Forum



# Sound Category Management Approach



## What is a Phase Gate?

- Formal milestones (check-in points) through a strategy's lifecycle to review status, monitor progress, schedules, stakeholder engagement, funding, and benefits to ensure continued alignment with business requirements

## Why the Phase Gate process?

- Ensure all stakeholders (vertical and horizontal) are aligned on the scope, objective and direction of sourcing initiatives
- Higher level oversight to align and optimize sourcing activities with top-level business needs
- Achieve the best possible TCO with substantiated benefits (quality and total cost)

***A Closed Loop Program for Continual Strategy Development & Execution***



# Procurement Function

- Contracting Approach
  - NERC/CIP
  - Cyber Security & Liability
- Standard contracting pose challenges
  - Scope is more dynamic and tied to emerging technology
- Developing new methods to address
  - Proof of concepts
  - Emerging Technology
  - Untested markets
- Integrate agile process to foster innovation
  - Using a corrective action process to capture continuous improvement opportunities
- Developing off-ramp capability
- Risk mitigation for obsolete material



# Questions?

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