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DOCKET CONTROL

Regulation and Compliance
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Kerri.Carnes@aps.com

May 2, 2016

Docket Control
Arizona Corporation Commission
1200 W. Washington Street
Phoenix, AZ 85007

RE: Arizona Public Service Company's Preliminary 2017 Integrated Resource Plan
IRP Stakeholder Workshop - Stakeholder Presentations
Docket No. E-00000V-15-0094

Attached are the Stakeholder Presentations used during the Arizona Public Service 2017 IRP Stakeholder Meeting on February 9, 2016. The Stakeholder Presentations can also be found at www.aps.com/resources.

If you have any questions, please feel free to contact me at 602-250-3341.

Sincerely,

Kerri A. Carnes

KC/kr

Arizona Corporation Commission
DOCKETED

MAY 02 2016

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Welcome

IRP Stakeholder Workshop

February 9, 2016

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Welcome and IRP Process

Jim Wilde

February 9, 2016

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IRP Stakeholder Meeting Agenda
February 9, 2016

Time	Topic	Presenter
9:00	Welcome and IRP Process	Jim Wilde
9:20	Energy Demand Forecast and Economic Conditions	Jordan Prassinos
9:40	Evolving Load Shape, Markets and Resource Implications	Jeff Burke/Pat Lowe
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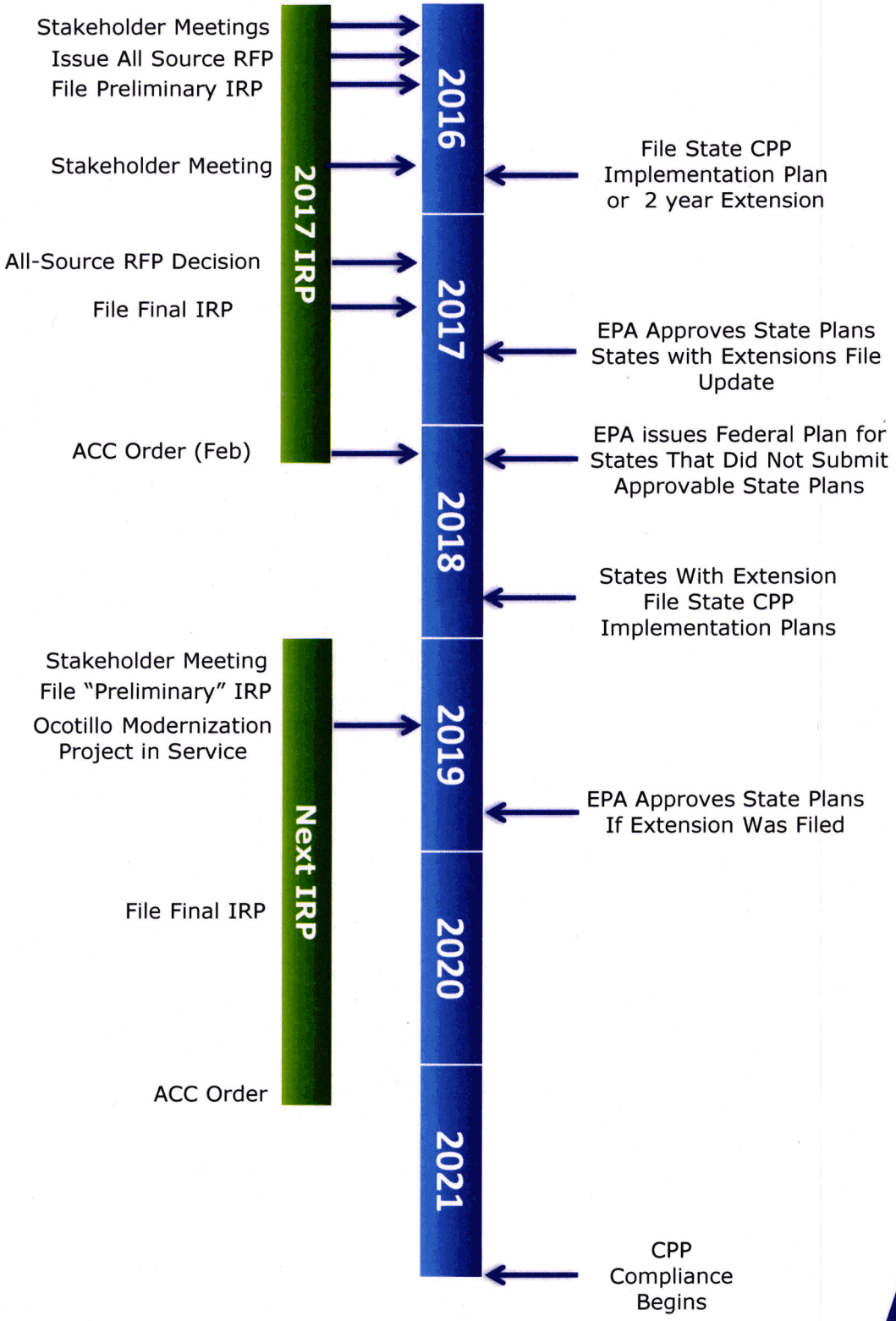
3:45	End	

Updated IRP Process

IRP Process Step	Start Date	Due Date	Responsibility
Pre Filing Workshops (optional)	9/1/2015	3/1/2016	LSEs, ACC
LSEs File Preliminary Resource Plans	3/1/2016	3/1/2016	LSEs
Staff Reviews Preliminary Plans / Stakeholder Review	3/1/2016	7/1/2016	Staff
ACC Holds Workshop(s) on Preliminary Plans	3/1/2016	7/31/2016	ACC
ACC Open Meeting to Review Preliminary Resource Plans	8/1/2016	8/31/2016	ACC
LSEs Provide Updates to Preliminary Resource Plans	10/1/2016	10/1/2016	LSEs
Pre-Filing Workshop on Final Resource Plans	9/1/2016	11/30/2016	ACC/LSE's
LSE's File Final Resource Plans	4/3/2017	4/3/2017	LSE's
Staff/Consultant Review Final Resource Plans and Stakeholder Review	4/4/2017	9/302017	Staff/Consultant
Staff/Consultant Docket ROO	10/1/2017	10/1/2017	Staff/Consultant
ACC Holds Open Meeting to Acknowledge Final Resource Plans	2/1/2018	2/1/2018	ACC

- IRP deferral to incorporate CPP impacts
- Increased opportunities for Commission/stakeholder/LSE dialogue
- Preliminary IRP to include
  - Load Forecast
  - Sources of assumptions and technologies evaluated
  - Load & Resource table
  - Proposed sensitivities & scenarios
  - Action Plan, including RFPs and associated selection criteria

Planning Timeline



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Energy Demand Forecast and Economic Conditions

Jordan Prassinos

February 9, 2016

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Discussion Topics

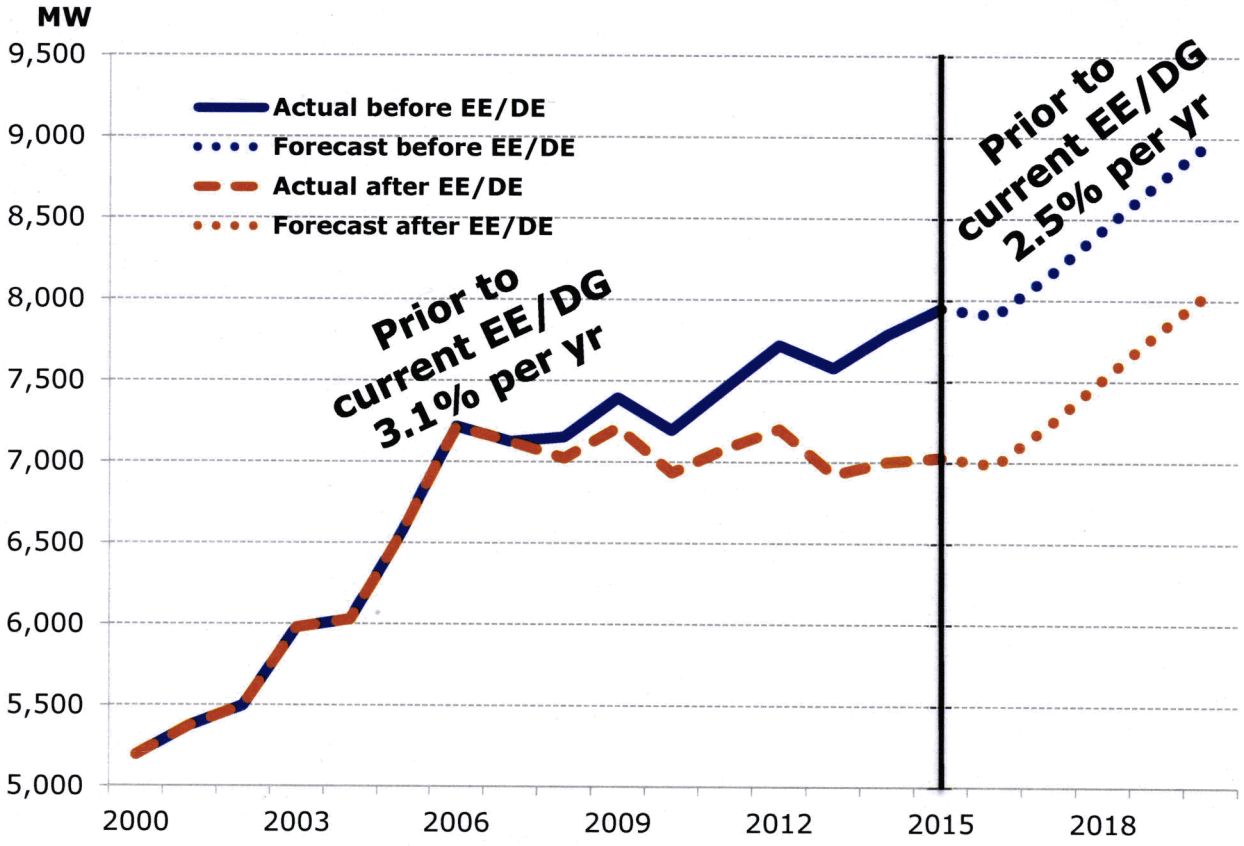
Peak Demand/Energy Outlook (O)

Underlying Economic Conditions (E)

Methodologies (M)

Annual Peak Demand Outlook

Actual Load before and after EE/DG impacts



Growth Rates

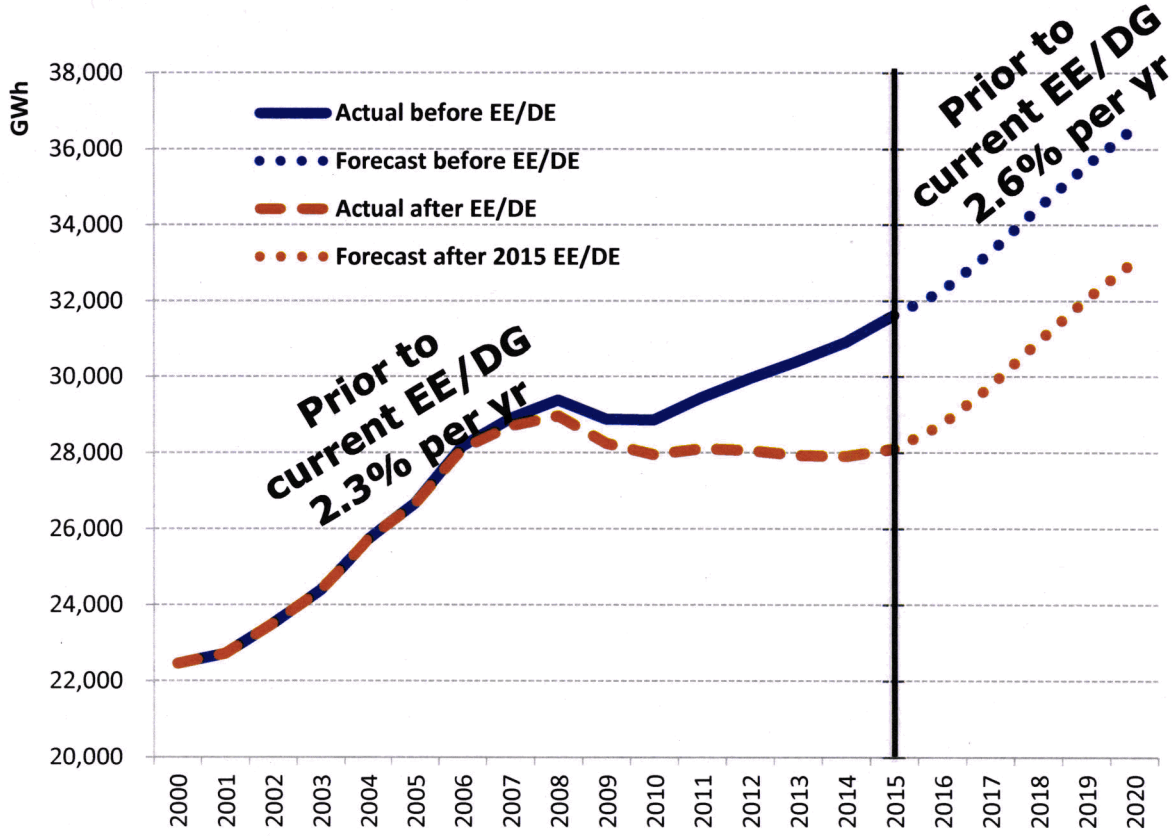
	Before EE/DG	After EE/DG
2000-07	4.6%	4.6%
2008-15	2.0%	0.0%
2016-20	2.5%	TBD

Historical EE and DG

- EE demand impact ~(800) MW in 2015.
- DG demand impact ~(125) MW in 2015. *Customer decision making driven.*

Energy Outlook

Annual Retail Sales Growth



Growth Rates

	Cust	Sales
2000-07	3.7%	3.7%
2008-15	1.0%	1.1%
2016-30	2.4%	2.6%

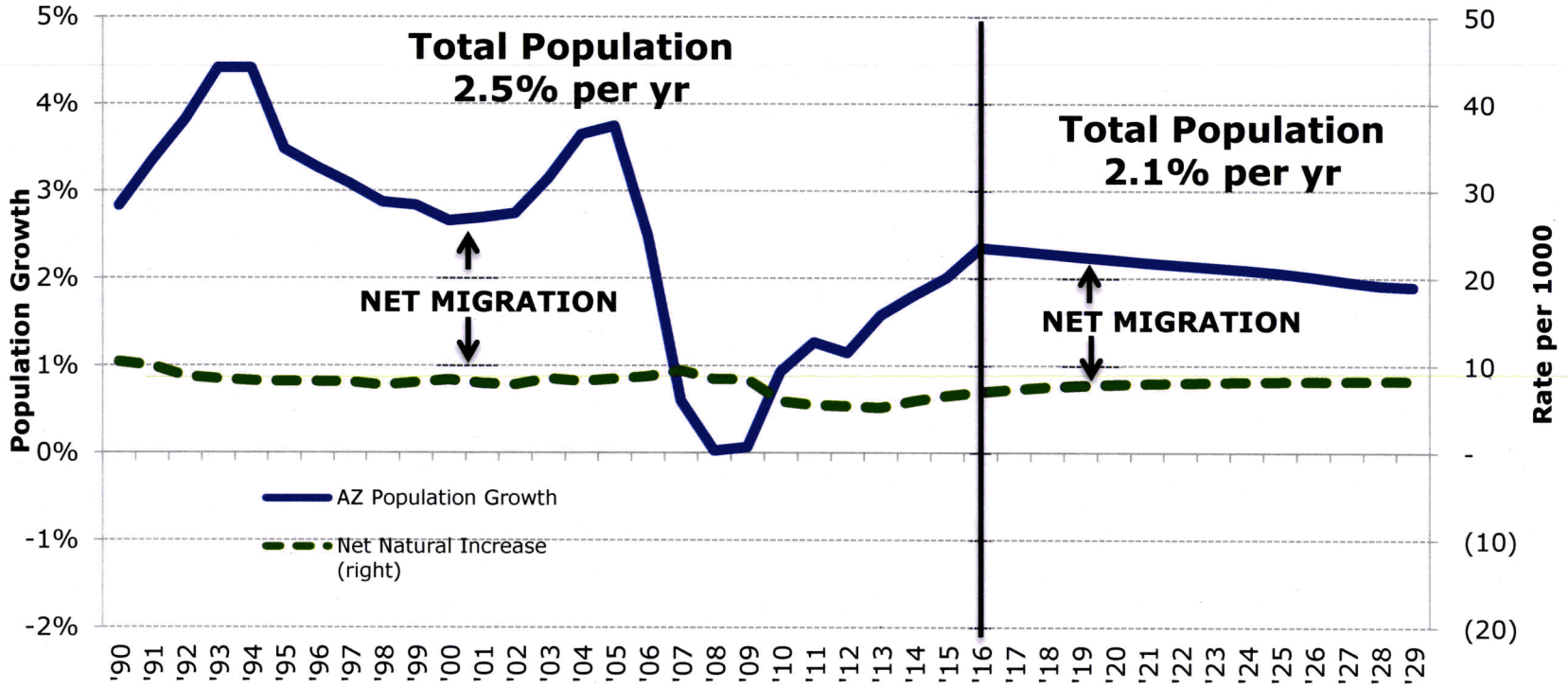
Historical EE and DG

- EE sales impact ~(2,800) GWh in 2015.
- DG sales impact ~(650) GWh in 2015.
  Customer decision making driven.

ECONOMIC CONDITIONS

E

Arizona Population Growth

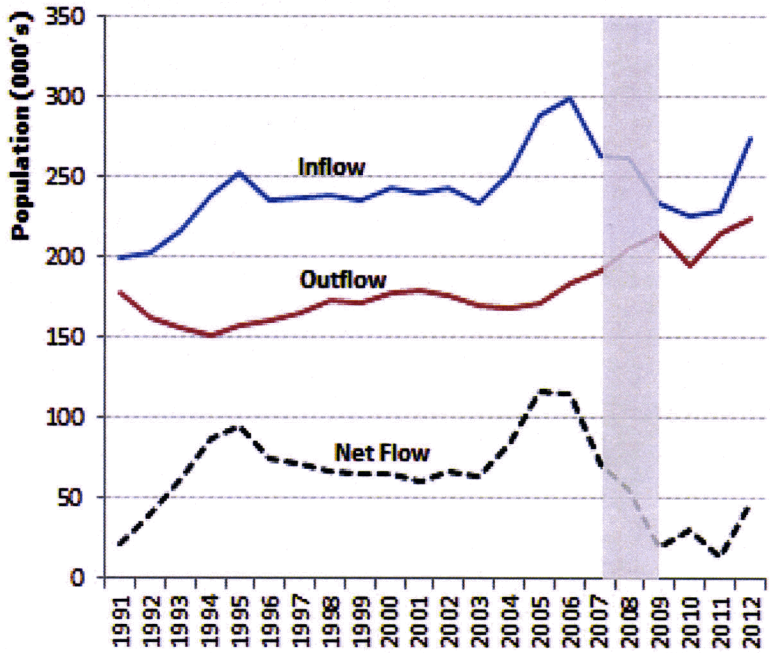


Population growth is core element to the demand and energy forecast

E

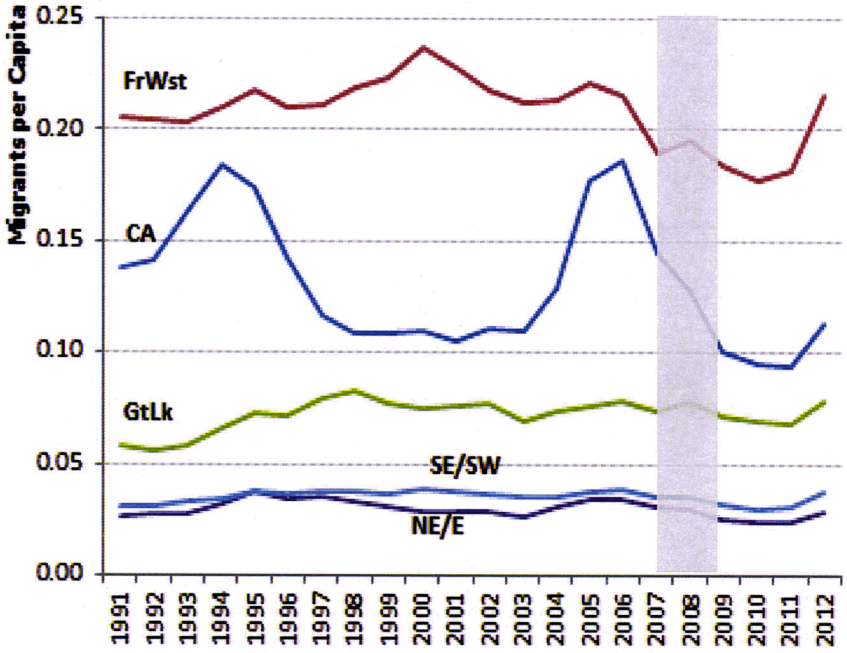
Migration Flows Reflecting Business Cycle, Geographic Influences

AZ Gross Population Inflows/Outflows



Gap between Inflow and Outflow of state population expanding

AZ In-Migration Rate by Region

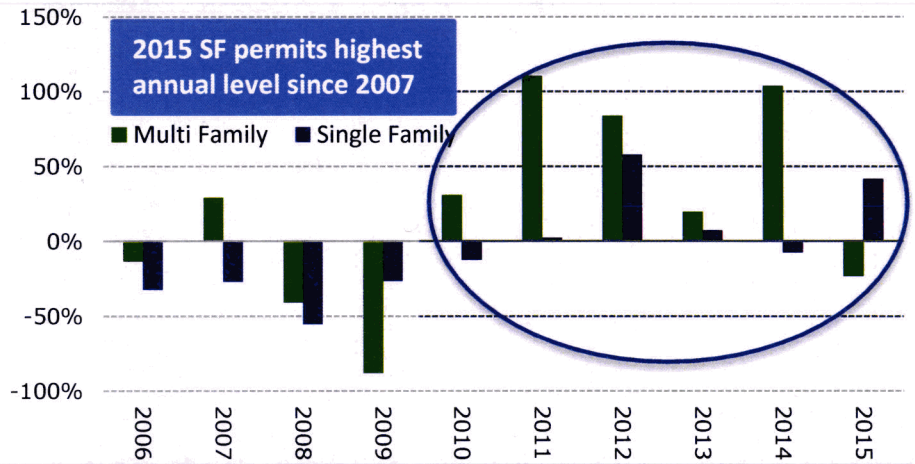


California and Far West In-Migration pointing back to pre-recession levels (although "boom" not imminent)

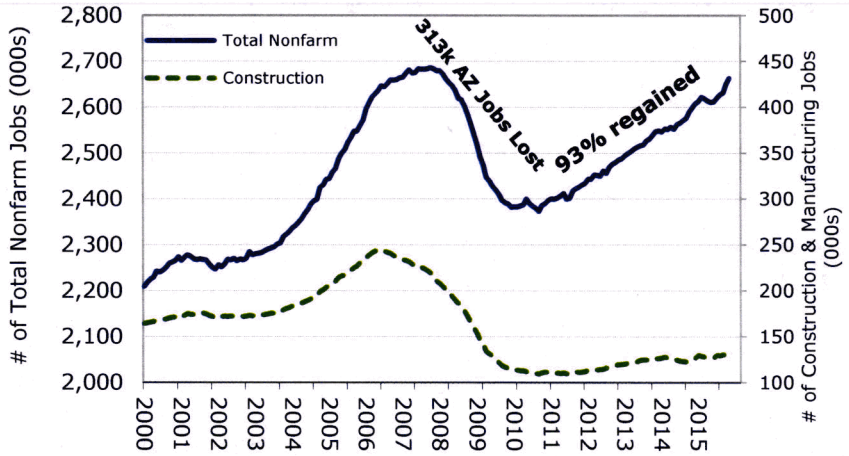
E

Economic Update

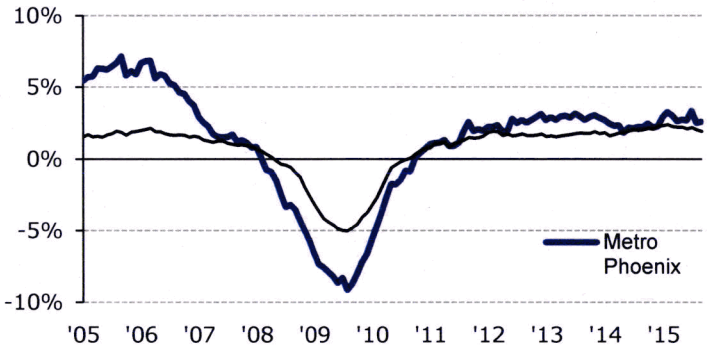
Phx Res Housing Permits Annual % Changes



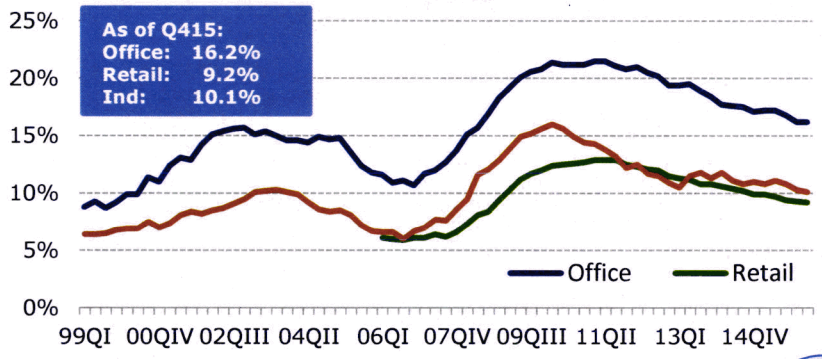
AZ Employment



Job Growth (Total Nonfarm) – Phoenix



Phx Non-Residential Vacancy Rates



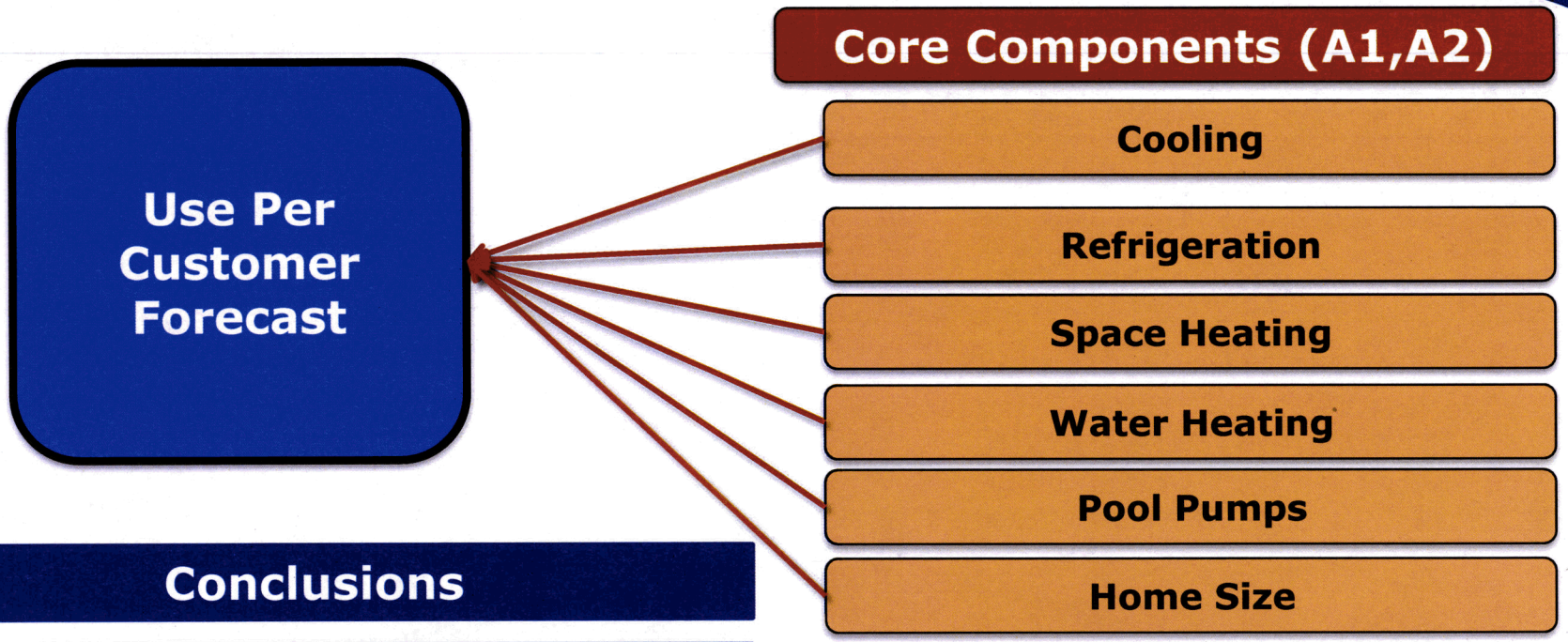
E

METHODOLOGIES

M

Residential End Use Modeling

Excluding impacts from EE/DG



Conclusions

Use Per Customer ↑ 0.8% – 1.1% from '16 to '30

Sources of increases: Home size of new customers, increased saturation of electronics, desert share intensity

Sources of decreases: Efficiencies from building codes and appliances replacing existing stock

M

Commercial Econometric Modeling

Excluding impacts from EE/DG

Independent Variables

Weather: Cooling x space*
Calculated at CDD65 multiplied by the natural log of humidity

Weather: Heating x space*
Calculated at HDD65

Economic: Occupied Floor Space
Inclusive of Retail, Office, and Industrial Floor Space

Pricing: Electricity Price x space*
Real APS Price

*Space includes retail, office, and industrial occupied floor space.

Econometric Model

Monthly Sales Forecast

Conclusions

Sales forecast ↑ 2.1% – 4.5% from '16 to '30

Energy requirements from Commercial account for over 40% of total retail energy

M

Large Commercial and Wholesale

Customer Specific Forecast

Forecast Elements

- **History:** Based on most recent usage and demand requirements
- **Specificity**: Engagement with Account Reps
- **Trend Intel:** Cross departmental work with Economic Development
- **Contractual:** Constant review of contractual requirements/changes

Conclusions

- 100+ Large Commercial sites above 3 MW
- Lrg Comm sites contribute over 3,000 GWh/yr
- Wholesale customers primarily Electric and Irrigation Districts (rural)

M

RECAP

1. Long term forecast excluding impacts of Energy Efficiency and Distributed Energy reflective of historic fundamentals.
2. Population integral component of electricity forecasting. Net migration supportive of current forecast.
3. Economic conditions/outlook supportive of current view of business cycle.
4. Current forecasting methodologies sound, consistent with industry.

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Evolving Load Shape, Markets and Resource Implications

Jeff Burke
Patrick Lowe

February 9, 2016

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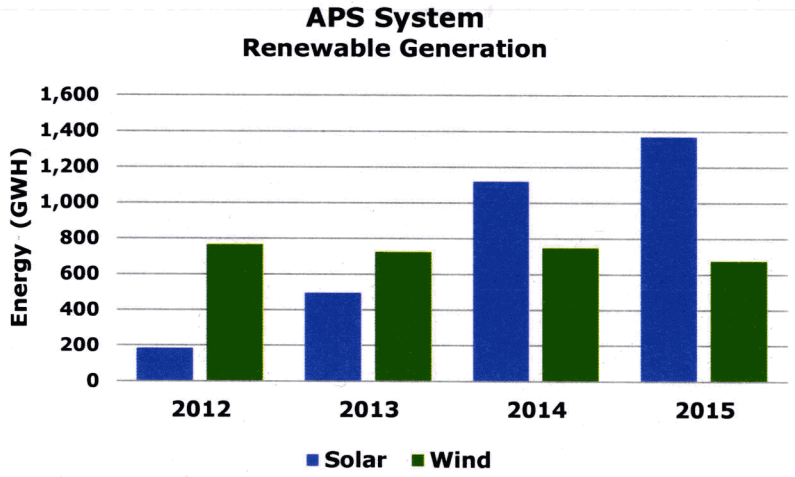
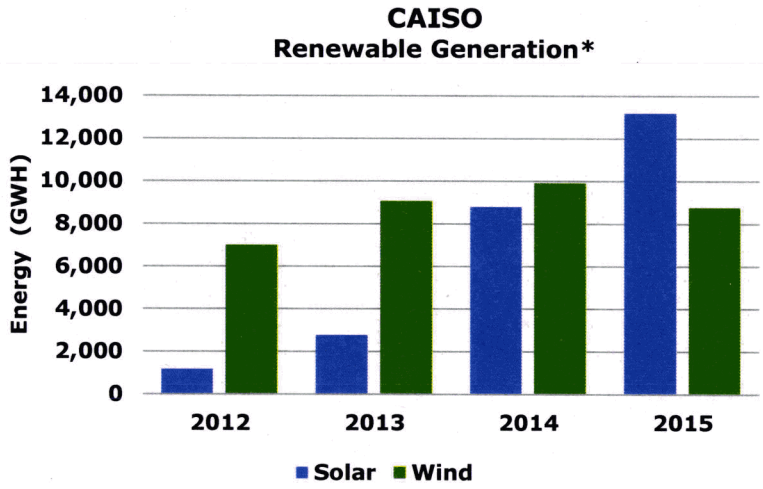
Growth of Grid-scale Renewable Energy

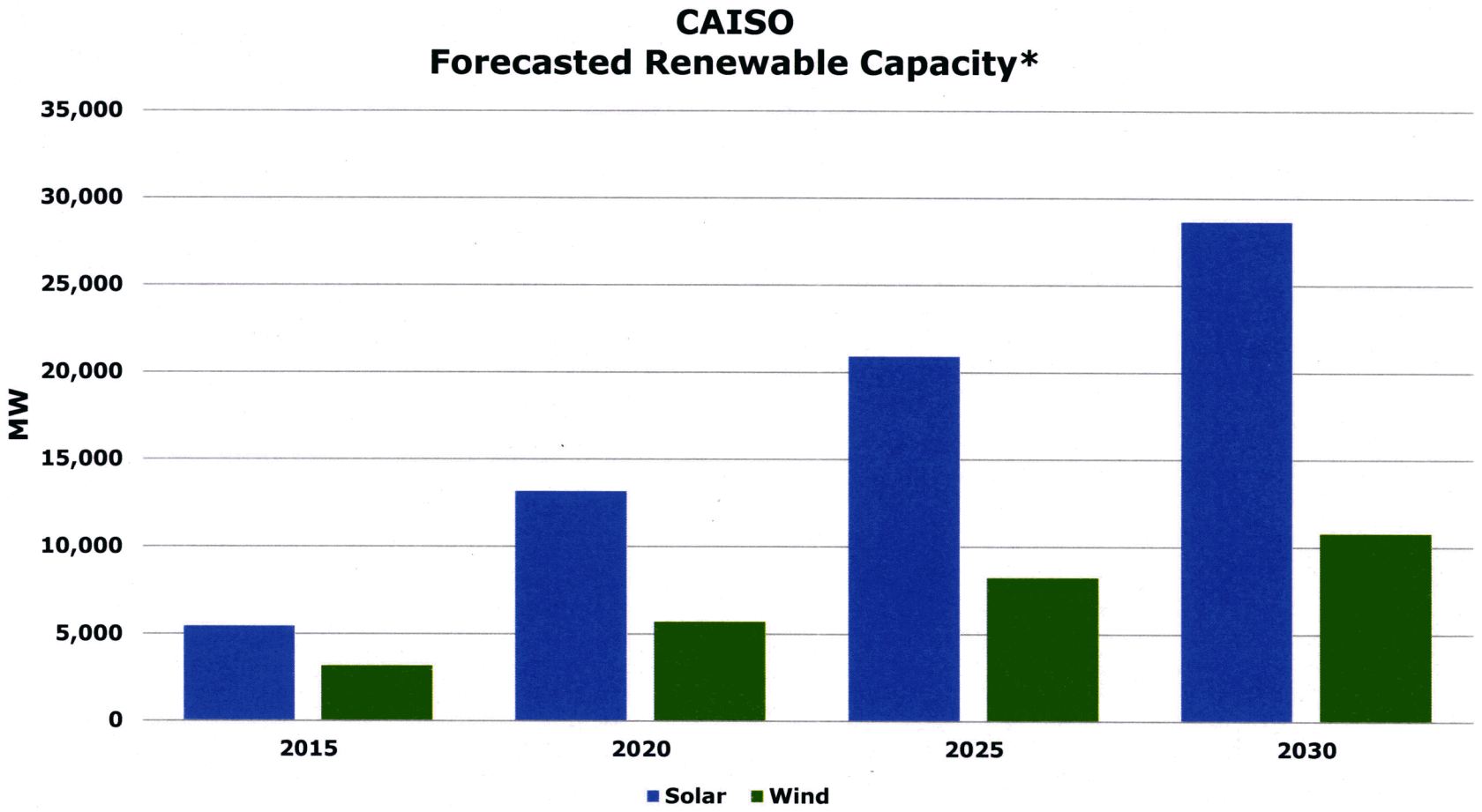
- Renewable production on the APS system has increased from 950 GWH's in 2012 to 2050 GWH's today
- Renewable production in CAISO has grown from 8,000 GWH's in 2012 to 22,000 GWH's today
  - Solar alone has grown from 1,100 GWH's to 14,000 GWH's





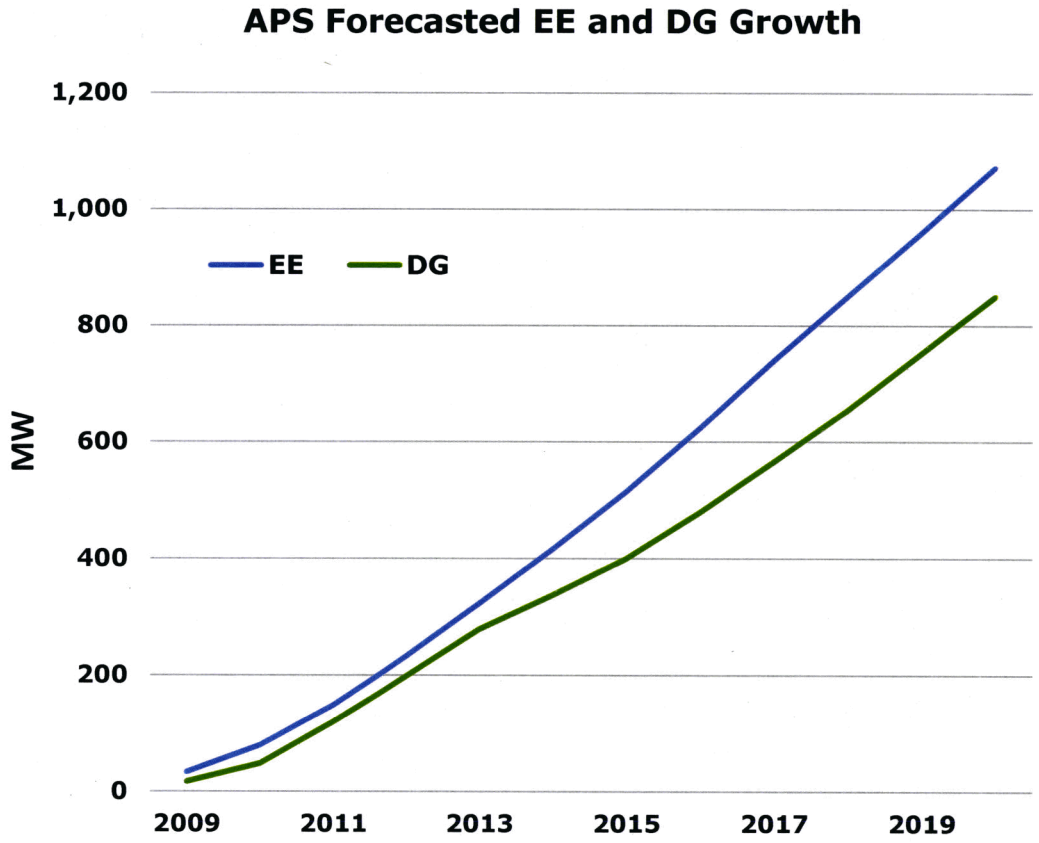
* Source: http://oasis.caiso.com/mrioasis/logon.do

Growth Expected to Continue



*Source: E3 renewable forecast for CAISO
https://ethree.com/documents/E3_Final_RPS_Report_2014_01_06_with_appendices.pdf

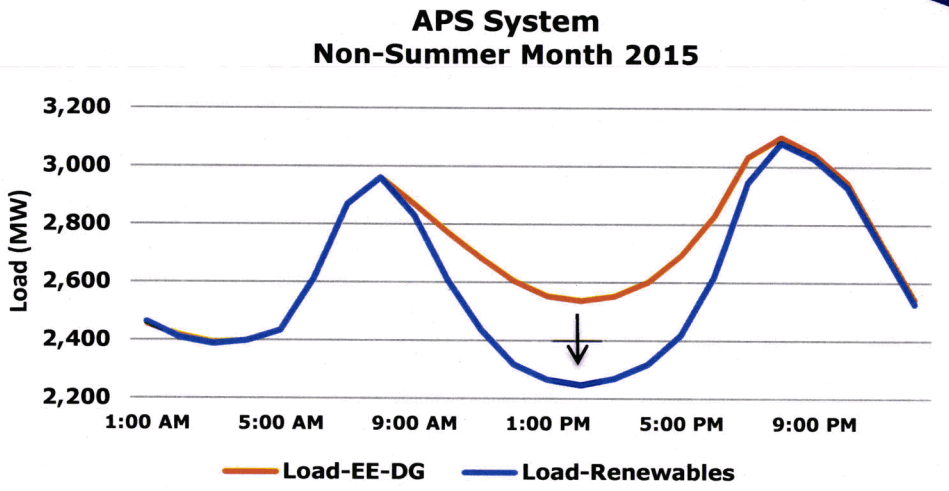
Energy Efficiency & Distributed Generation is Growing in Arizona

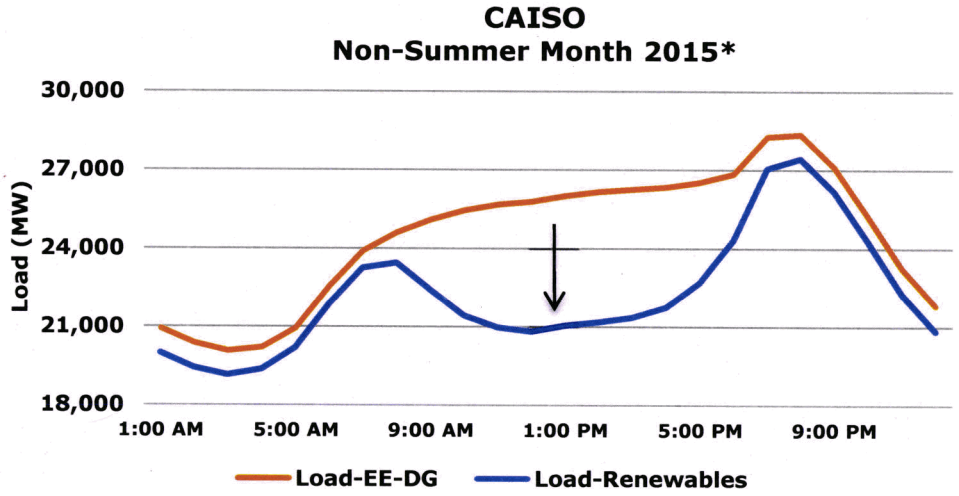


- Development of customer sited resources has changed the way customers use and receive energy
- These resources are expected to continue growing locally and regionally as part of diverse portfolios

Evolving load shapes

- The "duck curve" has become apparent in APS's net customer demand
- APS experiences non-summer ramp as net evening peak remains essentially the same
- CAISO having similar experiences

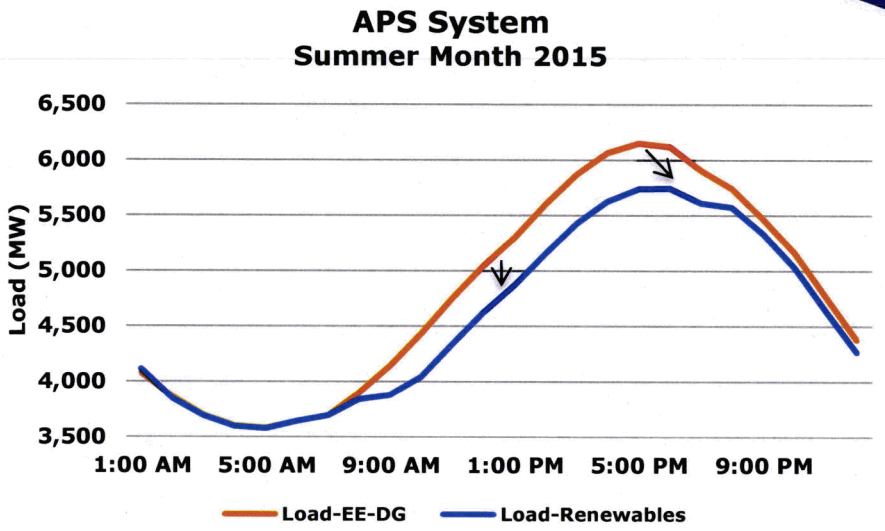


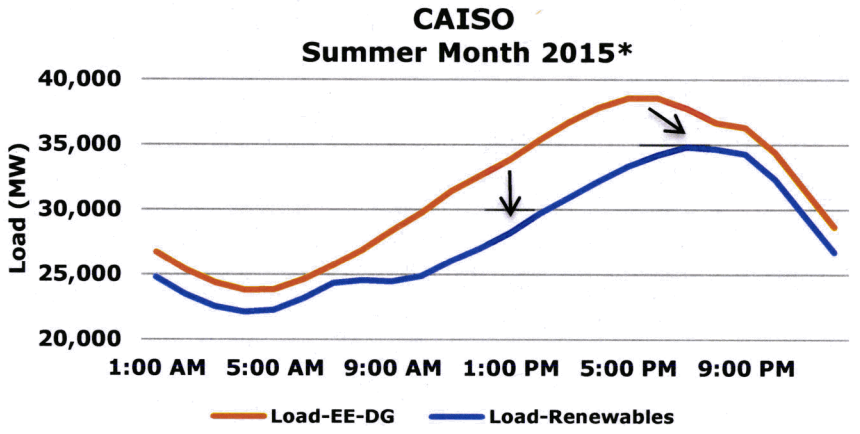


* Source: http://oasis.caiso.com/mrioasis/logon.do

Evolving load shapes

- Net customer demand peaks are being pushed back to later in the day
- By 6pm fixed panel solar is producing about 25% of what it was producing mid-day
- By 8pm fixed panel solar production is minimal, while APS's net demand has declined less than 10%

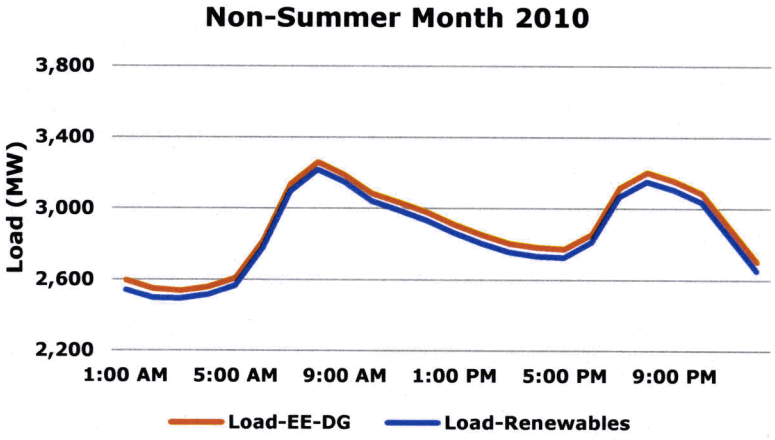




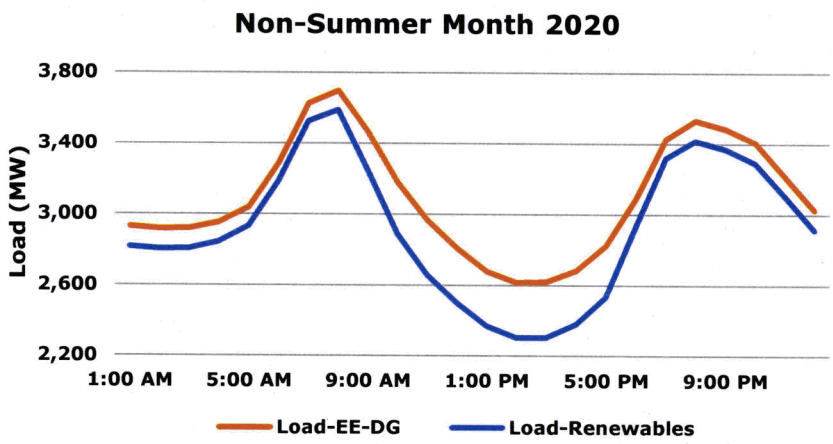
* Source: http://oasis.caiso.com/mrioasis/logon.do

Evolving load shapes

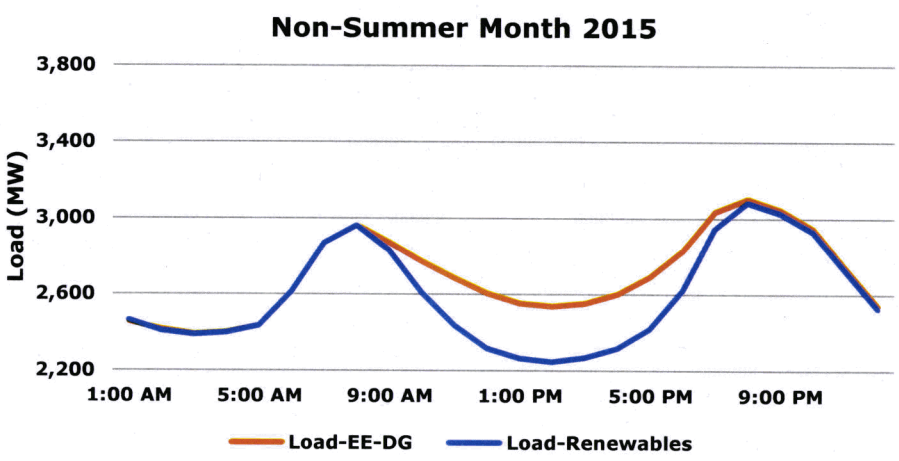
Where we were...



Where we could be going...

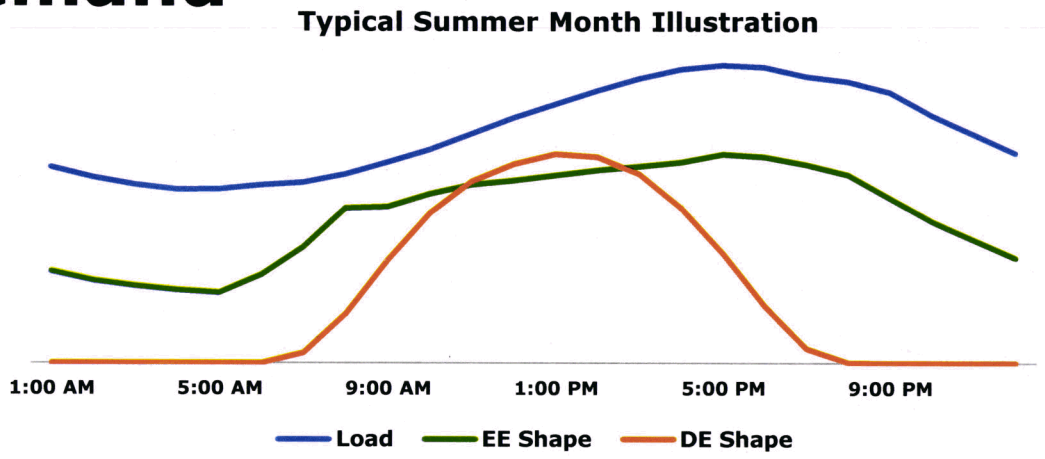


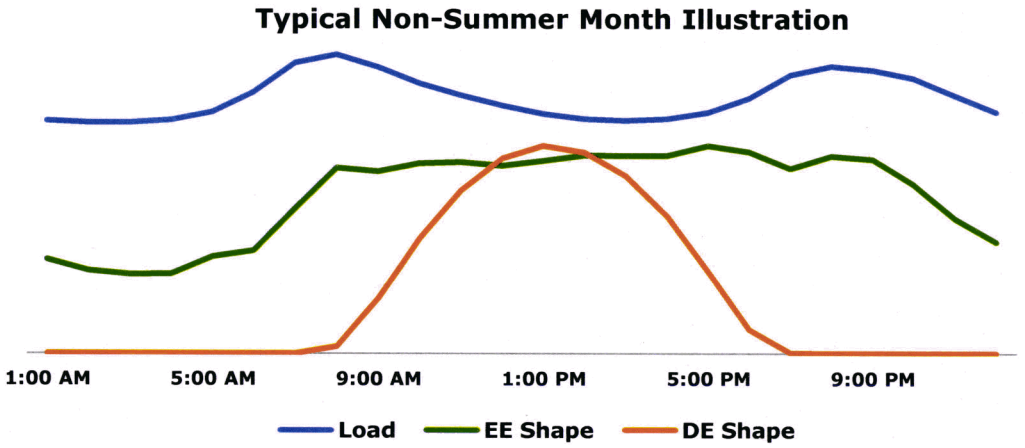
Where we are...



Integration of Resource Output with Customer Demand

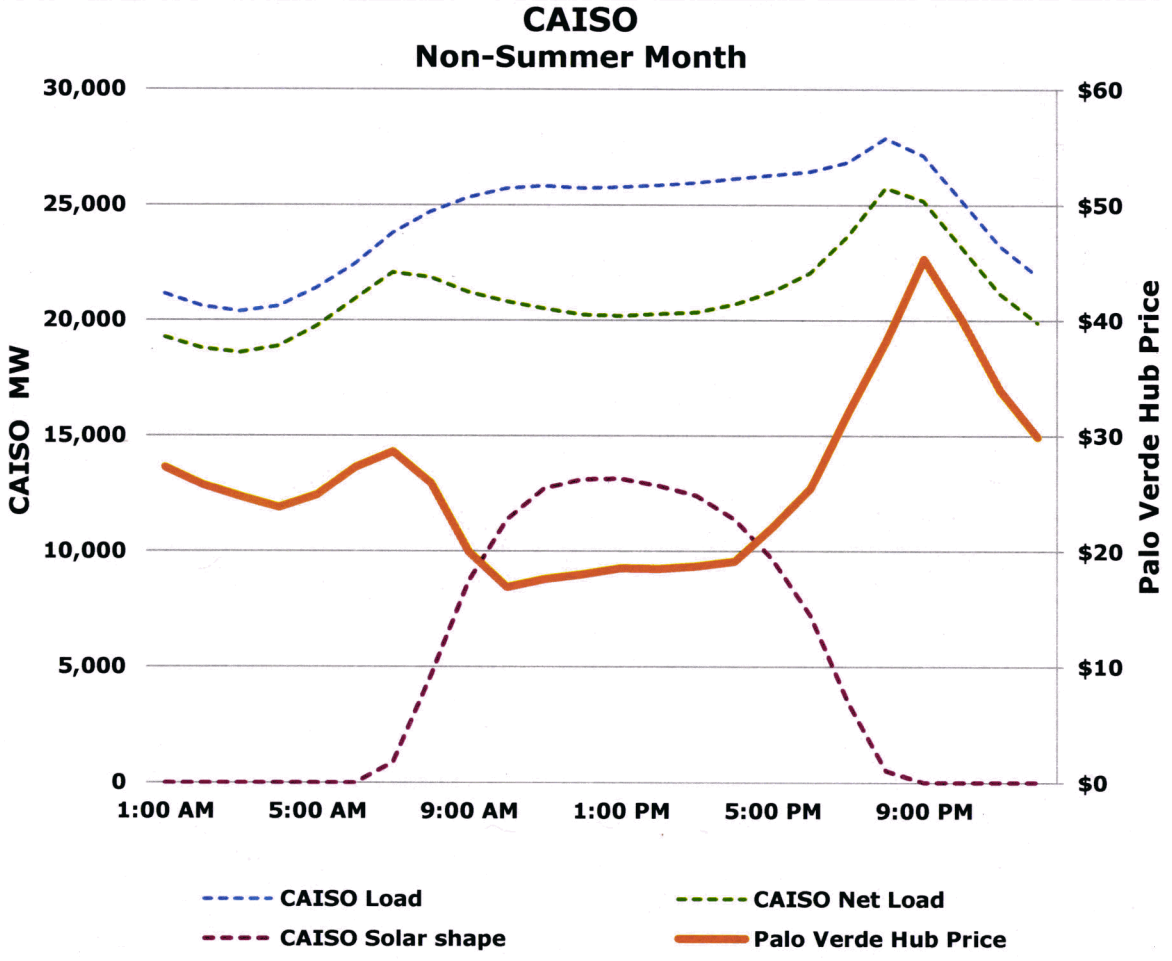
- Renewable resources not typically dispatchable
- Flexibly dispatched resources needed to provide platform for integrating growing renewable energy supplies





Market Price Shapes Have Changed

- Wholesale market pricing has been following a similar shape to the "duck curve"



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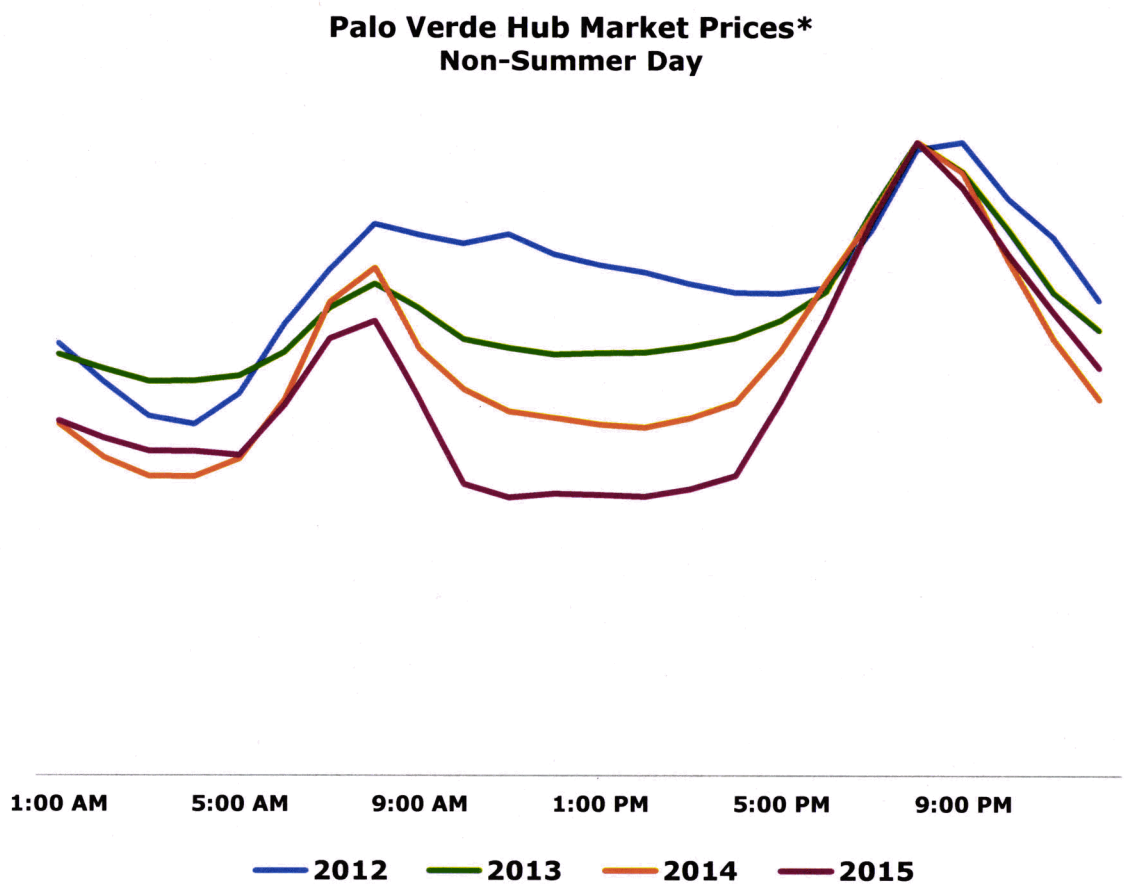
Market Price History – Illustration

Adjusted for natural gas prices

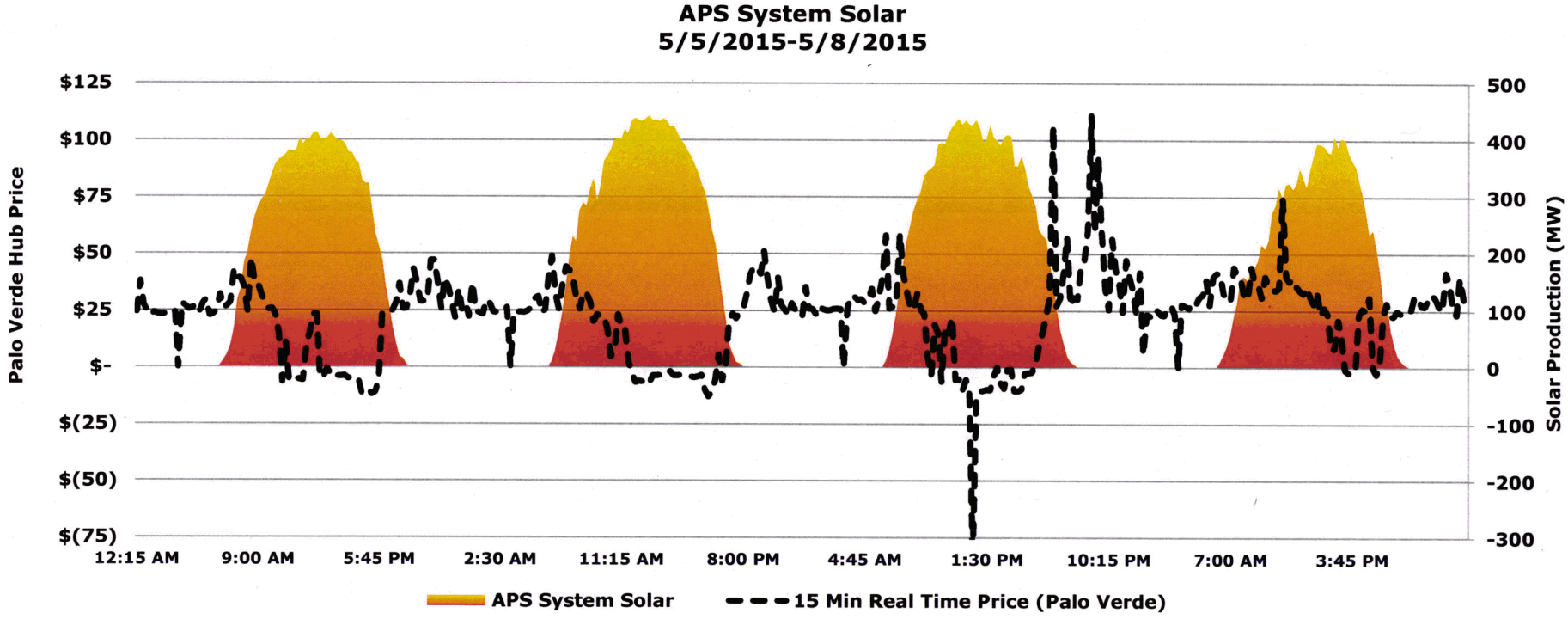


*Note: Prices have been scaled relative to peak for comparative purposes
Source: http://oasis.caiso.com/mrioasis/logon.do

- Adjusted for natural gas prices, mid-day wholesale power prices are roughly 50% lower than they were in 2012
- Provides economic purchase opportunities

Negative Market Prices

- Mild temperatures and supply/demand imbalances in non-summer months have influenced negative pricing conditions
- In 2015 negative pricing occurred in 0.6% of the hours in the day ahead market and 3.5% of the hours in the 15 min market



*Source: http://oasis.caiso.com/mrioasis/logon.do

Resource Implications

- Summer capacity is primary need
  - Meet forecasted peak demand growth
  - Sufficient market resources available in non-summer months
- Flexible resource capacity to integrate renewable energy now and for the future
  - Fast starting/ramping to meet dual peaks
  - Multiple starts per day due to reduced needs at mid-day
  - Flexible dispatch to take advantage of economic wholesale market opportunities

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Clean Power Plan Overview

Paul Smith

February 9, 2016

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Clean Power Plan Summary

- **On August 3, 2015, EPA released the final Emission Guidelines for existing sources, the final Standards of Performance for new, modified, and reconstructed sources, and a proposed rule for Federal Plans and Model Trading Rules**

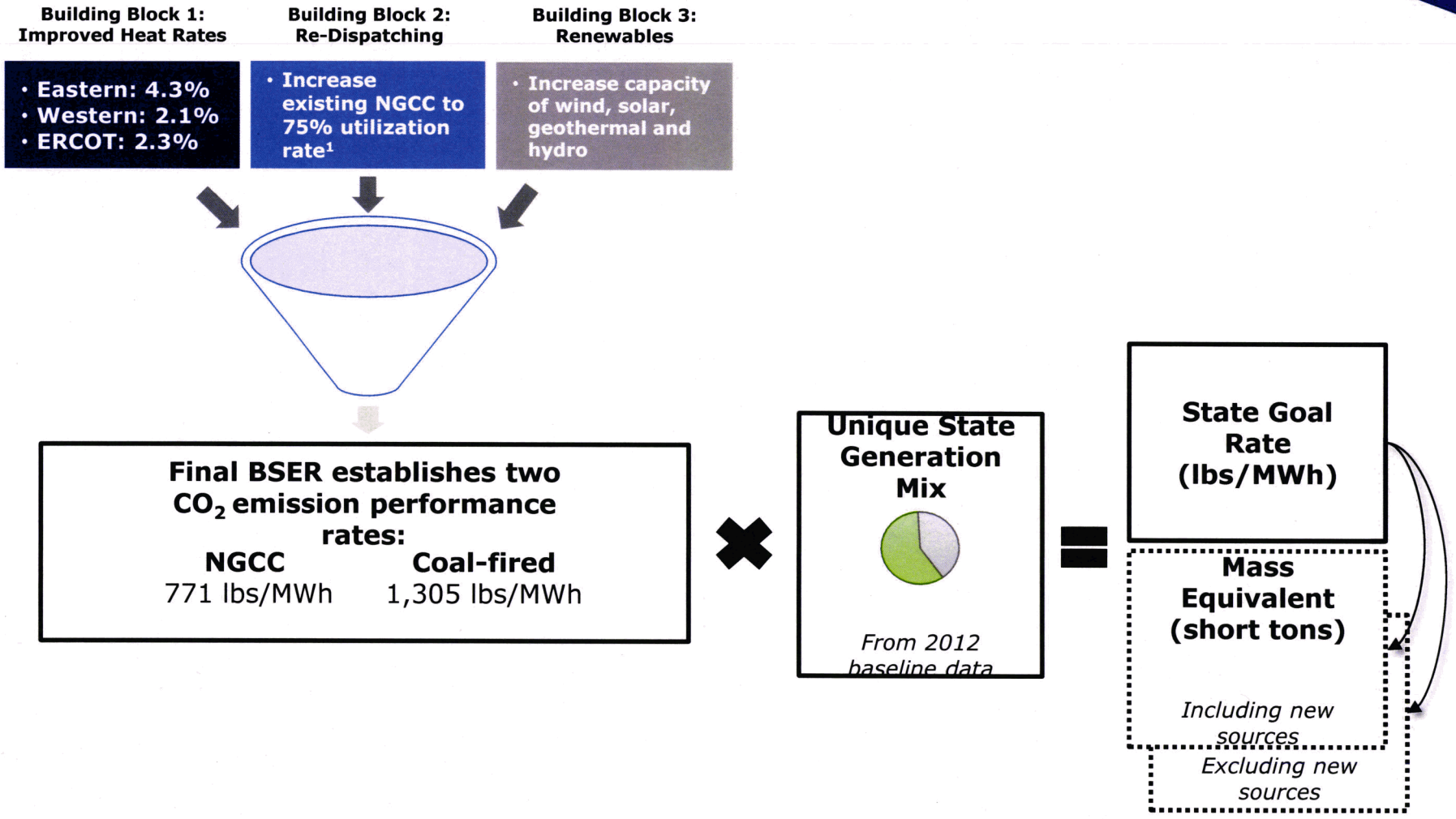
- **The Emission Guidelines establish carbon emission rate and mass goals for states and tribal lands**

- **The proposed rule for Federal Plans and Model Trading, proposes model trading rules that EPA will use to create "back-stop" federal plans and the states could use to create state compliance plans**

- **Comments on the proposed rule were submitted January 21, 2016**

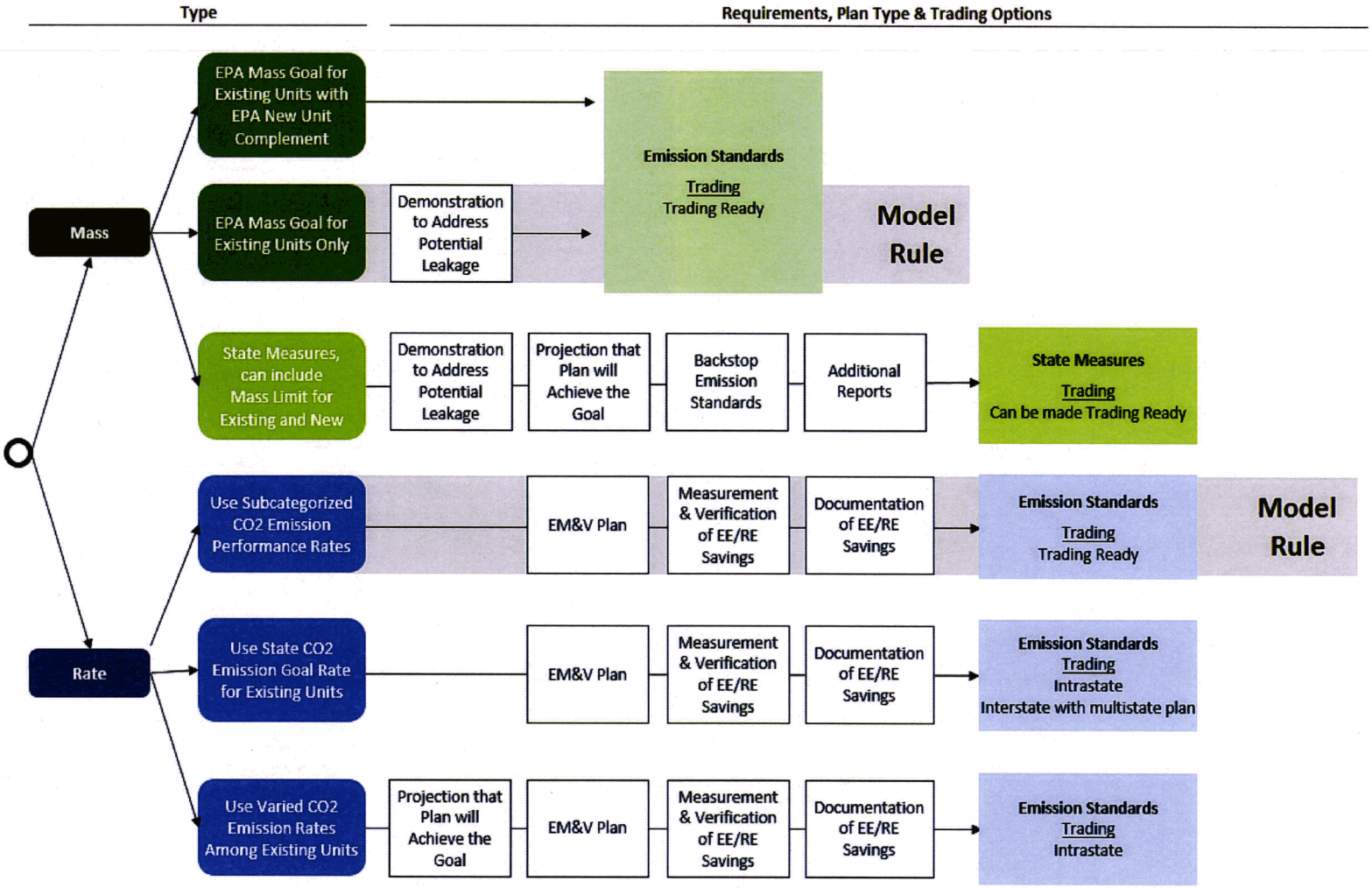
Overview of Methodology

Final Rule

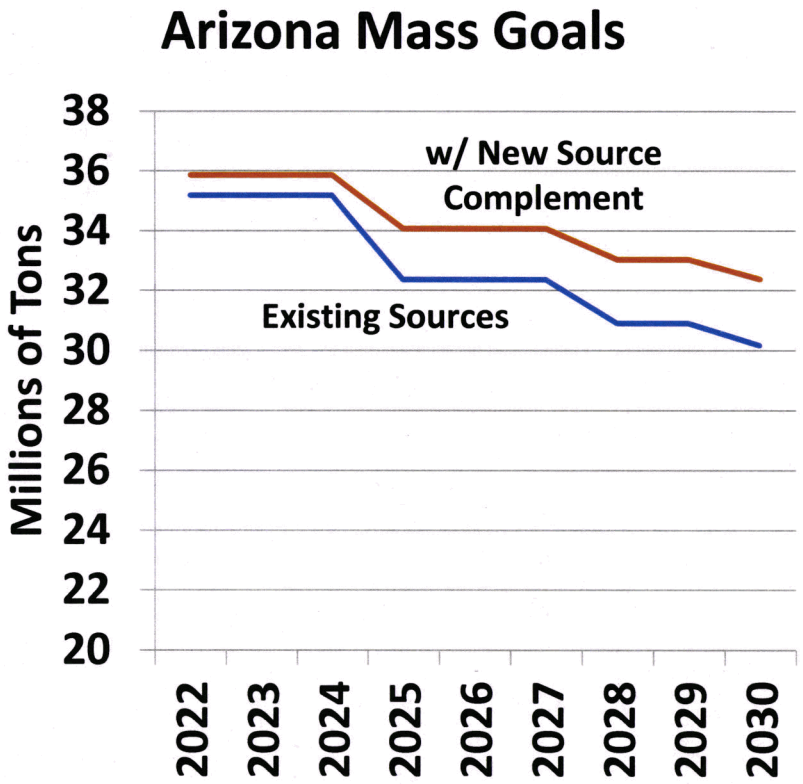


[1]*Includes NGCC units under construction.*

Compliance Options

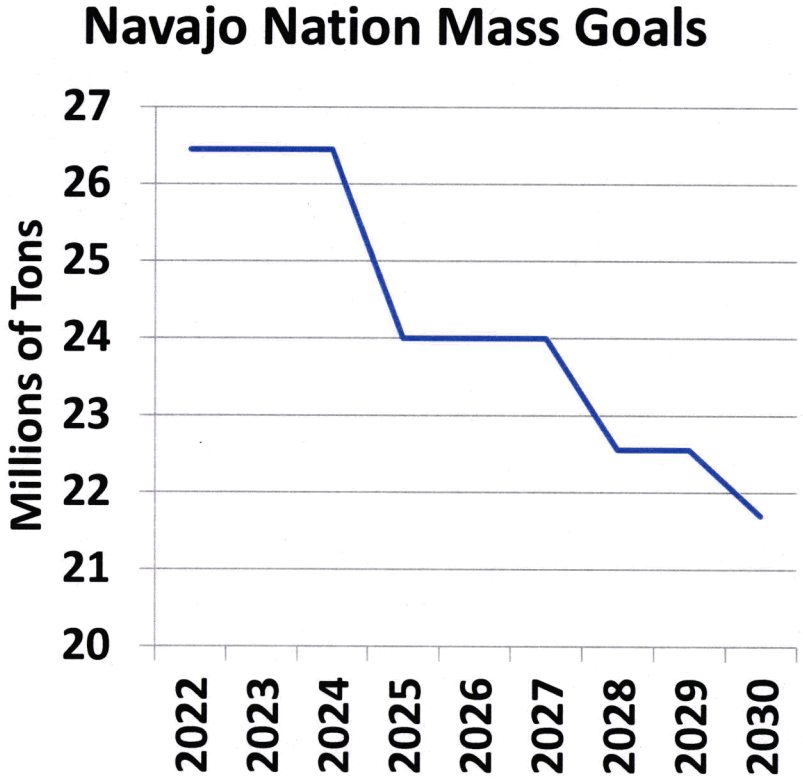


Arizona Mass Goals



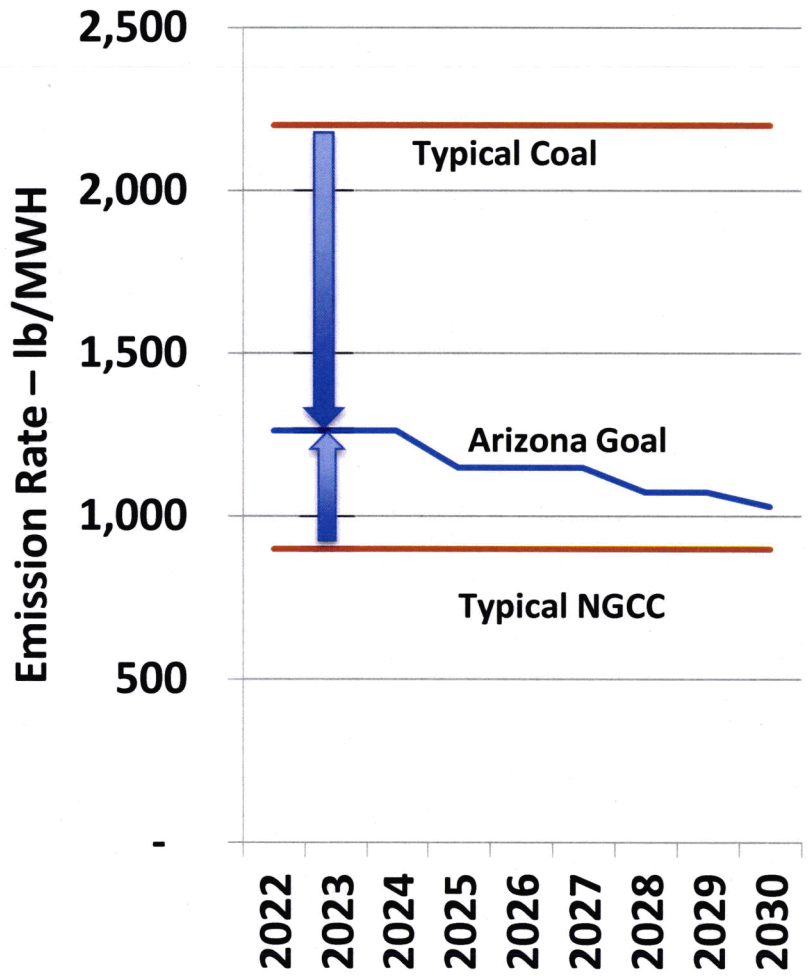
- Arizona mass emissions in 2012 were 40 million tons
- Goals shown are before Renewable Set-Asides and Output Based Set-Asides
- Arizona utilities expect load growth
- Mass limit unachievable without major resource operation changes and extensive additions of EE and RE
- New Source Complement not adequate to meet load growth

Navajo Nation CPP Goals



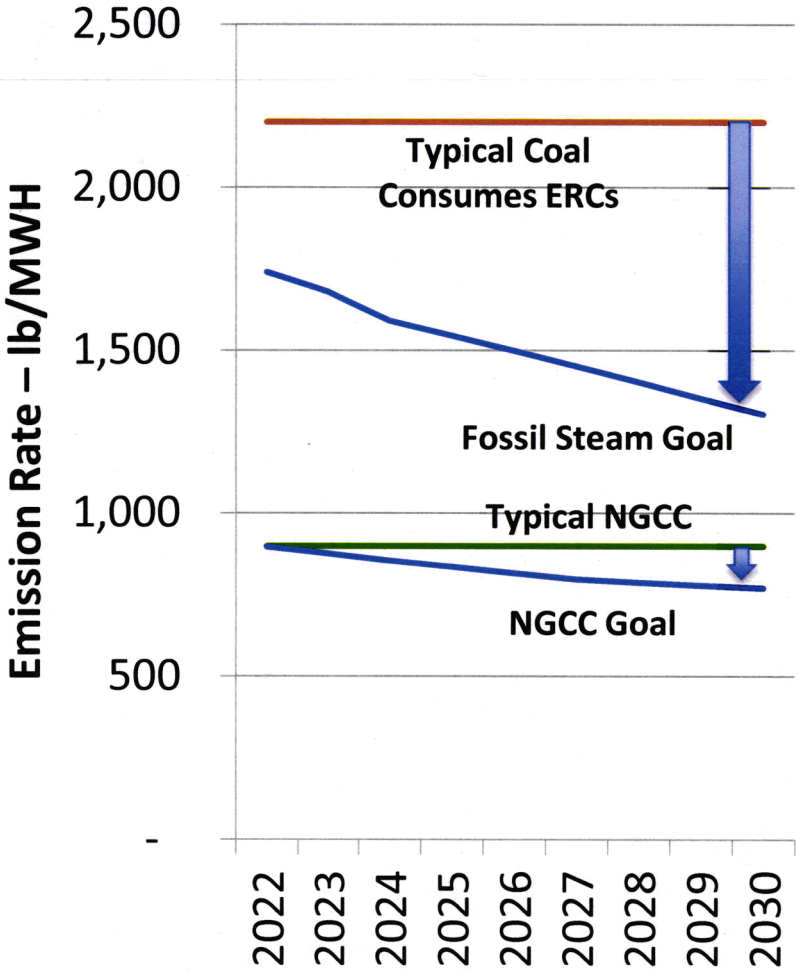
- Navajo Nation mass emissions in 2012 were 31.4 million tons
- Goals shown are before Renewable Set-Asides
- Goal of 21.7 million tons represents 31% reduction from 2012
- Retirements of FC 1-2-3 and a Navajo unit should help toward meeting mass goal
- However, treatment of units retired prior to 2022 is uncertain
- Rate-based goal (1,305 lb/MWH) appears unachievable

Rate-Based, State Average Goal



- Arizona state goal based on 2012 generation split, 49% Fossil Steam, 51% NGCC
- 2030 Goal 1,031 lb/MWH, 2012 actual was 1,552 lb/MWH
- Numerator – Quantified emissions from all affected units in the state
- Denominator – Quantified generation from all affected units in the state plus ERC from new renewables and energy efficiency
- Emission Rate Credits (ERCs) are MWH of emission free production, such as renewables and energy efficiency
- Compliance can be achieved though a combination of shifting coal to gas, and utilizing ERCs
- Not Trading Ready

Rate-Based, Sub-Categorized Goals



- **Numerator – Quantified emissions from all affected units in the state**
- **Denominator – Quantified generation from all affected units in the state plus ERC* from new renewables and energy efficiency**
- **Coal units require ERCs and Gas-Shift ERCs**
- **NGCCs also require ERCs, but also generate GS-ERCs**
- **Trading Ready**

*Emission Rate Credit (ERC)

APS Compliance Outlook

- **For rate-based compliance in Arizona, APS expects to be in a favorable position**
  - Retirement of Cholla 2 in 2016 plus commitment not to burn coal in Cholla 1 & 3 beyond 2025
  - Significant amount of ERCs from renewables added since 2012
  - Significant amount of ERCs from EE implemented since 2012
  - However, State Implementation Plan is under development

- **For mass-based compliance in Arizona, APS would be in a more challenging position**
  - Load growth projected, causing existing power plants to run more
  - Even mass-based with new source complement doesn't provide enough credits to keep up with load growth

- **For mass-based compliance on the Navajo Nation**
  - Retirement of FC 1-2-3 and one Navajo unit should help toward compliance goals
  - Still many unknowns regarding the Federal Plan, including treatment of units retiring prior to 2022

Arizona Compliance

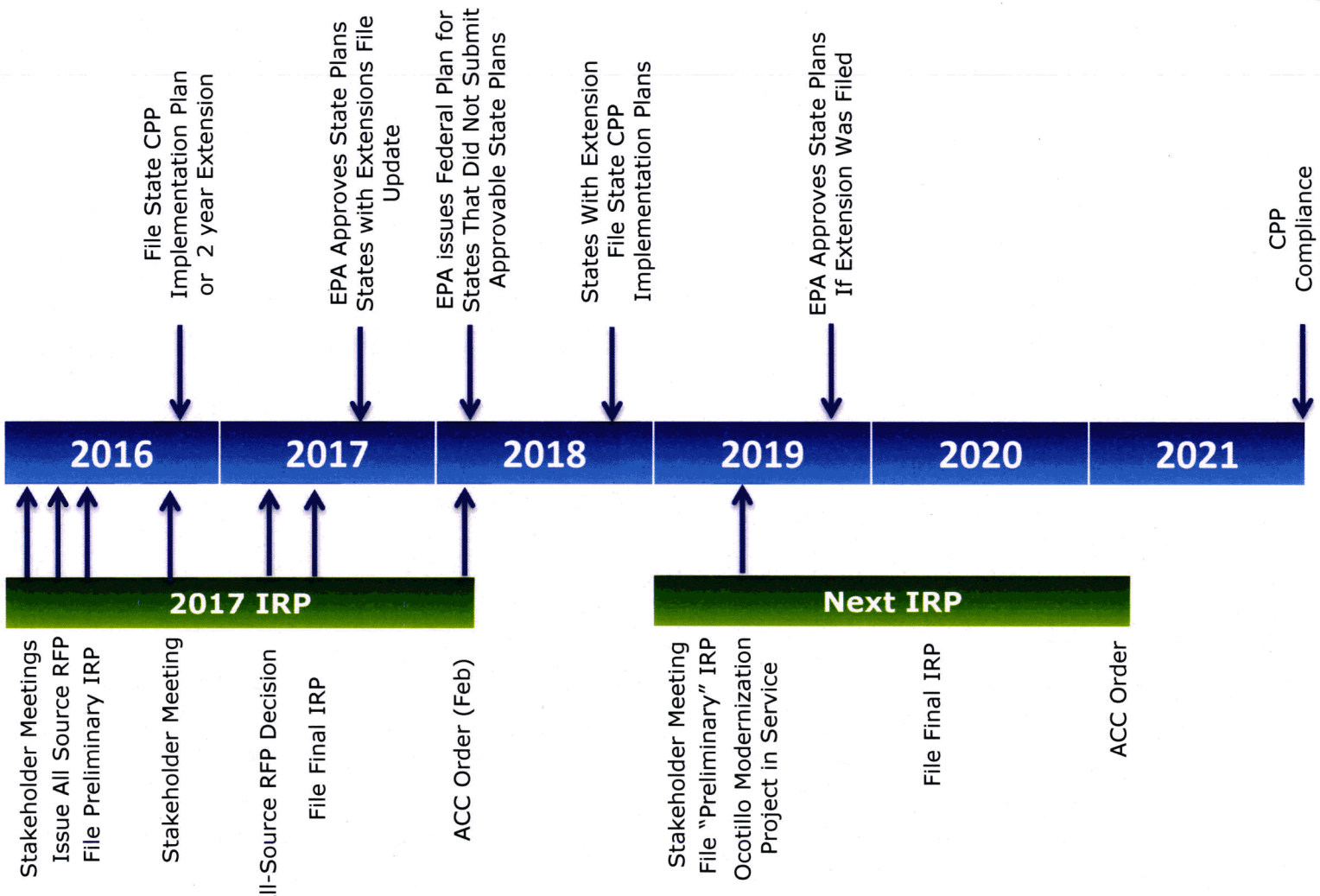
- **ADEQ is responsible for the State Implementation Plan**
- **APS is on ADEQ's Technical Work Group**
- **The Arizona Utilities retained PACE Global**
  - Detailed regional production modeling
  - Assess compliance options
- **Early results indicate that Arizona is better situated for rate-based compliance rather than mass-based compliance, but more work needs to be done**
- **Other considerations**
  - Availability of trading partners and mechanisms
  - Ease of administration
  - EM&V requirements

Concerns with Proposed Federal Plan and Model Trading Rules

- **APS submitted extensive comments on January 21, and also supported comments made by the Arizona Utilities Group (AUG) and the Edison Electric Institute (EEI)**

- **APS's Major concerns**
  - **Treatment of allowances related to retired units**
  - **Regulation of EGUs on the Navajo Nation**
  - **Inability of rate-based and mass-based states to trade**
  - **Both rate-based and mass-based Federal Plans and Model Trading Rules are needed**

Planning Timeline



IRP Stakeholder Meeting Agenda
February 9, 2016

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9:00	Welcome and IRP Process	Jim Wilde
9:20	Energy Demand Forecast and Economic Conditions	Jordan Prassinos
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Resource Needs

Jeff Burke

February 9, 2016

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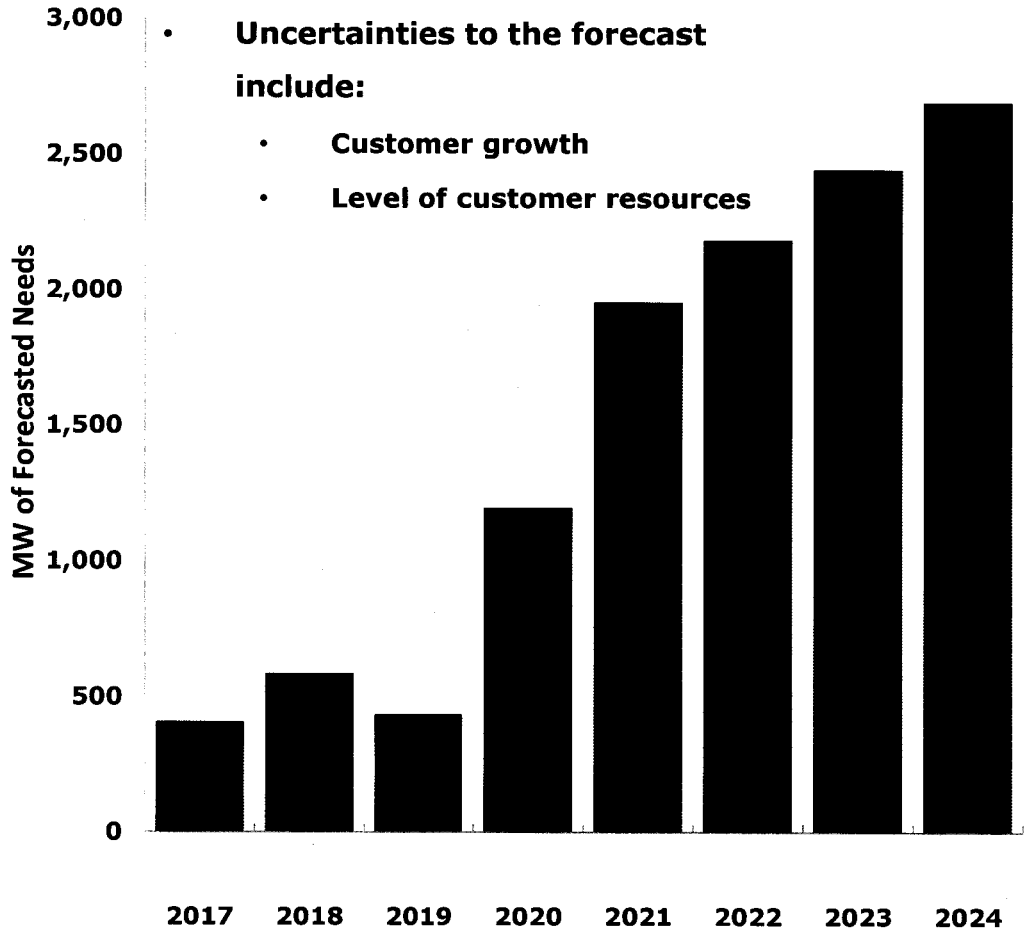
Fleet Changes Impacting Needs

- Cholla 2 retirement (260 MW)
  - Cholla 2 retired October 1, 2015
  - Plan to discontinue burning coal in Units 1&3 by 2025
    - Option to retire or convert to natural gas
  - Evaluation of on-going Cholla operations continues
- Ocotillo Modernization Project – 510 MW
  - Planned to be on-line by summer 2019
- Customer sited micro-grid – 33 MW
  - Approximately 33 MW of customer-sited back up generation for initial phase
- Customer solar – 40 MW
  - Solar project at Saguaro plant

Cumulative Resource Needs



- **Uncertainties to the forecast include:**
  - **Customer growth**
  - **Level of customer resources**

- Approximately 1,800 MW's of expiring contracts by 2021
- All Source RFP in 2016
  - Plan to issue in March
  - Deliveries to begin 2020
- Energy storage opportunities as economics improve and technologies mature
- Ocotillo modernization project planned in-service by summer 2019

NOTE: For purposes of this chart, resource needs are after the effects of OMP, EE, DG

Resource Need Summary

- Customer net load shapes have changed and are expected to continue changing as a result of increasing levels renewable generation
- Energy supplies available at PV Hub during non-summer mid-day hours
- Regional wholesale market pricing during non-summer months offers economic opportunities
- Primary resource need is for meeting peak summer-time demand
- Fast starting and ramping, flexibly dispatched resources fit best to integrate growing renewable energy supplies and take advantage of favorable market opportunities

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Action Plan Update

Jim Wilde

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Action Plan Items

- Ocotillo Modernization Project – 510 MW
  - Project on track for 2019 in-service
  - Steam units planned to be retired at "first-fire" and dismantling begins Fall 2019
- Coal Fleet
  - Cholla 2 retired October 1, 2015 – 260 MW
  - Upcoming decisions on Navajo Generation Station – 315 MW APS Share
  - Four Corners SCR installation begins Fall 2017
- Solar Partner Program – 10 MW
  - Installing West facing solar on 1,500 homes
  - Solar on grid side of meter
  - Monthly bill credit
- Solar Innovation Study
  - 75 home study, broken into three segments
  - Segments have differing combinations of: solar PV, smart inverter, HEM/load control, variable speed HVAC, energy storage

Action Plan Items

- Micro-grid
  - Working with military base and large data center to install back-up generation
  - Approximately 33 MW combined of generation for initial phase
- Customer Solar
  - Large customers desiring "green" footprint
  - Constructing 40 MW SAT solar pv project at Saguaro Power Plant
- Energy Imbalance Market (EIM)
  - Integration of variable energy resources
  - Cost savings for customers through coordinated dispatch over large geographic area
  - Plan to "go live" in October 2016
- All-Source RFP
  - Plan to issue in March of 2016
  - Seeking approximately 400-600 MW
  - Deliveries requested to begin in 2020

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EIM Overview

Drew Schroeder

February 9, 2016

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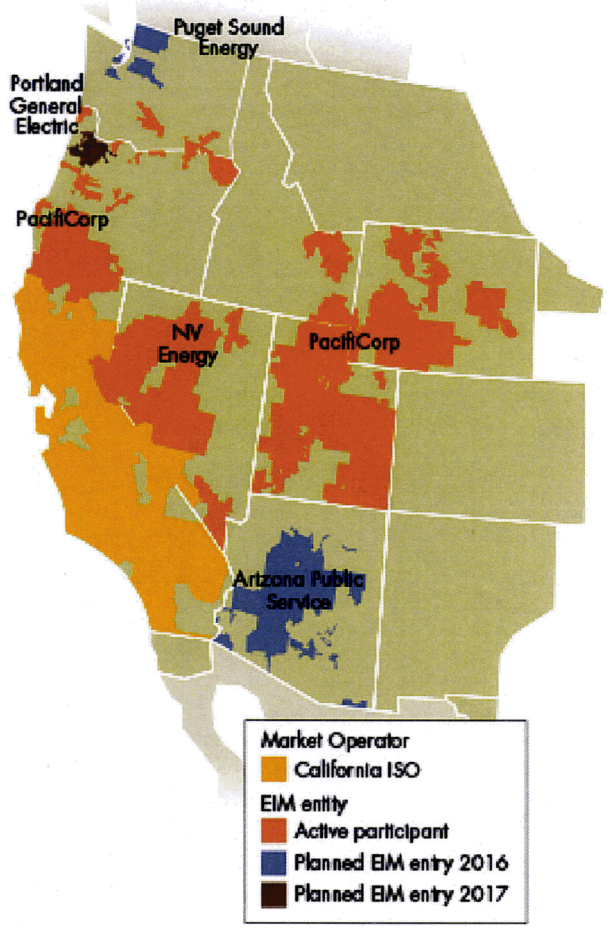
What is the western Energy Imbalance Market (EIM)?

- The EIM is an automated sub-hourly market that matches energy supply and demand across the participating footprint in real time (15 minute market and 5 minute market)

- The EIM is operated by CAISO to facilitate the most economic dispatch of generation resources to serve imbalances

- In the EIM, utilities are still responsible for holding reserves and ensuring reliability



Why Join EIM?

- Opportunity to provide meaningful savings directly to APS customers
  - E3 projected net annual benefits of $7 million per year
  - Done by reducing operating costs through EIM transfers

Why Join EIM?

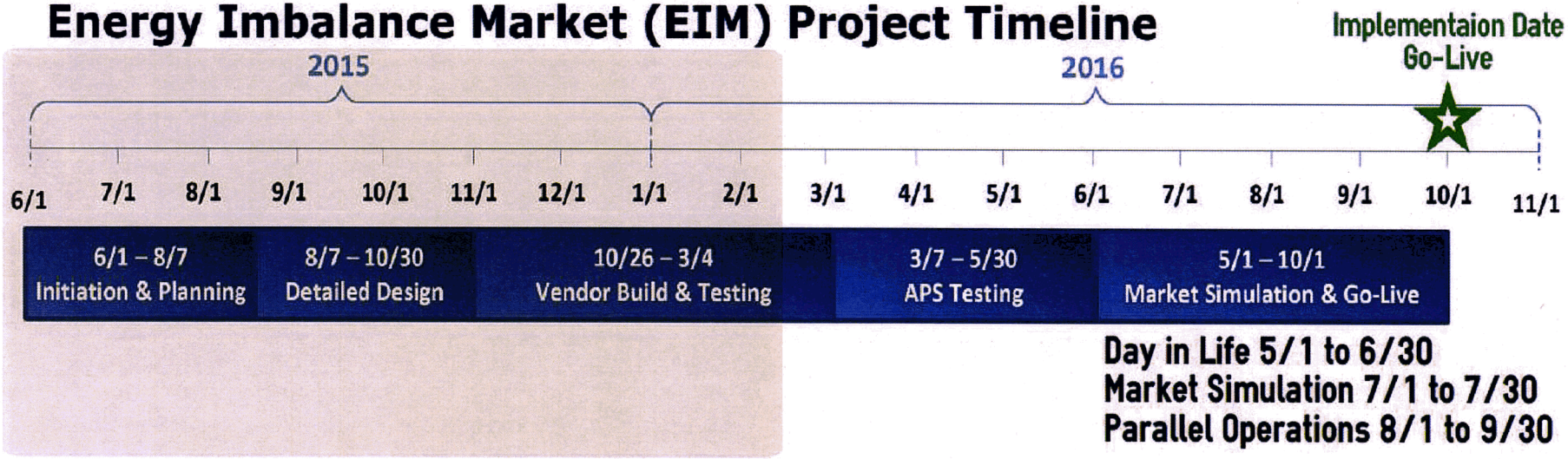
- Positions APS on the leading edge of dealing with a fast changing electricity landscape

CHALLENGES TODAY	EIM BENEFIT
Limited access in real time to lower energy prices in the region	Draws on a larger portfolio of resources to identify the lowest cost option in real time
Growth of renewables is increasing operational challenges such as intermittency	Ability to export excess renewables and react more economically to intermittency

APS Implementation

- Project structure, while remaining highly collaborative, is categorized in several key work streams:
  - Marketing and Trading
  - Settlements
  - Transmission Operations
  - Fossil Generation
  - Metering
  - Change Management
  - Regulatory

Energy Imbalance Market (EIM) Project Timeline



Day in Life 5/1 to 6/30
Market Simulation 7/1 to 7/30
Parallel Operations 8/1 to 9/30

Questions?

Resources:

CAISO EIM public site
https://www.caiso.com/informed/Pages/EIMOverview/Default.aspx

- Overview
- FAQs and company profiles
- Quarterly benefit reports
- Benefit assessments
- Implementation agreements

CAISO EIM Business Practice Manual
https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Energy%20Imbalance%20Market

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Energy Efficiency

Tom Hines

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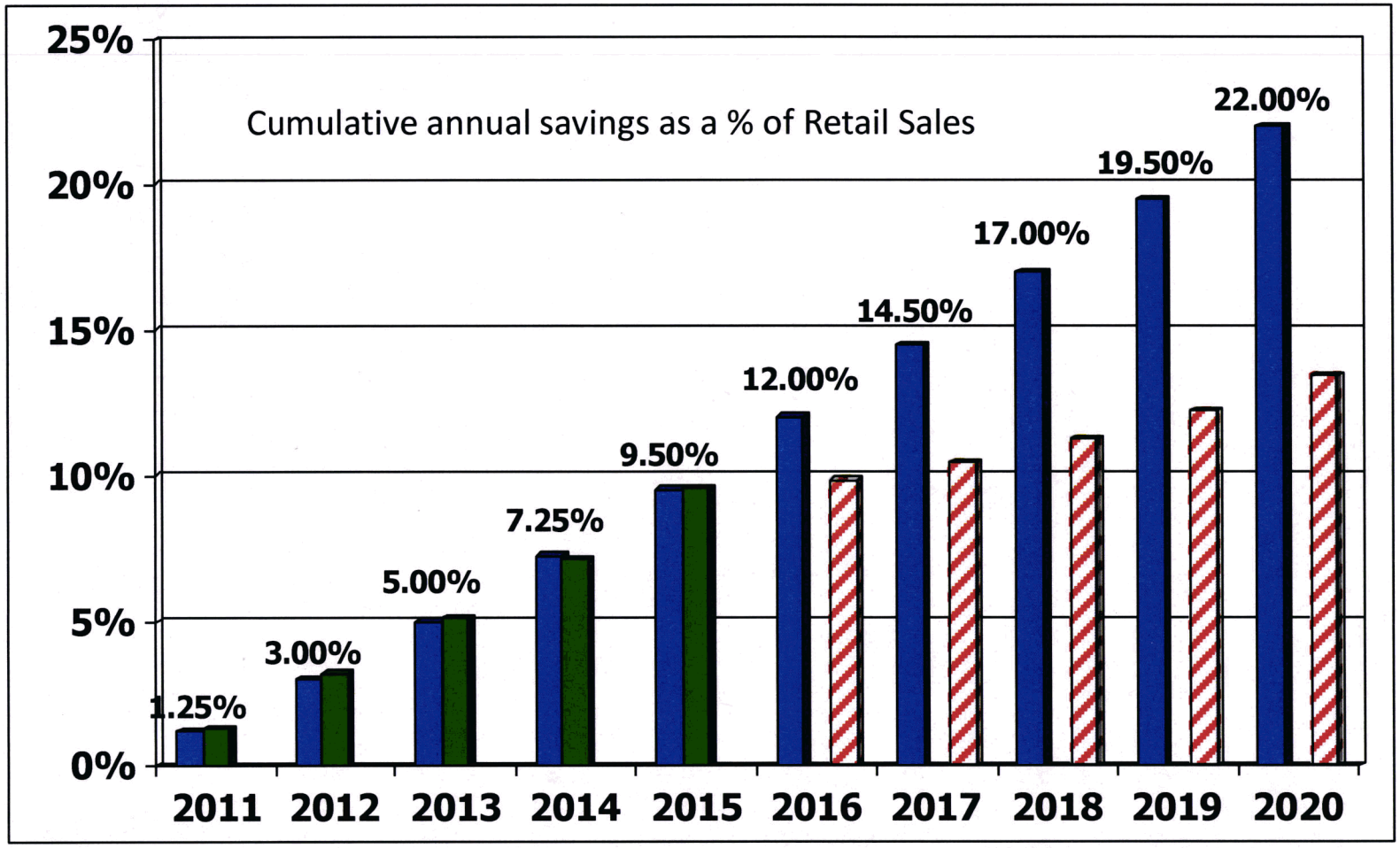
APS Energy Efficiency Programs

RESIDENTIAL	
Consumer Products	CFL lighting, LEDs, Pool pumps
Existing Homes HVAC	AC rebates, Duct repair, Diagnostics
Home Performance	Home energy audits and upgrades
New Homes	High performance new homes
Low Income	Weatherization, bill assistance
Conservation Behavior	Custom home energy reports
Multi-Family	Rental property efficiency upgrades
NON-RESIDENTIAL	
Large Existing Facilities	•Comprehensive non-residential EE upgrades •Addresses all segments and end uses with custom and prescriptive measures •Marketed as "Solutions for Business"
New Construction	
Small Business	
Schools	

Energy Efficiency (EE) Standard



* Savings for 2015 are preliminary; not yet MER adjusted

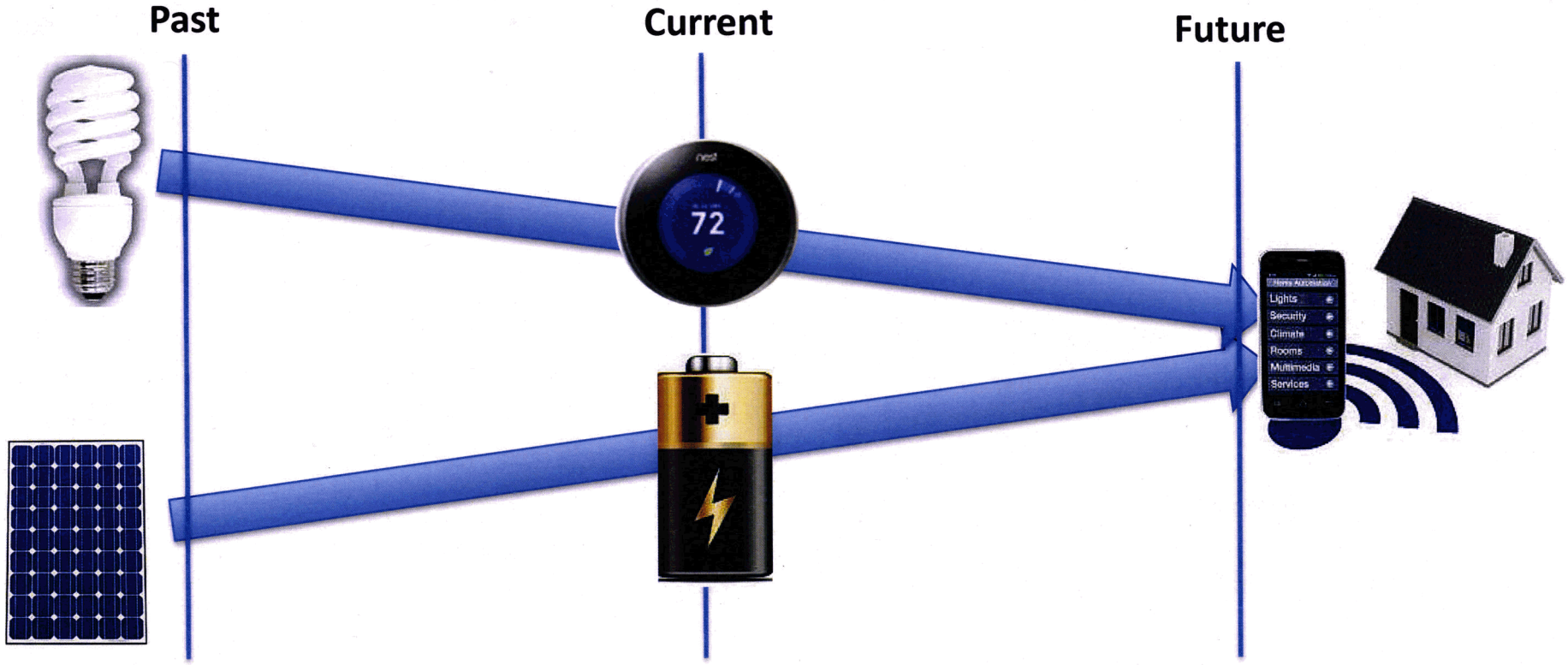
2015 EE Plan Highlights

- Began offering incentives for LED lighting
- Expanded behavioral conservation program
- Expanded residential new construction program participation
- New pre-paid energy conservation program
- New APS system savings initiative
- New schools pilot program

EE and Integrated Resource Planning

- Continued evaluation of cost effectiveness of all EE programs and technologies with updated avoided costs
  - Avoided costs are impacted by
    - Continued low natural gas prices
    - Increasing time dependence due to the decreasing value of mid-day energy
- Emphasize peak capacity reduction with less focus on mid-day energy savings
- Evaluate EE programs to align with changing resource needs

Emerging Technologies and Changing 'Distributed Energy Resource' Needs



A Look Ahead to 2017-2018

- Focus program budgets on highest value programs based on updated avoided costs
- Educate customers and support new technologies to shift energy use and manage demand
- Consider EPA Clean Power Plan requirements

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Renewable Energy Program

Marc Romito

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Renewable Energy Leadership

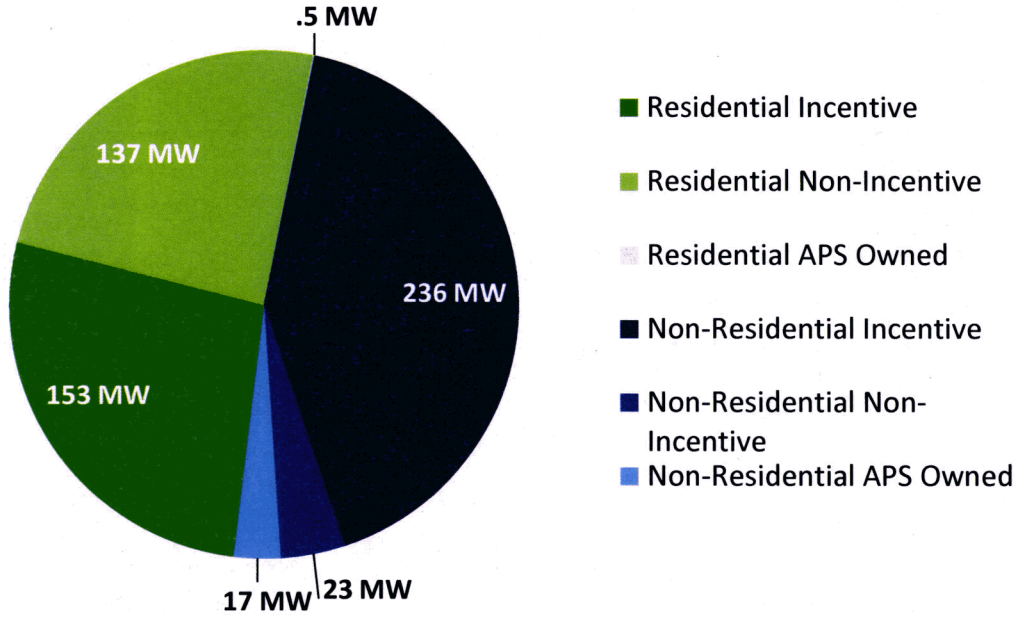
Customer Involvement:

- Nearly 42,000 renewable energy customers contributing 567 MWdc of distributed generation (DG).

Compliance Requirements:

- 2014 = 4.5%
  - (9.8% actual)
- 2015 = 5.0%
  - (expect 12.0%)

- Non-Res through 2022



Connected to APS = Connected to Renewables

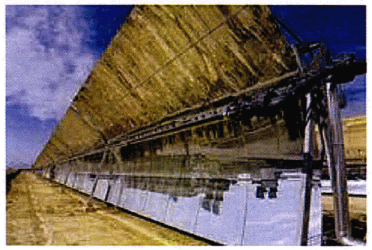
APS currently has over 1,200 MW of renewable production:

10%-30% of seasonal load

- Wind – 289 MW
- Solar – 949 MW with 50 MW under development
- Biomass – 14 MW
- Geothermal – 10 MW
- Biogas – 6 MW

Aragonne Mesa
90 MW

Snowflake
Biomass 14 MW



Solana CSP
250 MW (PPA)

Salton Sea -
Geothermal
10 MW

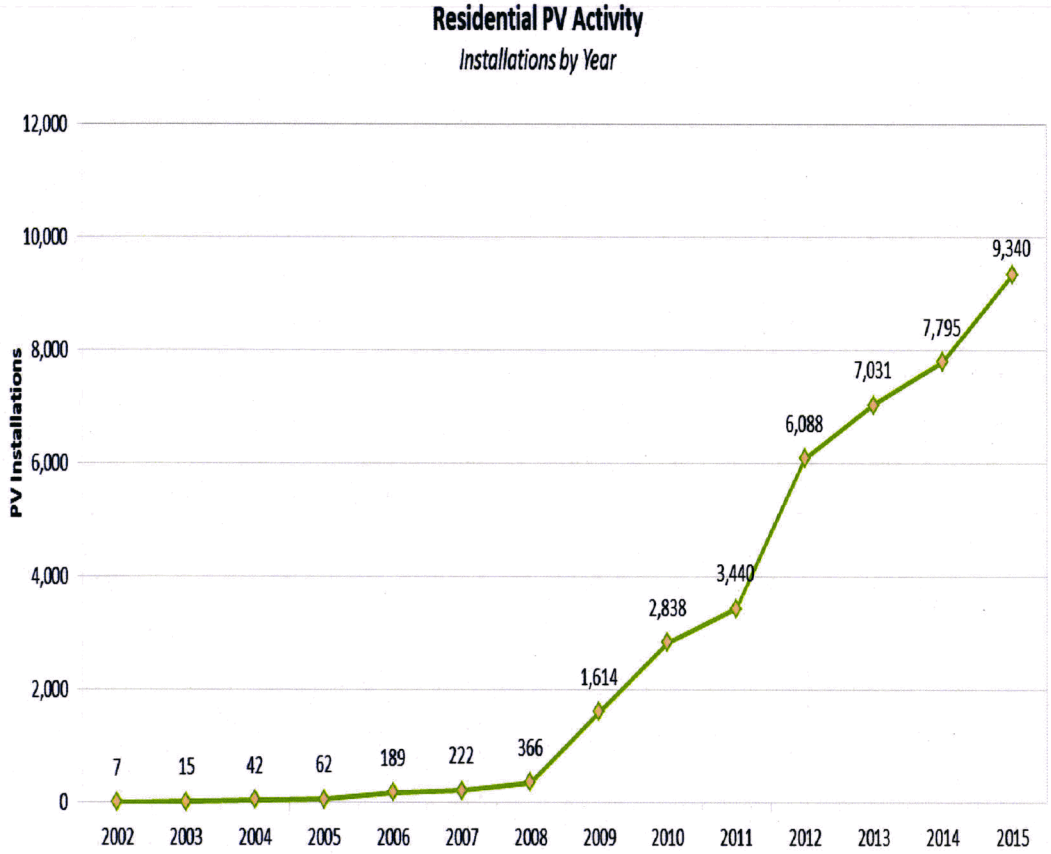
Glendale Landfill
2.8 MW

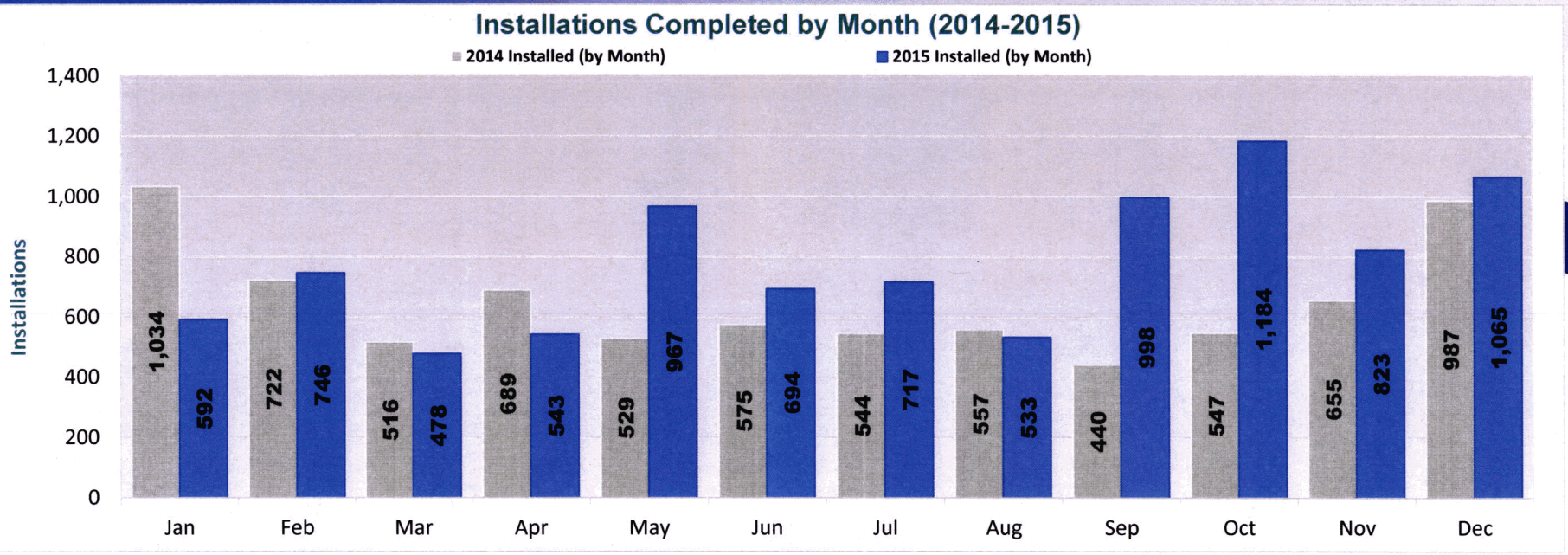
Why so much renewable energy?

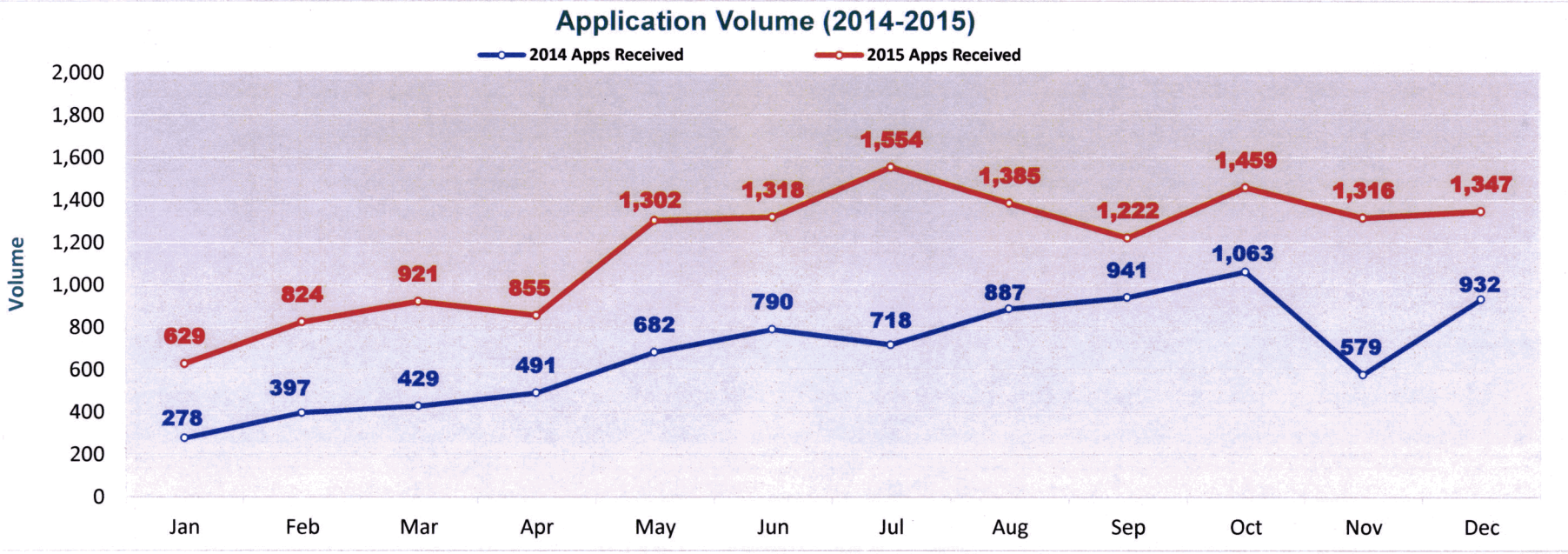
Renewable Energy Standard (RES)

We develop and implement programs & projects to make sure APS is compliant with the Renewable Energy Standard (RES):

- 15% of retail sales from renewables by 2025
  - Up to 70% of requirement from utility scale
  - At least 30% from distributed generation (customer sited)
    - Half from residential
    - Half from non-residential



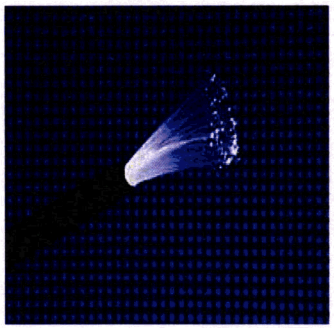

Installations Completed by Month (2014-2015)
2014 Installed (by Month)
2015 Installed (by Month)
Installations
1,400
1,200
1,000
800
600
400
200
0
1,034
592
722
746
516
478
689
543
529
967
575
694
544
717
557
533
440
998
547
1,184
655
823
987
1,065
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

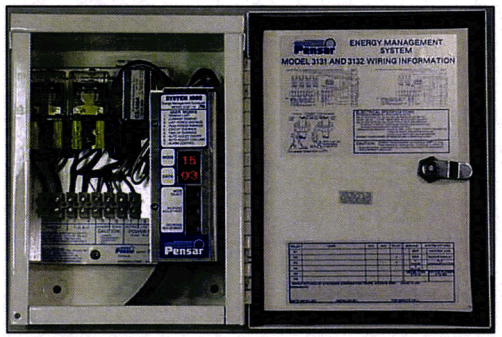

Application Volume (2014-2015)
2014 Apps Received
2015 Apps Received
Volume
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
629
824
921
855
1,302
1,318
1,554
1,385
1,222
1,459
1,316
1,347
278
397
429
491
682
790
718
887
941
1,063
579
932
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

APS Solar R&D Initiatives

- **Solar Partner Program (SPP)**
  - APS owned rooftop solar research and development program aimed at learning how to efficiently enable the integration of rooftop solar and battery storage with our grid

- **Solar Innovation Study (SIS)**
  - A 75 customer field home energy management and rate research and development program to examine the integration of behind the meter advanced technologies with demand-based rates



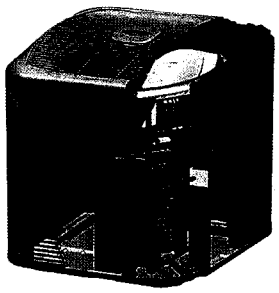


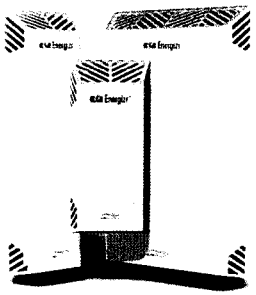
Solar Partner Program (SPP) Benefits

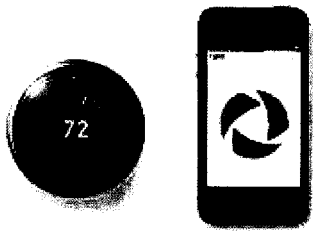
- Proof of ability to actively manage effects of solar by configuring smart inverters and issuing real-time commands in a cyber secure environment
- Validation of ability to mitigate adverse effects of increased photovoltaic (PV) through enhanced power regulating capabilities
- Validation of ability to provide ancillary services from a series of grid-tied batteries in coordination with solar inverters and traditional grid devices
- Collection and analysis of information that helps anticipate, identify and avoid impacts on the distribution grid
- Verification of distribution system models to be used in more accurately and efficiently planning grid upgrades

Solar Innovation Study (SIS) Benefits

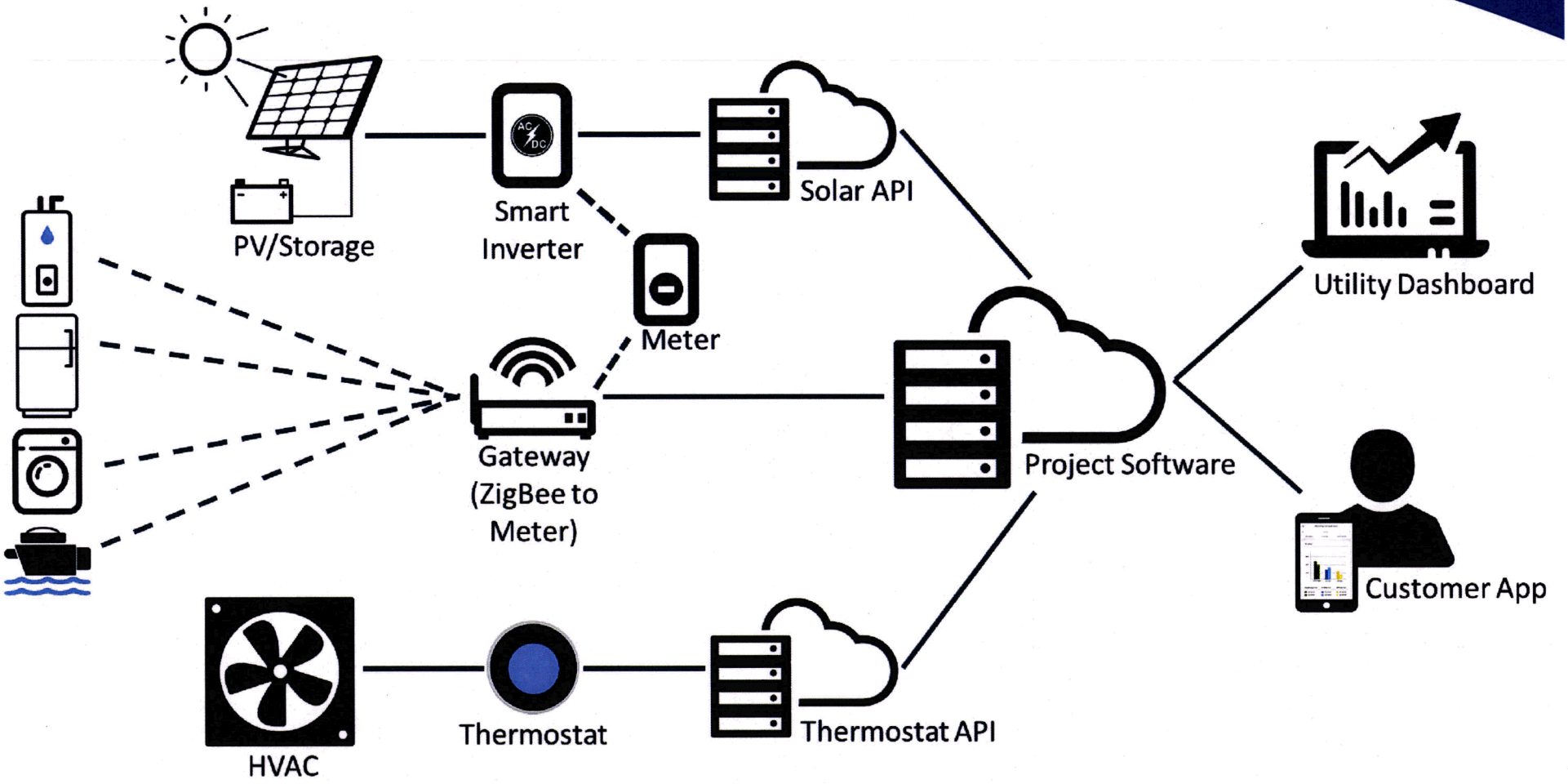
- Is a win for customers, market, and grid
- Tests ways that enable customers to control their demand
- Explores how DERs interact with each other to facilitate APS's transition to a smarter grid
- Provides data to expand industry-wide knowledge and to maximize use of emerging DERs in today's advanced energy market

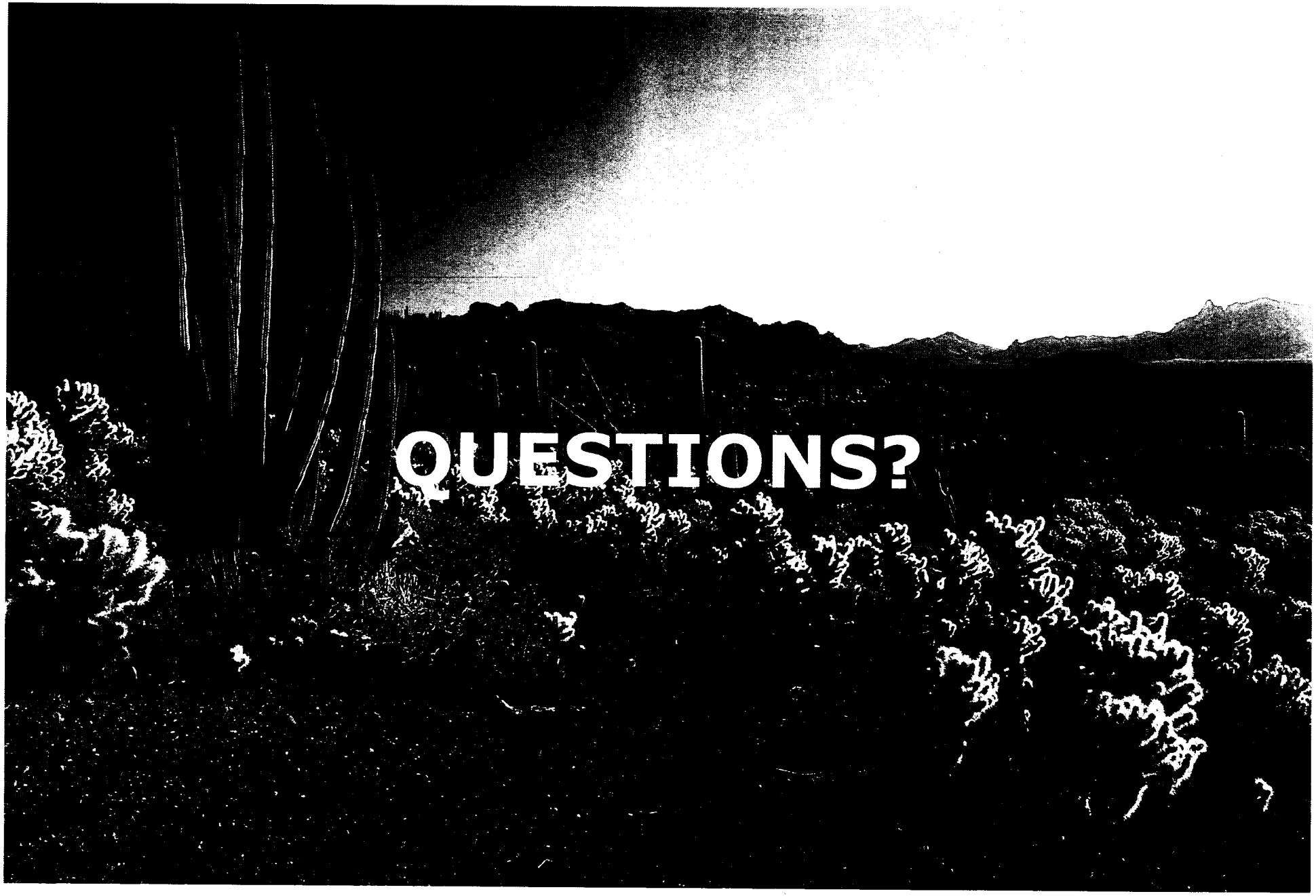






Technology Ecosystem

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Technology

Microgrids and Battery Storage

John Pinho

February 9, 2016

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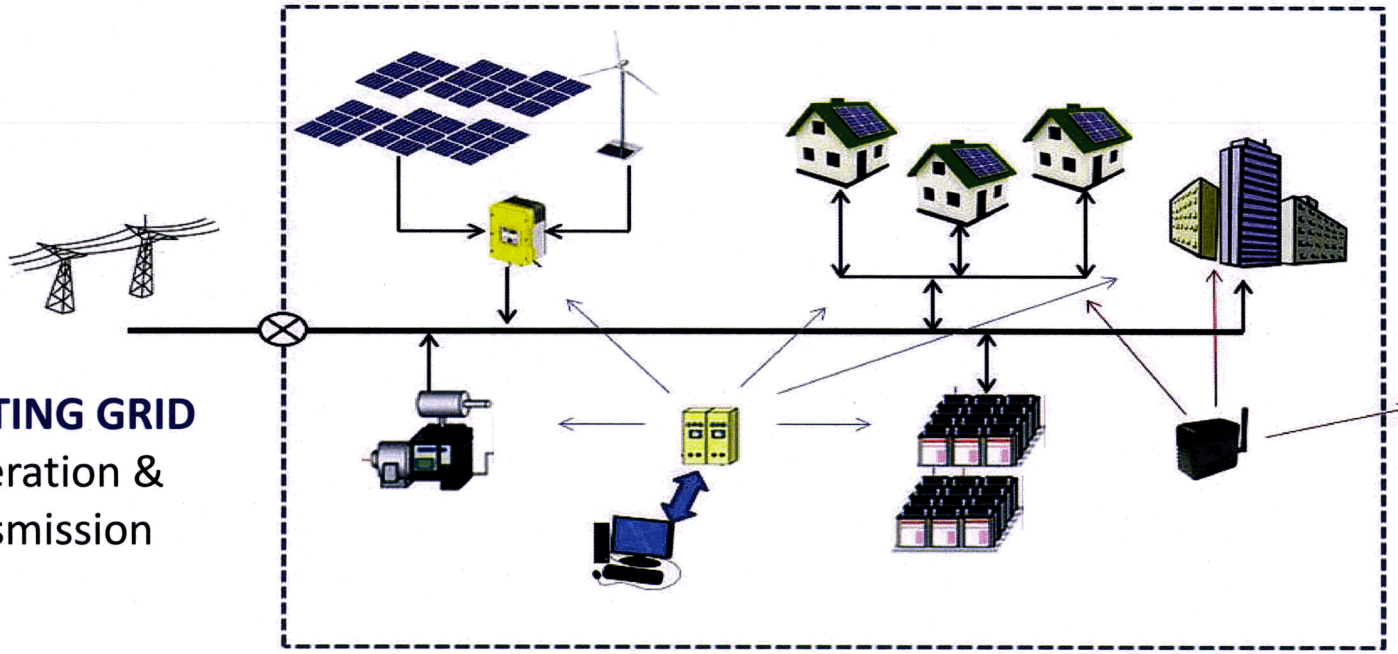
What is a Microgrid?



EXISTING GRID
Generation &
Transmission

CUSTOMERS

Microgrid - Multiple interconnected loads and Distributed Energy Resources (DER's) that can be operated in *parallel* with (supporting) the grid or in *island* mode (stand-alone)

Every Microgrid is a unique design, optimized for the customers

Microgrid Overview

Generation capabilities
- Low emission; ultra efficient generators
- Energy security and reliability

Flexible load management
- Demand response
- Peak shaving
- Frequency Response

Future capabilities
- Add Renewables: photovoltaic panels and smart inverters
- Add Energy Storage: battery systems

Partner with customers
- APS provides turn key design build, air permit and maintenance
- Host customer provides space for equipment on their site and provide a share of total project costs
- Non-participating customers benefit from lower cost energy capacity and ancillary services

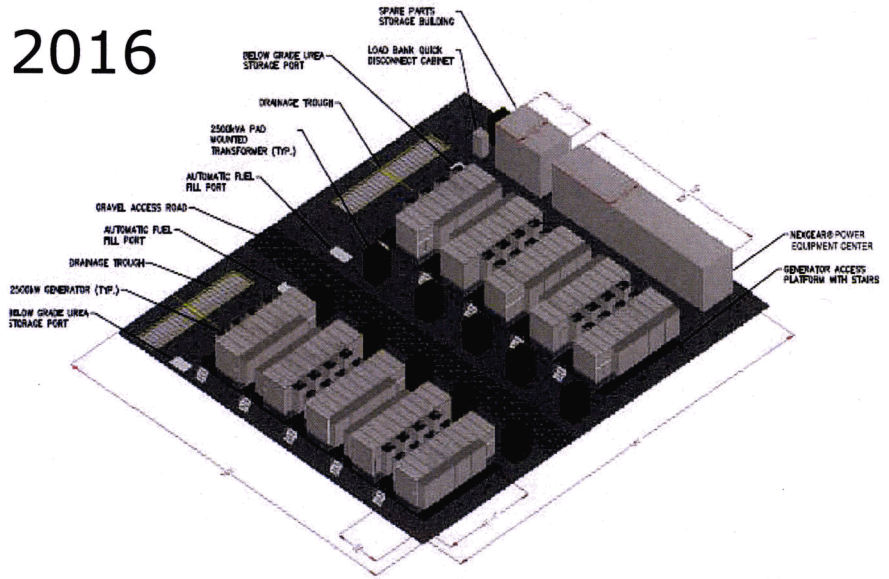
Microgrid Projects

Military Base

- 22MW capacity
- Ground breaking in February 2016
- In service Q3 2016

Data Center

- 11MW capacity
- Construction starts February 2016
- In service Q3 2016



Battery Energy Storage System (BESS) for SPP Feeders

Evaluate use of Battery Energy Storage System's (BESS) ability to improve power quality on Solar Partner Program (SPP) high PV penetration feeders

- Festival Ranch – Connected to feeder
- McMicken – Connected to substation

BESS for SPP Use Cases:

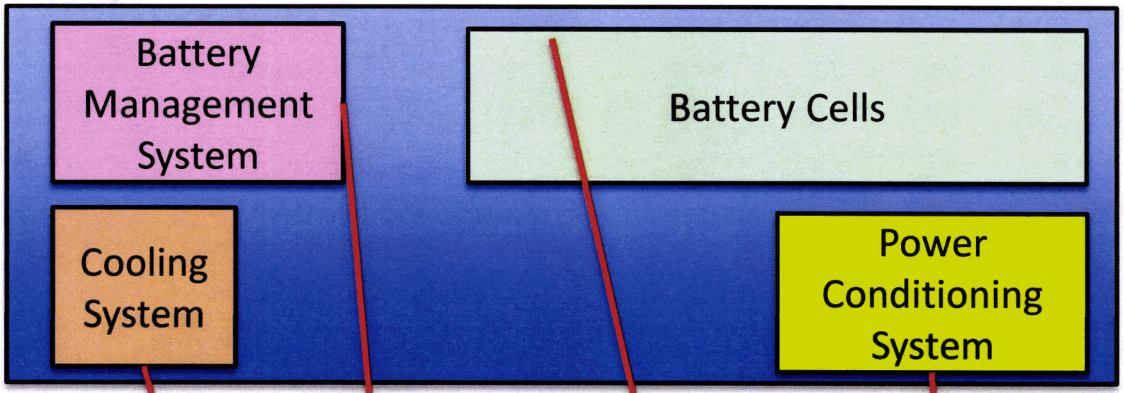
- Local voltage regulation
- Interoperability with Capacitor Banks, Integrated Volt/Var Control & Smart Inverters

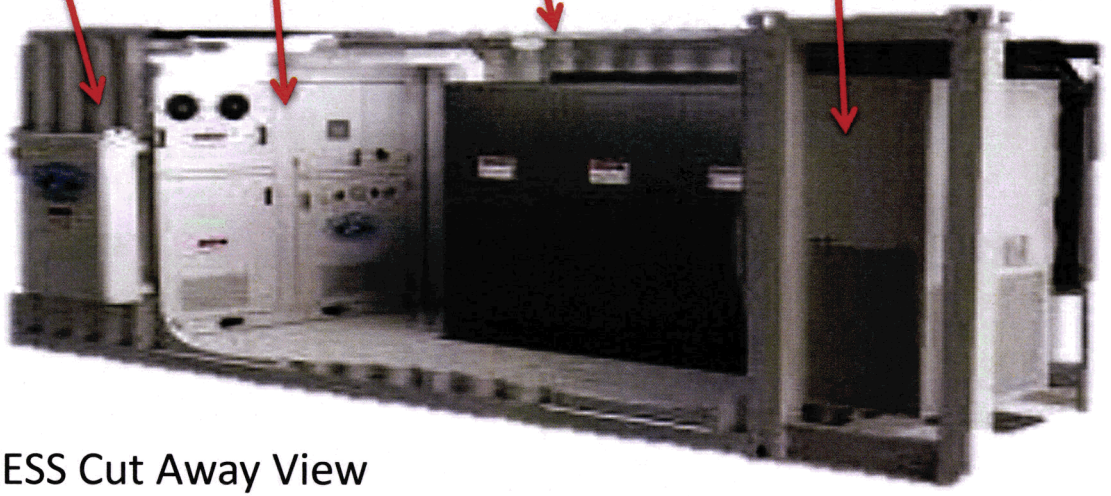
Planning to install two BESS @ 2MW/2MWh each

- In Service Q3 2016
- Testing for 12-16 months

BESS Configuration

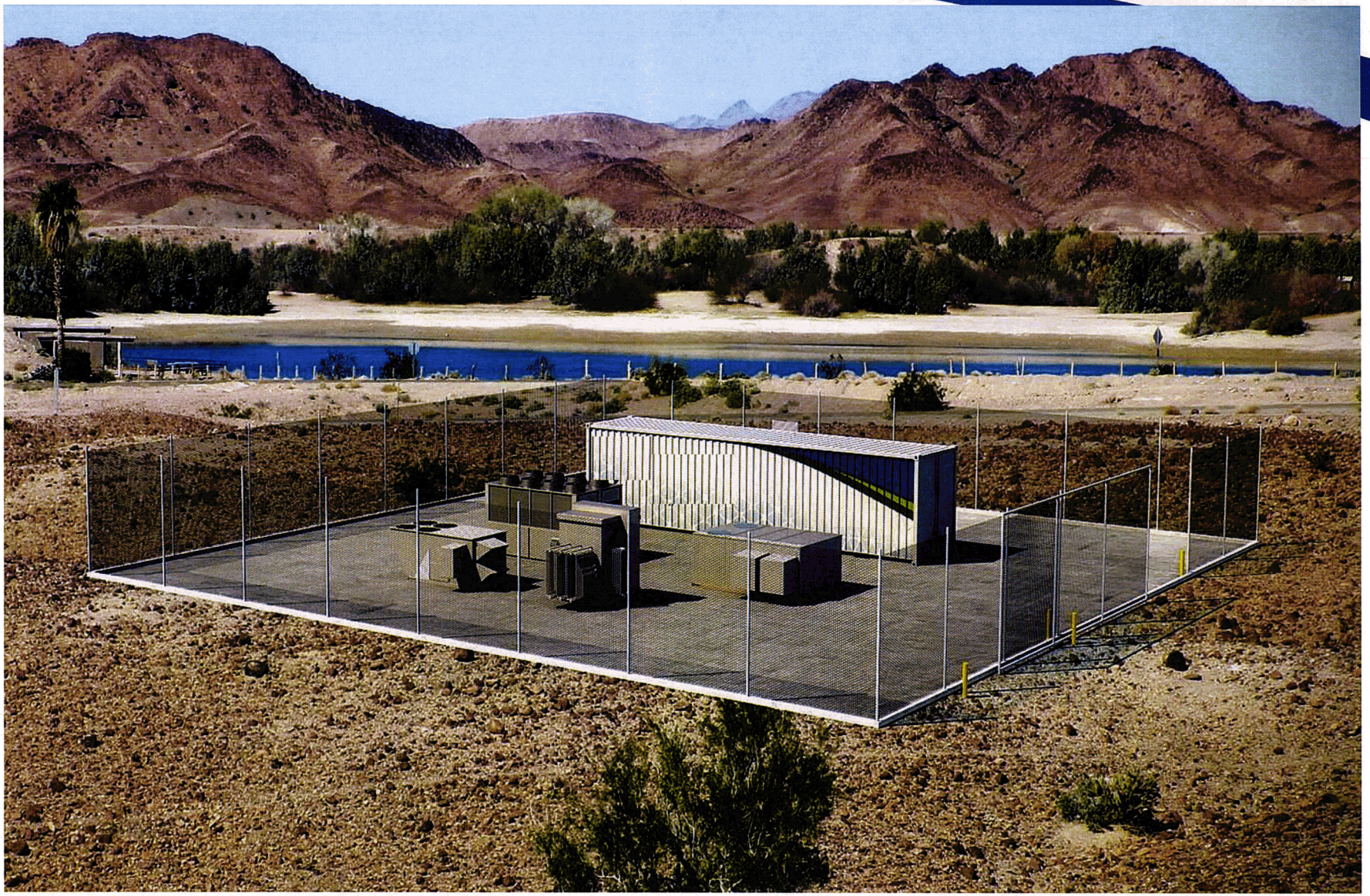
BESS Plan View





BESS Cut Away View

BESS Site Concept



IRP Stakeholder Meeting Agenda
February 9, 2016

Time	Topic	Presenter
9:00	Welcome and IRP Process	Jim Wilde
9:20	Energy Demand Forecast and Economic Conditions	Jordan Prassinos
9:40	Evolving Load Shape, Markets and Resource Implications	Jeff Burke/Pat Lowe
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10:30	Break	
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2:35	Assumptions, Portfolios & Sensitivities	Karen Hardy
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Assumptions, Portfolios and Sensitivities

Karen Hardy

February 9, 2016

Outline

Key Inputs

- Natural gas prices
- CO2 prices
- Peak capacity contributions
- Technology capital cost

Analytic Framework

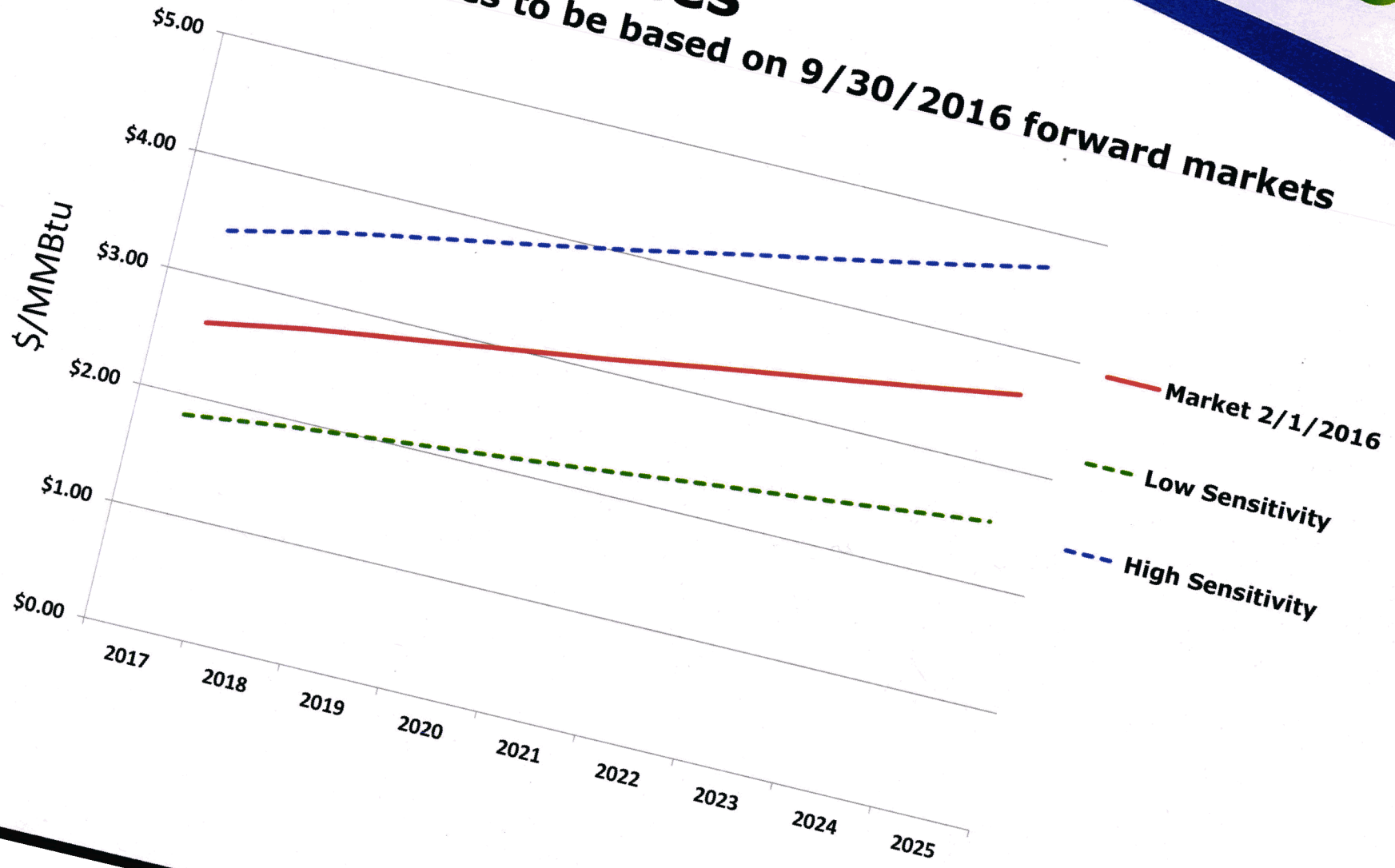
Resource Portfolios & Sensitivities

Key Inputs

	• Average annual growth rate before EE/DG of 2.5% to 3% per year; trajectory will be re-evaluated in Q3
Reserve requirements	• Minimum 15% planning reserve margin
	• Assumed rate of 2.5% per year
Cost curves	• Natural gas – to be based on 9/30/2016 forward markets • CO2 – to be based on CA carbon markets; start in 2022
	• After-tax WACC currently 7.2%

Natural Gas Prices

2017 IRP gas prices to be based on 9/30/2016 forward markets



CO2 Price Estimates

2017 IRP Values

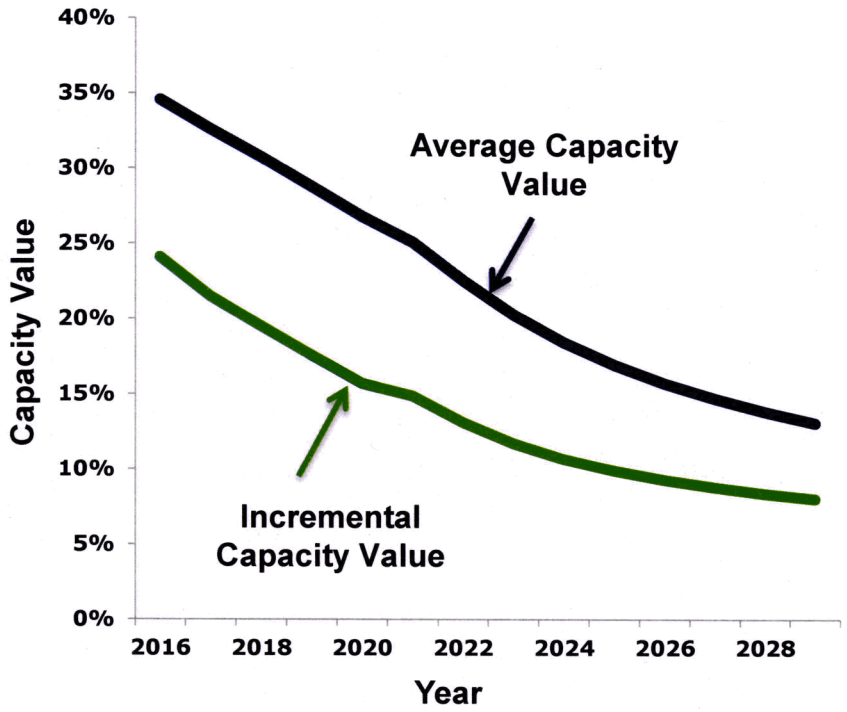
- Low price sensitivity to be zero CO2 costs
- Base price to be based on California carbon markets beginning in 2022, when EPA's Clean Power Plan compliance begins
- High price sensitivity - TBD

Capacity Values – Renewables

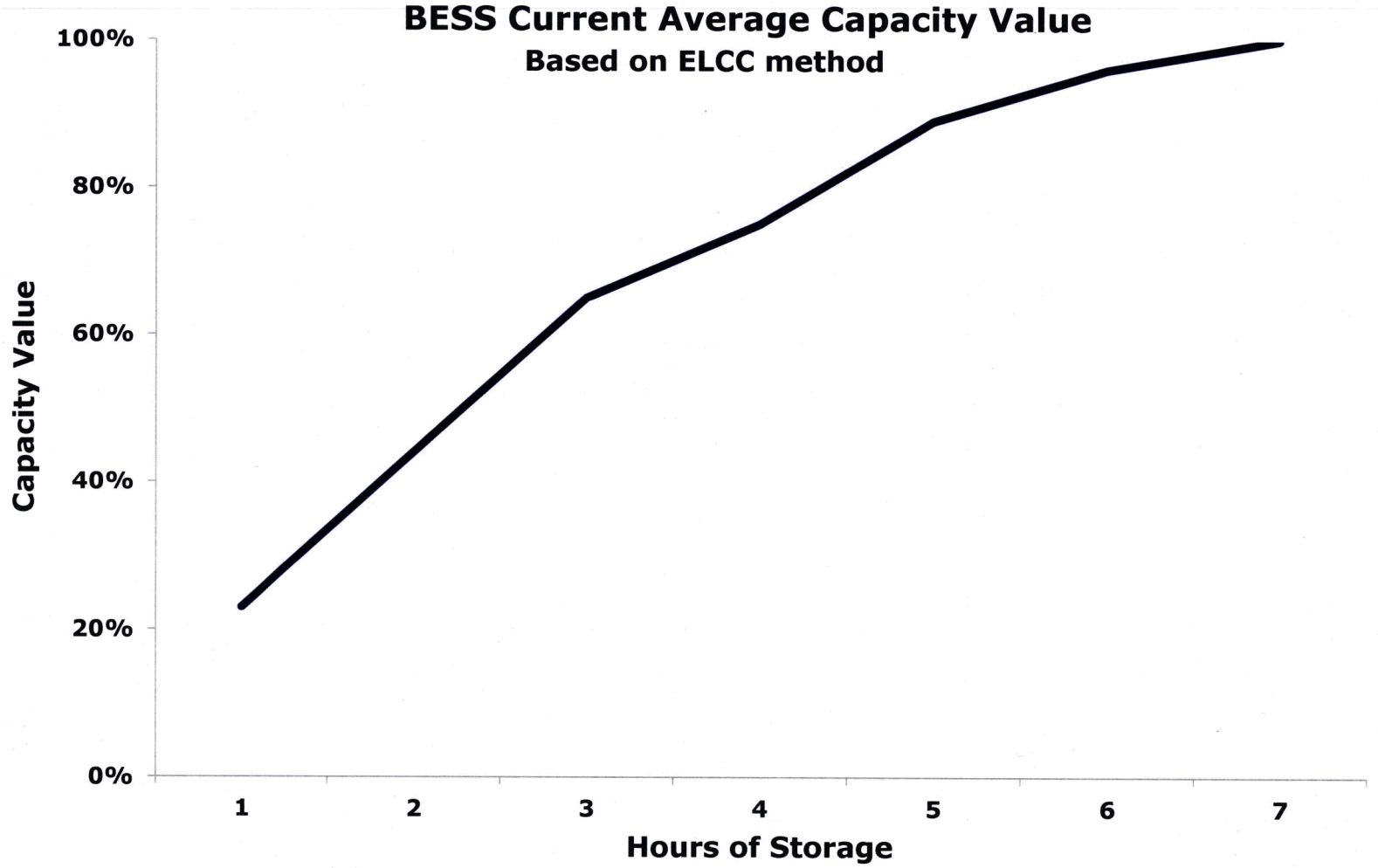
Current Average Values
Based on ELCC method

Solar PV – Single Axis Tracking	62%
Solar PV – Fixed Position	35%
Wind	20%
Geothermal	100%
Biomass / Biogas	100%

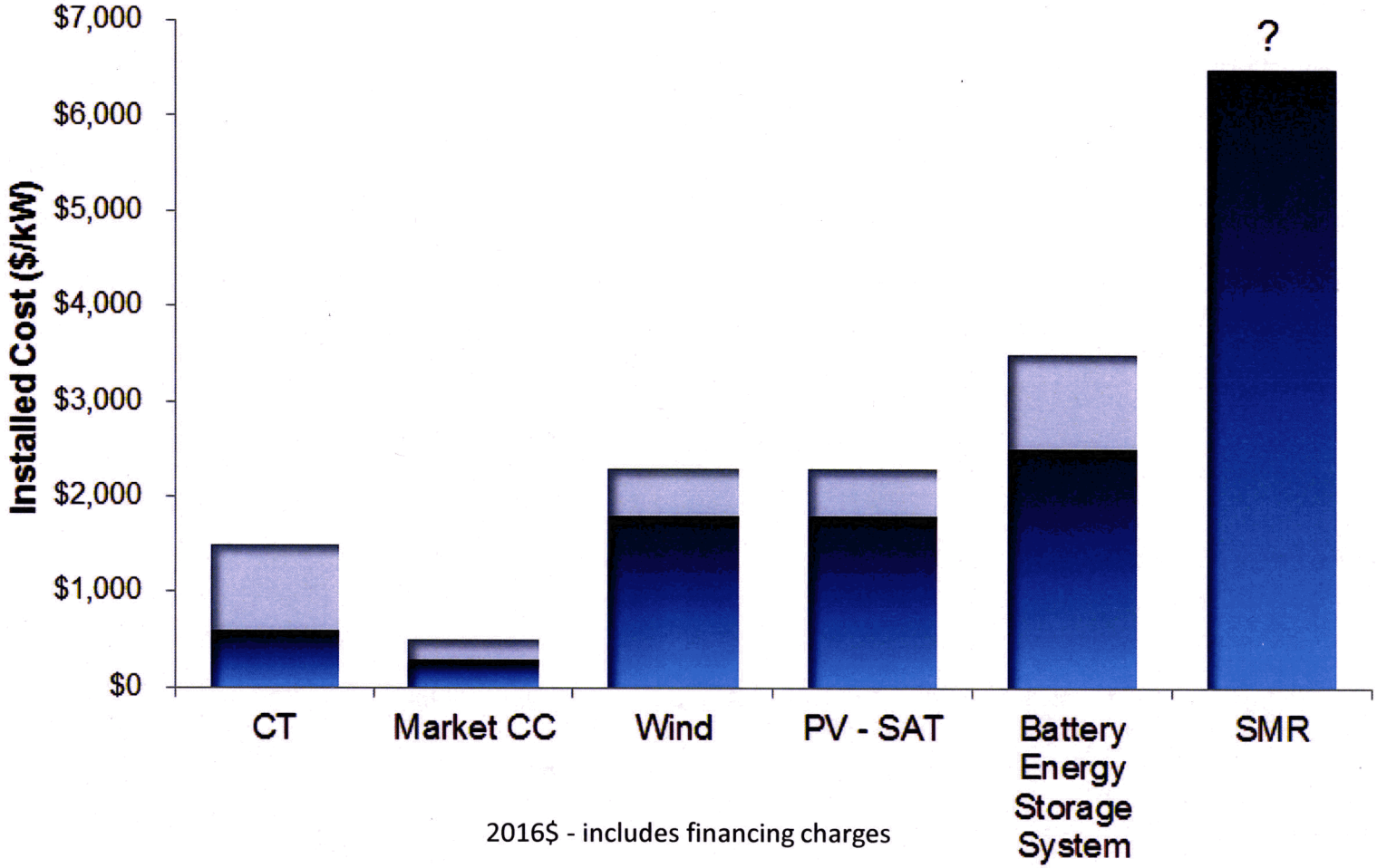
Fixed Position PV Capacity Values
Based on ELCC method



Capacity Values – Energy Storage

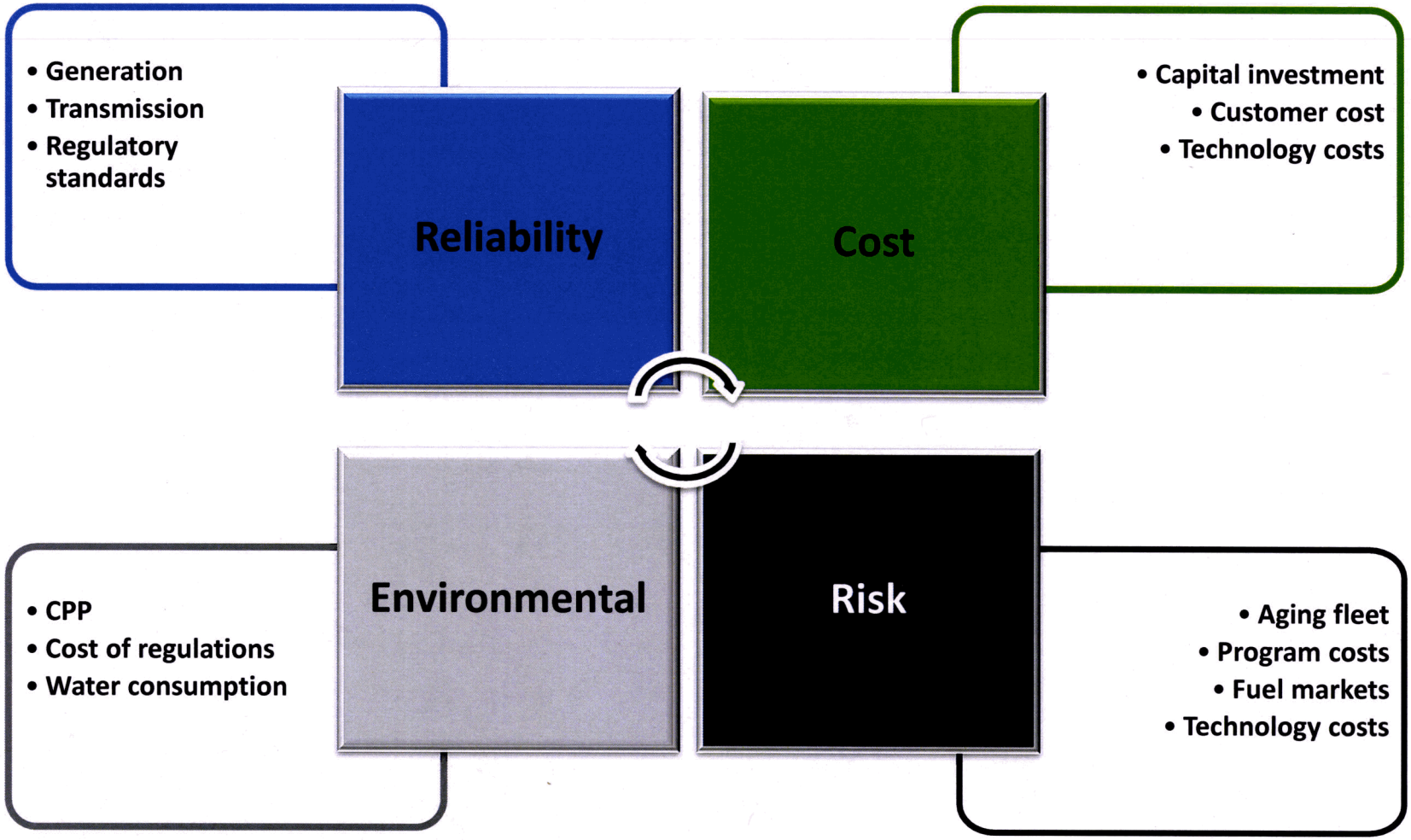


Technology Capital Cost
2016 Installation



2016$ - includes financing charges

Analytic Framework



Portfolios and Sensitivities

Portfolios

- Generation capacity expansion model selects optimal portfolio
- Adjust model to force selection of desired level of study resource
- Demonstrate how portfolio costs compare relative to each other, depending on resource selection

Sensitivities

- Adjust individual variables such as load forecast, gas prices, emission prices, etc.
- Demonstrate how portfolio costs move with uncertain variables
- Demonstrate robustness of each portfolio relative to adjustments in variables

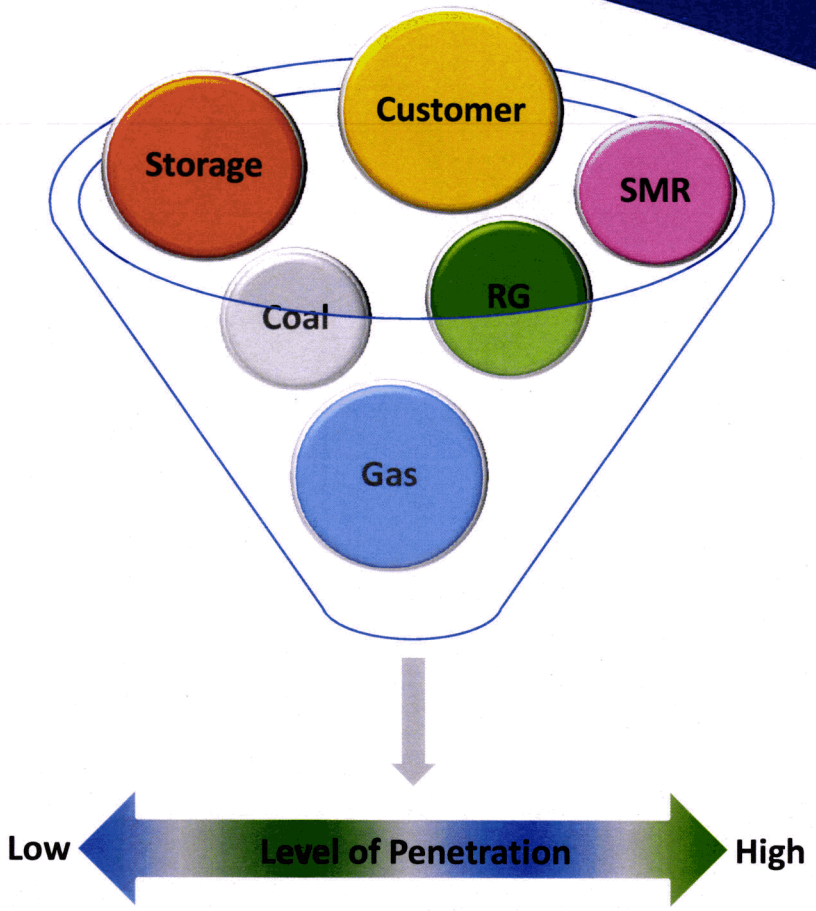
Considerations

Resource Variables

- Coal
- Natural gas
- Renewable generation
- Energy storage
- Small modular reactors
- Customer side resources
- Others ?

Input Variables

- Natural gas pricing
- Carbon pricing
- Load forecast
- Technology pricing
- Others?



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2016 All Source RFP Solicitation Overview

Sobia Naqvi
Jason Spitzkoff

February 9, 2016

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2016 All Source Agenda

1. Resource Parameters
2. Resource Need
3. RFP Timeline
4. RFP Deliverability Guidelines
5. Closing Points

RFP Parameters

- APS is seeking competitive proposals for capacity resources totaling approximately 400-600 MW
- This RFP will be open to both supply side and non-supply side technologies
- The following technologies shall be considered:
  - Thermal Generation
  - Energy Storage
  - Renewables
  - Non-Supply Side Technologies
  - Other applicable
- For supply side resources, each proposed facility must be a minimum of 25 MW in size, located on a single site
- For non-supply side, the minimum requirement is 25 MW aggregated program

RFP Parameters

- The following contract structures shall apply:
  - Tolling Power Purchase Agreements for Thermal Technologies
  - Asset Purchase Agreement of existing Thermal Technologies
  - Energy Storage Tolling Agreement
  - Renewable Energy Power Purchase Agreement
  - Load Management Agreement

- Delivery to APS under each Proposal must begin no earlier than January 1, 2020, and no later than June 1, 2020.

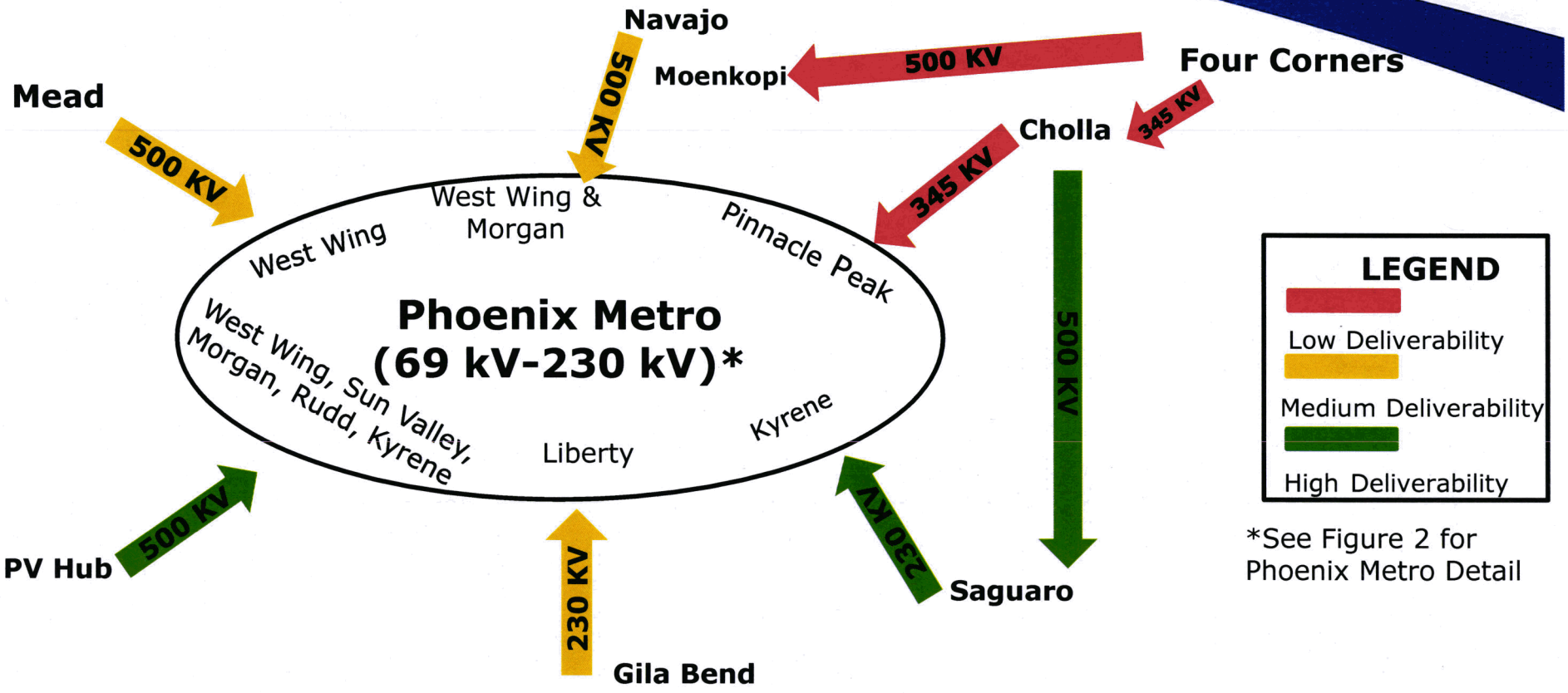
2016 All Source Resource Need

- 400-600 MW
- Capacity Need
- Dispatchable Products Preferred
- June through September
- Hours between 3pm to 9pm
- Delivered to APS Transmission System

2016 All Source Milestone Timeline

2016 All Source RFP Announcement	January 21, 2015
2016 All Source RFP Information Update	November 20, 2015
IRP Stakeholder Workshop	February 9, 2016
RFP Issued	March 11, 2016
RFP Bidder's Webinar	March 23, 2016
Notice of Intent to Bid	April 5, 2016
Confidentiality Agreement Due	May 11, 2016
RFP Responses Due	June 9, 2016
Shortlist Announced	September 15, 2016
Contract (s) Executed	March 31, 2017

2016 All Source High Voltage Deliverability

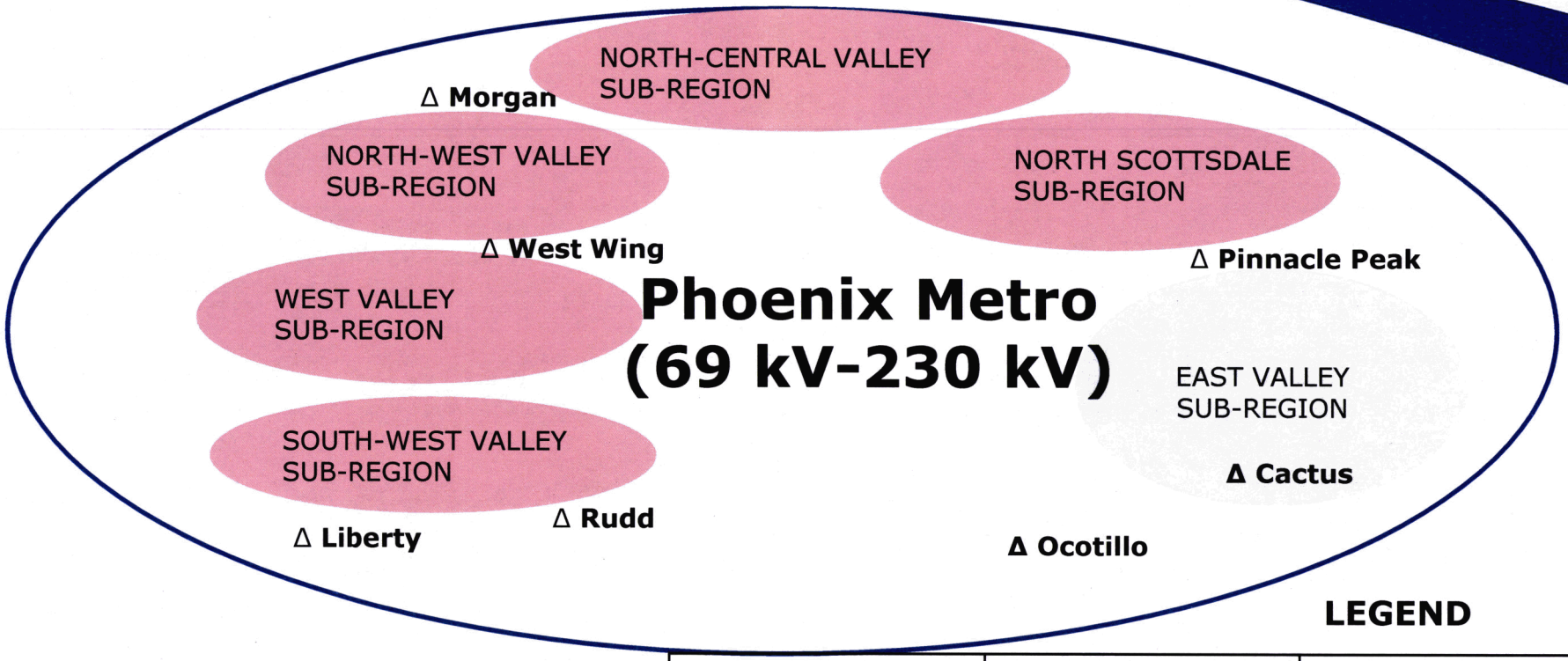


*See Figure 2 for Phoenix Metro Detail

2020 Indicative guideline for Deliverability of Product to APS Phoenix Metro load pocket for purposes of the 2016 All-Source RFP NOTES:

1. Information represented has been prepared by Resource Planning as an indicative guideline for 2020 Deliverability of Product to APS Phoenix Metro load pocket as currently estimated for purposes of the 2016 All Source RFP.
2. Deliverability rating is representative of current estimations of Deliverability in 2020.
3. Information does not represent official Available Transmission Capacity.
4. Official Available Transmission Capacity can be found on Oasis.
5. Information in these figures is NOT intended to provide definitive guidance to any potential bidder regarding the specifics of the transmission system that may be applicable to bidder's proposed facility. All bidders are responsible for performing their own independent evaluation of the transmission system as it may affect their proposed facilities.

2016 All Source Metro Phoenix Deliverability



LEGEND

	230 kV	69 kV
	Deliverability Limited by 69 kV	**Medium Deliverability**: 25 MW in one location. Total of 50 MW in each sub-region
	Highest Deliverability: 50-100 MW in one location on 230 KV system	**Highest Deliverability:** 25 MW in one location. Total of 80 MW on 69 kV system

2020 Indicative guideline for Deliverability of Product within APS Phoenix Metro load pocket for purposes of the 2016 All-Source RFP

Note:

- Substations identified for geographical purposes only. Substation identification does not imply APS ownership.

Closing Points

- Instructions and updates will be on

www.aps.com/rfp

- Key Points
  - Release of RFP March 11
  - Bidder's Webinar March 23
  - All communications during RFP must be through Power Advocate

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