REVISED 9-6-16

- DSM appendix slides - real $ noted
- Added slides 50 - 56

# Integrated Resource Plan
# Public Advisory Meeting #3

August 16, 2016

# Welcome & Safety Message

Bill Henley, VP of Regulatory and Government Affairs

# Meeting Guidelines

Joan Soller, Director of Resource Planning

# Agenda for today

9:30am Welcome
- Meeting Agenda and Guidelines
- Summary & Feedback from IRP Public Advisory Meeting #2

9:45am IRP modeling update
- Updates to modeling
- Draft model results for all scenarios

10:30am Stakeholder Feedback

10:45am Sensitivity analysis setup

11:30am Conclusion

# Meeting Guidelines

- Time for clarifying questions at end of each presentation
- Small group discussions
- Three ways to participate remotely:
  - The phone line will be muted. Press *6 to un-mute your line, and please remember to press *6 again to re-mute when you are finished asking your question.
  - Use WebEx online tool for questions during meeting
  - Email additional questions or comments to ipl.irp@aes.com
- All may email questions/comments by August 23 for IPL to respond via website by September 6

# Active cases before the commission

- Cause No. 42170, ECR-26
- Cause No. 44121, Green Power (GPR 9)
- Cause No. 43623, DSM 13
- Cause No. 44576, Rates (under appeal)
- Cause No. 44792, DSM 2017 Plan
- Cause No. 44794, $SO_2$ NAAQS and CCR
- Cause No. 44795, Capacity and Off System Sales Riders

# Summary & Feedback from IRP Public Advisory Meeting #2

Joan Soller, Director of Resource Planning

# Topics covered in Meeting #2

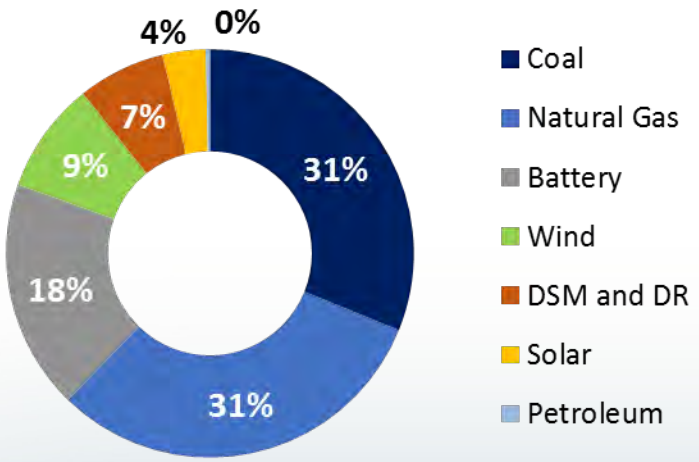
- Stakeholder presentations
- Portfolio Comparison based on Metrics
- Transmission & Distribution
- Load Forecast
- Environmental Risks
- Portfolio and Metrics Exercises
- Draft base case results

- Presentation materials, audio recording, acronym list, and meeting notes are available on IPL's IRP webpage here: https://www.iplpower.com/irp/

# Stakeholder interaction continues

- Since the June meeting, IPL has reached out to the following stakeholders:
  - Citizens Energy
  - Hoosier Interfaith Power & Light (HIPL)
  - IPL Advisory Board
  - National Association for the Advancement of Colored People (NAACP)

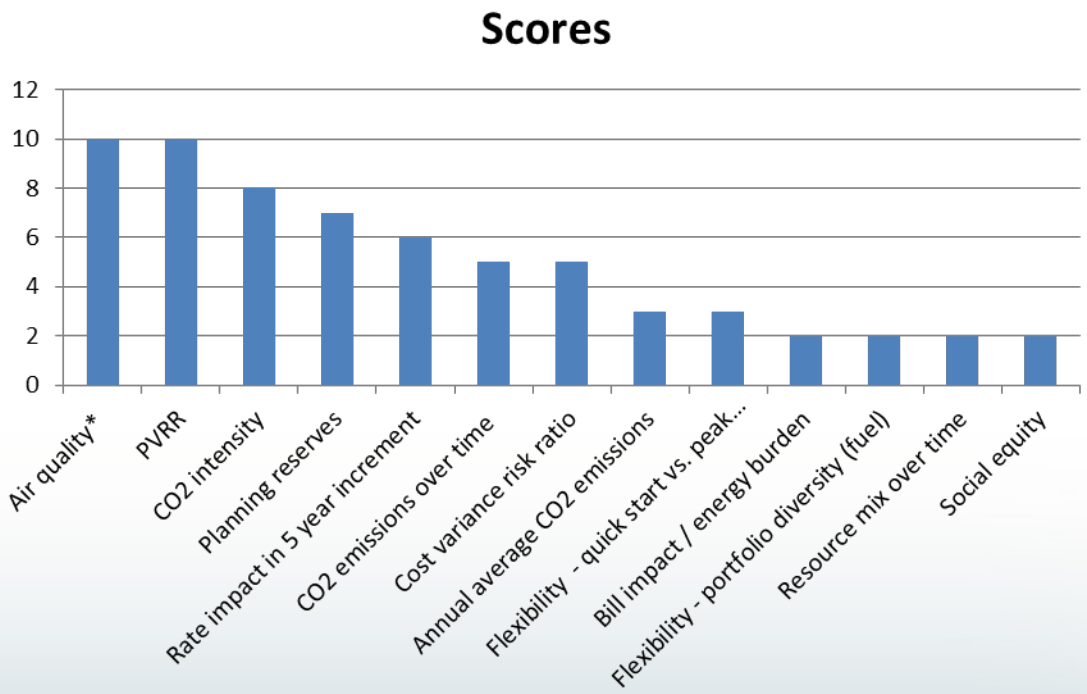
# Stakeholder portfolio exercise feedback




| Resource | Potential IPL 2034 Portfolio June 2016 | Range of Stakeholder Preferred Capacity Percentage |
|---|---|---|
| Coal | 32% | 0 – 30% |
| Natural Gas | 31% | 0 – 35% |
| Battery | 18% | 5 – 18% |
| Wind | 9% | 9 – 30% |
| DSM | 7% | 7 – 20% |
| Solar | 3% | 6 – 30% |
| Oil | 0% | 0 – 10% |

# Stakeholder metrics exercise feedback

| Metrics | Scores |
|---|---|
| Air quality* | 10 |
| PVRR | 10 |
| $CO_2$ intensity | 8 |
| Planning reserves | 7 |
| Rate impact in 5 year increment | 6 |
| $CO_2$ emissions over time | 5 |
| Cost variance risk ratio | 5 |
| Annual average $CO_2$ emissions | 3 |
| Flexibility - Quick start vs. peak load | 3 |
| Bill impact / energy burden | 2 |
| Flexibility - Portfolio diversity (fuel) | 2 |
| Resource mix over time | 2 |
| Social Equity | *2* |




green = stakeholder proposed

blue= IPL proposed

*other pollutants including PM, NOx, SO2, methane emissions

# Questions?

# IRP Modeling Update

Joan Soller, Director of Resource Planning

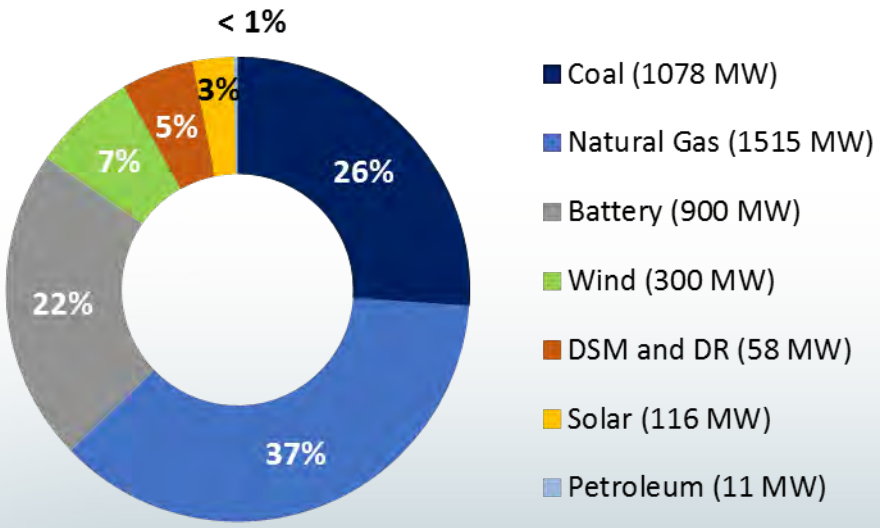
# Base case has evolved since last meeting

- Incorporated NERC standards voltage stability requirements
  - Minimum 450 MW baseload on 138 kV in addition to EV CCGT
- Adjusted battery capacity credit to 25% to represent 4 hour energy output durations
- Added wind parameters
  - Capacity credit in 2022 as a proxy for expected transmission expansion
  - Frequency response (via energy storage) per proposed order in FERC docket RM 16-6 and reactive power (via quick capacitors) provisions per recent FERC Order 827
  - Limit 250 MW per year and total of 1000 MW to mirror minimum loads

# Base case comparison

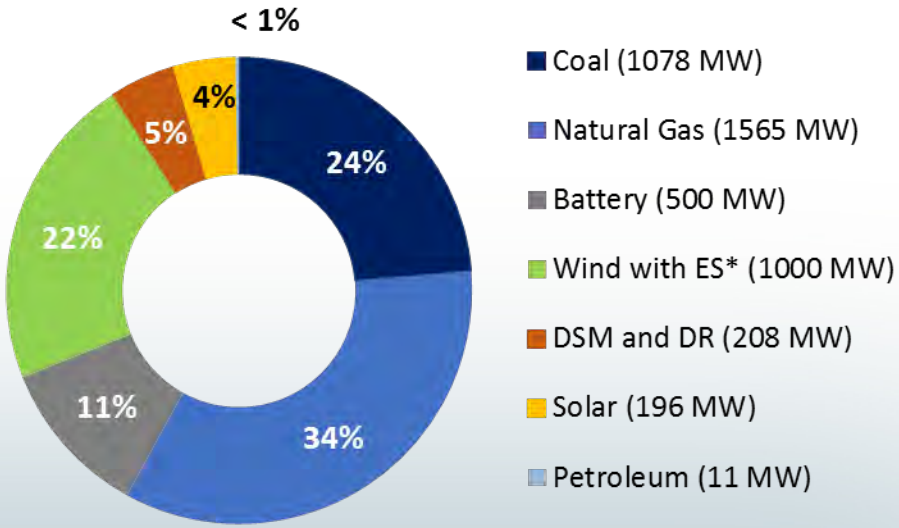
## Initial Base Case (June 2016)

**Potential IRP 2036 Portfolio (operating capacity)**



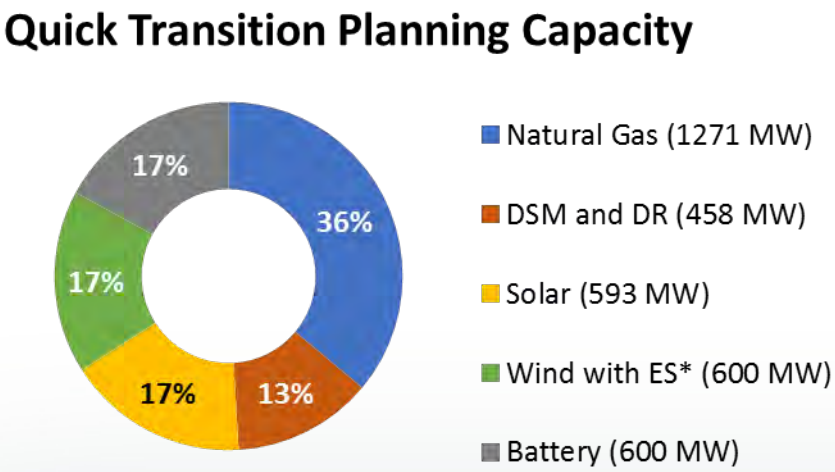

## Final Base Case (Aug 2016)

**Potential IPL 2036 Portfolio (operating capacity)**




*Wind resources are paired with Energy Storage (ES) in anticipation of proposed FERC rule for frequency response.

# IPL created a Quick Transition Scenario to reflect Stakeholder feedback




Inputs:

- All coal units retire by 2030
- Retain minimum NG on local 138 kV system to meet NERC standards
- Adopt maximum achievable DSM
- Balance comprised of solar, wind and storage

*Wind resources are paired with Energy Storage (ES) in anticipation of proposed FERC rule for frequency response.

# Summary of scenarios

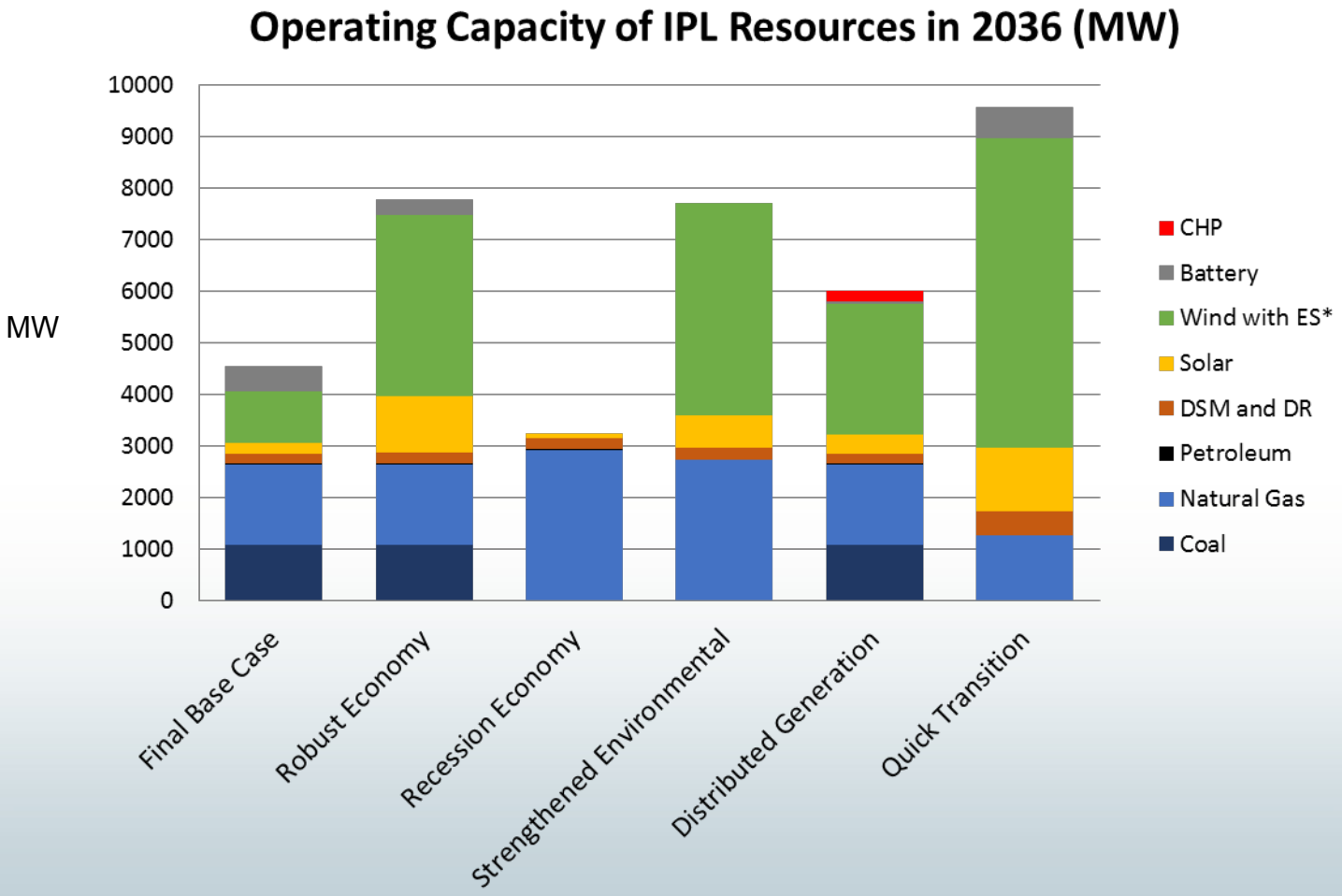
1. Base Case
2. Robust Economy
3. Recession Economy
4. Strengthened Environmental Rules
5. High Adoption of Distributed Generation
6. Quick Transition

# Scenario Characteristics/Variable Drivers

| | Scenario Name | Load Forecast | Natural Gas and Market Prices | Clean Power Plan (CPP) and Environment | Distributed Generation (DG) |
|---|---|---|---|---|---|
| 1 | Base Case | Use current load growth methodology | ABB Mass-based CPP Scenario | Mass-based CPP starting in 2022. Low cost environmental regulations: ozone, 316b, NSR, and CCR | Expected moderate decreases in technology costs for wind, storage, and solar |
| 2 | Robust Economy | **High*** | **High*** | Base Case | Base Case |
| 3 | Recession Economy | **Low*** | **Low*** | Base Case | Base Case |
| 4 | Strengthened Environmental Rules | Base Case | Base Case | **20% RPS + high carbon costs. High costs: NAAQS ozone, 316b, OSM, NSR*** | Base Case |
| 5 | Distributed Generation | Base Case | Base Case | Base Case | **Base case with fixed additions of 150 MW in 2022, 2025, and 2032*** |
| 6 | Quick Transition | Base Case | Base Case | Base Case | **Fixed portfolio to retire coal, add max DSM, minimum baseload (NG), plus solar, wind and storage*** |

***Purple font indicates changes.**

# Scenarios produce varied expansion plans

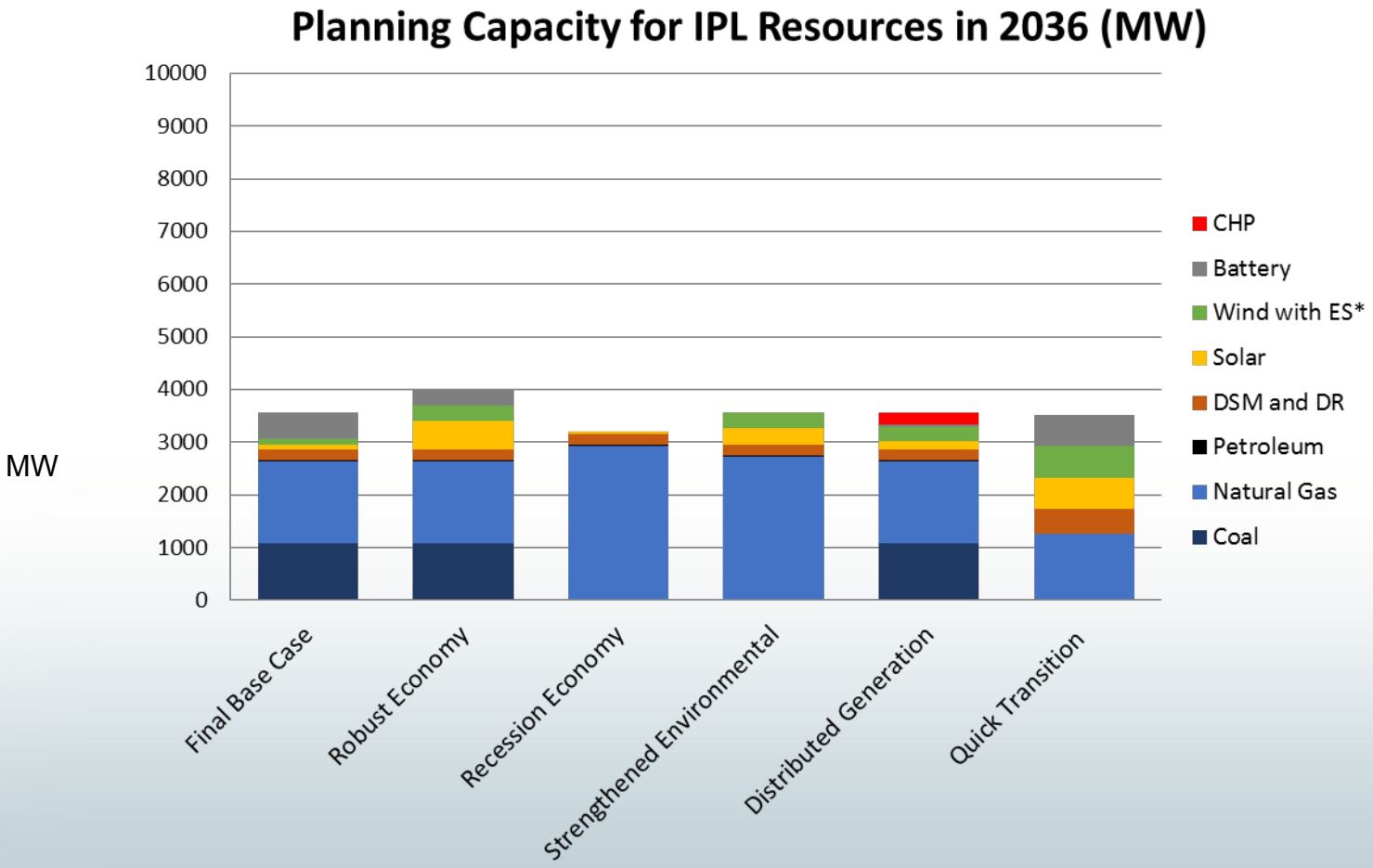



*Wind resources are paired with Energy Storage (ES) in anticipation of proposed FERC rule for frequency response.

# Scenario observations

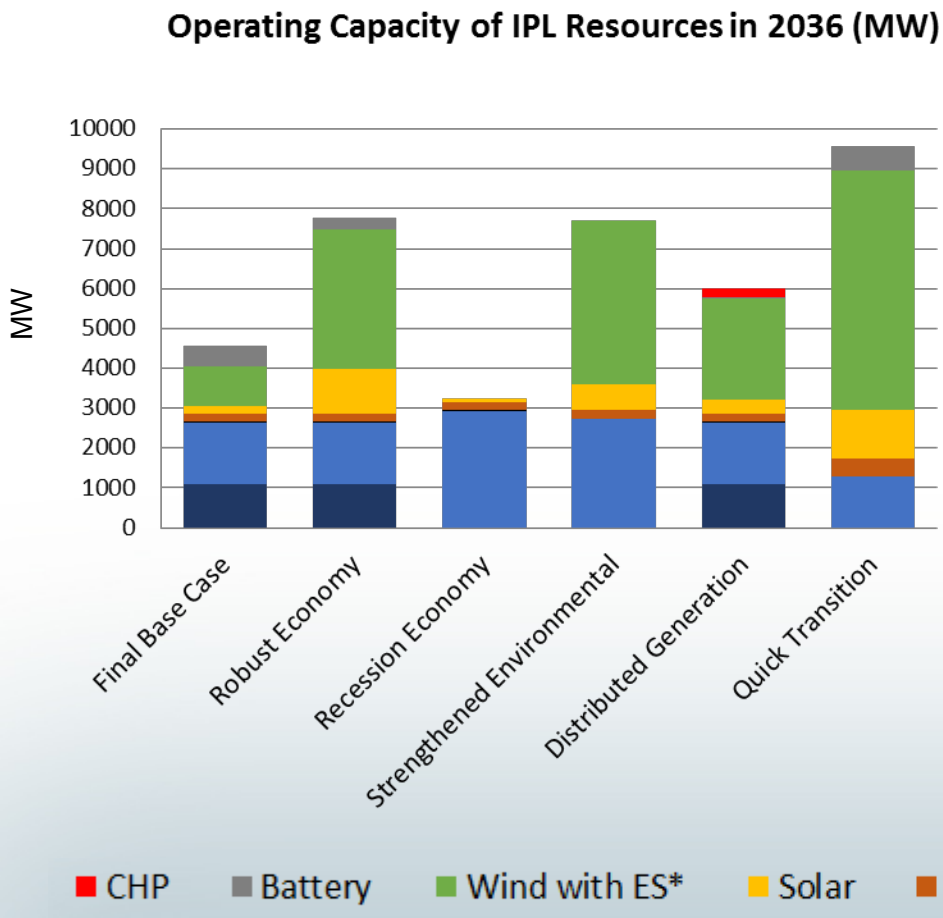
| | |
|---|---|
| **Base Case** | Assumes existing units operate through their estimated useful life. |
| **Robust Economy** | Load increased by ~370 MW with higher NG prices. |
| **Recession Economy** | Load decreased by ~300 MW, lower NG, includes Pete 1-4 refuel early. |
| **Strengthened Environmental** | Higher costs for $CO_2$, 316 b, NAAQS ozone, OSM, and NSR. Includes P1 retirement, P2-4 refuel. |
| **Distributed Generation** | Customers choose DG for reasons other than economics totaling ~450 MW or ~15% of IPL load. |
| **Quick Transition** | Asset additions are "lumpy“ in 2030 when there is an inflection point in Clean Power Plan compliance. The Maximum Achievable Potential DSM was added. |

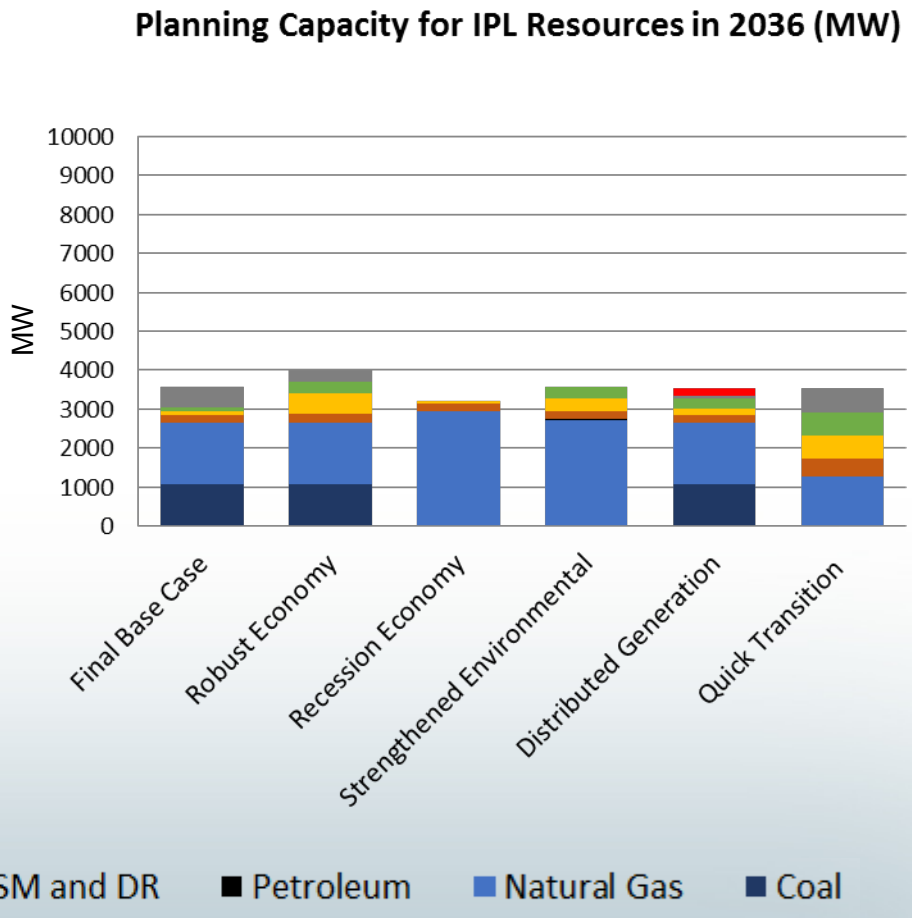
# Planning capacity provides resource adequacy in MISO




*Wind resources are paired with Energy Storage (ES) in anticipation of proposed FERC rule for frequency response.

# Planning capacity for renewables is lower than operating capacity

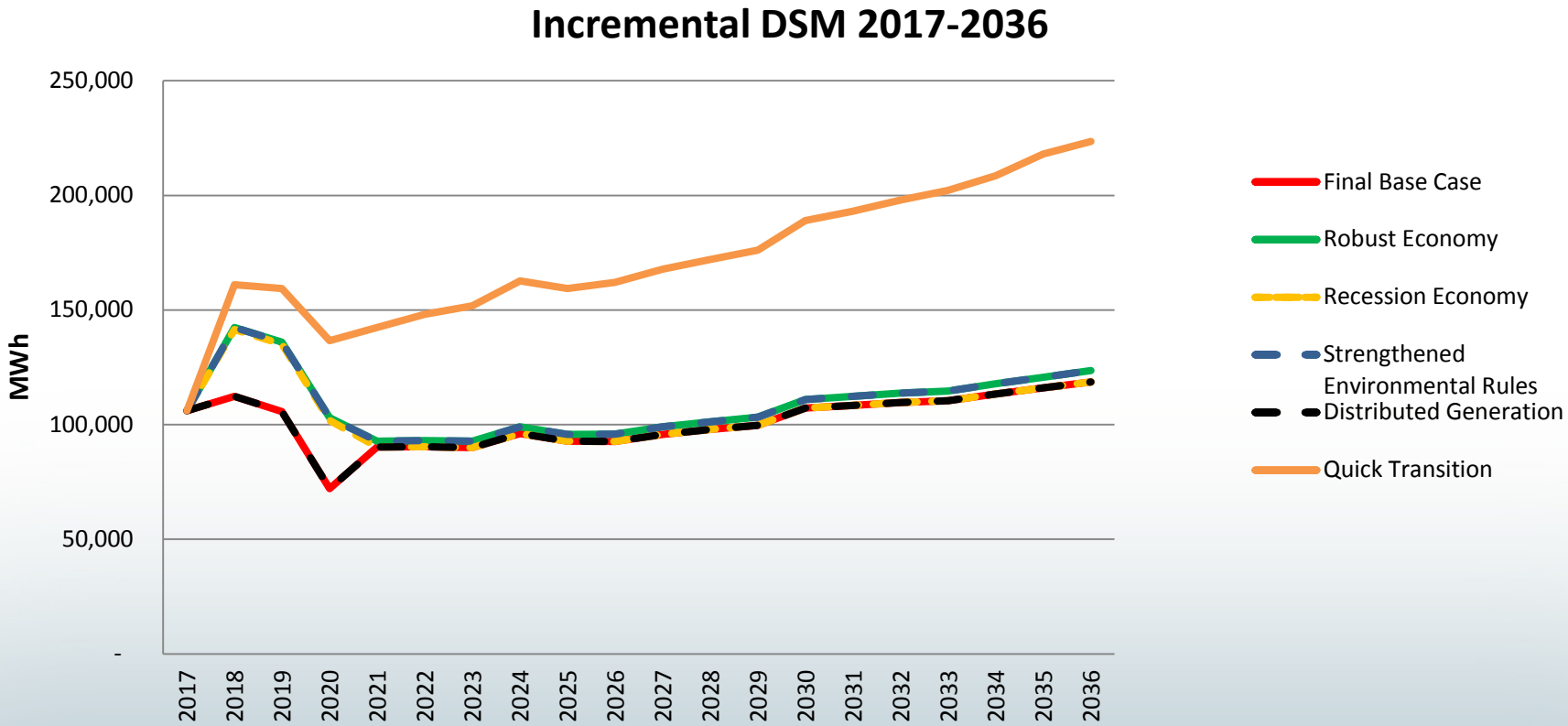


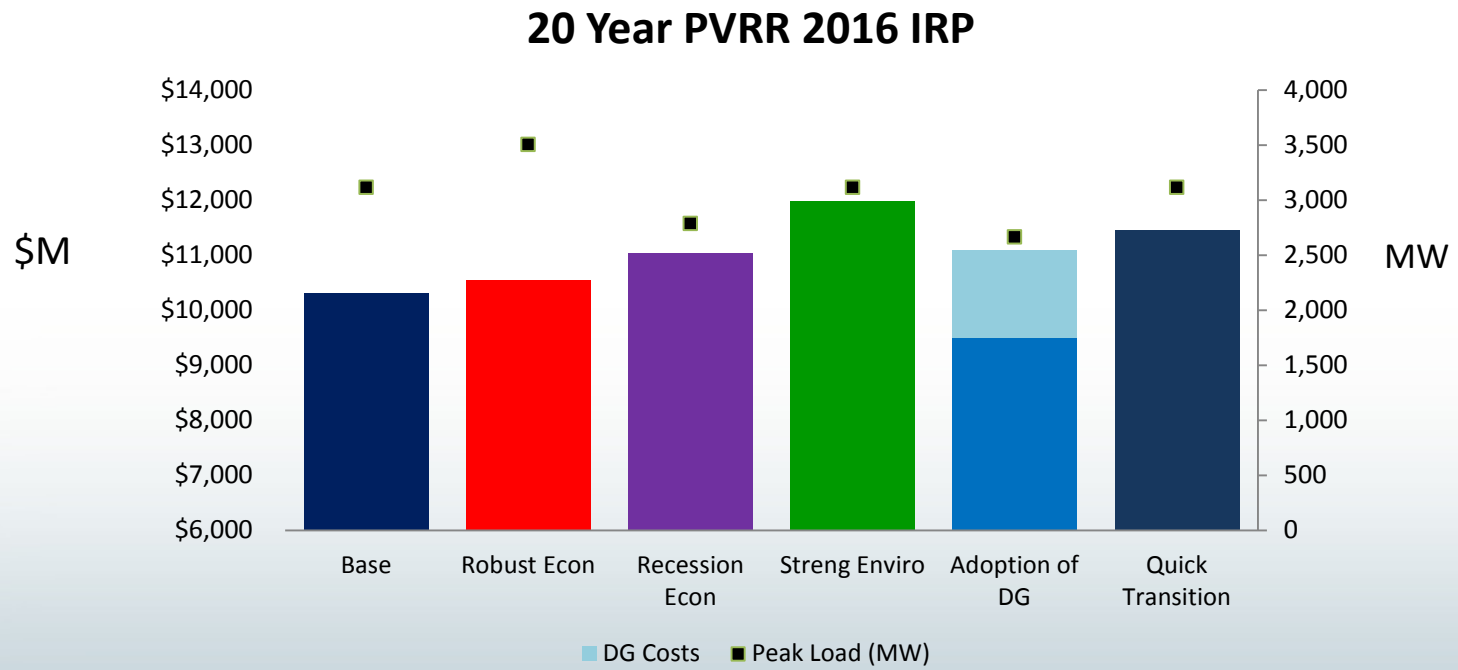

CHP | Battery | Wind with ES* | Solar | DSM and DR | Petroleum | Natural Gas | Coal

*Wind resources are paired with Energy Storage (ES) in anticipation of proposed FERC rule for frequency response.

# DSM varies by scenario



# Costs are shown as Present Value Revenue Requirement (PVRR) 2017 - 2036




*Light blue DG costs are estimated for 450 MW. Customer DG costs will vary.

# Questions?

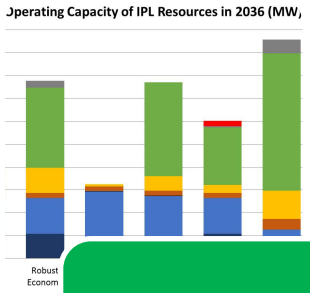
# Sensitivity Analysis Setup

Patrick Maguire
Director, Corporate Planning & Analysis

# Sensitivity analysis plan

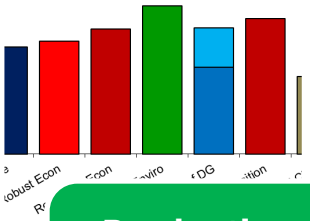
- Two deterministic carbon sensitivities for the base case
  - Delayed CPP from 2022 to 2030
  - High carbon cost for CPP
- Stochastic modeling for all portfolios
  - Multiple inputs varied in each model run
    - Examples: Load (peak and energy), commodity prices, carbon prices, capital costs, forced outage rates

# IRP modeling process



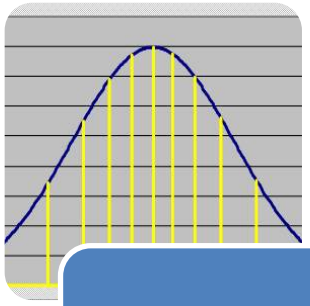

**Deterministic Capacity Expansion Model**

**Complete**



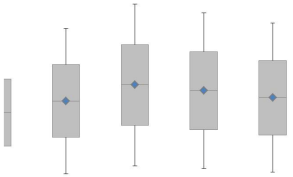
**Production Cost Model Run with Base Assumptions for All Portfolios**

**Complete**



**Stochastic Parameter Setup**

*In Progress*



**Stochastic Modeling and Risk Analysis**

*In Progress*

# Two modeling approaches

## Deterministic Model

Scenario

↓

CapEx Resource Plan

↓

Sensitivity a

e.g. NG ↑
NG ↑+ Load ↑

Sensitivity b

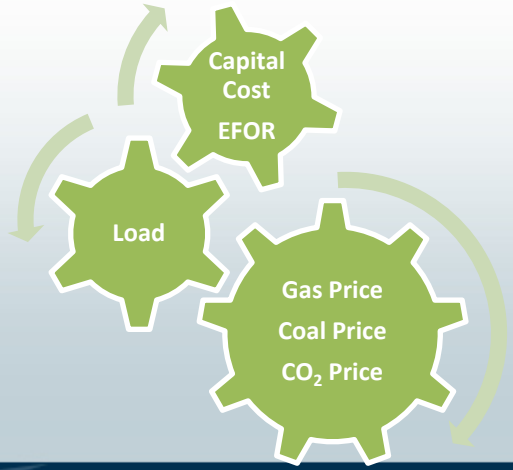
e.g. NG ↓
NG ↓+ Load ↓

## Stochastic Model

Scenario

↓

CapEx Resource Plan




*Example:*
10 variables
X 10 draws
100 iterations for each portfolio

# Why model stochastically?

## Deterministic Model

### *Advantages*

- Easy to administer with no formal probability calculations
- Can be comprehensive with the right amount and combination of variables

### *Shortcomings*

- More qualitative setup, e.g. variables changed by user-defined known and fixed amounts
- Difficult to capture correlations between variables

## Stochastic Model

### *Advantages*

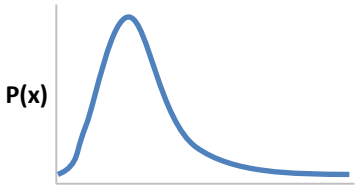
- More robust accounting for interrelatedness and correlation between variables
- Well-established statistical principles and common use guide the setup

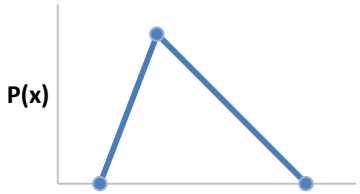
### *Shortcomings*

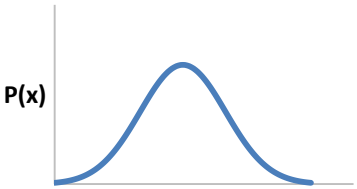
- Difficult to perform and consolidate statistical probability data and correlations
- All variable iterations fed into Integrated Model to generate power prices => significantly higher amount of model simulation time

# Parameter setup

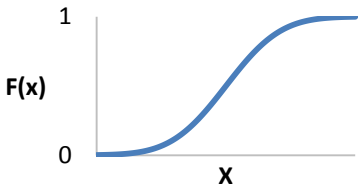
**Define the distribution**




**Determine Cumulative Distribution**

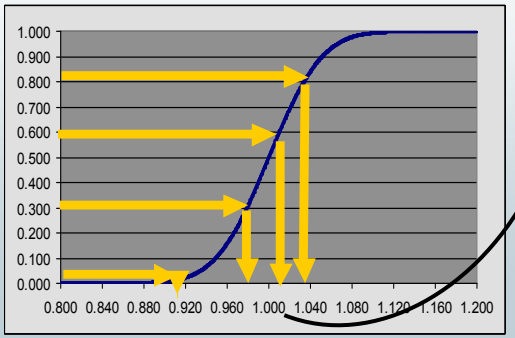



**Pick a random number**

**Use random number to get to multiplier**

*Account for specific variable characteristics:*

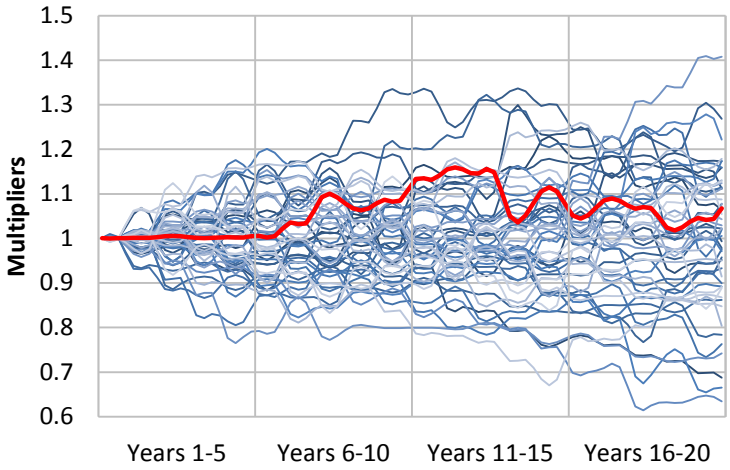
- *Random Walking*
- *Mean Reversion*
- *Seasonality*
- *Skewness*
- *Kurtosis*

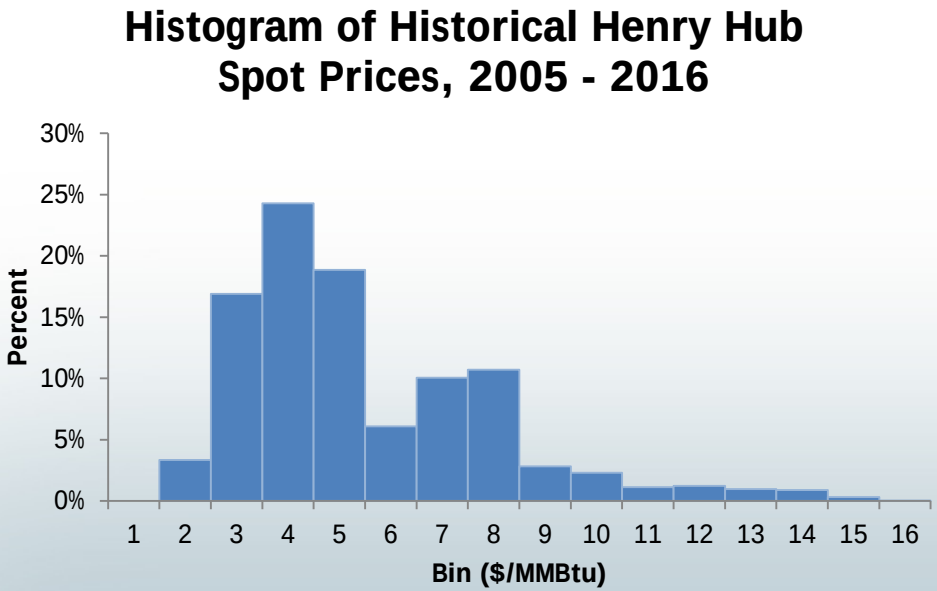


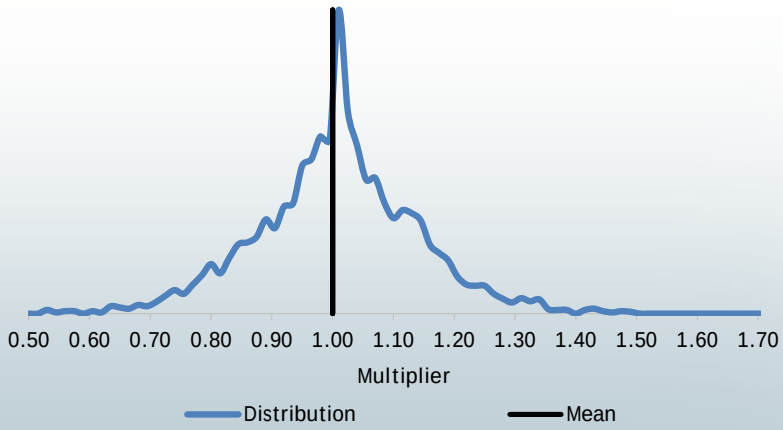

| |
|---|
| 1.037 |
| 0.980 |
| 0.952 |
| 1.005 |
| 1.002 |
| 1.013 |
| 1.003 |

# Stochastic Parameter: Gas

Well established market with extensive historical data



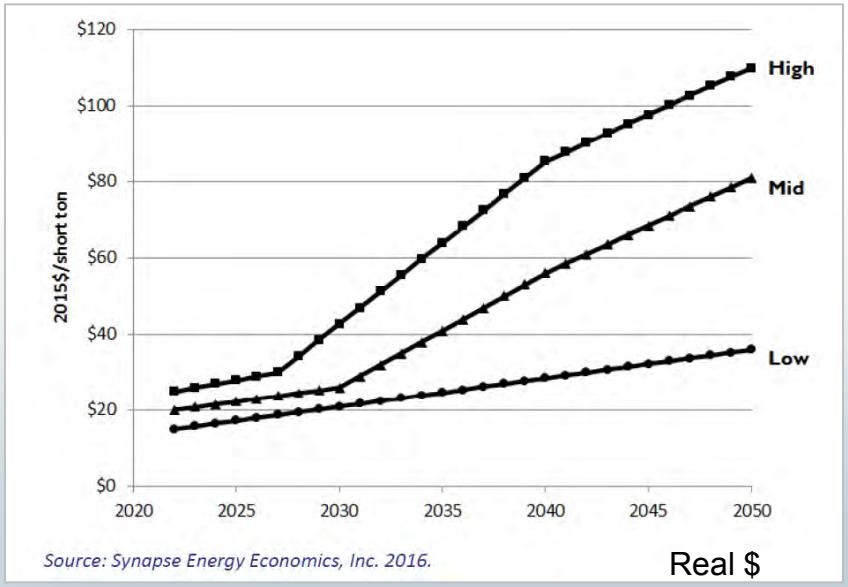



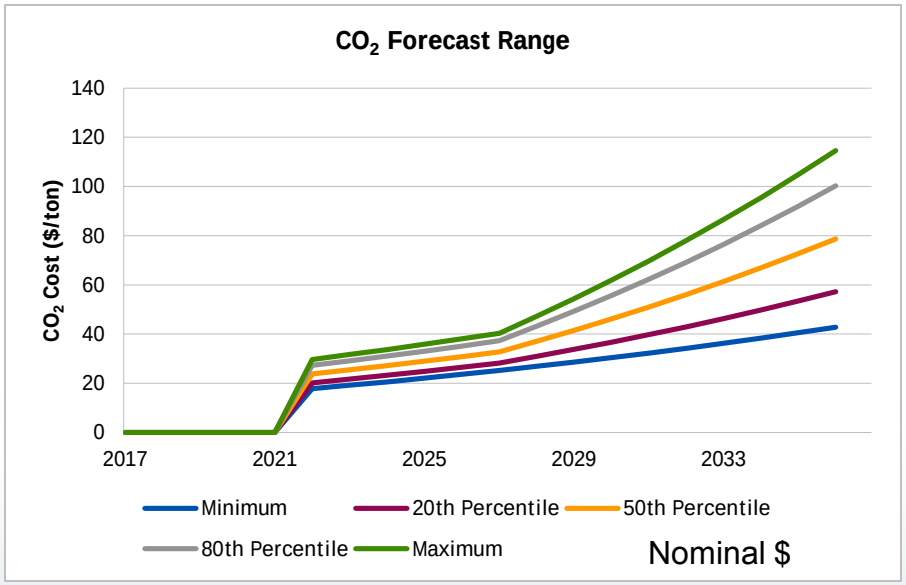



# Stochastic Parameter: $CO_2$

Lack of historical pricing complicates variable setup

Synapse forecasts guided the range of outcomes



# Use of Stochastic Parameters

***ILLUSTRATIVE PURPOSES ONLY***

**Variable Multipliers**

| Draw | Gas Price | Coal Price | Demand | etc. |
|---|---|---|---|---|
| 1 | 1.10 | 1.00 | 1.15 | ... |
| 2 | 1.18 | 1.06 | 1.01 | ... |
| 3 | 1.15 | 1.08 | 1.14 | ... |
| 4 | 0.97 | 0.97 | 1.03 | ... |
| 5 | 1.06 | 1.04 | 1.08 | ... |
| 6 | 1.04 | 0.98 | 1.11 | ... |
| 7 | 1.07 | 0.95 | 1.11 | ... |
| 8 | 1.09 | 1.07 | 0.95 | ... |
| 9 | 1.10 | 1.00 | 1.00 | ... |
| 10 | 1.06 | 1.07 | 0.99 | ... |
| 11 | 0.97 | 1.04 | 1.15 | ... |
| 12 | 1.15 | 1.08 | 0.97 | ... |
| 13 | 1.15 | 1.01 | 1.14 | ... |
| 14 | 1.01 | 1.04 | 1.10 | ... |
| 15 | 1.18 | 1.03 | 1.10 | ... |

*Fundamental Forecasts*

**Market Price Model**

| Draw | Power Price |
|---|---|
| 1 | $40.50 |
| 2 | $37.97 |
| 3 | $51.53 |
| 4 | $31.25 |
| 5 | $37.35 |
| 6 | $36.09 |
| 7 | $35.60 |
| 8 | $34.20 |
| 9 | $34.09 |
| 10 | $35.22 |
| 11 | $36.99 |
| 12 | $37.36 |
| 13 | $41.81 |
| 14 | $36.73 |
| 15 | $41.87 |

**Strategic Planning Model**

PVRR ($ in Billions)

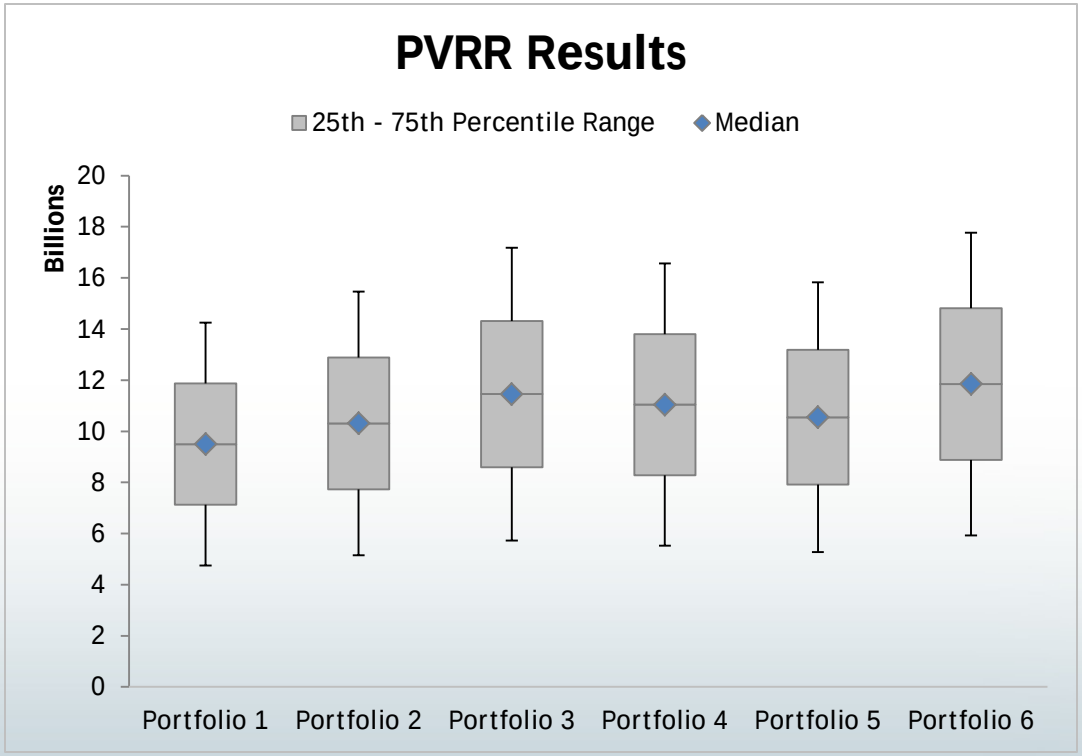
| Draw | Portfolio 1 | Portfolio 2 | Portfolio 3 |
|---|---|---|---|
| 1 | $9.6 | $10.8 | $10.4 |
| 2 | $10.1 | $10.6 | $7.7 |
| 3 | $10.9 | $12.2 | $8.6 |
| 4 | $8.7 | $9.4 | $10.6 |
| 5 | $9.2 | $12.8 | $7.6 |
| 6 | $8.4 | $10.8 | $9.7 |
| 7 | $10.3 | $12.4 | $10.9 |
| 8 | $11.2 | $11.1 | $8.9 |
| 9 | $7.9 | $8.3 | $10.0 |
| 10 | $8.8 | $12.5 | $8.6 |
| 11 | $7.9 | $9.8 | $11.4 |
| 12 | $11.9 | $9.0 | $9.1 |
| 13 | $9.5 | $11.9 | $9.5 |
| 14 | $7.5 | $8.1 | $8.5 |
| 15 | $11.0 | $12.2 | $11.4 |

# Model Results and Application

Stochastic results will guide the formation of the metrics

- Provides a range of results (PVRR, carbon emissions, etc.) across all iterations

***ILLUSTRATIVE PURPOSES ONLY***



# Questions?

# Next Steps

Joan Soller, Director of Resource Planning

# Written comments and feedback

- Deadline to send written comments and questions regarding this meeting to ipl.irp@aes.com is Tuesday, August 23
- All IPL responses will be posted on the IPL IRP website by Tuesday, September 6

# Final 2016 IPL IRP Public Advisory Meeting

***Friday, September 16, 2016***

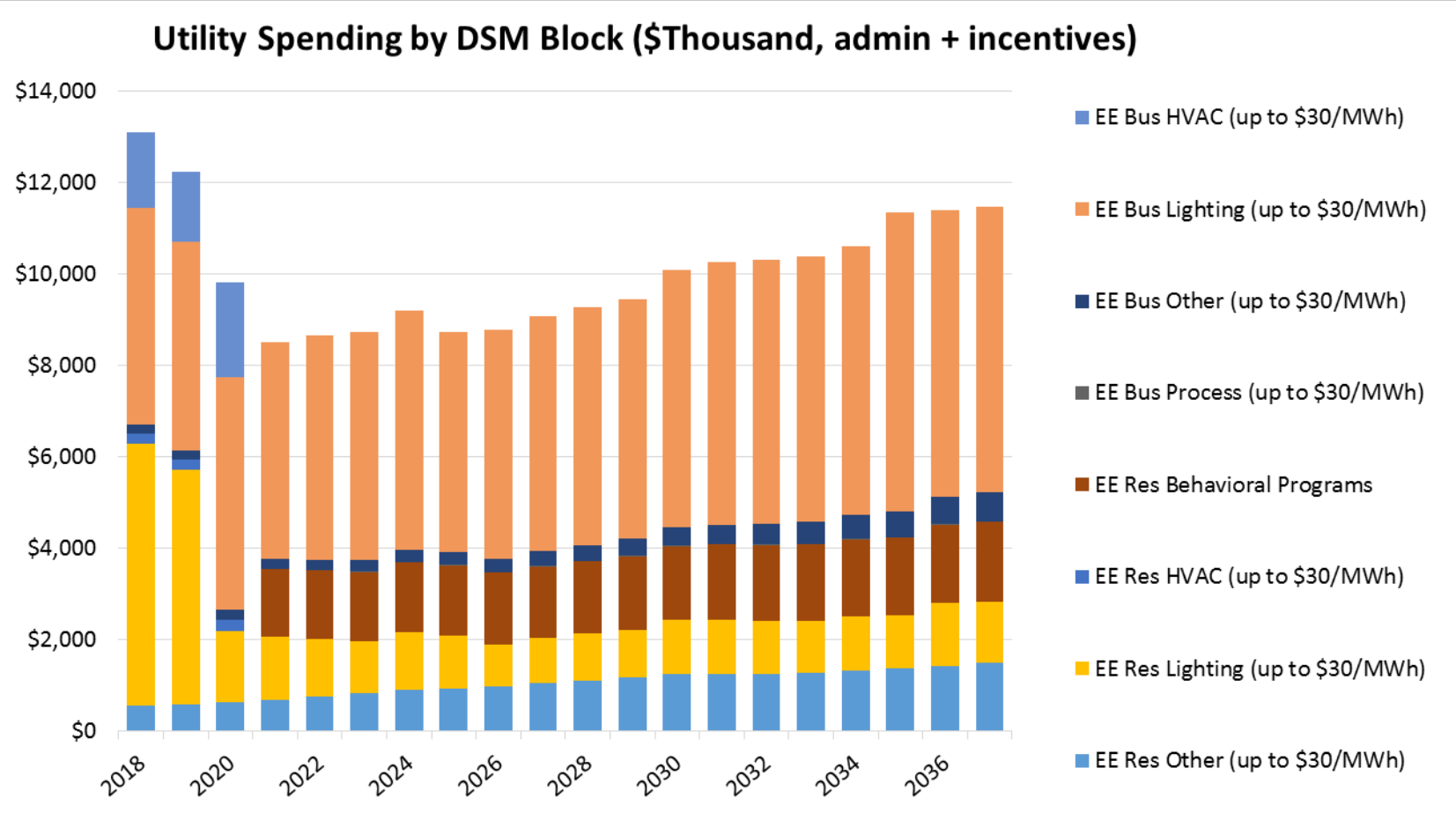
- Final model results
- Sensitivity analyses results
- Preferred Resource Plan
- Short-term Action Plan

# Thank you!

**We value your input and appreciate your participation. Please submit your feedback form and recycle your nametag at the registration table as you leave the meeting today.**

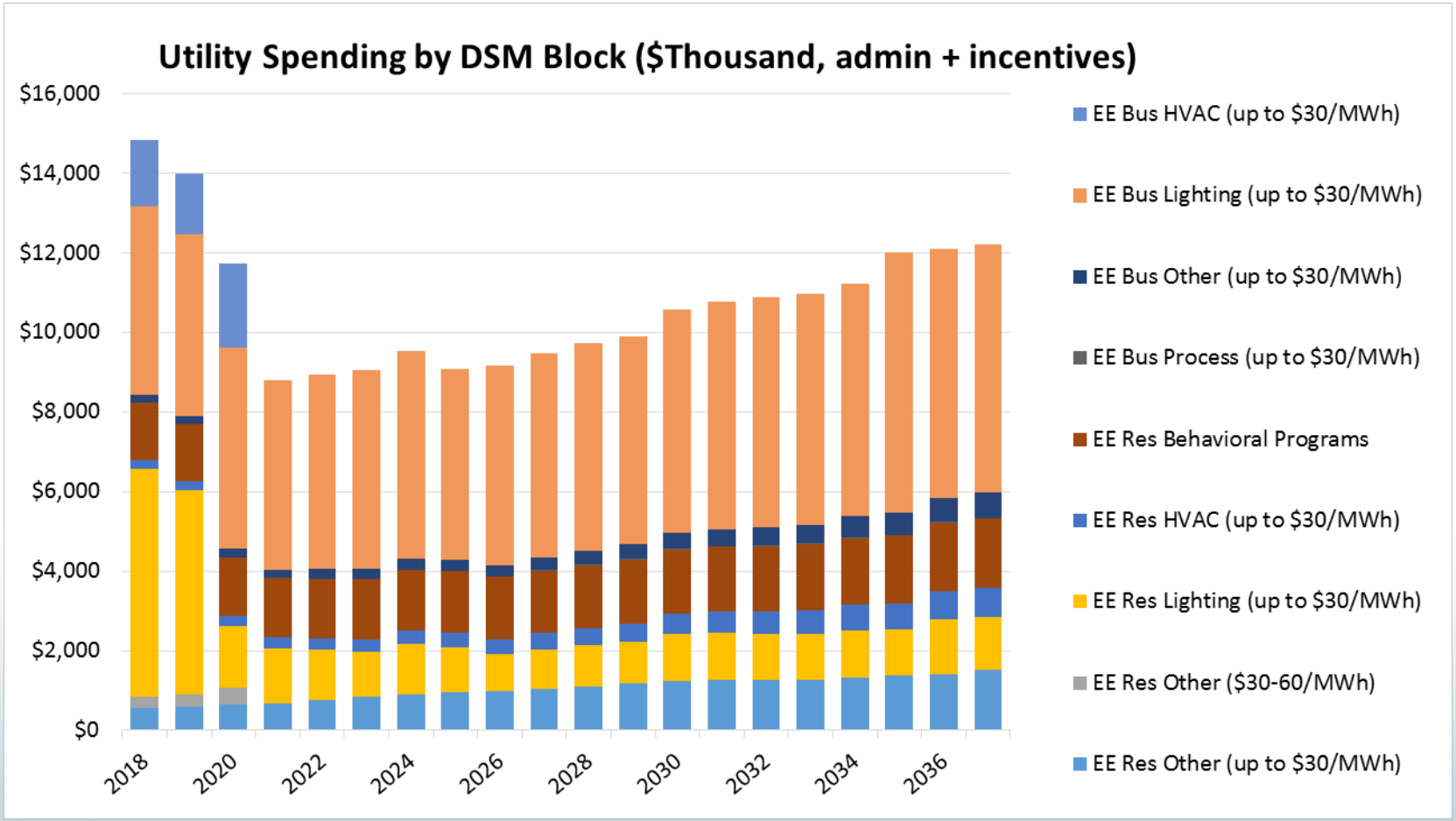
# APPENDIX – DSM DETAILS

# Base case



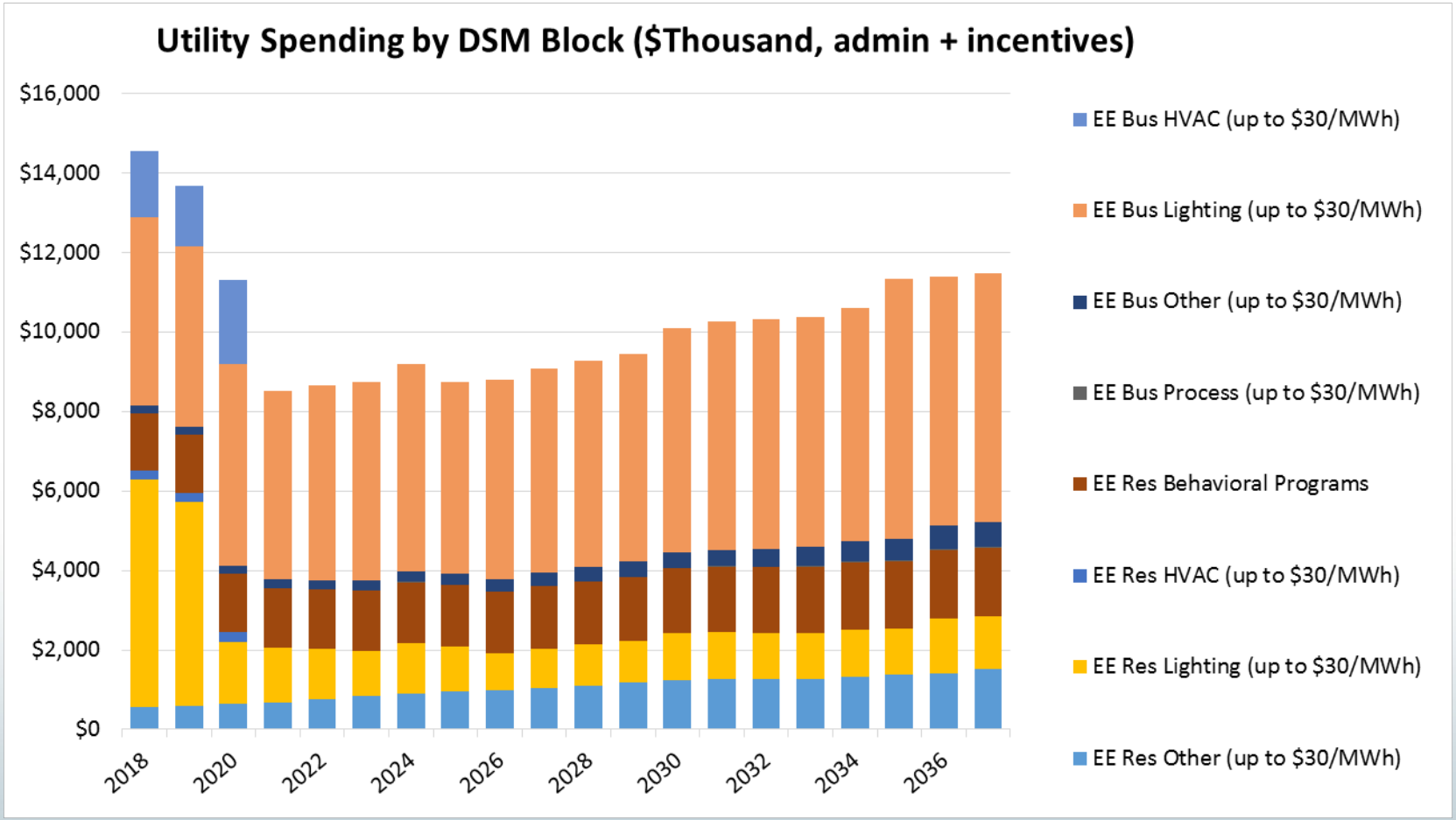

**in real $**

# Robust economy



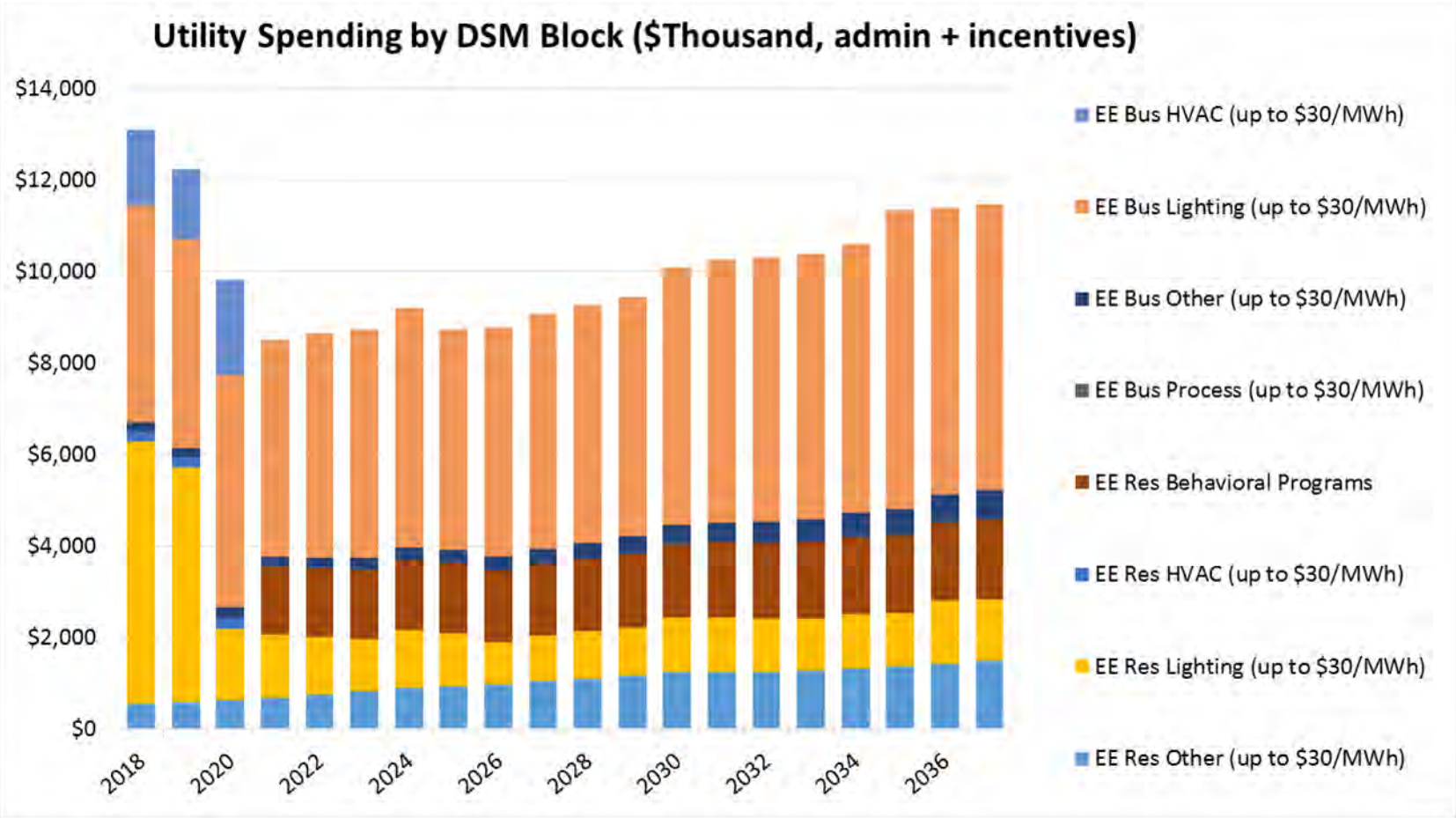

in real $

# Recession economy



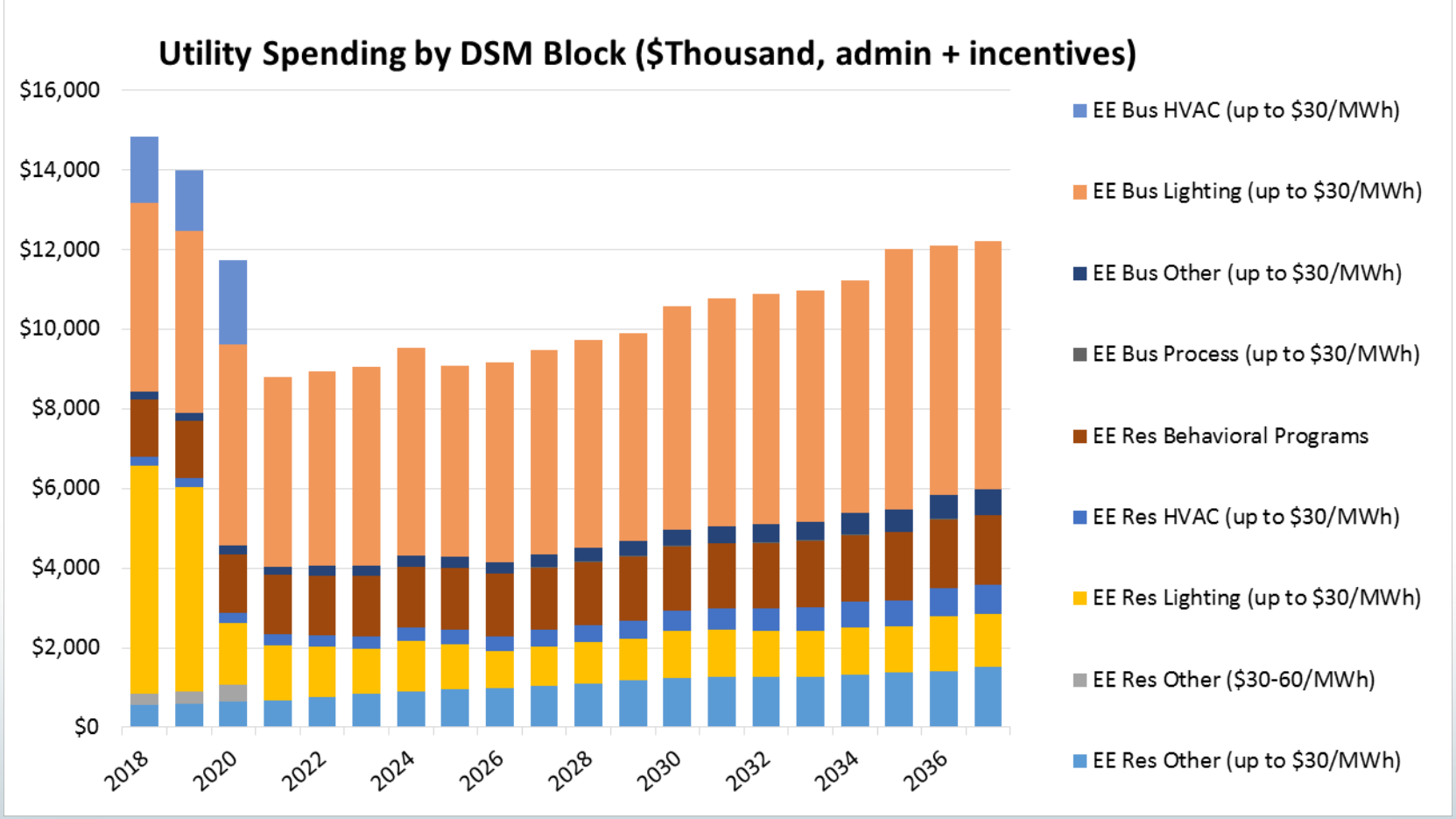

**in real $**

# Adoption of distributed generation



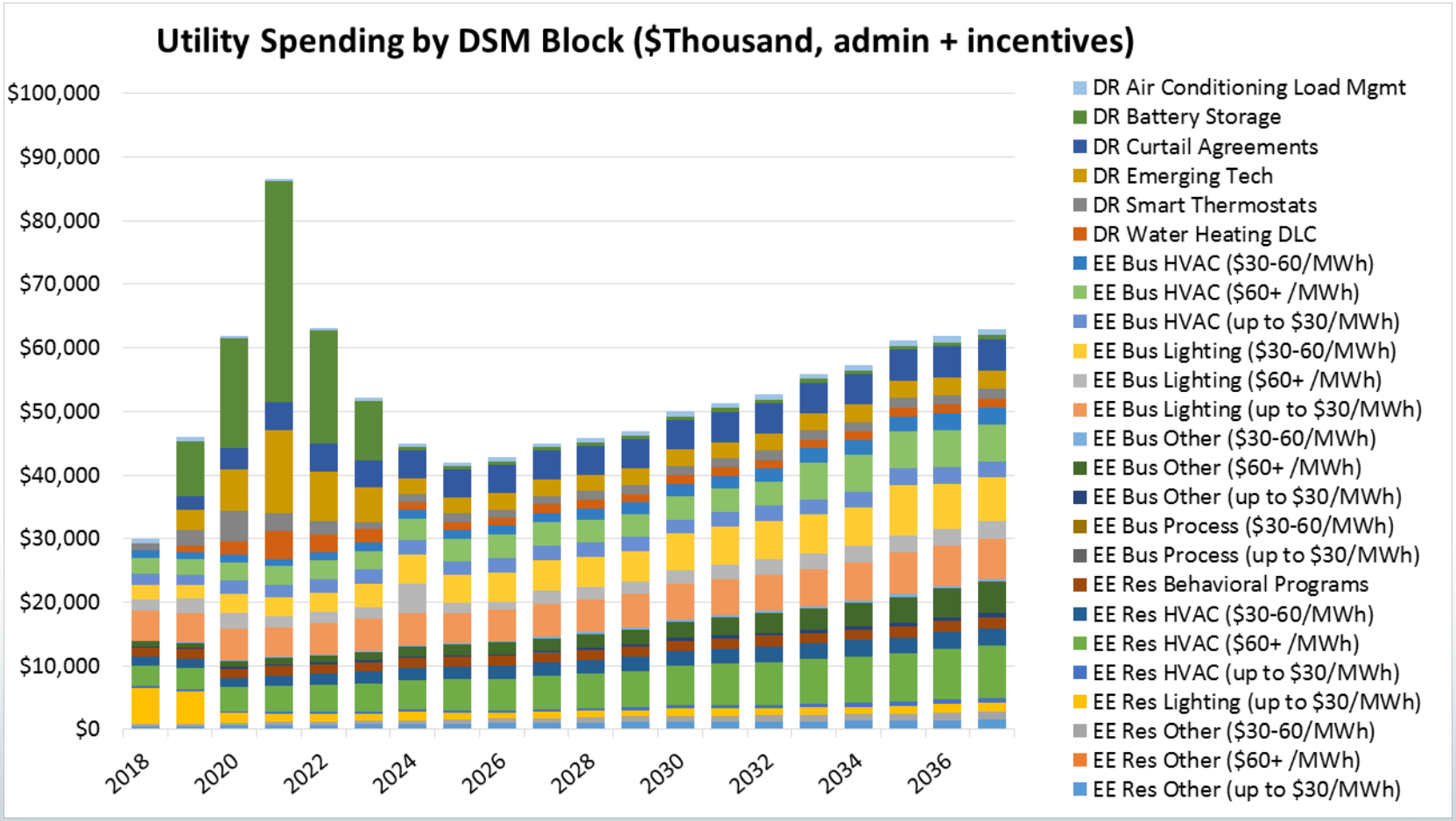

**in real $**

# Strengthened environmental




**in real $**

# Quick transition




**in real $**

# DSM building blocks selected

## (based upon maximum achievable)

| DSM Blocks Selected | Final Base Case | Robust Economy | Recession Economy | Strengthened Environmental | Distributed Generation |
|---|---|---|---|---|---|
| Res Other up to $30MWh 2018-2020 | X | X | X | X | X |
| Res Other $30-60MWh 2018-2020 | | X | | X | |
| Res Lighting up to $30MWh 2018-2020 | X | X | X | X | X |
| Res HVAC up to $30MWh 2018-2020 | X | X | X | X | X |
| Res Behavioral Program 2018-2020 | | X | X | X | |
| Bus Other up to $30MWh 2018-2020 | X | X | X | X | X |
| Bus Lighting up to $30MWh 2018-2020 | X | X | X | X | X |
| Bus HVAC up to $30MWh 2018-2020 | X | X | X | X | X |
| Res Other up to $30MWh 2021+ | X | X | X | X | X |
| Res Lighting up to $30MWh 2021+ | X | X | X | X | X |
| Res HVAC up to $30MWh 2021+ | | X | | X | |
| Res Behavioral Programs 2021+ | X | X | X | X | X |
| Bus Process up to $30MWh 2021+ | X | X | X | X | X |
| Bus Other up to $30MWh 2021+ | X | X | X | X | X |
| Bus Lighting up to $30MWh 2021+ | X | X | X | X | X |

# Quick Transition DSM

| DSM Blocks | 2018-2020 | 2021-2037 |
|---|---|---|
| EE Res Other (up to $30/MWh) | X | X |
| EE Res Other ($60+ /MWh) | X | X |
| EE Res Other ($30-60/MWh) | X | X |
| EE Res Lighting (up to $30/MWh) | X | X |
| EE Res HVAC (up to $30/MWh) | X | X |
| EE Res HVAC ($60+ /MWh) | X | X |
| EE Res HVAC ($30-60/MWh) | X | X |
| EE Res Behavioral Programs | X | X |
| EE Bus Process (up to $30/MWh) | X | X |
| EE Bus Process ($30-60/MWh) | X | X |
| EE Bus Other (up to $30/MWh) | X | X |
| EE Bus Other ($60+ /MWh) | X | X |
| EE Bus Other ($30-60/MWh) | X | X |
| EE Bus Lighting (up to $30/MWh) | X | X |
| EE Bus Lighting ($60+ /MWh) | X | X |
| EE Bus Lighting ($30-60/MWh) | X | X |
| EE Bus HVAC (up to $30/MWh) | X | X |
| EE Bus HVAC ($60+ /MWh) | X | X |
| EE Bus HVAC ($30-60/MWh) | X | X |
| DR Water Heating DLC | X | X |
| DR Smart Thermostats | X | X |
| DR Emerging Tech | X | X |
| DR Curtail Agreements | X | X |
| DR Battery Storage | X | X |
| DR Air Conditioning Load Mgmt | X | X |

ADDED 9-6-16

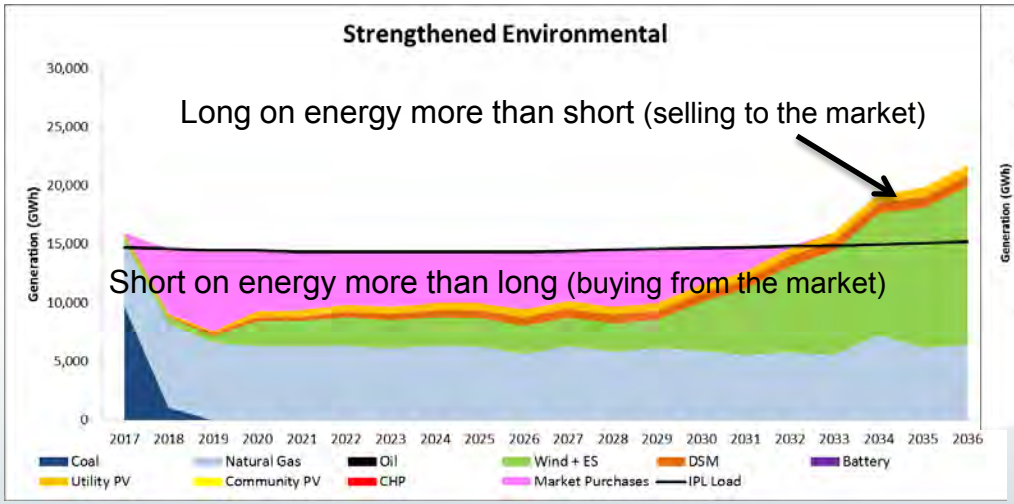
# APPENDIX II–
# ENERGY MIX BY SCENARIO

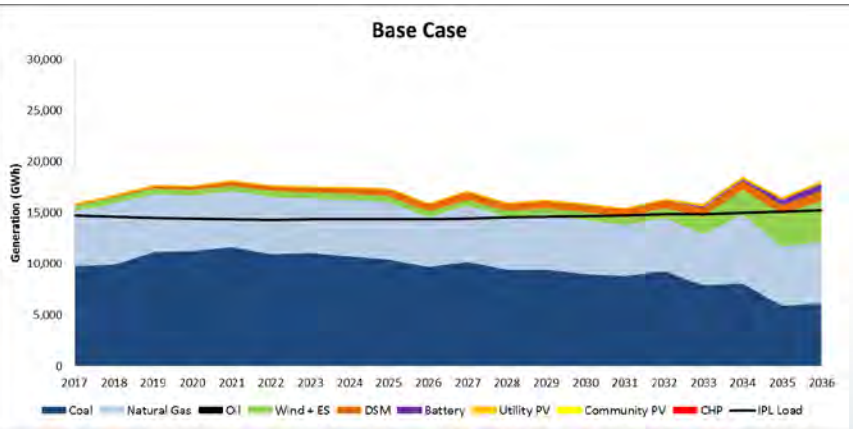
**ADDED 9-6-16**
**Will be discussed at the 9-16-16 meeting**

# How to Read Energy Mix Slides

- "Long"= more generation in a single hour than load
  "Short"= more load in a single hour than generation
- IPL is long and short throughout the year at different times

***These graphs will be shared again and discussed at the final public advisory meeting.***

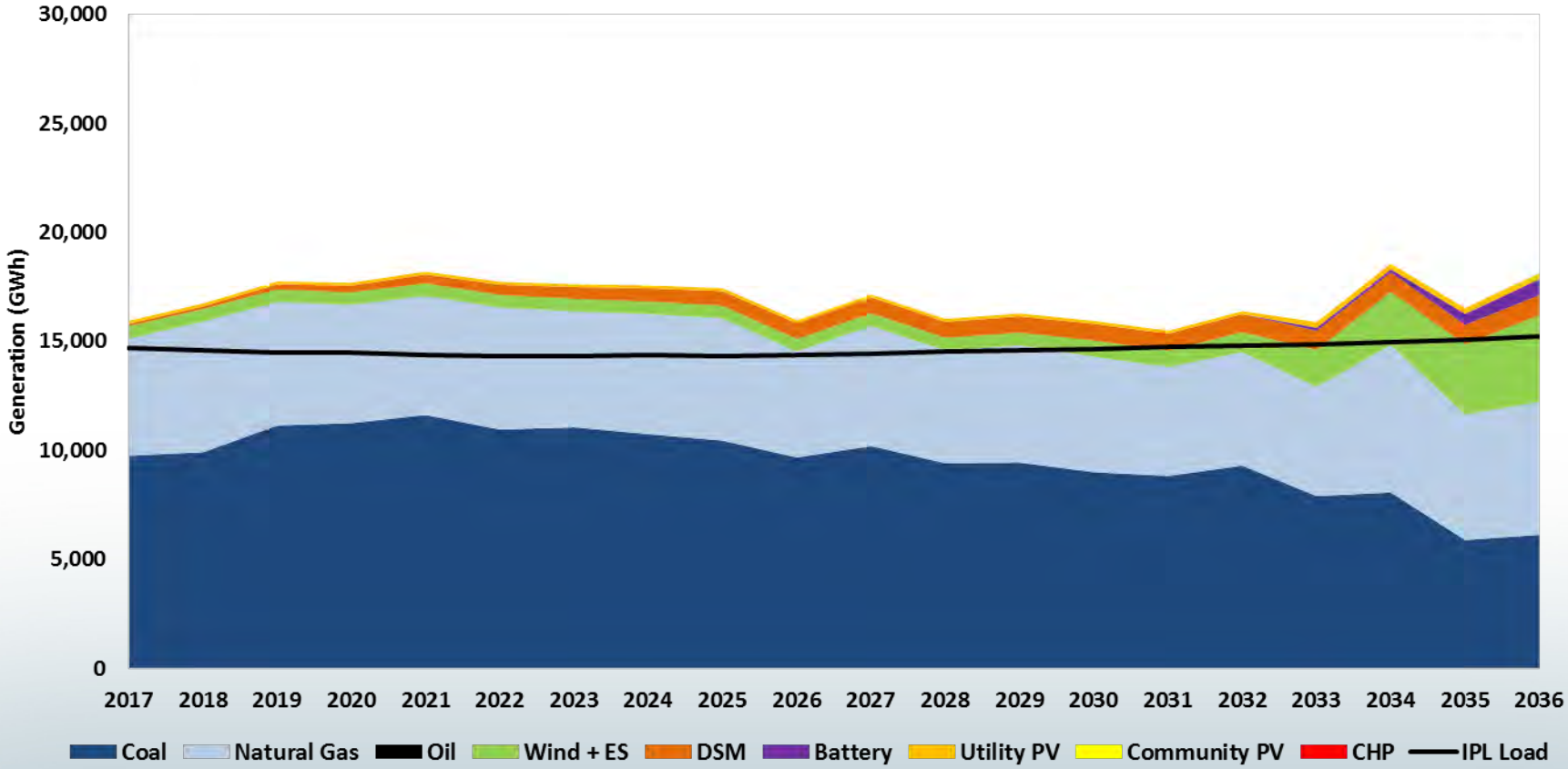



- Based on the nature of dispatching units, IPL will still buy and sell from the market in the base case

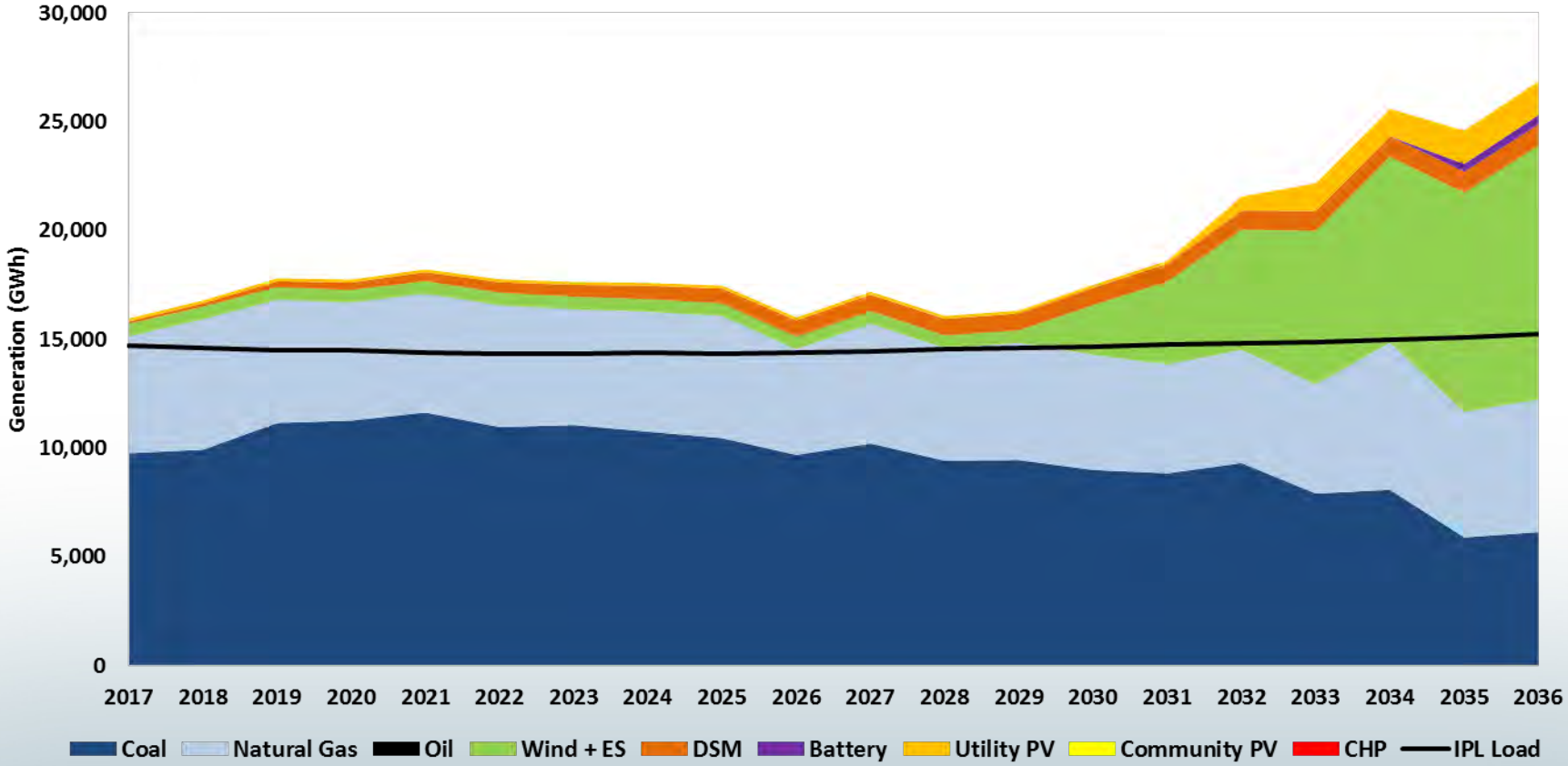
**ADDED 9-6-16**
**Will be discussed at the 9-16-16 meeting**

# Base Case Energy



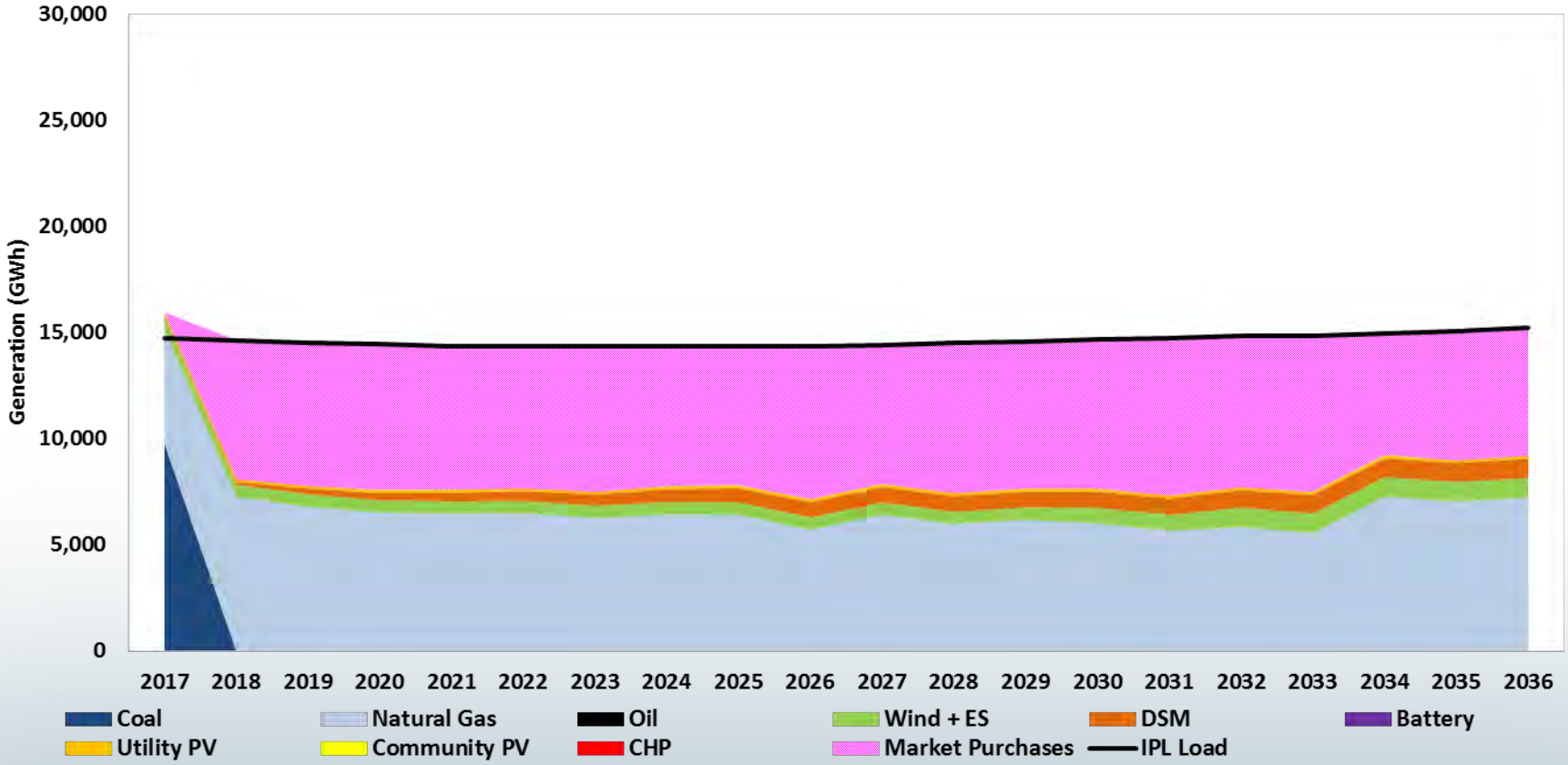
**ADDED 9-6-16**
**Will be discussed at the 9-16-16 meeting**

# Robust Economy Energy



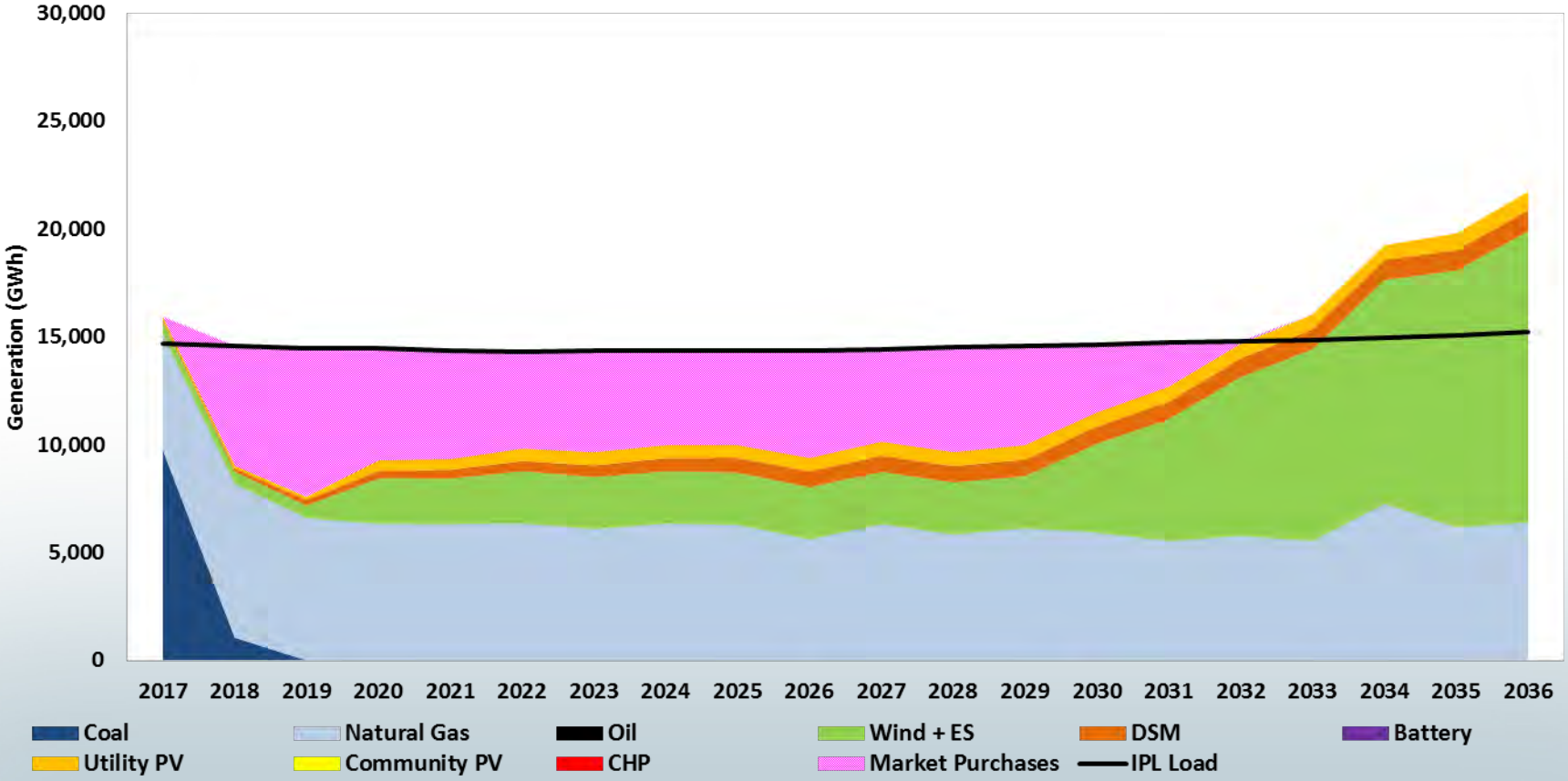
**ADDED 9-6-16**
**Will be discussed at the 9-16-16 meeting**

# Recession Economy Energy



**ADDED 9-6-16**
**Will be discussed at the 9-16-16 meeting**

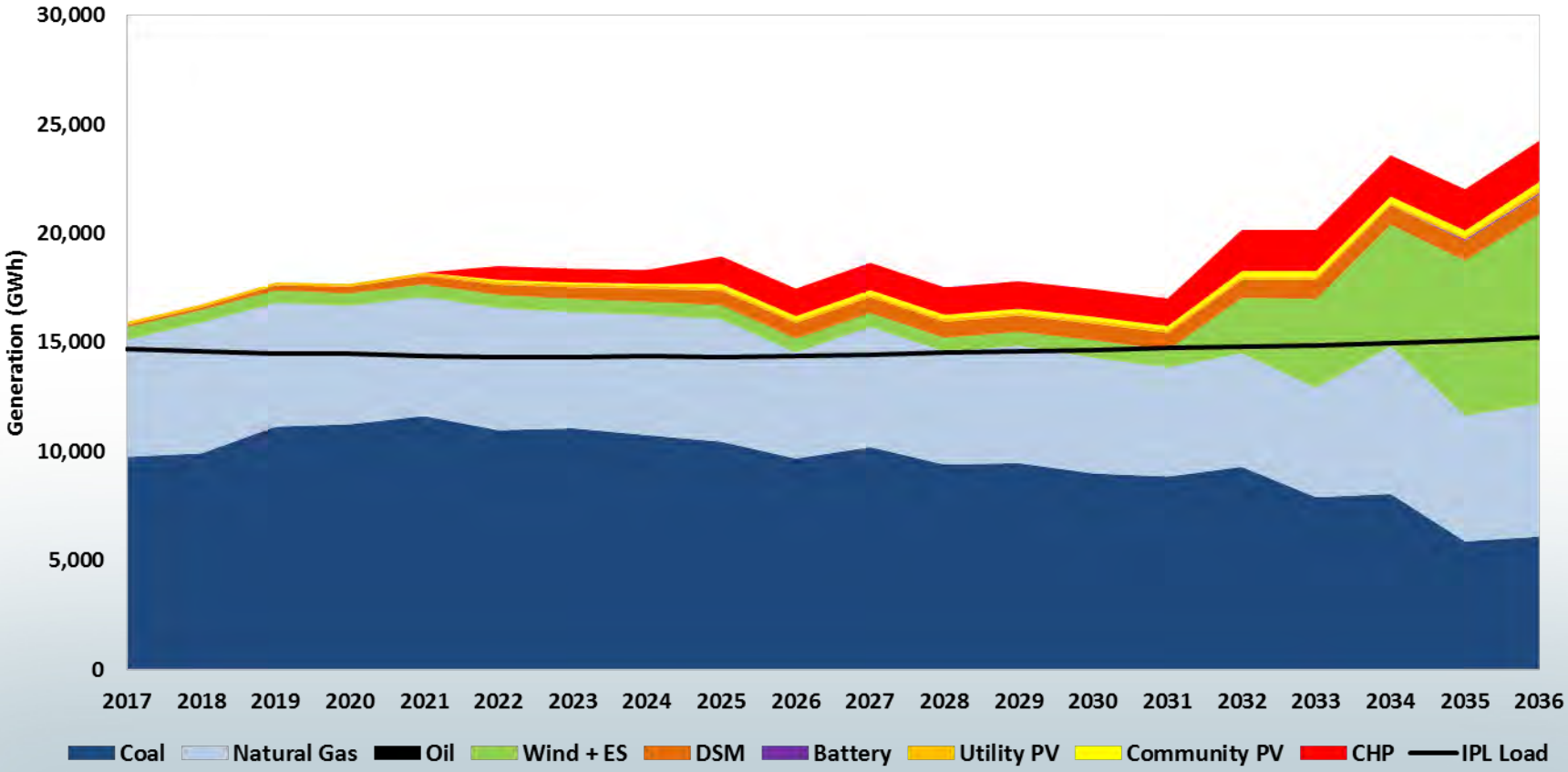
# Strengthened Environmental Energy



ADDED 9-6-16

Will be discussed at the 9-16-16 meeting

# High Customer Adoption of DG Energy



ADDED 9-6-16

Will be discussed at the 9-16-16 meeting

# Final Quick Transition Energy